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## Evaluating the **AD7616** 16-Channel DAS with 16-Bit, Bipolar Input, Dual Simultaneous Sampling ADC

### FEATURES

- Full featured evaluation board for the **AD7616**
- On-board power supplies
- Standalone capability
- High speed system demonstration platform (SDP-B) controller board-compatible
- PC software for control and data analysis

### EVALUATION KIT CONTENTS

- EVAL-AD7616SDZ** evaluation board
- DC wall wart

### ADDITIONAL EQUIPMENT NEEDED

- EVAL-SDP-CB1Z**; includes a USB cable
- Signal source
- PC running Windows XP SP3, Windows Vista, or Windows 7 with a USB 2.0 port

### ONLINE RESOURCES

- AD7616** data sheet
- EVAL-AD7616SDZ** user guide
- AD7616** evaluation software

### GENERAL DESCRIPTION

The **EVAL-AD7616SDZ** is a full featured evaluation board designed to easily evaluate all features of the **AD7616** analog-to-digital converter (ADC). The evaluation board can be controlled by the **EVAL-SDP-CB1Z** via the 120-way SDP connector (J10). The **EVAL-SDP-CB1Z** SDP-B board controls the evaluation board through a USB port of a PC using the evaluation board software, which is available for download from the **AD7616** product page.

Complete specifications for the **AD7616** device are provided in the **AD7616** data sheet and should be consulted in conjunction with this user guide when using the evaluation board. Full details on the **EVAL-SDP-CB1Z** are available on the SDP-B product page.

Table 1. **EVAL-AD7616SDZ** On-Board Components

Component	Description
<b>ADP7118</b>	Low noise low-dropout regulator (LDO)
<b>ADP7104ARDZ-5.0</b>	5 V low noise LDO
<b>ADR421</b>	Ultraprecision, low noise, 2.5 V XFET® voltage reference

### TYPICAL SETUP OF THE **EVAL-AD7616SDZ**

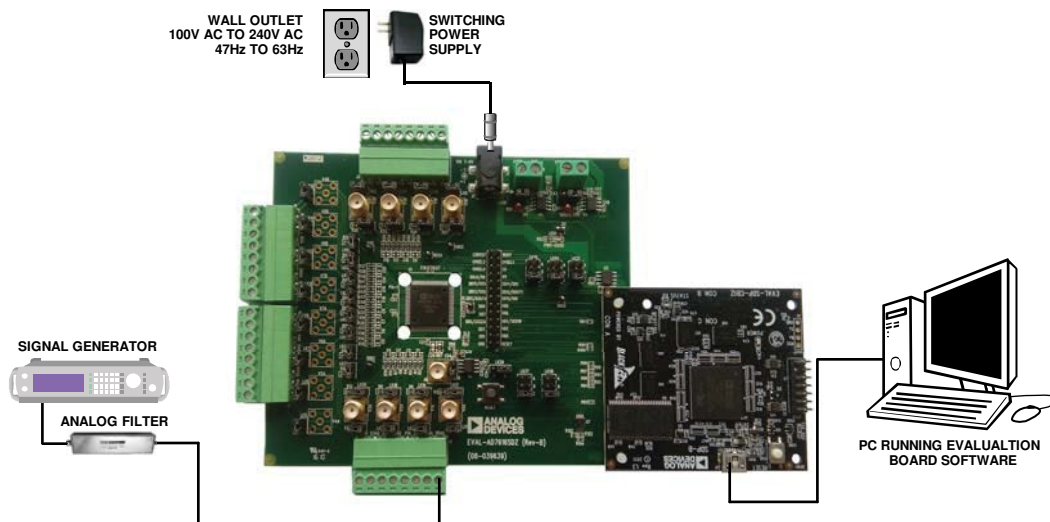


Figure 1. Typical Setup of the **EVAL-AD7616SDZ** (Left) and the **EVAL-SDP-CB1Z** (Right)

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**REVISION HISTORY**

**10/2016—Revision 0: Initial Version**

## QUICK START GUIDE

Follow these steps to evaluate the [AD7616](#) ADC:

1. Download and install the [AD7616](#) evaluation software, available on the [AD7616](#) product page. Ensure the [EVAL-SDP-CB1Z](#) board is disconnected from the USB port of the PC while installing the software. The PC may need to be restarted after the installation.
2. Ensure the various link options are configured as outlined in Table 3.
3. Connect the [EVAL-SDP-CB1Z](#) board to the evaluation board, shown in Figure 2.
4. Connect the [EVAL-SDP-CB1Z](#) board to the PC via the USB cable. For Windows® XP, search for the [EVAL-SDP-CB1Z](#) drivers. Choose to automatically search for the drivers for the [EVAL-SDP-CB1Z](#) board if prompted by the operating system.
5. Power up the [EVAL-AD7616SDZ](#) by inserting the 7 V to 9 V dc barrel jack, included in the evaluation kit, into the 7 V to 9 V dc barrel connector, labeled J7.
6. Launch the [AD7616](#) evaluation software from the **Analog Devices** subfolder in the **All Programs** menu.
7. Connect an input signal via the V0A connector.

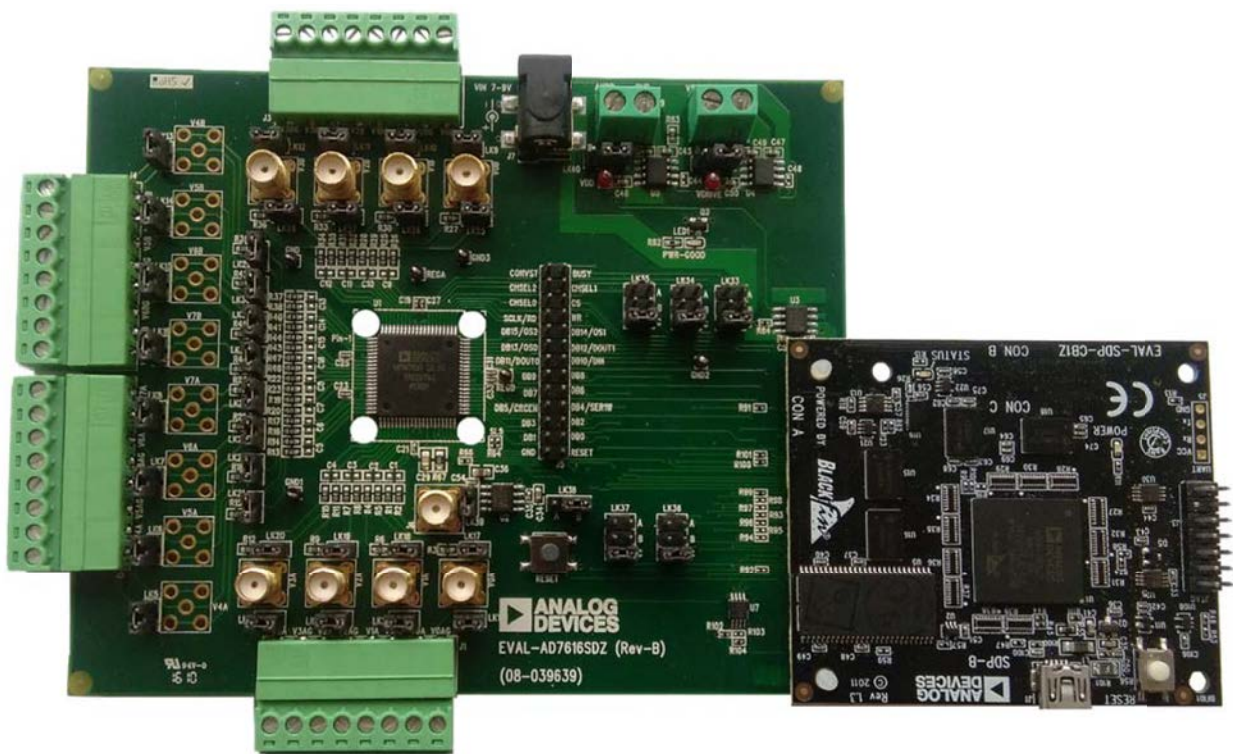


Figure 2. [EVAL-AD7616SDZ](#) Evaluation Board (Left) Connected to the [EVAL-SDP-CB1Z](#) Board (Right)

