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ANALOG DEVICES

EVAL-AD7928SDZ User Guide
UG-774

One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

Evaluating the AD7928 12-Bit, 8-Channel, SAR ADC

FEATURES

Full featured evaluation board for the AD7928
On-board power supplies
Standalone capability
System demonstration platform (SDP) compatible (EVAL-SDP-CB1Z)
PC software for control and data analysis (download from AD7928 product page)

EVALUATION KIT CONTENTS

EVAL-AD7928SDZ evaluation board
Evaluation software CD for the AD7928
Mains power supply adapter
Screw/nut kit

ADDITIONAL EQUIPMENT NEEDED

EVAL-SDP-CB1Z system demonstration platform
PC running Windows Vista or Windows 7 with USB 2.0 port
Signal source
SMB cables
USB cable

ONLINE RESOURCES

Documents Needed
AD7928 data sheet
EVAL-AD7928SDZ user guide
Required Software
AD7928 evaluation software
Design and Integration Files
Schematics, layout files, bill of materials

EVALUATION BOARD DESCRIPTION

The EVAL-AD7928SDZ is a full featured evaluation board that allows the user to easily evaluate all the features of the AD7928 analog-to-digital converter (ADC). The evaluation board can be controlled by the EVAL-SDP-CB1Z SDP board via a 120-way SDP connector (J102). The SDP board allows the evaluation board to be controlled through the USB port of a PC using the AD7928 evaluation software, which is available for download from the product page or from the installer CD included in the evaluation board kit.

On-board components include the following:

- ADP1613: 20 V, 2 A, step up, dc-to-dc regulator
- ADP7104ARDZ-5.0: 5 V, low noise LDO
- AD780: high precision, band gap voltage reference
- ADG3308: bidirectional logic level translator
- AD8022: dual high speed, low noise operational amplifier
- AD8066: dual *FastFET*™, low noise operational amplifier
- ADA4000-2: dual low cost, precision JFET input operational amplifier
- ADM1185: quad voltage monitor and sequencer
- ADP3303: high accuracy anyCAP®, 200 mA, low dropout linear regulator

TYPICAL SETUP

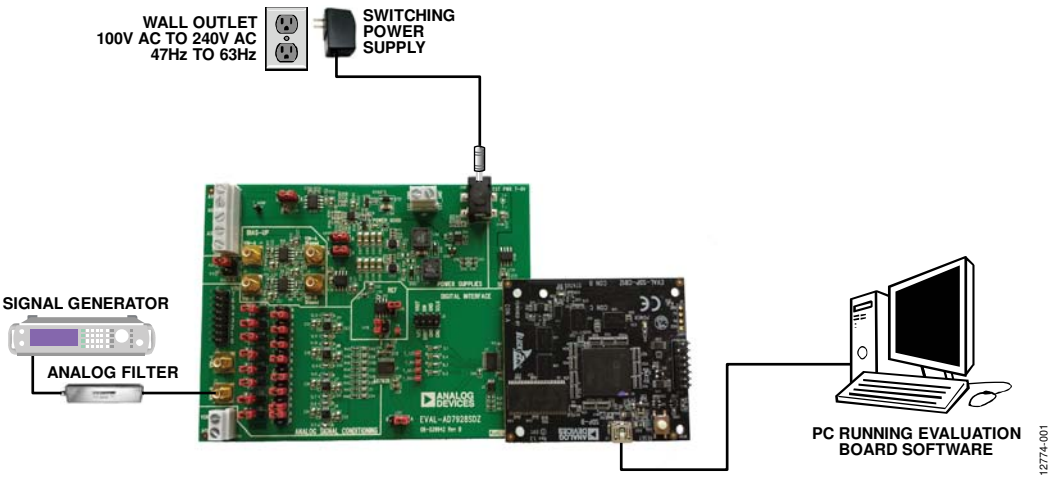

Figure 1.

TABLE OF CONTENTS

REVISION HISTORY

1/15—Revision 0: Initial Version

QUICK START GUIDE

Follow these steps to quickly evaluate the AD7928 ADC. For detailed instructions, see the subsequent sections.

1. Install the evaluation software from the AD7928 product page or from the included CD. Ensure that the EVAL-SDP-CB1Z SDP 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 that the various link options are configured as outlined in Table 2.
3. Connect the EVAL-SDP-CB1Z SDP board to the evaluation board as shown in Figure 2. Screw the two boards together using the enclosed nylon screw/nut set to ensure that the boards connect firmly together.
4. Connect the power supply adapter included in the evaluation kit to Connector J100 on the evaluation board.
5. Connect the EVAL-SDP-CB1Z SDP board to the PC via the USB cable. Choose to automatically search for the drivers for the SDP board if prompted by the operating system.
6. Launch the evaluation software from the **Analog Devices** subfolder in the **Programs** menu.
7. Connect an input signal via VIN-0, the J2 connector.

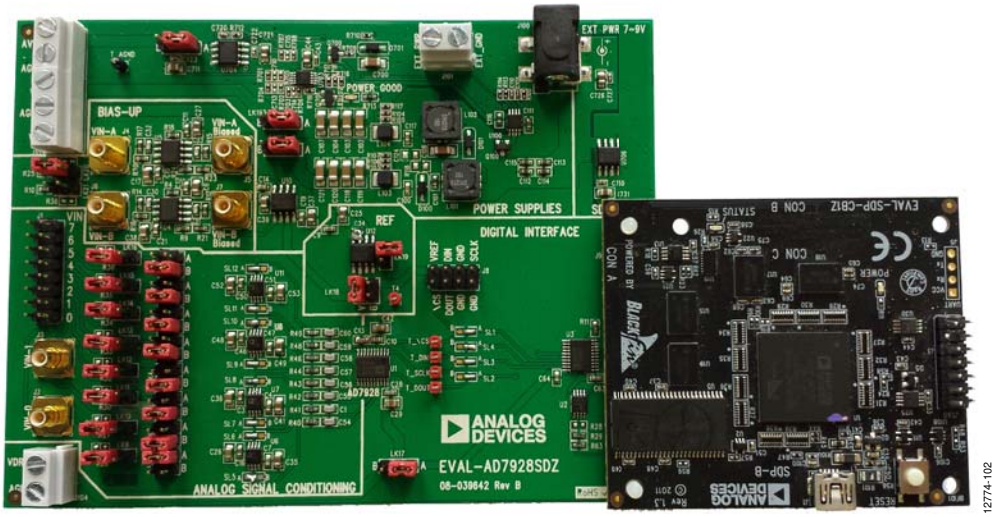

Figure 2. Evaluation Board (Left) Connected to the SDP Board (Right)

EVALUATION BOARD HARDWARE

DEVICE DESCRIPTION

The AD7928 ADC is a 12-bit, low power, 8-channel, successive approximation ADC. The device operates from a single 2.7 V to 5.25 V power supply and features throughput rates of up to 1 MSPS. The device contains a low noise, wide bandwidth track-and-hold amplifier that can handle input frequencies in excess of 8 MHz.

