# Evaluating the AD4113, 4-/8-Channel, 125kSPS, 16-Bit, Sigma Delta ADC with ±10V Inputs, Open-Wire Detection

## FEATURES

- Fully-featured evaluation board for the AD4113
- PC control in conjunction with the system demonstration platform (EVAL-SDP-CK1Z)
- PC software control and data analysis
- Standalone capability

## EVALUATION KIT CONTENTS

- EVAL-AD4113ARDZ evaluation board

## DOCUMENTS NEEDED

- AD4113 data sheet

## EQUIPMENT NEEDED

- EVAL-AD4113ARDZ evaluation board
- EVAL-SDP-CK1Z
- DC signal source
- PC running Windows® with a USB 2.0 port and the evaluation tool installed

## SOFTWARE NEEDED

- AD4113 Analysis | Control | Evaluation (ACE) Software

## GENERAL DESCRIPTION

The EVAL-AD4113ARDZ is a fully-featured evaluation board that can be used to evaluate all the features of the AD4113. The AD4113 is a 16-bit, 125kSPS analog-to-digital converter (ADC) with a ±10V input voltage range with eight single-ended or four differential channels. All channels have on-board overvoltage protection.

The EVAL-AD4113ARDZ board includes voltage references and power and data insulation and can be connected to EVAL-SDP-CK1Z system demonstration platform. The SDP board provides the connection to a PC via a universal serial bus (USB) port and can provide power to the EVAL-AD4113ARDZ board from the PC USB port. The ACE software configures the AD4113 device functionality and provides DC time domain analysis in the form of waveform graphs, histograms, and associated noise analysis for ADC performance evaluation.

Full specifications on the AD4113 are available in the AD4113 data sheet available from Analog Devices, Inc., and must be consulted with this user guide when using the EVAL-AD4113ARDZ evaluation board.