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## EVALUATION BOARD HARDWARE

### AD7616 DESCRIPTION

This user guide describes the evaluation board for the **AD7616** dual, simultaneous sampling ADC. The **AD7616** is a 16-channel, 16-bit, bipolar input ADC with independently selectable channel input ranges. The **AD7616** operates from a single 5 V analog power supply with a 2.3 V to 3.6 V  $V_{DRIVE}$ . The device features analog input clamp protection, a high impedance analog input, a first-order antialiasing filter, and an on-chip accurate reference. The **AD7616** can achieve throughput rates up to 1 MSPS per channel pair with 90.5 dB signal-to-noise ratio (SNR). The **AD7616** features oversampling capability with a digital filter which can achieve 92 dB SNR for an oversampling ratio of 2. The device also features a flexible channel sequencer with burst mode.

The **AD7616** has a flexible parallel/serial interface that is SPI-/QSPI-/MICROWIRE™-/DSP-compatible. It also features optional cyclical redundancy check (CRC). The **AD7616** comes in an 80-lead LQFP package.

The **AD7616** is ideally suited to applications such as power-line monitoring, multiphase motor control, instrumentation and control systems, and data acquisition systems (DAS).

### POWER SUPPLIES

Take care before applying power and signals to the **EVAL-AD7616SDZ** to ensure that all link positions are set according to the required operating mode. See Table 3 for the complete list of link options.

The **EVAL-AD7616SDZ** is supplied by an included 7 V to 9 V wall wart or separate  $V_{DRIVE}$  and  $V_{CC}$  supplies can be supplied to the **AD7616** via the J8 and J9 connectors, respectively.

### INPUT SIGNALS

The analog input range to the **AD7616** is independently selectable with an absolute maximum input voltage range of  $\pm 16.5$  V, which must not be exceeded. An input signal in the range of  $\pm 2.5$  V,  $\pm 5$  V, or  $\pm 10$  V must be connected to the evaluation board via any of the analog input connectors.

Table 2. Optional External Power Supplies

Power Supply	Connector	Voltage Range	Description
$V_{CC}$	J8	5 V $\pm$ 10%	Analog supply rail
$V_{DRIVE}$	J9	2.3 V to 3.6 V	Digital supply rail without <b>EVAL-SDP-CB1Z</b> connected

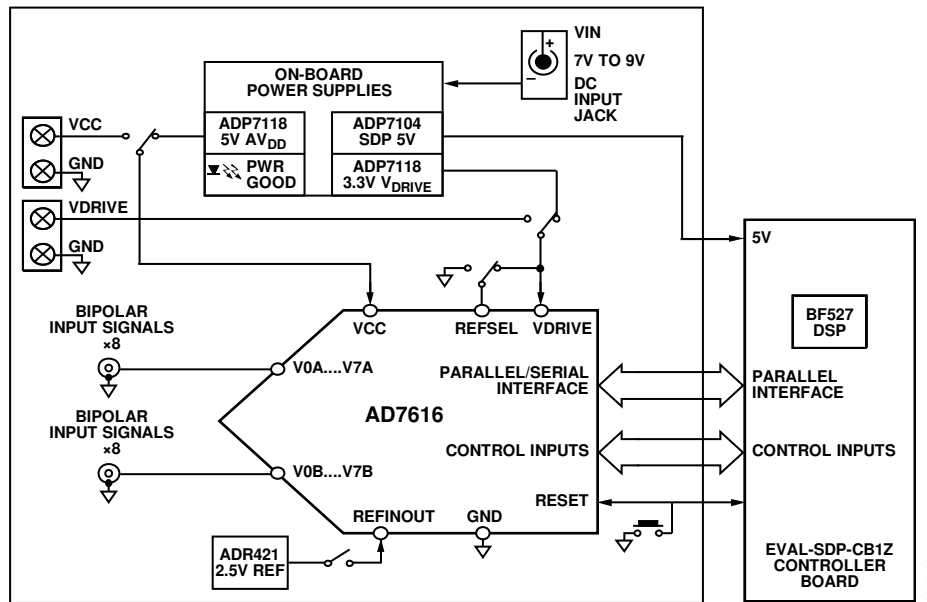


Figure 3. EVAL-AD7616SDZ Functional Block Diagram

## LINK CONFIGURATION OPTIONS

There are multiple link options that must be set correctly to select the appropriate operating setup before using the [EVAL-AD7616SDZ](#). The functions of these options are outlined in Table 3.

### Setup Conditions

Take care before applying power and signals to the [EVAL-AD7616SDZ](#) to ensure all link positions are set as required by the selected operating mode.

There are two modes to operate the [EVAL-AD7616SDZ](#): SDP-B controlled mode used with the [EVAL-SDP-CB1Z](#) board or in standalone mode.

Table 3 shows the default positions of the links when the [EVAL-AD7616SDZ](#) is packaged. It is set up to operate in SDP-B controlled mode with the power supplied from the VIN 7 V to 9 V barrel connector, J7.

**Table 3. Link Options**

Category	Link	Default Position	Function
Power Supplies	LK38	B	This link selects the <a href="#">AD7616</a> reference source. Position A—internal reference selected. Position B—external reference selected.
	LK39	Inserted	When LK39 is inserted, REFINOUT is connected to the <a href="#">ADR421</a> external reference. When LK39 is removed, REFINOUT is disconnected from the <a href="#">ADR421</a> and an external reference can be supplied via the SMA connector, J6.
	LK40	B	This link selects the <a href="#">AD7616</a> VCC supply source. Position A—VCC supply is sourced from the terminal connector, J9. Position B—VCC supply is derived from the VIN 7 V to 9 V connector, J7.
	LK41	B	This link selects the <a href="#">AD7616</a> V <sub>DRIVE</sub> supply source. Position A—V <sub>DRIVE</sub> supply is sourced from the terminal connector, J8. Position B—V <sub>DRIVE</sub> supply is derived from the VIN 7 V to 9 V connector, J7
Analog Input	LK1 to LK16	Inserted	When these links are inserted, the V <sub>xx</sub> GND pin for each channel is connected to board ground. Remove these links if the V <sub>xx</sub> GND pin for a channel is to be sensed from the signal source.
	LK17 to LK32	Removed	When these links are inserted, the analog inputs are connected to the respective V <sub>xx</sub> GND through a 270 Ω resistor. Remove the respective link if an analog input is applied to a channel.
Serial Interface	LK33 to LK35	C	In Hardware Mode, these links select the input channels for next conversion in Channel Group A and Channel Group B. In software mode, these pins must connect to AGND, Position C. Position A—The CHSELx pins are controlled via the SDP interface. Position B—CHSELx pins are connected to V <sub>DRIVE</sub> . Position C—CHSELx pins are connected to AGND.
Hardware/ Software Mode Range Select	LK36 to LK37	C	These pins are dual-purpose. With the HW_RNGSELx pins tied to ground, the <a href="#">AD7616</a> operates in Software mode. In hardware mode, these links select the analog input range. Refer to the <a href="#">AD7616</a> data sheet for detailed range selection instructions. Position A—Both pins are connected to the 120-way connector, J10. Position B—Both pins are tied to V <sub>DRIVE</sub> . Position C—Both pins are tied to AGND.