Full data on the AD7928 is available in the AD7928 data sheet, which should be consulted in conjunction with this user guide when using the evaluation board. Full details on the EVAL-SDP-CB1Z are available at the SDP board product page.

HARDWARE LINK OPTIONS

The functions of the link options are described in Table 2. The default setup is configured to operate the evaluation board with the main power supply adapter and to interface to the SDP board.

POWER SUPPLIES

Before applying power and signals to the evaluation board, ensure that all link positions are set according to the required operating mode. See Table 2 for the complete list of link options.

The EVAL-AD7928SDZ evaluation board is supplied with a wall-mountable switching power supply that provides 9 V dc output. Connect the supply to a 100 V to 240 V ac wall outlet at 50 Hz to 60 Hz. The output from the supply is provided through a 2.0 mm inner diameter jack that connects to the evaluation board at J100. The 9 V supply is connected to the on-board, 5 V linear regulator that supplies the correct bias to each of the various sections on the evaluation board and on the EVAL-SDP-CB1Z SDP board.

When using the EVAL-AD7928SDZ evaluation board with the EVAL-SDP-CB1Z SDP board, power the evaluation board through the J100 connector.

If the evaluation board is used without the 9 V adapter, an external power supply in the range of 2.7 V to 5.25 V must be connected to the AVDD input (Connector J102) to supply the AD7928 V_{DD} pin, and LK102 must be set in accordance with Table 2. In addition, an external supply in the range of ±5 V to ±10 V must be connected to the V+, V−, and AGND of the J103 connector, and LK103-1 and LK103-2 must be set in accordance with Table 2 to drive the input buffer amplifiers and reference buffer amplifier.

Each supply is decoupled on this evaluation board using 10 µF tantalum and 100 nF multilayer ceramic capacitors.

Table 1. External Power Supplies Required

Power Supply	Voltage Range	Description
DC Jack	7 V to 9 V ± 5%	Supplies power to on-board power management devices
AVDD	2.7 V to 5.25 V	Analog supply rail
V+/V−	±5 V to ±10 V	Amplifier supply rail
VDRIVE	2.7 V to 5.25 V	Digital logic supply

Table 2. Link Options

Link	Default Position	Function
LK1	A	This link is used to select the input to VIN-0. In Position A, the input is connected to the SMB Connector J2. In Position B, the input is connected to AGND.
LK2 to LK8	B	These links are used to select the inputs to VIN-1 to VIN-7. In Position A, the input is connected to the respective pin on Header Connector J1. In Position B, the input is connected to AGND.
LK9 to LK16	Not inserted	Adds a 51 Ω termination resistor to AGND at VIN. Inserted: 51 Ω termination on the VIN input. Not inserted: no 51 Ω termination on the VIN input.
LK17	A	Selects the source of VDRIVE. In Position A, VDRIVE is tied to AVDD. In Position B, VDRIVE is sourced from External Connector J5.
LK18	B	Selects the reference source for the REF_{IN} pin. In Position A, the REF192 voltage reference is selected. In Position B, the AD780 voltage reference is selected. In Position C, the reference can be externally applied to the header pin on Connector J9.
LK19	Not inserted	Selects the reference output of the AD780. Inserted: REF_{IN} = 3 V Not inserted: REF_{IN} = 2.5 V
LK20	Not inserted	Adds a 51 Ω termination resistor to AGND at VIN-A. Inserted: 51 Ω termination on the VIN-A input. Not inserted: no 51 Ω termination on the VIN-A input.
LK21	Not inserted	Adds a 51 Ω termination resistor to AGND at VIN-B. Inserted: 51 Ω termination on the VIN-B input. Not inserted: no 51 Ω termination on the VIN-A input.
LK102	A	This link selects either the on-board or external AVDD supply. In Position A, the on-board generated +5 V supply is used for AVDD. In Position B, the externally supplied AVDD to Connector J703 is used.
LK103-1	A	This link selects either the on-board or external amplifier negative supply. In Position A, the on-board generated −10 V supply is used for VSS. In Position B, the externally supplied VSS to Connector J100 is used.
LK103-2	A	This link selects either the on-board or external amplifier positive supply. In Position A, the on-board generated +10 V supply is used for VDD. In Position B, the externally supplied VDD to Connector J100 is used.

SOCKETS/CONNECTORS

The connectors and sockets on the EVAL-AD7928SDZ evaluation board are outlined in Table 3.

Table 3. On-Board Connectors

Connector	Function
J1	VIN-0 to VIN-7 header pin connector
J2	VIN-0 analog input SMB connector
J3	VIN-1 analog input SMB connector
J4	VIN-A analog input signal to bias up circuit
J5	VIN-A biased analog output from bias up circuit
J6	VIN-B analog input signal to bias up circuit
J7	VIN-B biased analog output from bias up circuit
J8	Header connector for digital interface
J9	120-way connector for EVAL-SDP-CB1Z interface
J100	7 V to 9 V, 2.0 mm dc jack connector
J101	External power connector, 7 V to 9 V dc input
J102	External AVDD power connector
J103	External V+, V−, and AGND power connector
J104	External VDRIVE power connector

The default interface to this evaluation board is via the 120-way connector, which connects the EVAL-AD7928SDZ evaluation board to the EVAL-SDP-CB1Z SDP board.

TEST POINTS

There are numerous test points on the EVAL-AD7928SDZ evaluation board. These test points provide easy access to the signals from the evaluation board for probing, evaluation, and debugging.

It is also possible to communicate with the AD7928 device via the test points to operate the evaluation board in standalone mode without the need for the EVAL-SDP-CB1Z SDP board.

BASIC HARDWARE SETUP

The EVAL-AD7928SDZ evaluation board connects to the EVAL-SDP-CB1Z SDP board. The SDP board is the controller board, which is the communication link between the PC and the main evaluation board.

Figure 2 shows a photograph of the connections between the EVAL-AD7928SDZ daughter board and EVAL-SDP-CB1Z controller board.

The analog input range to the AD7928 is 0 V to 2 × REF_{IN} and must not be exceeded. Connect an input signal within this range to the evaluation board via any analog input connector: J1, J2, or J3.

If an input signal is a bipolar input, it must be connected to either VIN-A or VIN-B, Connector J4 or Connector J6, respectively. This bias-up circuitry biases the bipolar input signal for unipolar operation. The default configuration of the bias-up circuit is for use with the AD7928 analog input range extending from 0 V to 2 × REF_{IN} (RANGE bit set to 0). For use with the analog input range extending from 0 V to REF_{IN} (RANGE bit set to 1), change Resistor R21 and Resistor R23 in the bias-up circuitry to 3 kΩ.

If using the evaluation board in the default mode of operation, ensure that the link options are in their default positions as outlined in Table 2. Ensure that all links are in the appropriate position before connecting the evaluation board to the EVAL-SDP-CB1Z SDP board.