## EVAL-AD4113ARDZ PHOTOGRAPH

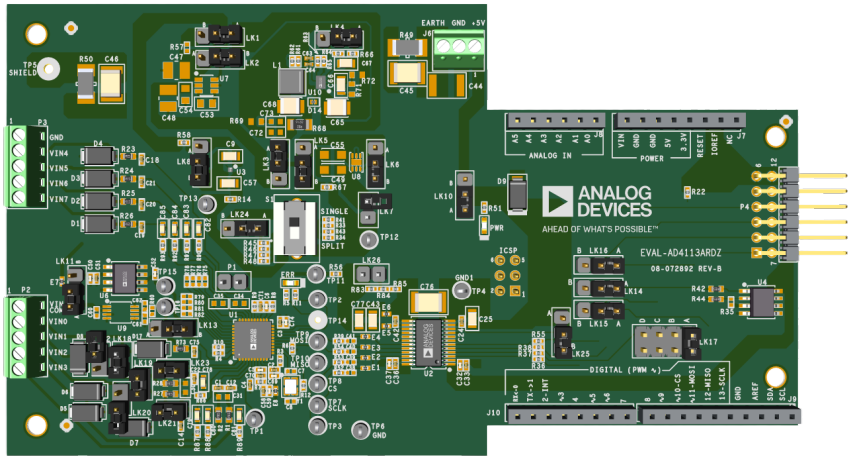



*Figure 1. EVAL-AD4113ARDZ Photograph*



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## REVISION HISTORY

**4/2026—Revision 0: Initial Version**



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## EVAL-AD4113ARDZ EVALUATION BOARD BLOCK DIAGRAM

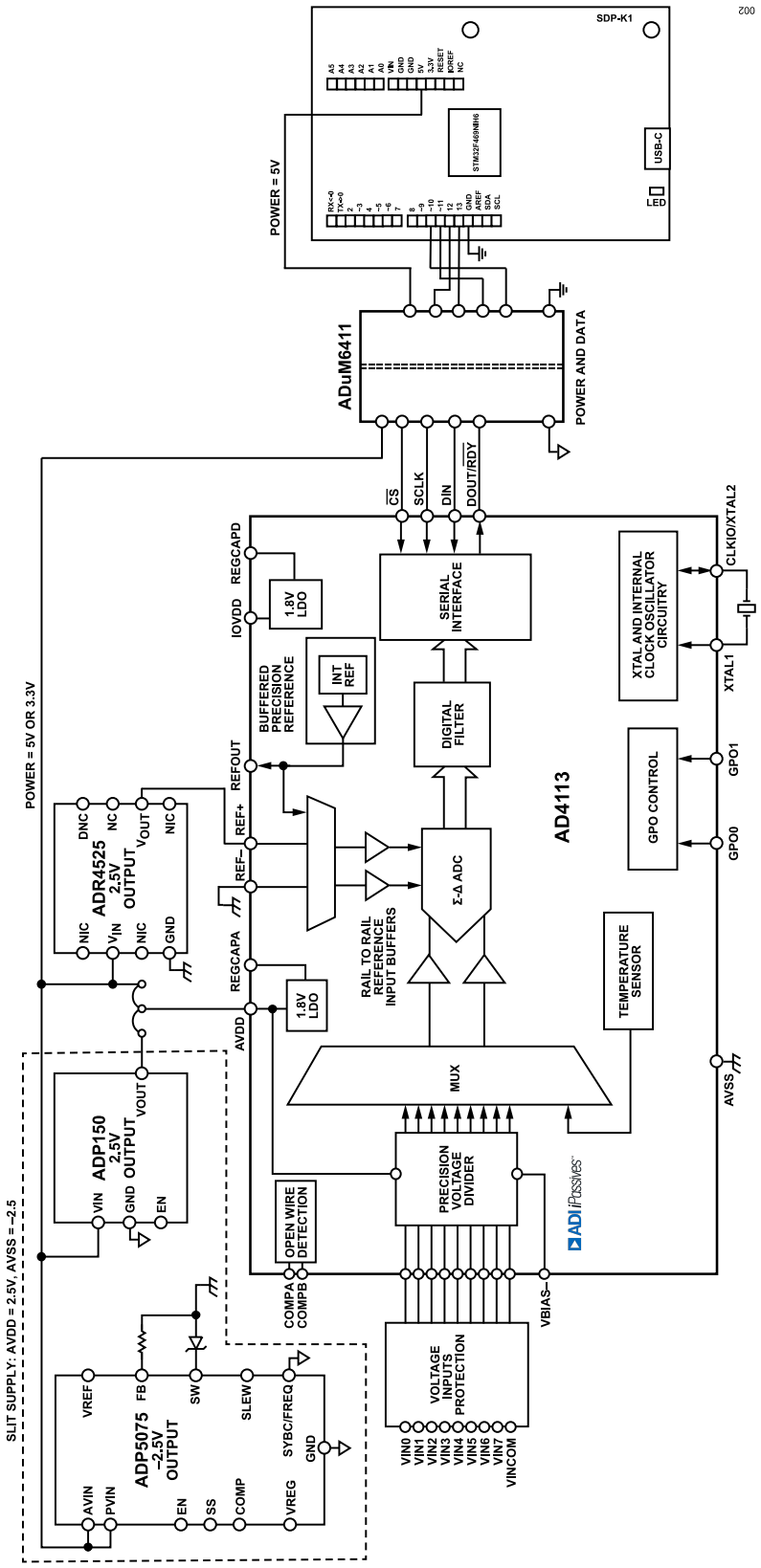



*Figure 2. EVAL-AD4113ARDZ Evaluation Board Block Diagram*



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## EVALUATION BOARD QUICK START PROCEDURE

To set up the evaluation board, do the following steps:

1. Disconnect the EVAL-SDP-CK1Z board from the USB port of the PC. Install the ACE Software. Restart the PC after installation.
2. Connect the EVAL-SDP-CK1Z board to the EVAL-AD4113ARDZ evaluation board.
3. Connect the SDP board to the PC via the USB cable. For Windows XP, it may be necessary to search for the SDP drivers. Choose to automatically search for the drivers for the SDP board if prompted by the operating system.
4. Launch the ACE Software.

### QUICK START MEASUREMENT

To quick start measurement, do the following steps:

1. Connect the DC signal source to the selected voltage input (for example, VIN0 and VIN1 for differential input).
2. Launch the ACE Software and select the AD4113 board.
3. Double-click the AD4113 chip, then click **Proceed to Waveform Analysis**.
4. To capture and measure the data, in the **Waveform Analysis** tab, click **Run Once**.

The sample count in the top left area of the **Waveform Analysis** tab sets the number of samples collected in each batch.

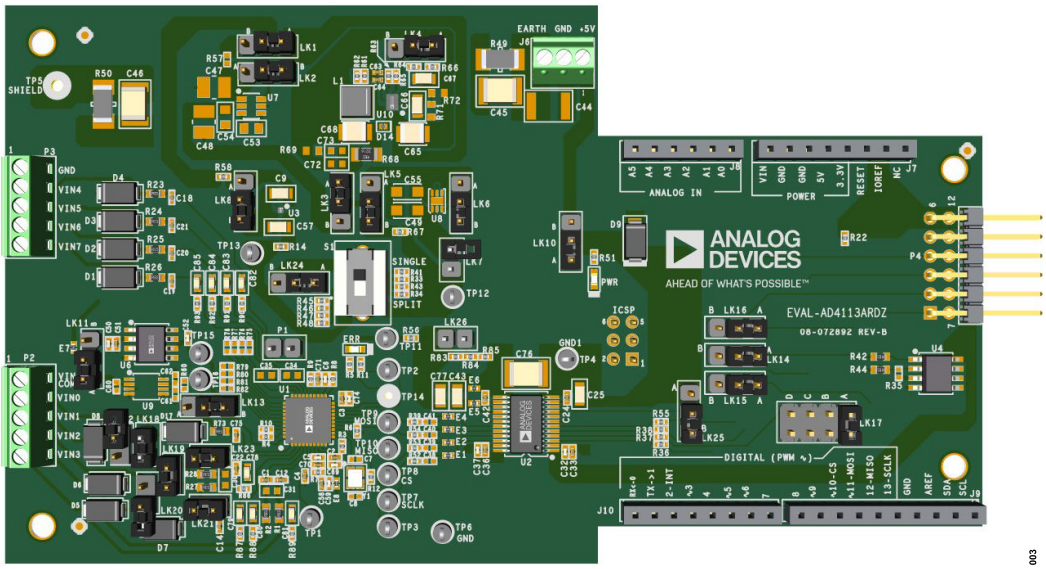



*Figure 3. EVAL-AD4113ARDZ*



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## EVALUATION BOARD HARDWARE

### DEVICE DESCRIPTION

The AD4113 is a highly accurate, high resolution, multiplexed, Σ-Δ ADC with eight single-ended or four differential voltage inputs. The maximum channel-to-channel scan rate is 24.845kSPS (40.25µs) for fully settled data. The output data rates range from 2.5SPS to 125kSPS. The device includes integrated analog reference buffers, an integrated precision 2.5V reference, and an integrated oscillator. For the complete specifications, refer to the AD4113 data sheet. Full details on the EVAL-AD4113ARDZ evaluation board are available on the product web page.

### SETUP PROCEDURES

After following the instructions in the Software Installation Procedures section, setup the EVAL-AD4113ARDZ evaluation and the EVAL-SDP-CK1Z boards, as detailed in this section.

The ACE Software and drivers must be installed before connecting the EVAL-AD4113ARDZ evaluation and the EVAL-SDP-CK1Z boards to the USB port of the PC to ensure that the PC correctly recognizes the evaluation system.