## EVALUATION BOARD CIRCUITRY

### SOCKETS/CONNECTORS

The connectors and sockets on the [EVAL-AD7616SDZ](#) are described in Table 4.

The default interface to this evaluation board is via the 120-way connector, which connects the [EVAL-AD7616SDZ](#) to the [EVAL-SDP-CB1Z](#). If using the [EVAL-AD7616SDZ](#) in standalone mode, communication is achieved via the J5 single-inline (SIL) header pins.

### TEST POINTS

There are several test points and SIL headers on the [EVAL-AD7616SDZ](#). These test points provide easy access to the signals from the evaluation board for probing, evaluation, and debugging.

**Table 4. On-Board Connectors**

Connector	Function
J1	Analog inputs (V0A to V3A)
J2	Analog inputs (V4A to V7A)
J3	Analog inputs (V0A to V3B)
J4	Analog inputs (V4B to V7B)
J5	Digital input/output pins for debug/standalone mode
J6	External reference SMA input
J7	External power connector, 7 V to 9 V dc input
J8	External V <sub>DRIVE</sub> power connector
J9	External VCC power connector
J10	120-way connector for the <a href="#">EVAL-SDP-CB1Z</a>

## EVALUATION BOARD SOFTWARE SOFTWARE INSTALLATION PROCEDURES

Download the [AD7616](#) evaluation software from the [AD7616](#) product page to install on a PC before using the [EVAL-AD7616SDZ](#) evaluation board.

There are two steps to the installation process:

- [AD7616](#) evaluation software installation
- [EVAL-SDP-CB1Z](#) driver installation

### Warning

The evaluation board software and drivers must be installed before connecting the [EVAL-AD7616SDZ](#) and [EVAL-SDP-CB1Z](#) to the USB port of the PC to ensure the evaluation system is correctly recognized when it is connected to the PC.

### Installing the [AD7616](#) Evaluation Board Software

To install the [AD7616](#) evaluation board software,

1. Download the [AD7616](#) evaluation software to a Windows-based PC and unzip the file.
2. Double-click the **setup.exe** file to begin the installation. By default, the software is saved to the following location: **C:\Program Files\Analog Devices\AD7616\**.
3. A dialog box appears asking for permission to allow the program to make changes to the PC. Click **Yes** to begin the installation process.

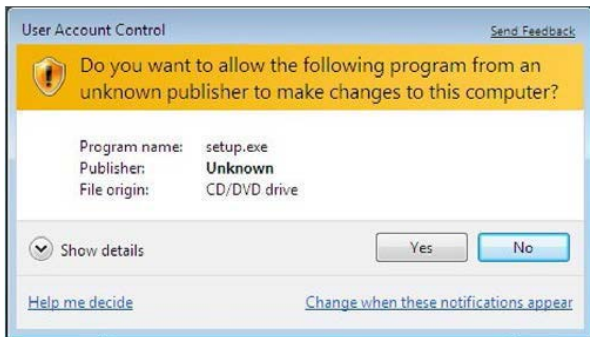


Figure 4. Evaluation Software Installation—User Account Control Dialog Box

4. Select the location to install the software and click **Next**.

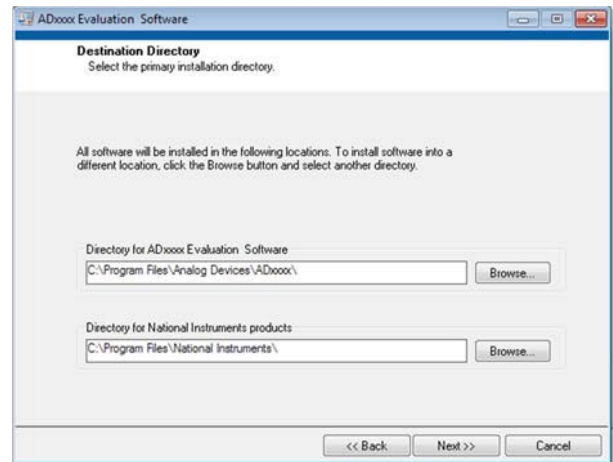


Figure 5. Evaluation Software Installation—Destination Directory Dialog Box

5. A license agreement appears. Read the agreement, select **I accept the License Agreement**, and click **Next**.



Figure 6. Evaluation Software Installation—Accepting the License Agreement

6. A summary of the installation displays. Click **Next** to continue.

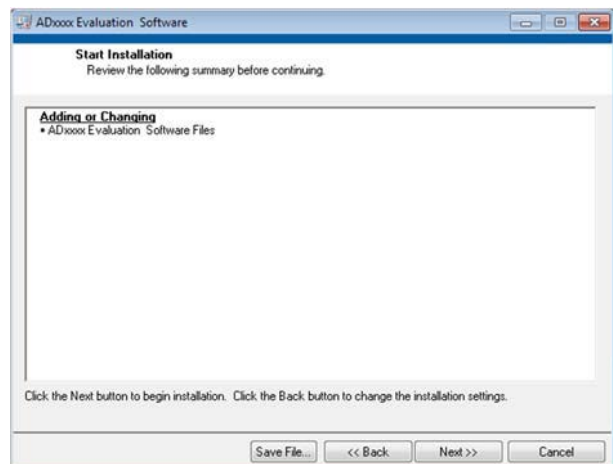


Figure 7. Evaluation Software Installation—Start Installation Dialog Box



- The **Installation Complete** dialog box informs the user when the evaluation software installation is complete. Click **Next** to proceed with the installation of the drivers.

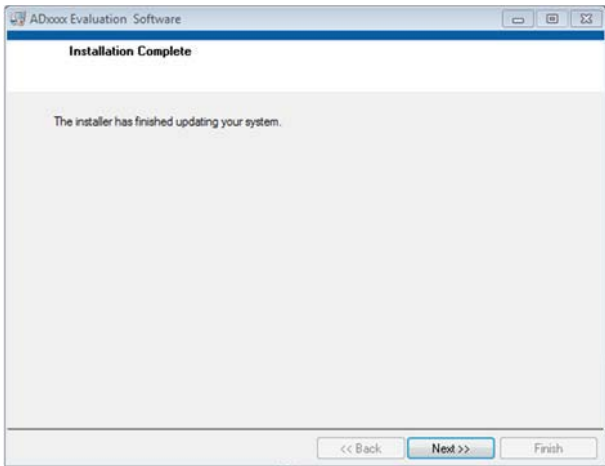


Figure 8. Evaluation Software Installation—**Installation Complete** Dialog Box

**Installing the EVAL-SDP-CB1Z SDP Board Drivers**

After the installation of the AD7616 evaluation board software completes, the **ADI SDP Drivers Setup** wizard window opens for the installation of the **EVAL-SDP-CB1Z** SDP board drivers. To install the drivers, continue with the following process:

- Ensure all other applications are closed and click **Next** to begin the driver installation process.



Figure 9. **EVAL-SDP-CB1Z** Drivers Installation—**Setup Wizard**

- Select a location to install the drivers and click **Install**.

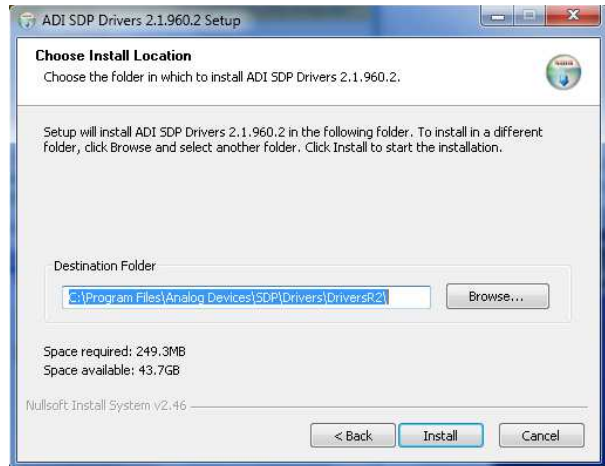


Figure 10. **EVAL-SDP-CB1Z** Drivers Installation—**Choose Install Location** Dialog Box

- Click **Install** to proceed with the installation.