Before powering up the EVAL-SDP-CB1Z SDP board, connect the EVAL-AD7928SDZ evaluation board to the 120-pin, Connector J9, on the SDP board. After the evaluation board and the SDP board have been connected securely using the provided nylon screw set, apply power to the EVAL-AD7928SDZ evaluation board. The EVAL-AD7928SDZ requires an external 7 V to 9 V dc power supply (included) to be connected to either the 2.0 mm barrel connector, J100, or the external power connector, J101.

Before connecting the EVAL-SDP-CB1Z SDP board to the PC, ensure that the evaluation software (supplied on included CD) has been installed. The full software installation procedure is detailed in the Evaluation Board Software section.

Connect the EVAL-SDP-CB1Z SDP board to the PC via the USB cable enclosed in the EVAL-SDP-CB1Z kit. If using a Windows® XP platform, you may need to search for the SDP board drivers. Choose to automatically search for the drivers for the SDP board if prompted by the operating system.

Caution

Always remove power from the EVAL-AD7928SDZ evaluation board before removing the EVAL-SDP-CB1Z controller board.

EVALUATION BOARD SOFTWARE

SOFTWARE INSTALLATION

The EVAL-AD7928SDZ kit includes the evaluation software on a CD; the software is also available for download from the AD7928 product page.

There are two parts to the installation:

- AD7928 evaluation software installation
- EVAL-SDP-CB1Z SDP board drivers installation

Warning

The evaluation board software and drivers must be installed before connecting the evaluation board and SDP board to the USB port of the PC to ensure that the evaluation system is correctly recognized when it is connected to the PC.

Installing the Evaluation Software

To install the EVAL-AD7928SDZ evaluation board software

1. Insert the included evaluation software installation CD into the CD drive of a Windows-based PC, and open the contents of the CD.
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\AD7928**.
3. A dialog box appears asking for permission to allow the program to make changes to your computer. Click **Yes** to begin the installation process.

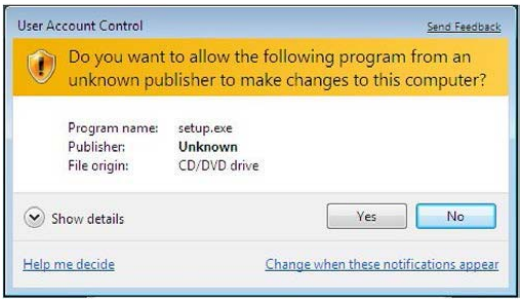

Figure 3. Evaluation Software Installation—User Account Control

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

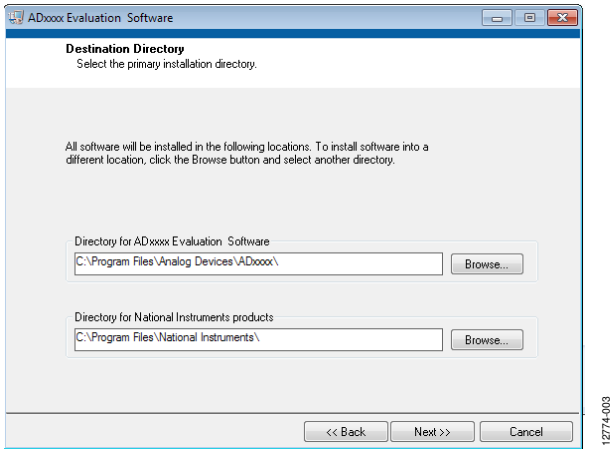

Figure 4. Evaluation Software Installation—Destination Directory

5. A license agreement appears. Read the agreement, select **I accept the License Agreement**, and then click **Next**.
6. A summary of the installation is displayed. Click **Next** to continue.

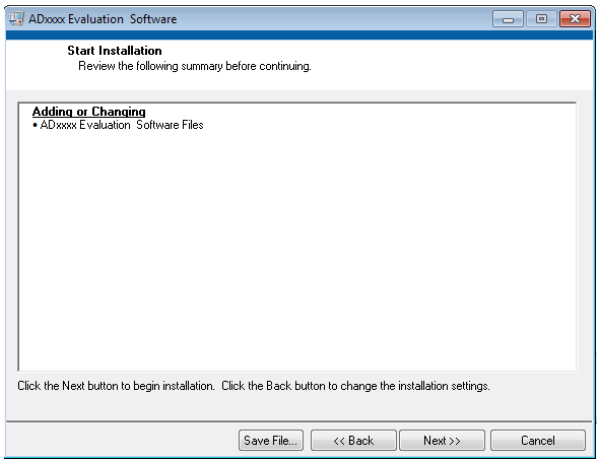

Figure 5. Evaluation Software Installation—Start Installation

7. A dialog box informs you when the evaluation software installation is complete. Click **Next** to proceed with the installation of the SDP drivers.

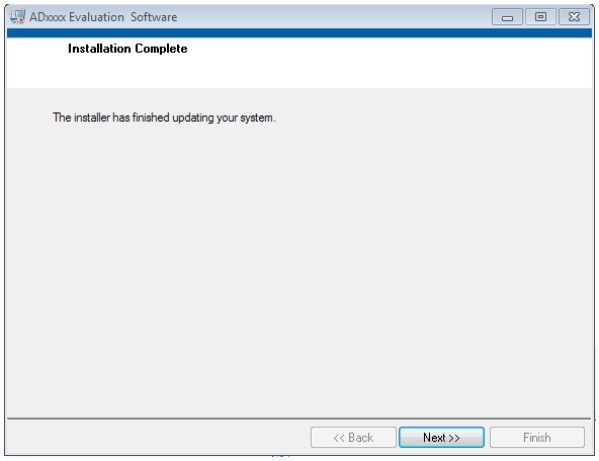

Figure 6. Evaluation Software Installation—Installation Complete

8. The installation of the evaluation software completes.

Installing the SDP Board Drivers

After the evaluation board software installation is complete, the **ADI SDP Drivers Setup** wizard window opens for the installation of the EVAL-SDP-CB1Z SDP board drivers.