### Configuring the EVAL-AD4113ARDZ Evaluation and EVAL-SDP-CK1Z Boards

To configure the boards, do the following steps:

1. Connect the EVAL-SDP-CK1Z to the Arduino headers of the EVAL-AD4113ARDZ evaluation board.
2. Ensure that LK10 is in Position A (USB).
3. Connect the EVAL-SDP-CK1Z board to the PC using the USB cable.

After following the instructions in the Software Installation Procedures section, setup the EVAL-AD4113ARDZ evaluation and the EVAL-SDP-CK1Z boards, as detailed in this section.

### HARDWARE LINK OPTIONS

For the default link options, see Table 1. By default, the board is powered from the EVAL-SDP-CK1Z board via LK10 (Position A). The ADuM6411 output is set to 5V by default.

***Table 1. Default Link Options***

| Link | Default Position | Description |
|---|---|---|
| LK1 | A | Selects which inverter to use.<br>**Position A:** ADP5075 is used as inverter.<br>**Position B:** LTC1983 is used as inverter. |
| LK2 | B | Enables the LTC1983 (U7) LDO for split supply. $V_{OUT}$ of U7 is $V_{IN}$ for ADP7182.<br>**Position A:** U7 $V_{OUT}$ = −3V.<br>**Position B:** LTC1983 is in shutdown mode.<br>Note that the LTC1983 and ADP7182 are DNI. |
| LK3 | A | Selects between LTC1983 or ADP5075 output.<br>**Position A:** ADP5075_VOUT.<br>**Position B:** LTC1983_VOUT. |
| LK4 | A | Used for setting ADP5075_VOUT.<br>**Position A:** ADP5075_VOUT = −2.5V, set to bypass LDO (U8) only.<br>**Position B:** ADP5075_VOUT = −3V. |
| LK5 | B | Option to bypass or connect to LDO (U8).<br>**Position A:** Connects to LDO.<br>**Position B:** Bypass LDO.<br>Note that do not bypass LDO (U8) when using LTC1983 for split supply configuration. |
| LK6 | B | Enables/disables the ADP7182 LDO (U8) for split supply configuration.<br>**Position A:** ADP7182 $V_{OUT}$ = −2.5V.<br>**Position B:** ADP7182 is in shutdown mode. |
| LK7 | Removed | Disconnect if LDO (U8) is bypassed. |
| LK8 | B | Enables/disables the ADP150 (U3) LDO for split supply configuration.<br>**Position A:** ADP150 $V_{OUT}$ = 2.5V.<br>**Position B:** ADP150 is in shutdown mode. |
| LK10 | A | Selects the power supply voltage.<br>**Position A:** Board is powered from USB through the Arduino connector.<br>**Position B:** Board is powered from external DC power supply connector. |
| LK11 | B | Selects which external reference to be used.<br>**Position A:** LTC6655 is used as a reference. |



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## EVALUATION BOARD HARDWARE

*Table 1. Default Link Options (Continued)*

| Link | Default Position | Description |
|---|---|---|
| | | **Position B:** ADR4525 is used as a reference. |
| | | Note that the LTC6655 is DNI. |
| LK13 | B | Connects the selected external reference to REF+ pin. |
| | | **Position A:** LTC6655 output connects to REF+ pin. |
| | | **Position B:** ADR4525 output connects to REF+ pin. |
| | | Note that the LTC6655 is DNI. |
| LK14, LK15, LK16 | A | Selects which Arduino SPI Lines to connect. |
| | | **Position A:** Standard Arduino Headers. |
| | | **Position B:** Alternate IFCSP Header. |
| LK17 | A | **Position A:** Selects CS_ARD_1. |
| | | **Position B:** Selects CS_ARD_2. |
| | | **Position C:** Selects CS_ARD_3. |
| | | **Position D:** Selects CS_ARD_4. |
| LK18 | Inserted | Connects VINCOM to GND_ISO. This configuration is typical for single-ended measurement. |
| LK19 | Inserted | Shorts VIN0 and VIN1 for noise test configuration. |
| LK20, LK22 | Removed | Connects VIN0 and VIN1 to the Zener diode, D7, and D8, respectively, to evaluate the voltage inputs of the AD4113 directly by removing external components. |
| LK21, LK23 | Inserted | Bypasses R27 and R28 on VIN0 and VIN1, respectively. By inserting this link, the resistor is removed from the input path and AD4113 can be evaluated directly. |
| LK24 | A | Selects the IOVDD supply. |
| | | **Position A:** Connects IOVDD to SWD_AVDD = 5V in Single Supply. |
| | | **Position B:** Connects IOVDD to V_ISO = 3.3V in Split Supply. |
| | | Note that when in split supply configuration, ensure that LK26 is inserted for V_ISO = 3.3V. |
| LK25 | B | Used to shutdown ADuM6411 for isolation purposes only. |
| | | **Position A:** ADuM6411 is OFF or in shutdown mode. |
| | | **Position B:** ADuM6411 is ON. |
| LK26 | Removed | Selects the VISO_OUT supply. |
| | | **Inserted:** VISO_OUT = 3.3V. |
| | | **Removed:** VISO_OUT = 5V. |

*Table 2. Single Supply Links: AVDD = 5V, AVSS = 0V, IOVDD = 5V*

| Link | Position |
|---|---|
| LK1, LK3, LK4, LK10, LK14, LK15, LK16, LK17, LK24 | A |
| LK2, LK5, LK6, LK8, LK11, LK13, LK25 | B |
| LK7, LK20, LK22, LK26 | Removed |
| LK18, LK19, LK21, LK23 | Inserted |

*Table 3. Split Supply Links: AVDD = 2.5V, AVSS = −2.5V, IOVDD = 3.3V (ADP150 = 2.5V, ADP5075 = −2.5V)*

| Link | Position |
|---|---|
| LK1, LK3, LK4, LK8, LK10, LK14, LK15, LK16, LK17 | A |
| LK2, LK5, LK6, LK11, LK13, LK24, LK25 | B |
| LK7, LK20, LK22 | Removed |
| LK18, LK19, LK21, LK23, LK26 | Inserted |