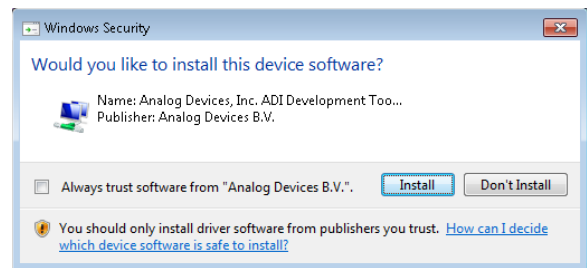


Figure 11. **EVAL-SDP-CB1Z** Drivers Installation—**Windows Security** Dialog Box

- To complete the drivers installation, click **Finish**, which closes the installation wizard.

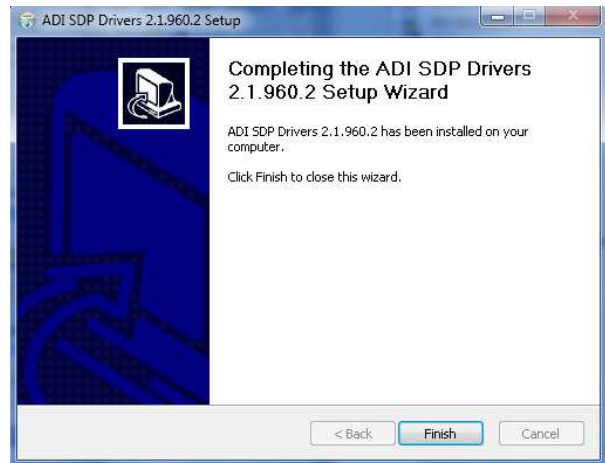


Figure 12. **EVAL-SDP-CB1Z** Drivers Installation—**Completing the Installation**

## EVALUATION BOARD SETUP PROCEDURES

The [EVAL-AD7616SDZ](#) connects to the [EVAL-SDP-CB1Z](#). The [EVAL-SDP-CB1Z](#) is the controller board, which is the communication link between the PC and the [EVAL-AD7616SDZ](#). Figure 2 shows a photograph of the connections between the [EVAL-AD7616SDZ](#) evaluation board and the [EVAL-SDP-CB1Z](#).

After following the instructions in the Software Installation Procedures section, set up the [EVAL-AD7616SDZ](#) and [EVAL-SDP-CB1Z](#) as detailed in this section.

### Warning

The evaluation software and drivers must be installed before connecting the evaluation board and [EVAL-SDP-CB1Z](#) to the USB port of the PC to ensure that the evaluation system is correctly recognized when it is connected to the PC.

### Connecting the [EVAL-AD7616SDZ](#) and [EVAL-SDP-CB1Z](#) to a PC

1. Ensure all configuration links are in the appropriate positions (see Table 2).
2. Connect the [EVAL-AD7616SDZ](#) board securely to the CON A J2 120-way connector on the [EVAL-SDP-CB1Z](#).
3. The [EVAL-AD7616SDZ](#) board requires an external power supply adapter, which is included in the [EVAL-AD7616SDZ](#) kit. Connect this power supply to the dc barrel connector, J7, on the [EVAL-AD7616SDZ](#) board.
4. Connect the [EVAL-SDP-CB1Z](#) board to the PC via the USB cable enclosed in the [EVAL-SDP-CB1Z](#) kit.

## Verifying the Board Connection

1. Allow the **Found New Hardware Wizard** to run after the [EVAL-SDP-CB1Z](#) board is plugged into the PC. If using Windows XP, search for the [EVAL-SDP-CB1Z](#) drivers. Choose to automatically search for the drivers for the [EVAL-SDP-CB1Z](#) board if prompted by the operating system.
2. Check that the evaluation board is connected to the PC correctly using the **Device Manager** of the PC by right-clicking **My Computer** and then **Manage**. A dialog box appears asking for permission to allow the program to make changes to the computer. Click **Yes**. The **Computer Management** window appears. From the list of **System Tools**, click **Device Manager**.
3. Under **ADI Development Tools**, **Analog Devices System Demonstration Platform SDP-B** appears (see Figure 13), indicating the [EVAL-SDP-CB1Z](#) driver software is installed and the board is connected to the PC correctly.

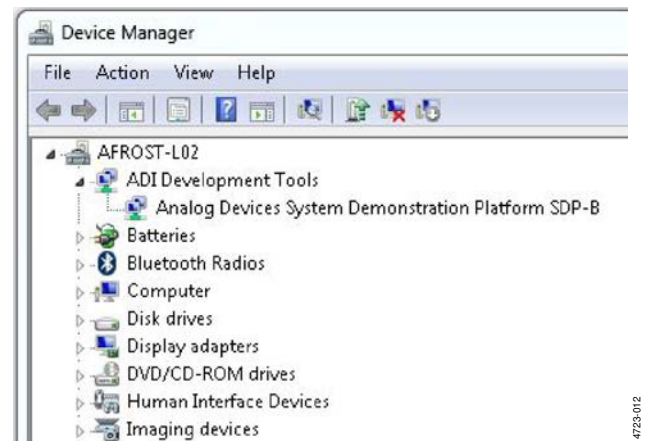


Figure 13. **Device Manager** Window—Checking the [EVAL-SDP-CB1Z](#) Is Connected to the PC Correctly

## Disconnecting the [EVAL-AD7616SDZ](#) Evaluation Board

Always remove power from the [EVAL-SDP-CB1Z](#) or click the reset tact switch (located alongside the mini USB port) before removing the [EVAL-AD7616SDZ](#) evaluation board.

## AD7616 EVALUATION SOFTWARE OPERATION

### LAUNCHING THE SOFTWARE

After the EVAL-AD7616SDZ and EVAL-SDP-CB1Z boards are correctly connected to the PC, the AD7616 evaluation software can launch.

1. From the **Start** menu, select **Programs > Analog Devices > AD7616**. The main window of the software then opens (see Figure 21).
2. If the EVAL-AD7616SDZ evaluation board is not connected to the USB port via the EVAL-SDP-CB1Z when the software is launched, a connectivity error displays (see Figure 14). Connect the EVAL-AD7616SDZ and EVAL-SDP-CB1Z to the USB port of the PC and wait a few seconds, then click **Refresh** and follow the instructions.

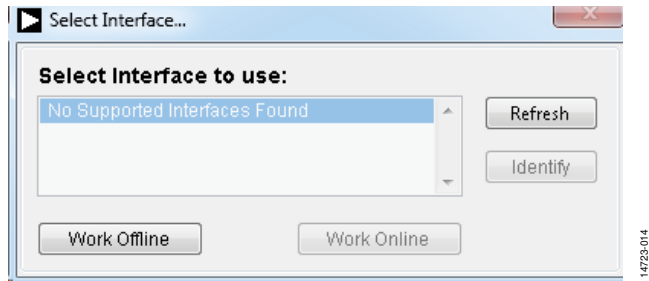


Figure 14. Connectivity Error Alert

### SETTING UP THE SYSTEM FOR DATA CAPTURE

After completing the steps in the Software Installation Procedures section and the Evaluation Board Setup Procedures section, set up the system for data capture as follows:

1. Select the desired device settings
2. Click the **Sample** button to gather data

### DESCRIPTION OF MAIN WINDOW

When the software launches, the main software window opens (see Figure 21) and displays the significant control buttons and analysis indicators of the AD7616 evaluation board software.