1. The **ADI SDP Drivers Setup Wizard** opens. Click **Next >** to begin the driver installation process.

Figure 7. EVAL-SDP-CB1Z Drivers Installation—Setup Wizard

2. Select a destination folder for the SDP drivers, and click **Install**.

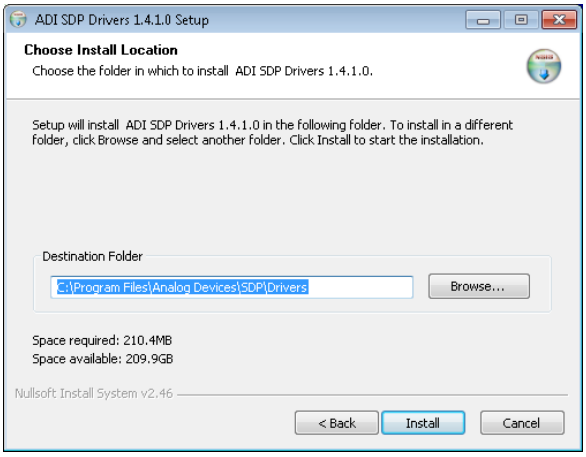

Figure 8. EVAL-SDP-CB1Z Drivers Installation—Choose Install Location

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

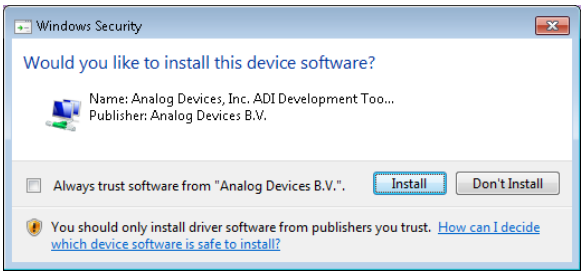

Figure 9. EVAL-SDP-CB1Z Drivers Installation—Windows Security

4. The SDP drivers installation completes. Click **Finish**.

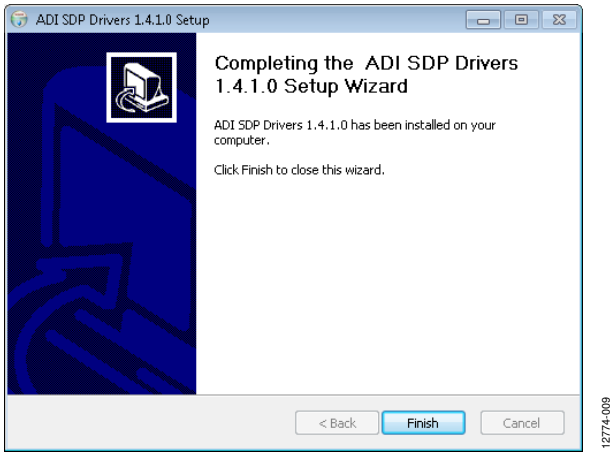

Figure 10. EVAL-SDP-CB1Z Drivers Installation—Complete

After the evaluation software installation is complete, connect the EVAL-AD7928SDZ evaluation board to the EVAL-SDP-CB1Z SDP board as described in the Evaluation Board Hardware section.

When you first plug in the EVAL-SDP-CB1Z SDP board via the USB cable provided, allow the **Found Hardware Wizard** to run. After the drivers are installed, check that the board is connected correctly by looking at the **Device Manager** of the PC. The **Device Manager** can be found by right-clicking **My Computer** > **Manage** > **Device Manager** from the list of **System Tools**.

The EVAL-SDP-CB1Z SDP board appears under **ADI Development Tools**, as shown in Figure 11.

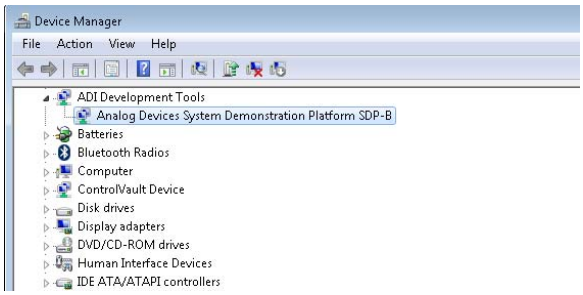

Figure 11. Device Manager

LAUNCHING THE SOFTWARE

After the evaluation board and SDP board are correctly connected to your PC, the AD7928 evaluation software can be launched.

From the **Start** menu, click **Programs** > **Analog Devices** > **AD7928.** The main window of the evaluation software then opens (see Figure 13).

If the evaluation board is not connected to the USB port via the EVAL-SDP-CB1Z SDP board when the software is launched, a connectivity error displays (see Figure 12). Connect the EVAL-AD7928SDZ evaluation board to the USB port of the PC, wait a few seconds, click **Rescan**, and follow the instructions.