*Table 4. Split Supply Links: AVDD = 2.5V, AVSS = −2.5V, IOVDD = 3.3V (ADP150 = 2.5V, LTC1983 = −3V, ADP7182 = −2.5V)*

| Link | Position |
|---|---|
| LK2, LK4, LK5, LK6, LK8, LK10, LK14, LK15, LK16, LK17 | A |
| LK1, LK3, LK11, LK13, LK24, LK25 | B |
| LK20, LK22 | Removed |



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## EVALUATION BOARD HARDWARE

*Table 4. Split Supply Links: AVDD = 2.5V, AVSS = −2.5V, IOVDD = 3.3V (ADP150 = 2.5V, LTC1983 = −3V, ADP7182 = −2.5V) (Continued)*

| Link | Position |
|---|---|
| LK7, LK18, LK19, LK21, LK23, LK26 | Inserted |

### ANALOG INPUTS

Eight voltage inputs are available on P2 and P3 (see Table 5). If a different common voltage must be set for a single-ended measurement, remove LK18 and connect the required voltage to VINCOM on P2.

### REFERENCE OPTIONS

The EVAL-AD4113ARDZ evaluation board includes an external 2.5V reference, the ADR4525 and LTC6655 (DNI). By default, LK11 and LK13 is on Position B, connecting the external reference, ADR4525, to the REF+ pin of the AD4113.

### POWER SUPPLIES

By default, the EVAL-AD4113ARDZ evaluation board is powered from the USB. The board can be also powered from the J6 connector (see Table 5) by setting LK10 to Position B. The ADuM6411 isoPower® digital isolator is used to isolate power and data lines.

*Table 5. Connector Details*

| Connector | Function | Connector Type |
|---|---|---|
| P1 | Connects to GPIOs of AD4113 | 2-pin header, 2.54mm pitch |
| P2, P3 | Voltage Inputs to AD4113 | Connector, header, 90°, 5-position, 2.54mm pitch |
| P4 | PMOD for Factor | 12-pin header, 2 |
| J6 | External Supply Voltage (Optional) | Connector, header, 90°, 3-position, 3.81mm pitch |
| J7 | Arduino Header (Power) | 8-position, receptacle connector, |
| J8 | Arduino Header (Analog) | 6-position receptacle connector, 2.54mm pitch |
| J9 | Arduino Header (Digital 1) | 10-position receptacle connector, 2.54mm pitch |
| J10 | Arduino Header (Digital 0) | 8-position receptacle connector, 2.54mm pitch |
| J11 | Arduino Header (IFCSP) | 6-position, 2 row, receptacle connector, 2.54mm pitch |



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## SERIAL INTERFACE

The EVAL-AD4113ARDZ evaluation board connects via the serial-peripheral interface (SPI) to the Blackfin® ADSP-BF527 on the EVAL-SDP-CK1Z board. There are four primary signals: $\overline{CS}$, SCLK, DIN, and DOUT/$\overline{RDY}$ (all are inputs except for DOUT/$\overline{RDY}$, which is an output).

The EVAL-AD4113ARDZ evaluation board connects to any micro-controller board that uses the Arduino standard headers. This can be developed user code in for a variety of platforms.

To operate the EVAL-AD4113ARDZ evaluation board in standalone mode, disconnect any board connected, and J9 (see Table 5) can be used to access all SPI signals and set the input/output voltage levels.



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## EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

### SOFTWARE INSTALLATION PROCEDURES

The EVAL-AD4113ARDZ evaluation kit includes a link to the software, and a user can install that before using the EVAL-AD4113ARDZ evaluation board.

The EVAL-AD4113ARDZ evaluation board software and drivers must be installed before connecting both the evaluation board and the EVAL-SDP-CK1Z board to the PC. This ensures that the evaluation system is correctly recognized when it is connected to the PC.

#### Installing the ACE Software

To install the ACE Software, do the following steps:

1. With the EVAL-SDP-CK1Z board disconnected from the USB port of the PC, download the ACE evaluation software package to start the ACE evaluation software installation.
2. Click ***Download ACE Installer***.
3. Run the installer and follow the instructions to complete the software installation process.

During the installation process, make sure to select the **Precision Converter Components** check box when prompted and select the **LibIIO Wrapper** check box to ensure that all necessary software components are installed (see Figure 4).

The **LibIIO Wrapper** must be installed for ACE to detect the connected hardware. To install the **LibIIO Wrapper** after the ACE installation, click the **Help** button in the main ACE window. In the **ACE Help** panel that appears, expand the **Application Resources** section, and a link to run a local copy of the **LibIIO Wrapper Installer** appears.

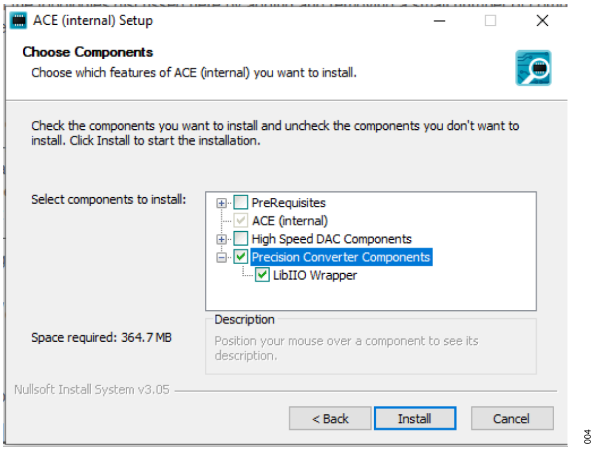



*Figure 4. Select Precision Converter Components during ACE Installation*

When the following prompt appears, make sure to select **LibIIO** and **LibIIODrivers** check boxes, then click **Install**, as shown in Figure 5.

