ANALOG DEVICES

EVAL-AD7760EDZ/EVAL-AD7762EDZ User Guide
UG-593

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 AD7760 and AD7762 Using the EVAL-CED1Z

FEATURES

Full featured evaluation board for the AD7760/AD7762
EVAL-CED1Z-compatible
On-board 4.096 V reference
Crystal clock oscillator MCLK source
Evaluation software for control and data analysis
  (download from product page)
Filter programmability—load custom filter to ADC

EVALUATION KIT CONTENTS

EVAL-AD7760EDZ or EVAL-AD7762EDZ evaluation board
EVAL-AD7760EDZ/EVAL-AD7762EDZ software CD
  (also available for download from product page)

ADDITIONAL EQUIPMENT NEEDED

EVAL-CED1Z (must order separately), includes a USB cable
Bench top power supply to Connector J2

GENERAL DESCRIPTION

This user guide describes the evaluation boards for the AD7760/AD7762 Σ-Δ analog-to-digital converters (ADCs). The AD7760, a 24-bit ADC, combines wide input bandwidth and high speed with the benefits of Σ-Δ conversion with a performance of 100 dB SNR at 2.5 MSPS, making it ideal for high speed data acquisition.

The AD7762 derivative is a parallel version with a maximum output data rate of 625 kSPS.

Complete specifications for the AD7760/AD7762 are available in the AD7760 and AD7762 data sheets available from Analog Devices, Inc.; the data sheets should be consulted in conjunction with this user guide when using the evaluation board.

The evaluation software is available to download from the AD7760 and AD7762 product pages.

The AD7760 interfacing signals are created by the EVAL-CED1Z board, which is used in conjunction with the evaluation board to enable data acquisition via the provided software and USB link. The kit requires the controller evaluation and development (CED1) board, the EVAL-CED1Z, which must be purchased separately. The evaluation board includes all routing required for evaluating the ADC.

The combination of the evaluation board and the EVAL-CED1Z board allied with the EVAL-AD7760EDZ/EVAL-AD7762EDZ software allows the user to upload samples taken by the AD7760/AD7762 onto a PC showing the waveform being sampled, as well as allowing the data to be shown in histogram or FFT format. The AD7760/AD7762 can also be used on a standalone basis (without the EVAL-CED1Z); however, in this case, the user must provide the interface and acquisition requirements.

TYPICAL SETUP
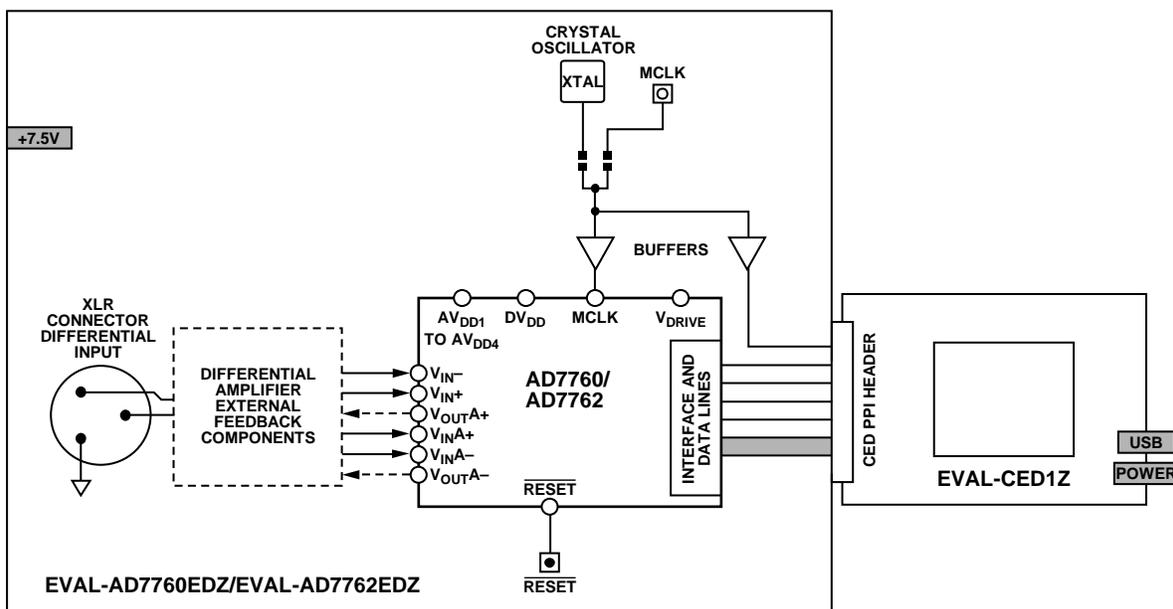
Figure 1. Typical Setup (EVAL-AD7760EDZ/EVAL-AD7762EDZ on Left and EVAL-CED1Z on Right)