#### ADC Reset

The **ADC Reset** button, Label 1 in Figure 21, performs a hardware reset to the AD7616. This returns the device to a known-good state and reinitializes all registers to their default value.

#### Window Tabs

Label 2 in Figure 21 are the tabs that switch between the **Device Configuration**, **Waveform**, **Analysis** and **Register Map** views.

#### Input Range

The **Input Range** drop-down menu, Label 3 in Figure 21, sets the analog input range for analysis on the AD7616. The range must match that selected from the **Input Range** button, otherwise the analysis results is incorrect.

#### Sampling Frequency

The **Sampling Freq** field, Label 4 in Figure 21, controls the throughput rate of the device. The software is capable of running at a maximum throughput rate of 1 MSPS.

#### Help

The **Help** button, Label 5 in Figure 21, launches a short tutorial on how to use the AD7616 evaluation software. Use the tutorial in conjunction with this user guide.

#### Input Range

The **Input Range** button, Label 6 in Figure 21, allow independent configurations of the input range per channel. Clicking the button the **VA\_INPUT\_RANGE** window, shown in Figure 15.

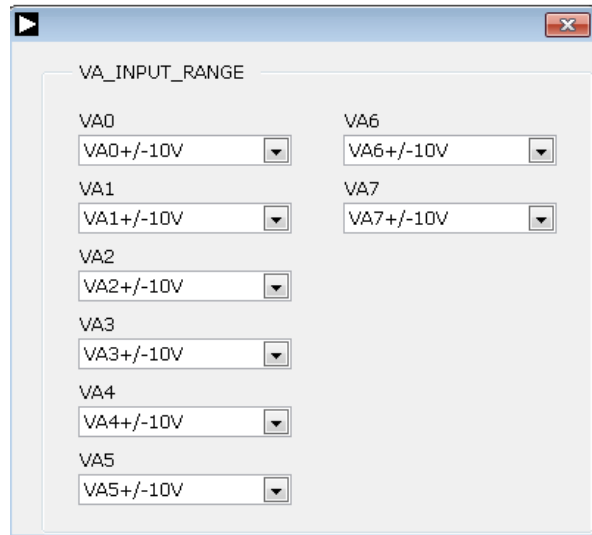


Figure 15. Input Range Window

#### Multiplexer Configuration

The **Multiplexer Configuration** button, Label 7 in Figure 21, allows the user to select the next channel for conversion when the sequencer is not in use. Clicking the button opens the **INPUT\_MUX** window, prompting the user to configure the channel pair on to which the conversion performs, shown in Figure 16.

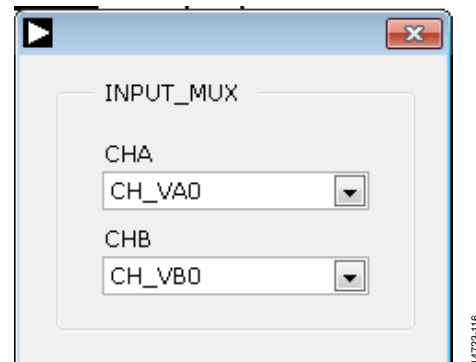


Figure 16. Multiplexer Configuration in Manual Mode

**Sequencer Control**

The **Flexible Sequencer** button, Label 8 in Figure 21, enables the sequencer and burst modes on the AD7616. The user can program the 32-layer sequencer stack registers via the **Register Map** tab, shown in Figure 25. Any combination of ADC A/ ADC B channel pairs can be configured in the sequencer stack. It is not possible to configure two ADC A channels or two ADC B channels in the one layer. Refer to the AD7616 data sheet for a detailed explanation of the sequencer. Clicking the button opens the SEQUENCER\_ALL window, shown in Figure 17.

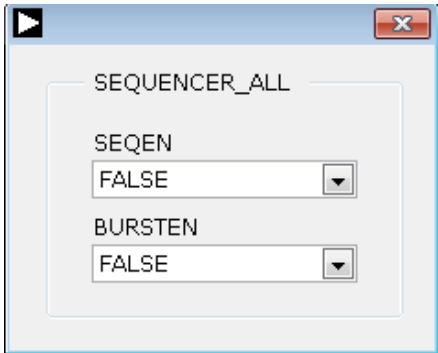


Figure 17. SEQUENCER\_ALL Window

Additionally, the software continuously monitors the channels programmed to the sequencer stack for nonperiodic channels within the sequence. If it detects a sequence with nonperiodic channels, a warning message appears, alerting the user (see Figure 18). It is only possible to perform fast Fourier transform (FFT) analysis on periodically sampled data; if a nonperiodic sequence is detected, the associated FFT for that channel disables. The user can still sample and plot the waveform data for the nonperiodic sequence after acknowledging the warning message.

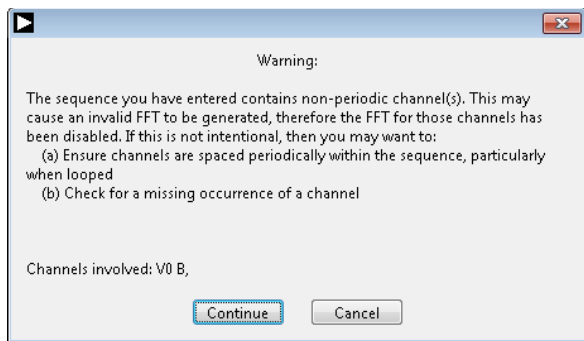


Figure 18. Nonperiodic Sequence Warning

**Oversampling**

The **Oversampling** button, Label 9 in Figure 21, allows the user to select the oversampling ratio of the on-board digital filter. Clicking the button opens the OSR window, shown in Figure 19.

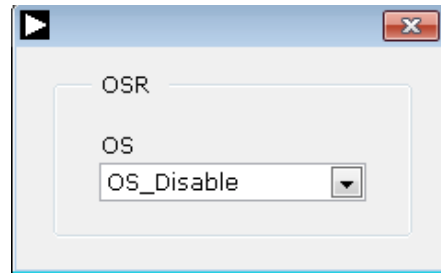


Figure 19. OSR Window

**ADC Configuration**

The **ADC Configuration** button, Label 10 in Figure 21, allows the user to view/control the self detect error flag, the status register output, and the CRC of the AD7616. Refer to the AD7616 data sheet for a detailed explanation of these register items. Clicking the button opens the ADC\_CONFIG window, shown in Figure 20.