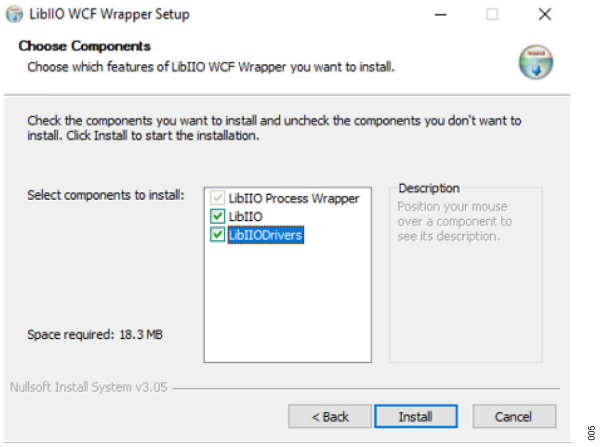



*Figure 5. Select LibIIO Components during ACE Installation*

### HARDWARE SETUP

When the ACE evaluation software installation is complete, do the following steps to set up the EVAL-SDP-CK1Z and EVAL-AD4113ARDZ evaluation board together:

1. Connect the EVAL-SDP-CK1Z and EVAL-AD4113ARDZ evaluation board using the Arduino headers.
2. Connect the power supplies configuration.
3. Connect the USB cable to the EVAL-SDP-CK1Z.
4. Open the ACE Software.

### SOFTWARE OPERATION

To start the ACE evaluation software, from the Windows Start menu, click Analog Devices > ACE. The software window opens (see Figure 6) until the software recognizes the AD4113 evaluation board. When the software recognizes the board, double-click on the icon in the **Start** view to open the main window, as shown in Figure 6. Make sure to check the AD411x plug-in in the **Plug-in Manager**.

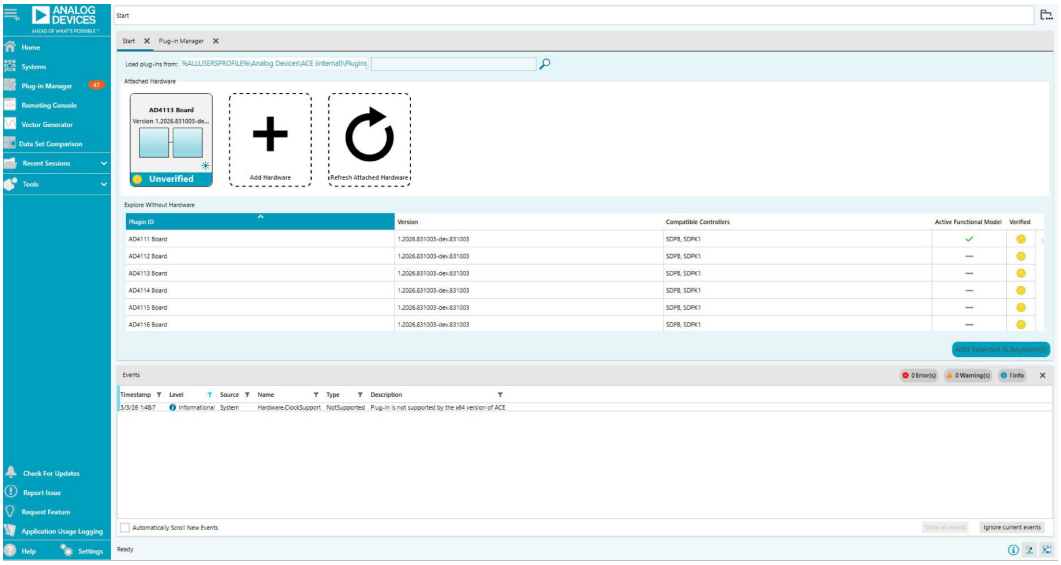
By clicking on the part in the main ACE evaluation software window (see Figure 7), the Chip view appears, as shown in Figure 8.

The Chip view shows the block diagram of the AD4113. This tab allows the user to select inputs, set up the ADC, reset the ADC, and view errors present, as well as configure the device for different demonstration modes. Figure 8 shows the Chip view in detail, and the following sections discuss the different elements on the Chip view of the software window.



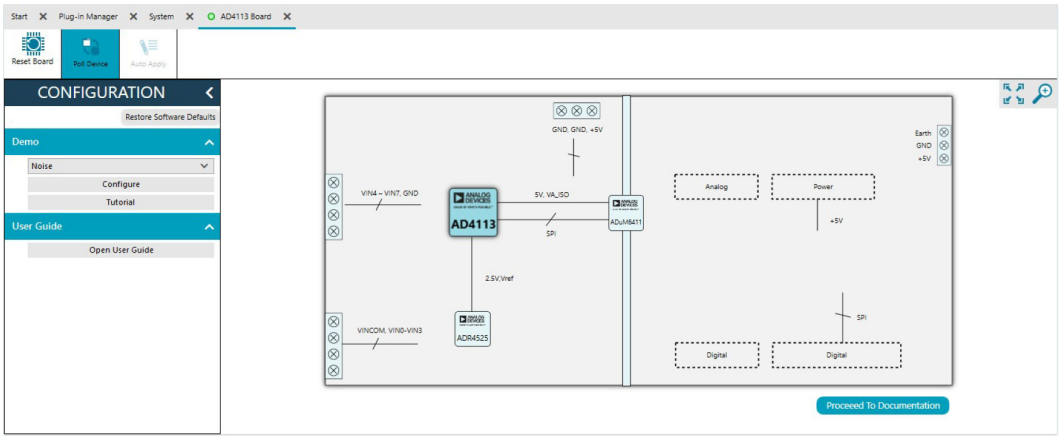
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## EVALUATION BOARD SOFTWARE QUICK START PROCEDURES




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*Figure 6. ACE Interface Window*




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*Figure 7. Evaluation Board View*



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## EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