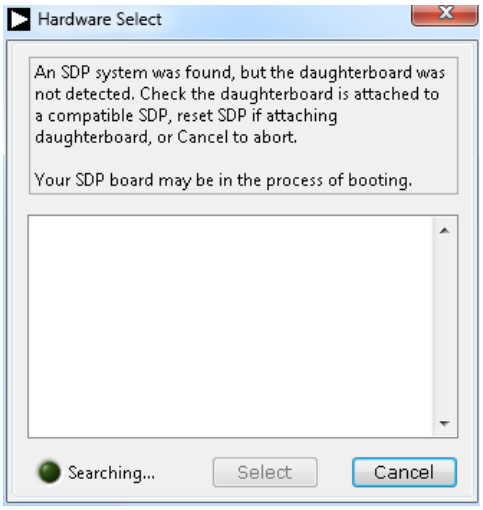

Figure 12. Connectivity Error Alert

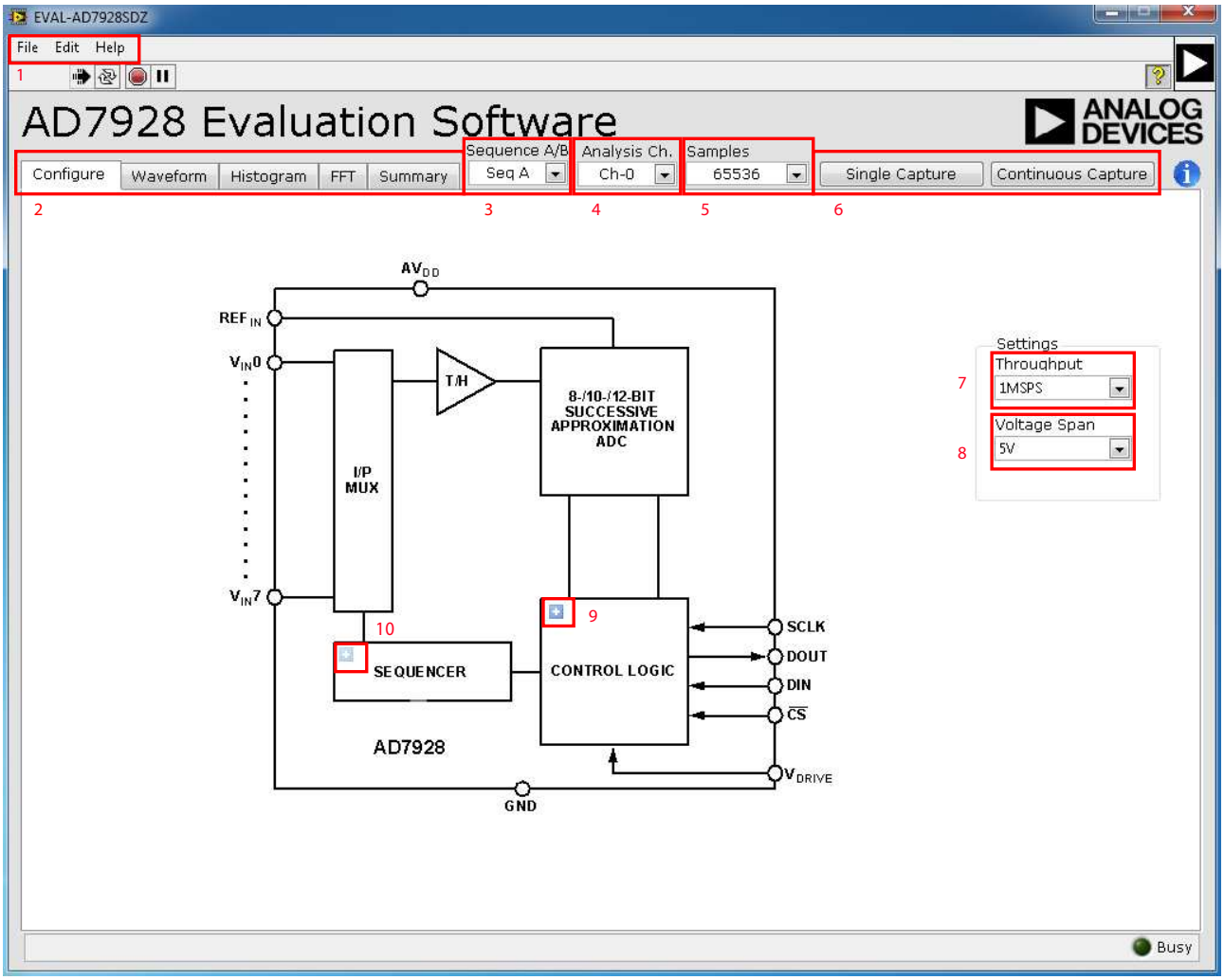

Figure 13. AD7928 Evaluation Software Main Window

DESCRIPTION OF MAIN WINDOW

The following tools allow user control of the different chart displays. When the software is launched, the main AD7928 evaluation software window opens (see Figure 13).

The main evaluation software window, as shown in Figure 13, has the following features:

- Menu bar
- Control buttons
- Configuration display
- Data capture display

Menu Bar

The menu bar, Label 1 in Figure 13, consists of the **File**, **Edit**, and **Help** menus.

File Menu

- **Save Data.** Saves captured data in comma separated values (CSV) format for future analysis.
- **Load Data.** Loads previously captured data in CSV format for analysis.
- **Save Image**. Saves current tab image as a JPEG file.
- **Exit.** Exits the program.

Edit Menu

- **Reinitialize**. Places the evaluation board in a known default state.

Help Menu

- **User Guide.** Opens the evaluation kit user guide.
- **Context Help.** Turns on context sensitive help.
- **About.** Links to the Analog Devices, Inc., website.

Control Buttons, Drop-Down Boxes, and Indicators

The **Configure**, **Waveform**, **Histogram**, **FFT**, and **Summary** tabs, Label 2 in Figure 13, control which tab is displayed. In each of these tabs, device configuration and data analysis results can be set and viewed, respectively.

The **Sequence A/B** drop-down box, Label 3 in Figure 13, selects the desired set of data for analysis when two separate sequences are programmed to the shadow register.

The **Analysis Ch.** drop-down box, Label 4 in Figure 13, selects the desired channel for analysis to be performed on after samples have been gathered on more than one channel.

The **Samples** drop-down box, Label 5 in Figure 13, configures how many samples are taken on each capture. In multichannel mode, this is the total number of samples acquired; therefore, each channel acquires Samples/N samples, where N is the number of channels being used.

The capture buttons, Label 6 (**Single Capture** and **Continuous Capture**) in Figure 13, select whether the ADC acquires one set of samples or acquires samples until told to stop.

Throughput, Label 7 in Figure 13, selects the rate of data capture by the ADC, up to a maximum rate of 1 MSPS.

Voltage Span, Label 8 in Figure 13, sets the maximum input signal peak-to-peak range for data analysis. This value must always match the value of either REF_{IN} or $2 \times REF_{IN}$, depending on the selected setting in the control register.

Configuration Buttons

There are two configuration buttons, for configuring the control register, contained within the block diagram under the **Configure** tab. Clicking the blue icon shown in Figure 14 produces dialog boxes that allow you to configure the respective section of the block diagram.

Figure 14. Configuration Button

The two buttons, Label 9 and Label 10 in Figure 13, configure the control register and shadow register respectively. Clicking either of the icons brings up their respective dialog box (Figure 15 and Figure 16). Refer to Table 7 through Table 10 of the AD7928 data sheet for details regarding the function of these registers. The default configuration is for single channel operation with the sequencer disabled.

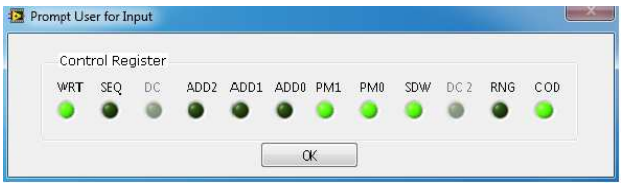

Figure 15. Control Register Dialog Box

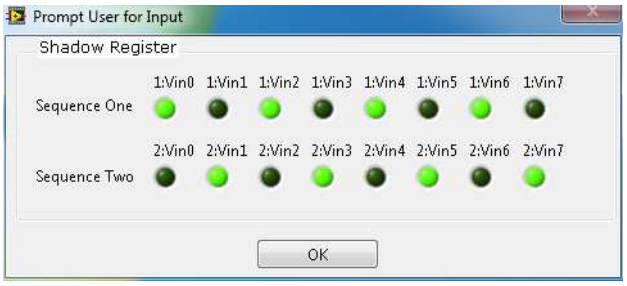

Figure 16. Shadow Register Dialog Box

Data Capture Display

Four tabs display the conversion data in different formats: **Waveform**, **Histogram**, **FFT**, and **Summary**.

The tools shown in Figure 17 allow user control of the different chart displays within the four tabs.

Figure 17. Chart Tools

WAVEFORM CAPTURE

Figure 18 shows the **Waveform** tab, which is used for waveform capture.

The waveform analysis reports the amplitudes recorded from the captured signal as well as the frequency of the signal tone.

The analysis report is generated for the channel selected via the **Analysis** drop-down box (see Label 1 in Figure 18). All enabled channels are shown in the waveform plot (see Label 2 in Figure 18).