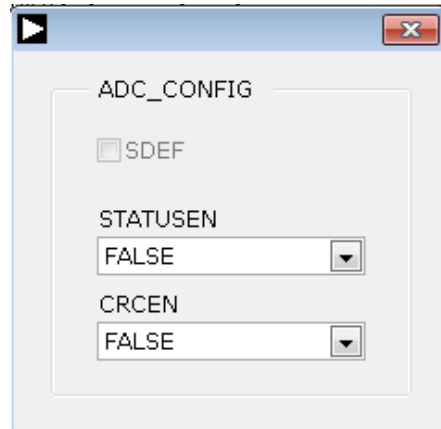


Figure 20. ADC\_CONFIG Window

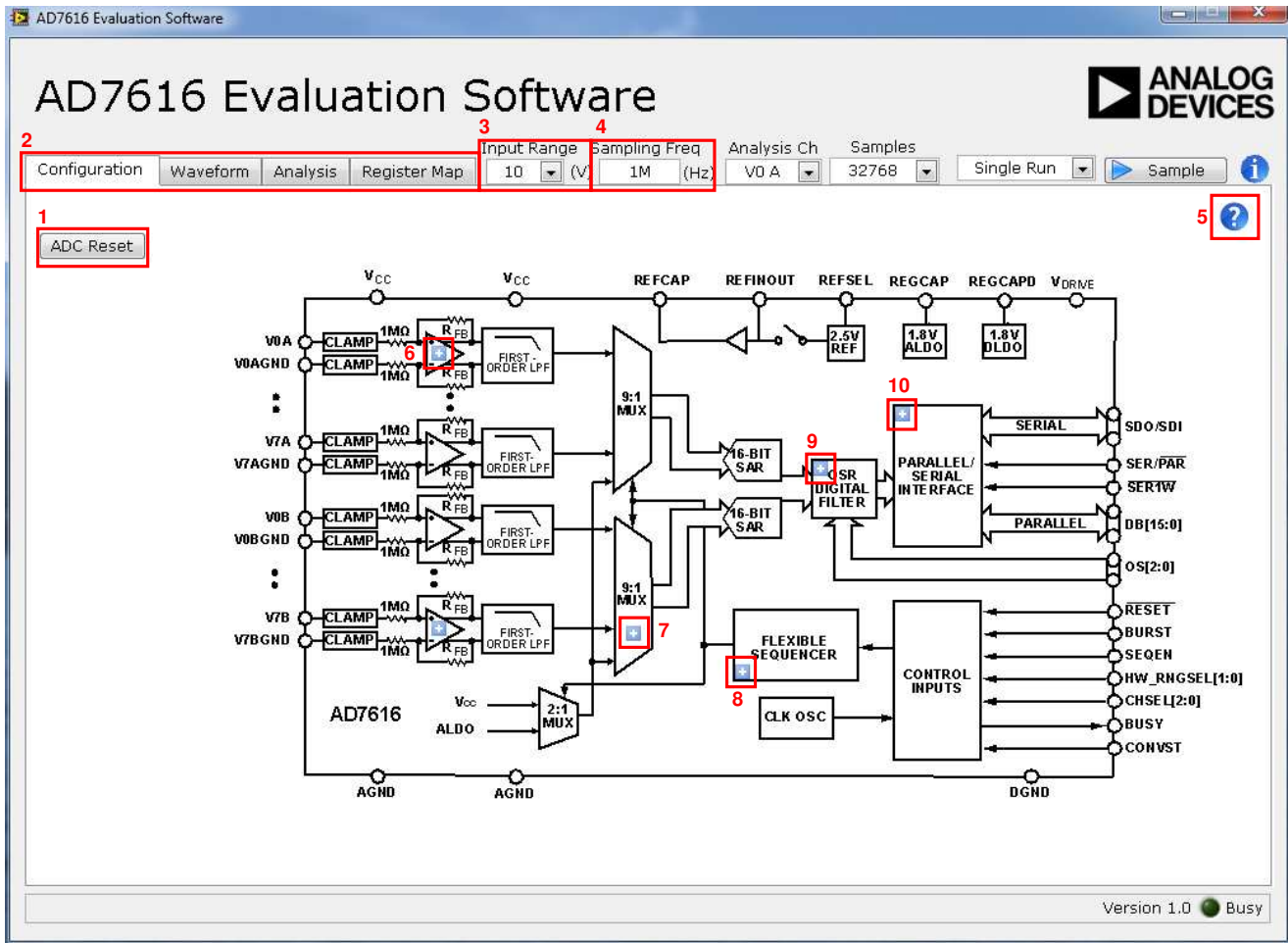


Figure 21. AD7616 Evaluation Software Main Window

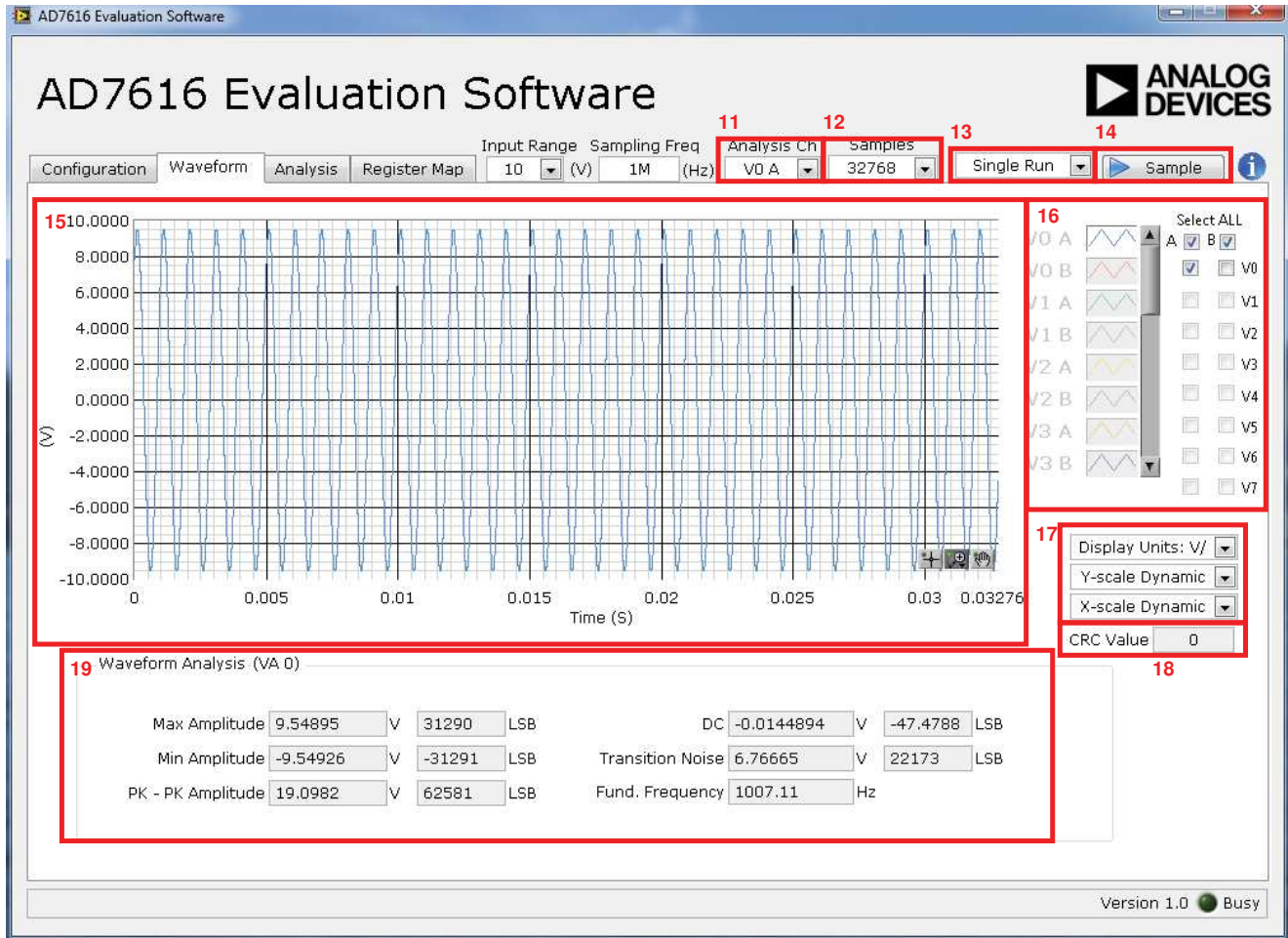


Figure 22. **Waveform Tab**

**WAVEFORM ANALYSIS**

Figure 22 illustrates the **Waveform** tab used for waveform capture.

**Analysis Channel**

The **Analysis Ch** drop-down menu, Label 11 in Figure 22, selects a channel to perform waveform analysis on. The results display in the waveform analysis pane, Label 15 in Figure 22 and in the **Analysis** tab.

**Samples**

The **Samples** drop-down menu, Label 12 in Figure 22, selects the number of samples to acquire per ADC acquisition.