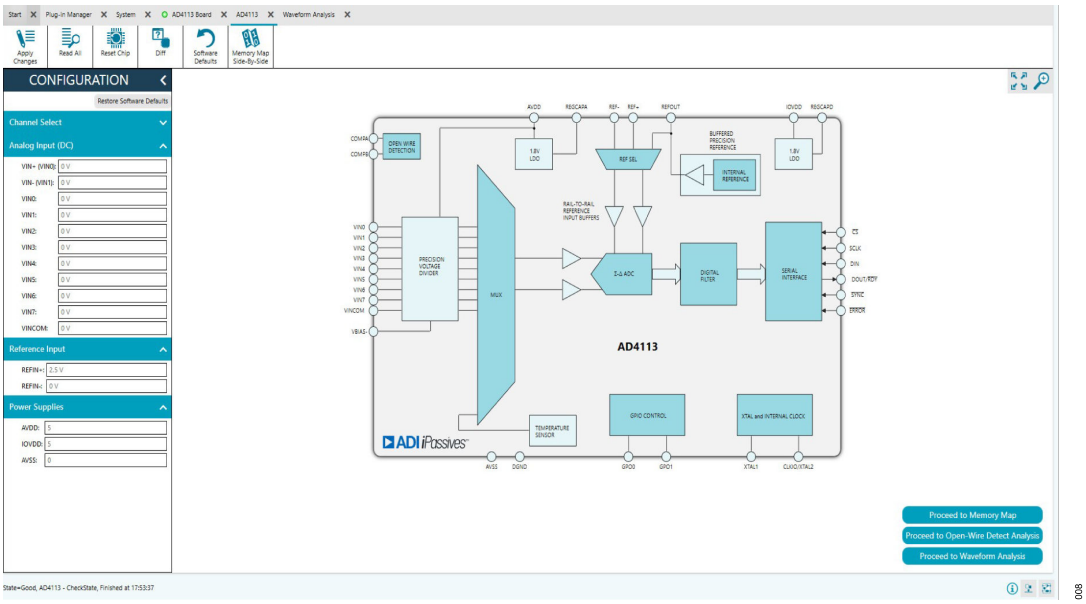



*Figure 8. Chip View*

### Configuration Tab

The **Configuration** tab is same as the Chip view. It shows a block diagram of the AD4113. This tab allows the user to select inputs, setup the ADC, reset the ADC, and view errors present, as well as configure the device.

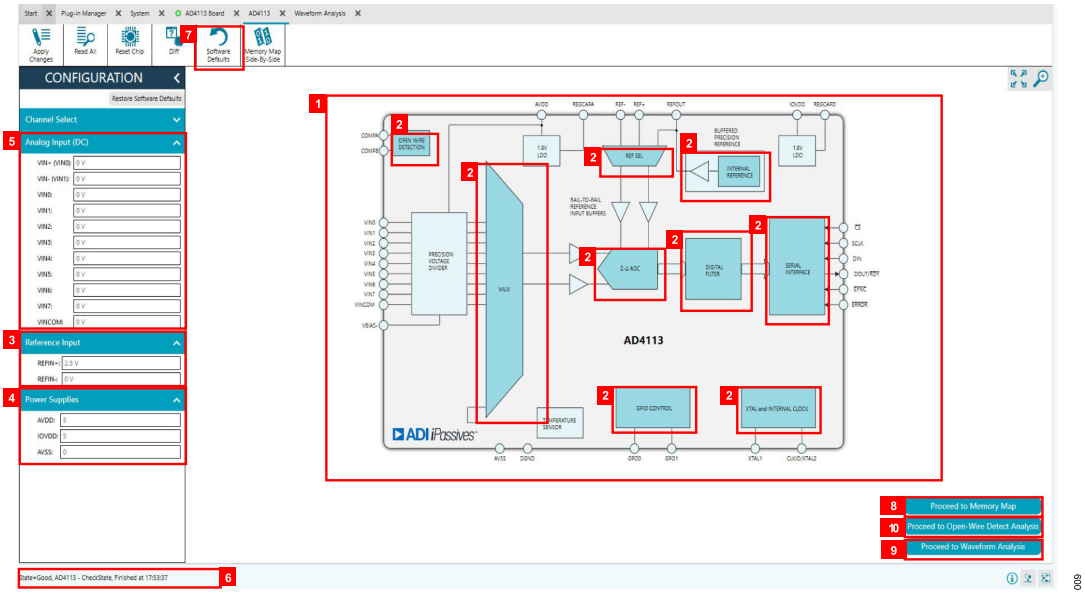



*Figure 9. Chip View/Configuration Tab*



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## EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

### Functional Block Diagram

The functional block diagram of the AD4113 (Label 1 in Figure 9) shows each of the functional blocks within the AD4113. Clicking a functional block on this diagram opens the configuration pop-up window for that block.

### Configuration Pop-Up Button

Each block has a pop-up window (Label 2 in Figure 9), which opens a different window to configure the relevant block.

### External Parameters

There are three external parameters that are set by the EVAL-AD4113ARDZ evaluation board but must be entered into the software: the external reference (**Reference Input**, Label 3 in Figure 9), **AVDD**, and **AVSS** (**Power Supplies**, Label 4 in Figure 9). The external reference on the EVAL-AD4113ARDZ evaluation board is set to 2.5V by using the ADR4525. If using a different external reference voltage, change the value in the software to ensure correct calculation of results in the **Waveform** and **Histogram** tabs in the Waveform Analysis window. The **Analog Input (DC)** (Label 5 in Figure 9) is used in setting the analog inputs when using the integrated active functional model.

### Status Bar

The status bar (Label 6 in Figure 9) shows status updates.

### Reset

Click Reset (**Software Defaults**, Label 7 in Figure 9) to perform a software reset of the AD4113. There is no hardware reset pin on the AD4113. To perform a hard reset, remove power from the board. The software reset has the same effect as a hard reset.

### Proceed to Memory Map Button

Opens the **Memory Map** tab (Label 8 in Figure 9).

### Proceed to Waveform Analysis Button

Opens the **Waveform** tab (Label 9 in Figure 9).