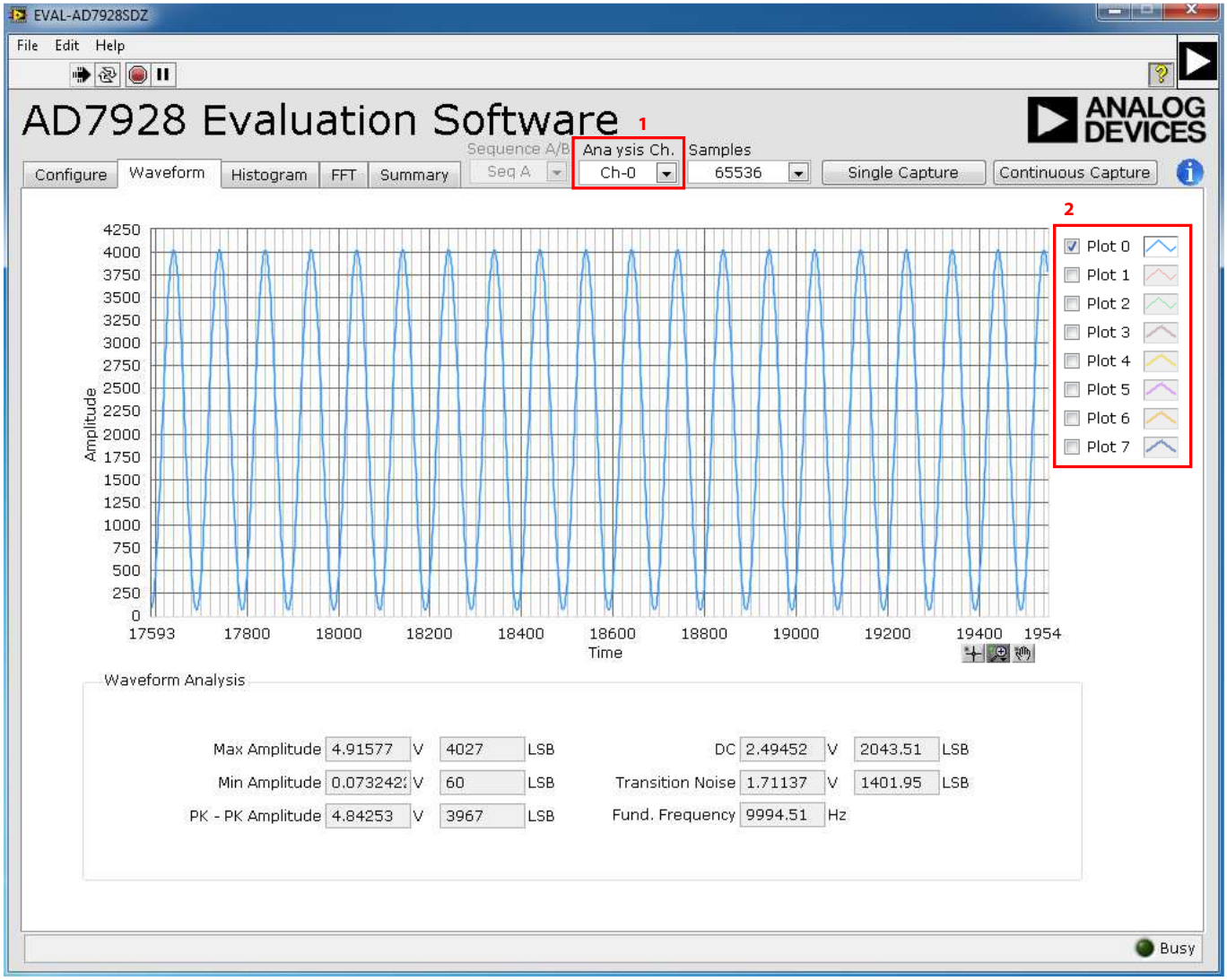

*Figure 18. **Waveform** Capture Tab*

AC TESTING—HISTOGRAM

Figure 19 shows the **Histogram** capture tab. The histogram shows the ADC code distribution for the ac input, computes the mean and standard deviation (or transition noise) of the converter, and displays the results.

Raw data is captured and passed to the PC for statistical computations. To perform a histogram test, select the **Histogram** tab in the AD7928 evaluation software main window and click **Single Capture** or **Continuous Capture** (Label 1 in Figure 19).

Note that an ac histogram requires a quality signal source applied to the input VIN connector or the AIN0 connector.

DC TESTING—HISTOGRAM

The histogram is more commonly used for dc testing. Similar to ac testing, the histogram shows the ADC code distribution for the dc input, computes the mean and standard deviation (or transition noise) of the converter, and displays the results.

Raw data is captured and passed to the PC for statistical computations. To perform a histogram test, select the **Histogram** tab in the AD7928 evaluation software main window and click **Single Capture** or **Continuous Capture** (Label 1 in Figure 19).

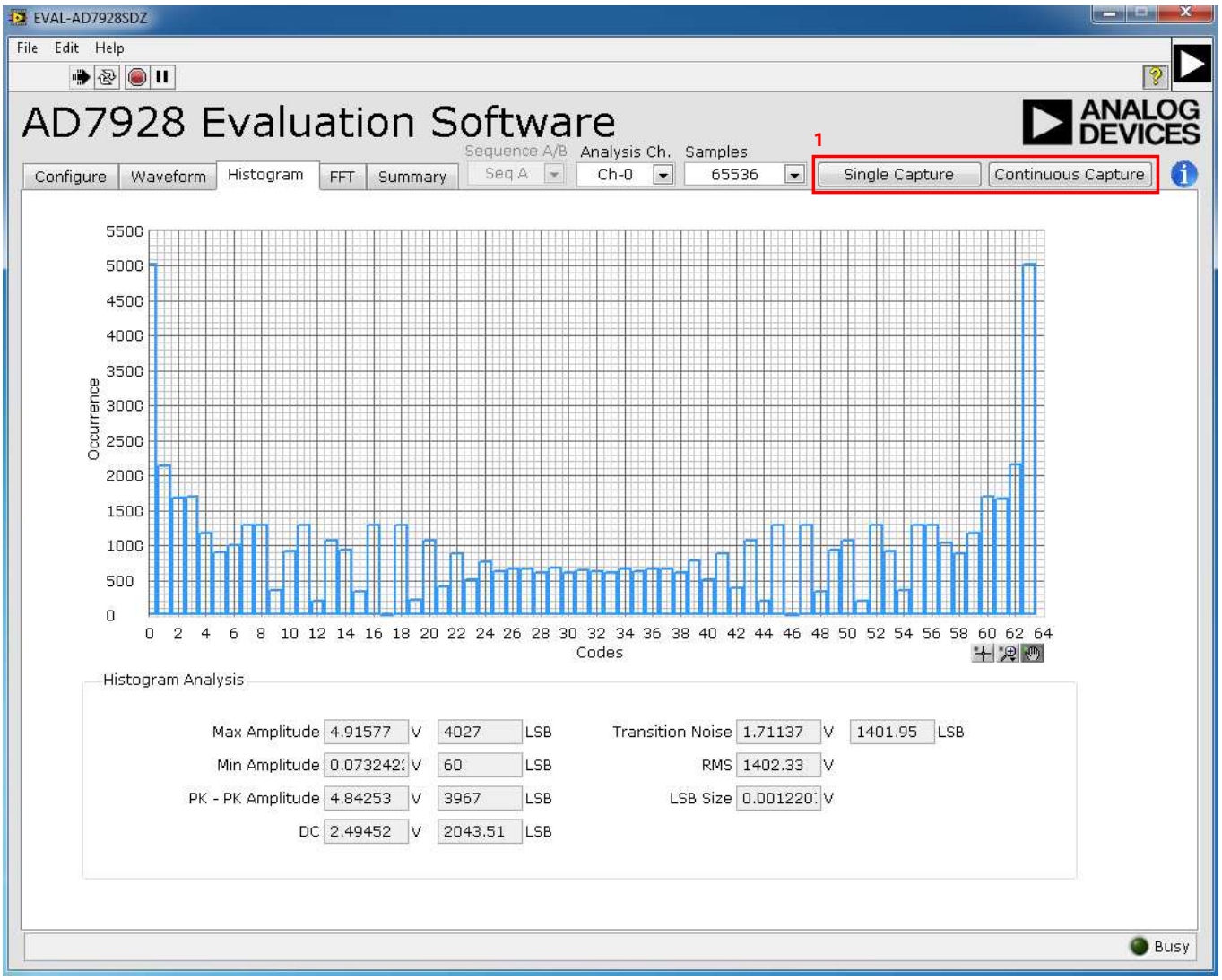

*Figure 19. **Histogram** Capture Tab*

AC TESTING—FFT CAPTURE

Figure 20 shows the **FFT** capture tab. The FFT tests the traditional ac characteristics of the converter and displays a fast Fourier transform (FFT) of the results. As in the histogram test, raw data is captured and passed to the PC, where the FFT is performed, displaying the signal-to-noise ratio (SNR), signal-to-noise-and-distortion (SINAD), and total harmonic distortion (THD).