**Batch**

The **Batch** drop-down menu, Label 13 in Figure 22, dictates whether a single batch of samples is gathered, defined by the **Samples** drop-down, or whether samples are gathered continuously until the user manually stops acquisition.

**Sample**

The **Sample** button, Label 14 in Figure 22, initiates a single or continuous acquisition depending on the option selected in the **Batch** drop-down menu.

**Waveform Graph**

The data waveform graph, Label 15 in Figure 22, the data waveform shows each successive sample of the ADC output. The user can zoom and pan the waveform using the embedded waveform tools. The user can change the scales on the axes by typing values into the x-axis and y-axis.

**Channel Selection**

The checkboxes listed under Label 16 in Figure 22 allow the user to choose which channels to display on the data waveform graph. These controls only affect the display of the channels on the graph and do not have any effect on the channel settings in the ADC register map.

**Display Units and Axis Controls**

Label 17 in Figure 22 contains controls to format the waveform graph. Click the **Display Units** drop-down menu to select whether the data graph displays in units of volts or codes. This affects both the waveform graph and the histogram graph in the **Analysis** tab. The axis controls can be switched between dynamic and fixed.

When selecting either **Y-scale Dynamic** or **X-scale Dynamic**, the corresponding axis width automatically adjusts to show the entire range of the ADC results after each batch of samples.

When selecting either **Y-scale Fixed** or **X-scale Fixed**, the user can control the corresponding axis ranges; the ranges do not adjust after each sample batch.

**CRC Value**

When CRC is enabled in the Status register, the CRC result is calculated in the software for the received data and compared with the CRC result appended to the conversion results. Errors detected are shown in Label 18 in Figure 22.

**Waveform Analysis (VA 0)**

The **Waveform Analysis (VA 0)** pane, Label 19 in Figure 22, displays amplitude, frequency, and noise analysis data for the selected analysis channel.

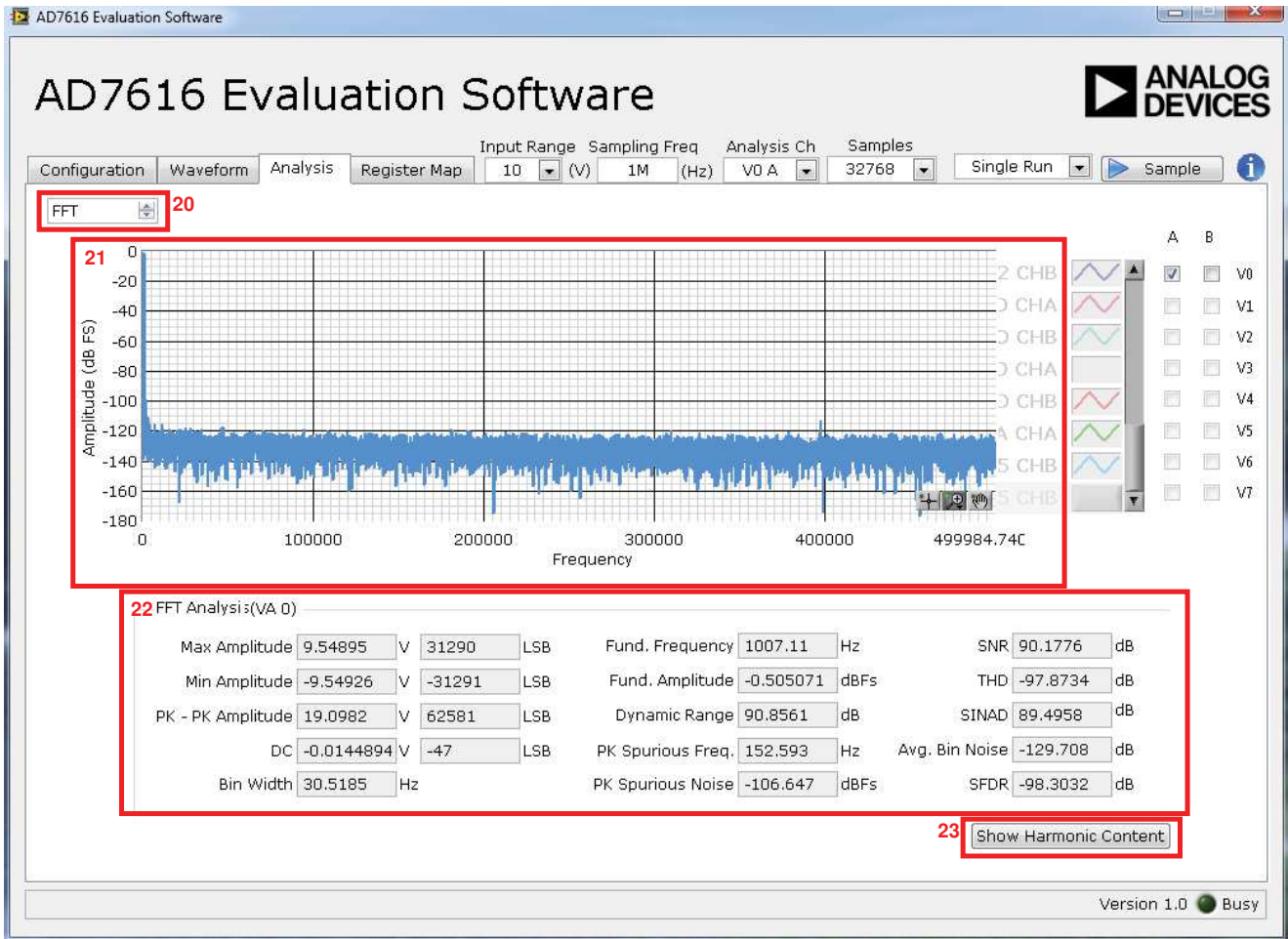


Figure 23. Analysis Tab for FFT Analysis

### ANALYSIS TAB

Figure 23 shows the Analysis tab displaying FFT and histogram information for the last batch of samples gathered.

#### FFT/Histogram Selection

The FFT/Histogram Selection spin box, Label 20 in Figure 23, allows the user to display FFT or histogram analysis in the Analysis tab.

The waveform graph and FFT Analysis (VA 0) data (Label 21 and Label 22, respectively) change display according to the option selected in the FFT/Histogram Selection spin box.

#### Harmonic Content

The Show Harmonic Content button, Label 23 in Figure 23, displays the harmonic content of the sampled signal when viewing the FFT analysis.