### Proceed to Open-Wire Detect Analysis Button

Opens the **Open-Wire Detect Analysis** tab (Label 10 in Figure 9).

### Waveform Tab

The **Waveform** tab shown in Figure 10 shows the different waveforms for voltage input, and select the channel. The **Waveform** tab graphs the conversions gathered and processes the data, calculating the peak-to-peak noise, rms noise, and resolution.




*Figure 10. Waveform Tab*



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## EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

### Waveform Graph and Controls

The data waveform graph (Label 11 in Figure 10) shows each sample of the ADC output. Zoom in on the data in the graph using the control toolbar (Label 12 in Figure 10). Change the scales on the graph by typing values into the x-axis and y-axis fields.

### Samples

The samples numeric control (**Sample Count**, Label 13 in Figure 10) set the number of samples gathered per batch.

### Input Range

Sets the input range of the ADC (**Channel 0 Applied Range**, Label 14 in Figure 10). This setting affects the **Effective Resolution**, and **Peak-to-peak Resolution** results (**Results - Resolution** tab, Label 18 in Figure 10) which are calculated with reference to the used input range.

### Run

Click **Run Once** or **Run Continuously** (Label 15 in Figure 10) to start gathering ADC results. If a user clicks **Run Once**, the ADC returns the number of samples specified by the samples control. If a user clicks **Run Continuously**, the ADC continuously returns samples until stopped by the user. Samples specifies the amounts of samples to be shown on the data graph. This control is unrelated to the ADC mode. Results appear in the waveform graph (Label 11 in Figure 10).

### Plot Selection

The plot selection control (Label 16 in Figure 10 ) selects which channel to display on the data waveform graph and shows the channel number next to the on and off controls. These controls only affect the channel displayed on the waveform graphs and have no effect on the channel settings in the ADC register map.

### Display Units and Axis Controls

Click the units drop-down box (Label 17 in Figure 10 ) to select whether the data graph displays in units of voltage or code.

### RESULTS Pane

The RESULTS pane (Label 18 in Figure 10 ) shows parametric values for the selected display format. The bottom of **RESULTS** pane also has buttons that allow the user to import or export sample data.

### Histogram Tab

The **Histogram** tab shown in Figure 11 generates a histogram using the gathered samples and processes the data, calculating the peak-to-peak noise, rms noise, and resolution (**RESULTS**, Label 19 in Figure 11).

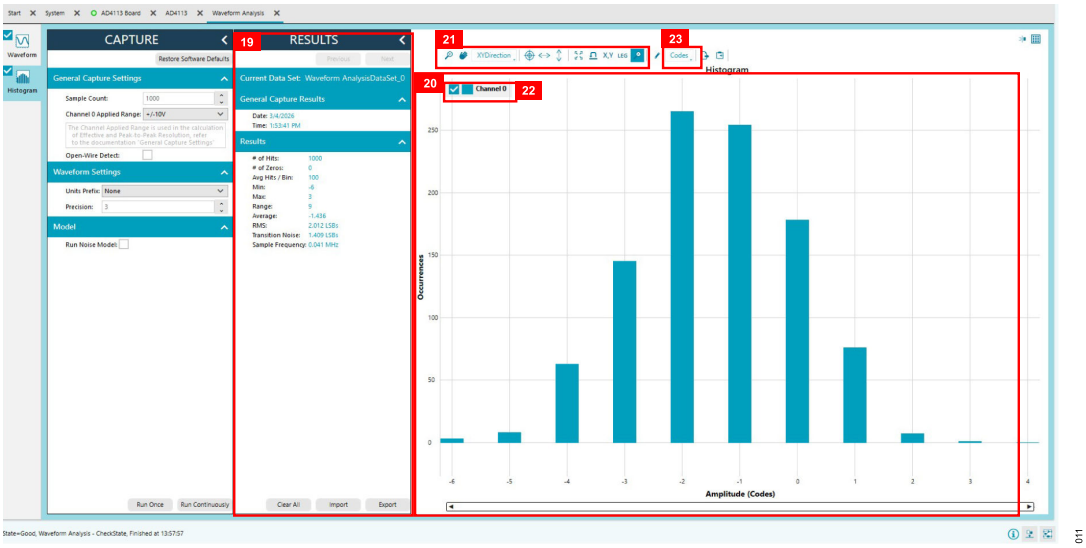



*Figure 11. Histogram Tab*



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## EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

### Histogram Graph and Controls

The data histogram graph (Label 20 in Figure 11) shows the number of times each sample of the ADC output occurs. Zoom in on the data using the control toolbar (Label 21 in Figure 11) in the graph.

### Plot Selection

The plot selection control (Label 22 in Figure 11) selects which channel display on the data waveform and shows the name of the channel number next to the on and off controls. These controls only affect the histogram graphs and have no effect on the channel settings in the ADC register map.

### Display Units and Axis Controls

Click the units drop-down box (Label 23 in Figure 11) to select whether the data graph displays in units of voltage or code.

### Memory Map

The memory map shown in Figure 12 allows the user to configure the different register settings of the AD4113.