To perform an ac test, do one of the following:

1. Apply a bipolar sinusoidal signal to the evaluation board at either VIN-A or VIN-B (Connector J4 or Connector J6 respectively) and feed the biased-up signal from either VIN-A biased or VIN-B biased (Connector J5 or Connector J7 respectively) to any analog input, VIN-0 through to VIN-7 (Connector J1, Connector J2, or Connector J3).
2. Apply a unipolar sinusoidal signal directly to any analog input, VIN-0 through to VIN-7.

A low distortion source, better than 115 dB, is required to allow true evaluation of the device. One possibility is to filter the input signal from the ac source. There is no suggested band-pass filter, but consideration must be taken in the choice of filter.

Figure 20 displays the spectral analysis results of the captured data.

- The plot is the FFT image of the analysis channel selected.
- The **FFT Analysis** panel displays the performance data: **SNR**, **THD**, **SINAD, Dynamic Range**, and noise performance along with the input signal characteristics (see Label 1 in Figure 20).
- Click **Show Harmonic Content** to switch the panel to display the frequency and amplitude of the fundamental in addition to the second harmonics to the fifth harmonics (see Label 2 in Figure 20).

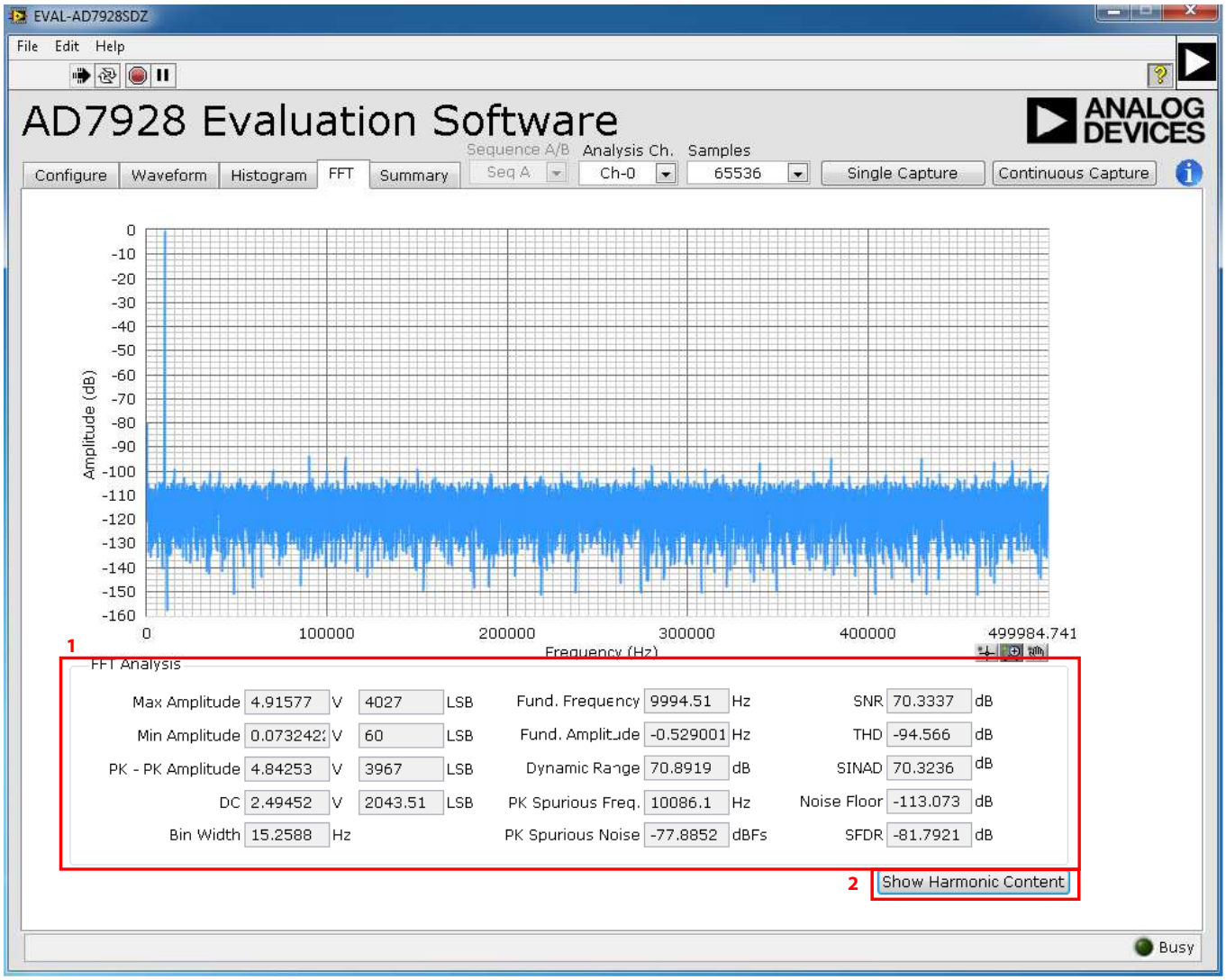

*Figure 20. **FFT** Capture Tab*

SUMMARY TAB

Figure 21 shows the **Summary** tab. This tab captures and displays all of the information in one panel with a synopsis of the information, including key performance parameters, such as **SNR** and **THD** (Label 1 and Label 2, respectively, in Figure 21). Waveform, histogram, and FFT plots are also displayed in summary format.