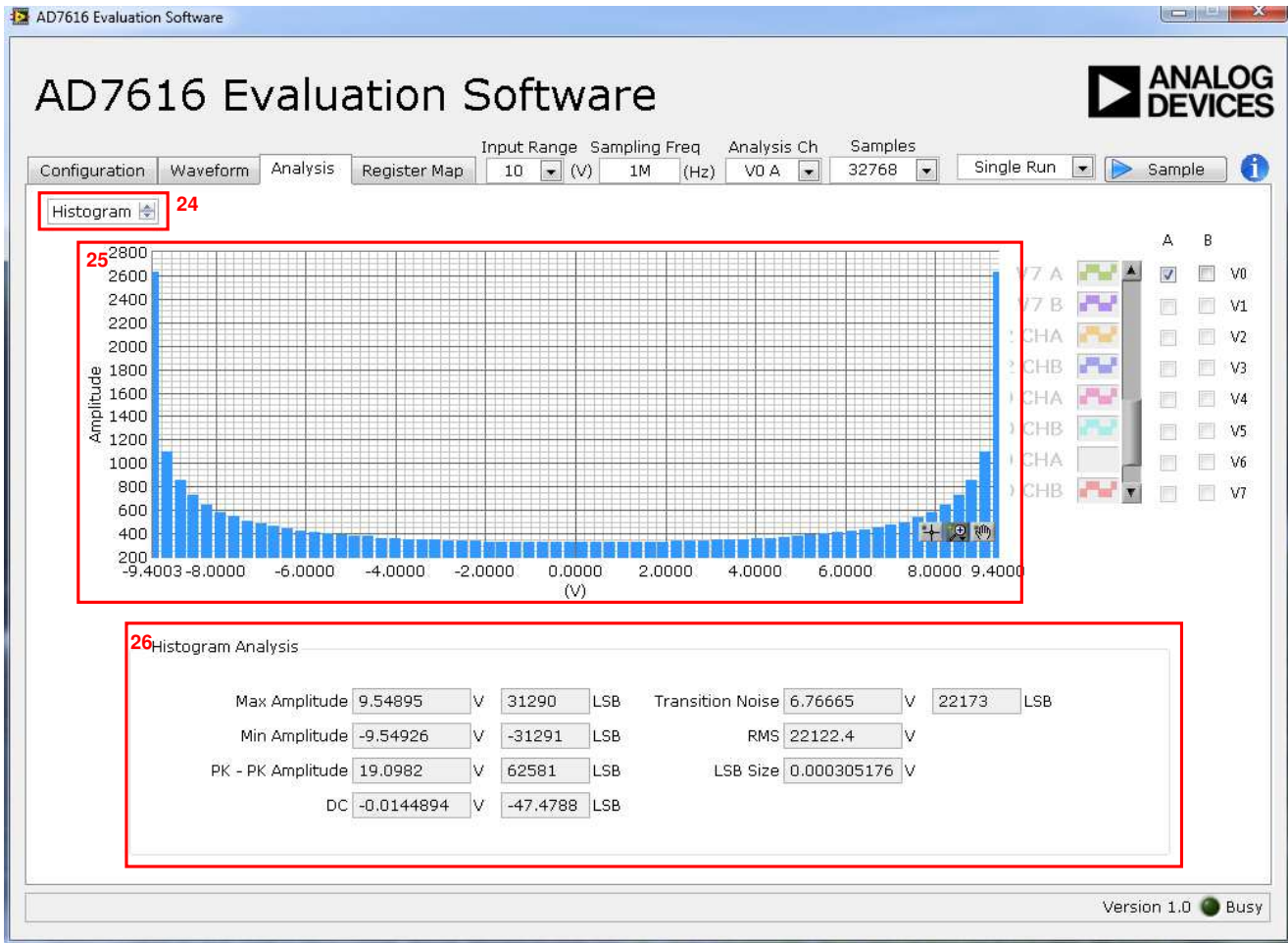


Figure 24. Analysis Tab for Histogram

### Histogram Graph

The histogram graph is displayed in Label 25, Figure 24. This graph displays the number of hits per code seen within the sampled data. Useful for dc analysis, the histogram indicates noise performance of the device.

### Histogram Analysis

The **Histogram Analysis** pane, Label 26 in Figure 24 changes display according to the option selected in the **FFT/Histogram Selection** spin box. It provides information related to the dc performance of the [AD7616](#).

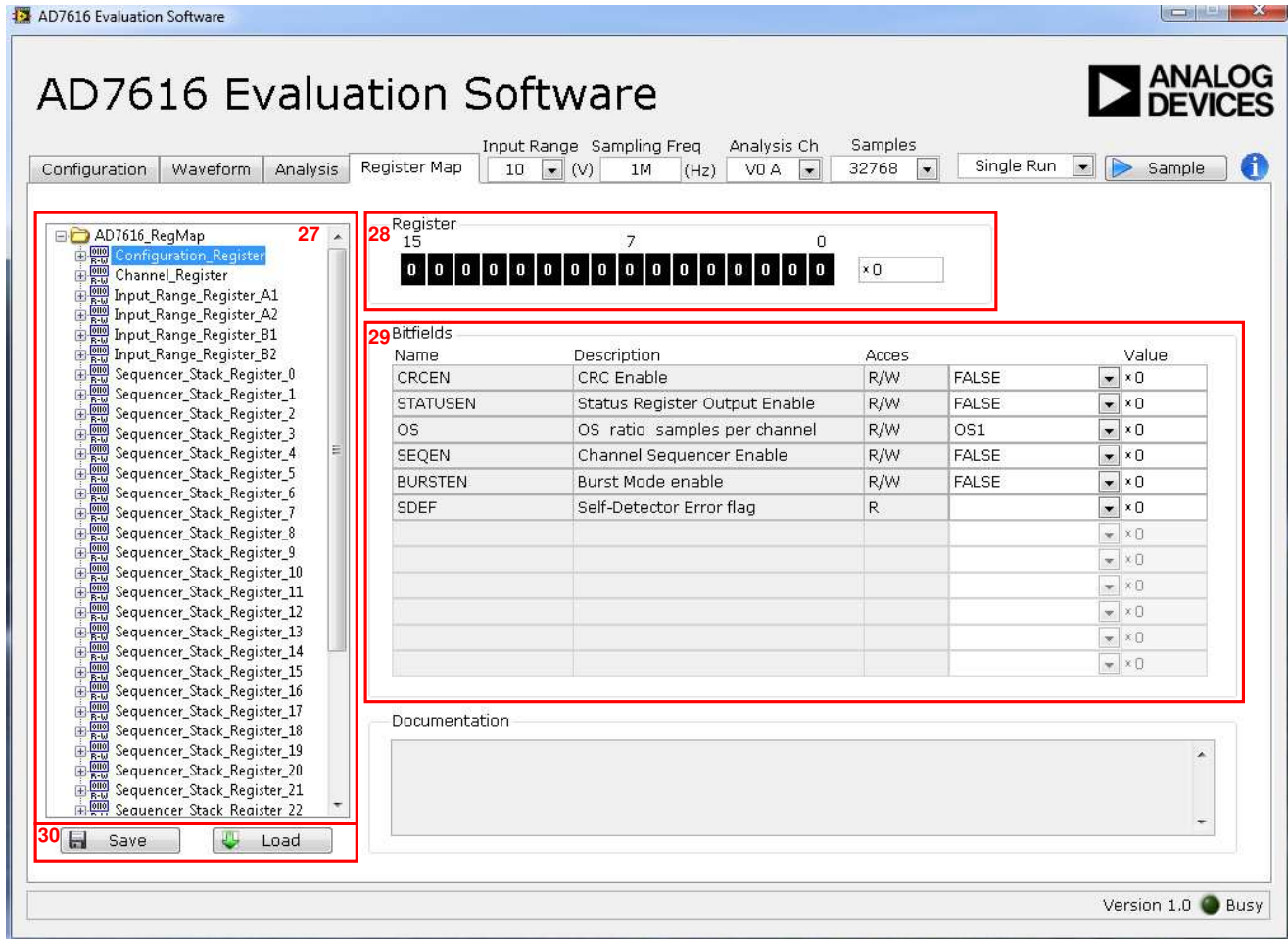


Figure 25. Register Map Tab

**REGISTER MAP TAB**

**Register Tree**

The register tree, Label 27 in Figure 25, displays the full register map in a hierarchical tree view. Each register is shown as a branch. Click the expand button next to each register to show the bitfields contained within the corresponding register.

**Register Control**

The Register pane, Label 28 in Figure 25, allows the user to change an individual bit of the register, selected from the register tree, by either clicking the relevant bit or typing the register value into the numeric field.

**Bitfields**

The Bitfields pane, Label 29 in Figure 25, shows the bitfields within a selected register. The values can be changed using the Value drop-down menu or directly entering a value in the numeric field.

**Save and Load**

The Save button, Label 30 in Figure 25, allows the user to save the current register map setting to a file. The Load button allows the user to load a setting from a previously saved file.

**EXITING THE SOFTWARE**

To exit the software, click the Close button of any window, or press Esc.

## 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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