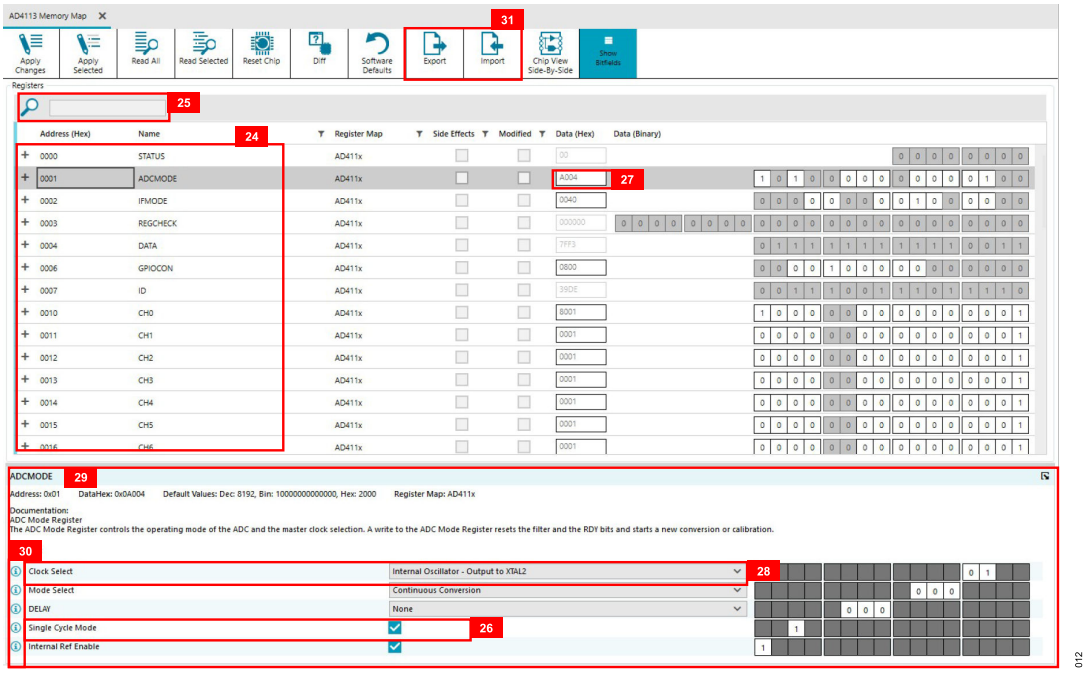



*Figure 12. Memory Map*

### Register Tree

The register maps nested list (Label 24 in Figure 12) shows the full register map in a tree control. Each register is shown. Clicking the expand button next to each register shows all the bit fields contained within that register.

### Register Tree Search

The register tree search box (**Registers**, Label 25 in Figure 12) allows the user to search the tree for any register or bit field. Enter a value into this field to filter the register tree.

### Register and Bit Field Control

The register and bit field control section (Label 26 in Figure 12) allows the user to change the individual bit of the register selected in the register tree by clicking the bits or by programming the register value directly into the number control field (Label 27 in Figure 12). This control also shows all bit fields for the selected register. Change the values by using a drop-down box (Label 28 in Figure 12) or by selecting or clearing a check box.

### Documentation

The bit field **Documentation** (Label 29 in Figure 12) contains the documentation for the register or the bit field selected. This field can be updated by selecting a register or bit field in the register tree or hovering over the register or bit field in the register tree or register control. This documentation appears by the button (Label 30 in Figure 12).



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## EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

### Open-Wire Detect Analysis Tab

The AD4113 has an open-wire detection feature. The open-wire detection feature is supported in user software. ACE includes a demo mode that configures the device and enables its open-wire detection feature. An open wire on an input is detected by comparing the absolute difference between the two channels associated with an input to a threshold. The suggested threshold is 300mV input. If the difference is greater than this threshold, an open wire is flagged by the software.

### Open-Wire Channel Pairs

For open-wire detection to properly function, the voltage inputs must be assigned two channels per measurement. Voltage inputs must also be assigned to specific channel pairs to ensure that open-wire detection measurements work correctly. For the correct channel pairings for single-ended and differential input, refer to the AD4113 data sheet. The enabled channels are shown in the **General Capture Settings** (Label 32 in Figure 13).

### Results

The **Results - Open-Wire Detect** tab (Label 33 in Figure 13) shows the conversion on Channel A and Channel B and its delta. When the delta of the two channels exceeds the threshold voltage, the ACE flags an open wire.

### Open-Wire Detect Graph

The waveform graph (Label 34 in Figure 13) shows the conversion for Channel A and Channel B based on the set **Sample Count** value.

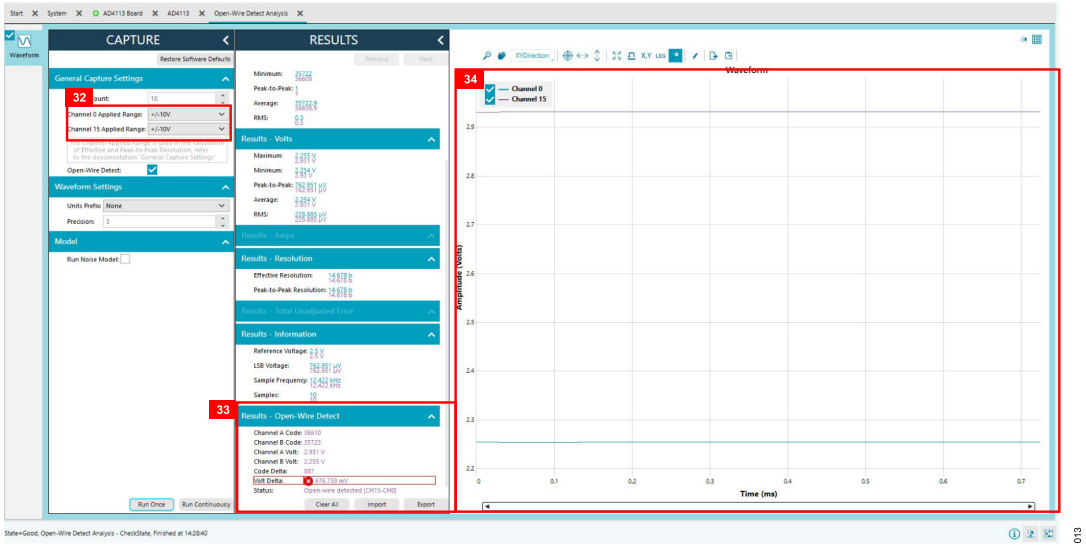



*Figure 13. Open-Wire Detection Analysis Tab*



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## NOTES



**ESD Caution**
**ESD (electrostatic discharge) sensitive device**. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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