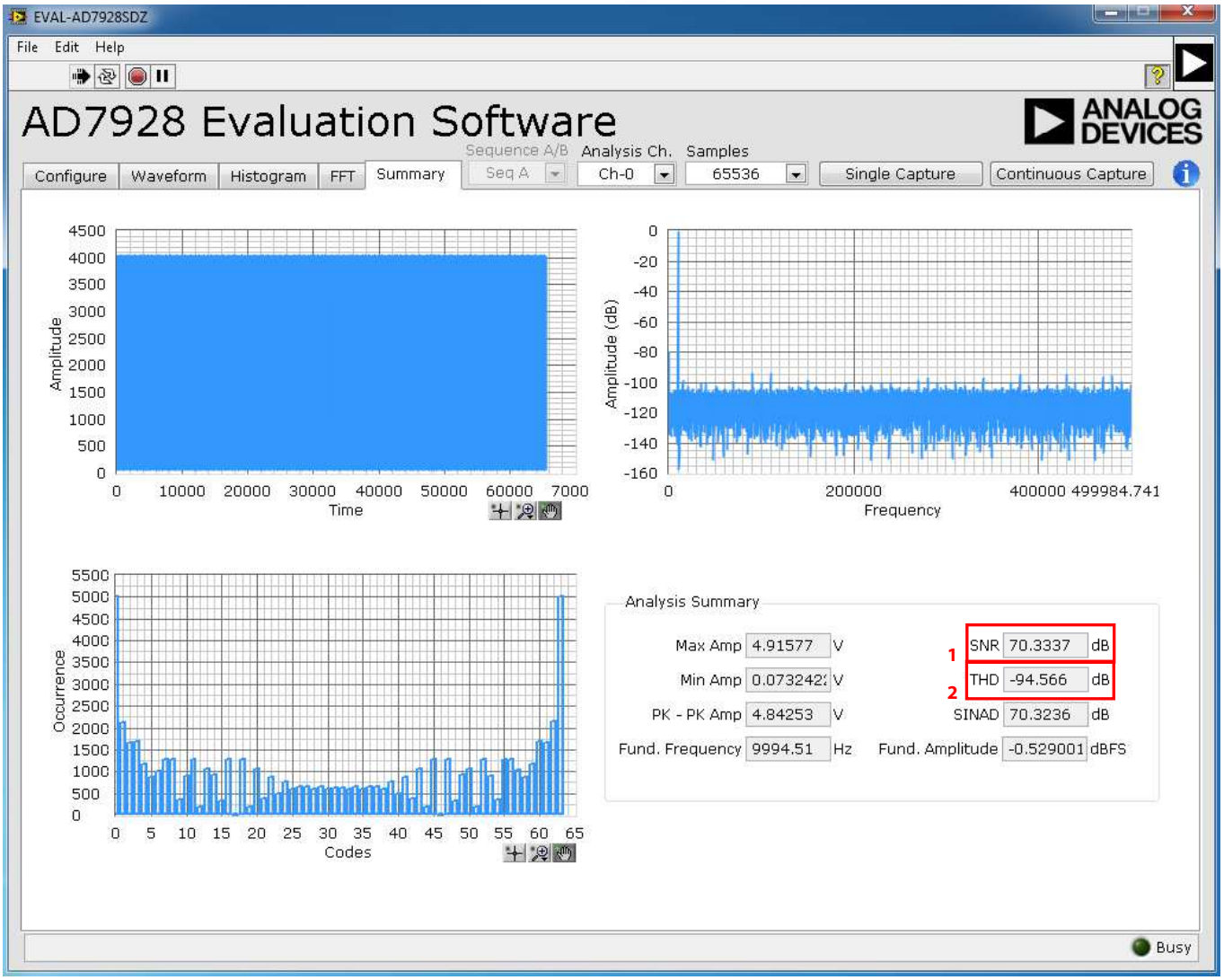

*Figure 21. **Summary** Tab*

SAVING FILES

The software can save the current captured data for future analysis. The software can capture the current plot images and the current device configuration, as well as the raw waveform data, histogram data, and ac spectrum data.

Saving Data

To save data, go to the **File** menu and click **Save Data** (or use the keyboard shortcut **Ctrl** + **S**). This action saves the raw data captured as seen in the **Waveform** tab in CSV format.

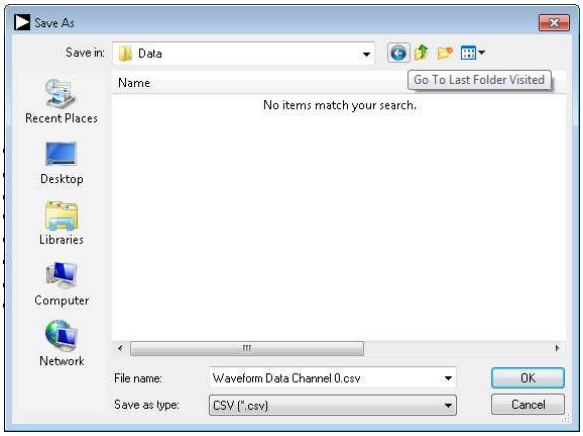

*Figure 22. **Save As** Data Dialog Box*

Saving Plot Images

To save plot images, go to the desired analysis tab, click the **File** menu, and then click **Save Image**.

The images are saved in JPEG format and do not contain any raw data information. Plots saved as images cannot be loaded back into the evaluation environment.

Figure 23 shows the **Save As** image dialog box. Save the images to an appropriate location.

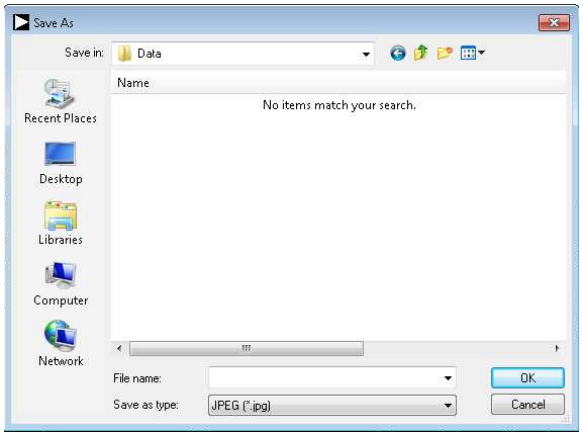

*Figure 23. **Save As** Image Dialog Box*

OPENING FILES

Loading Captured Data

The software can load previously captured data for analysis.

Go to the **File** menu, click **Load Data** (or use the keyboard shortcut **Ctrl** + **O**), and select waveform data previously saved in CSV format. The waveform data is a raw data capture that rebuilds the histogram and ac spectrum analyses upon being loaded into the evaluation platform.

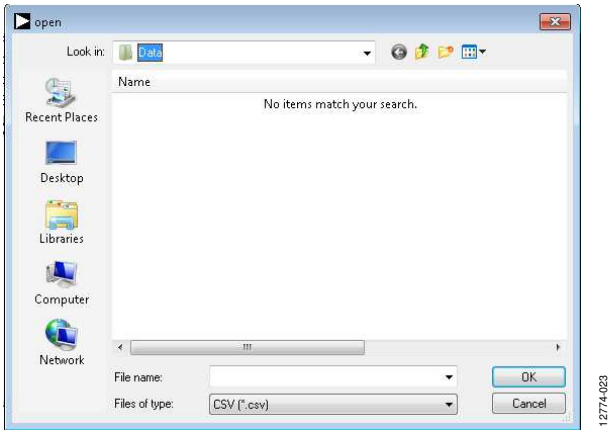

*Figure 24. **Open** File Dialog Box*

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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