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REVISION HISTORY

9/15—Revision 0: Initial Version

GETTING STARTED

The EVAL-AD7760EDZ/EVAL-AD7762EDZ controls and evaluates the performance of the AD7760/AD7762 when operated with the EVAL-CED1Z board. The software is compatible with Windows® 2000 and Windows XP. If the setup file does not run automatically, run setup.exe from the CD provided.

INSTALLING THE SOFTWARE

When the CD is inserted into the PC, an installation program automatically begins. This program installs the evaluation software. The user interface on the PC is a dedicated program written especially for the AD7760/AD7762 when operated with the EVAL-CED1Z board.

Warning

The software must be installed before the USB cable is connected between the EVAL-CED1Z and the PC, to ensure that the appropriate USB driver files have been properly installed before the EVAL-CED1Z is connected to the PC.

STARTING THE SOFTWARE

When the software is run for the first time with the EVAL-CED1Z board connected to the PC, the PC automatically finds and identifies the new device. Follow the instructions that appear on screen to install the drivers for the CED1 on the PC.

If an error appears when the software is first started, the PC is not recognizing the USB device. To correct this error,

1. Access the device manager by selecting **Device Manager** from the **Hardware** tab of the **System Properties** window.
2. Examine the devices listed under the **Universal Serial Bus Controller** heading.
3. If an unknown device is listed, right-click the unknown device and click **Update Driver**.
4. After the **New Hardware Wizard** runs twice, note that, under the **ADI Development Tools**, the following is listed: **ADI Converter Evaluation and Development Board (WF)**.
5. Restart the PC.

SETTING UP THE SYSTEM

Follow the steps in this section to set up the evaluation board, the EVAL-CED1Z, and the software to begin using the complete system.

1. Insert the CD into the appropriate computer drive. Initial software installation information as shown in Figure 2 appears.
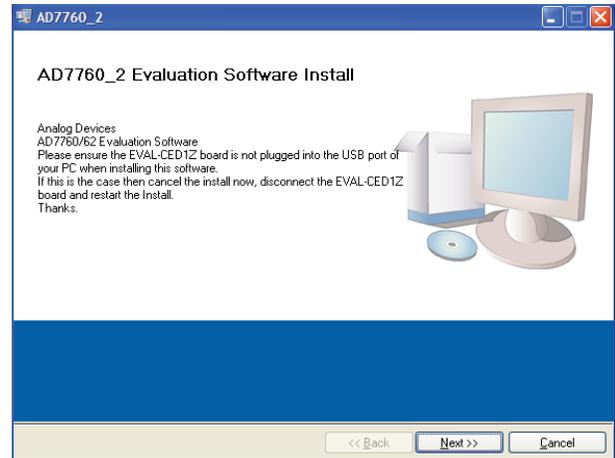
Figure 2. Initial Software Install

2. Choose the destination directory. Note that the default directory is shown. If a different location is preferred, click **Browse** and select the desired location. Then, click **Next**.
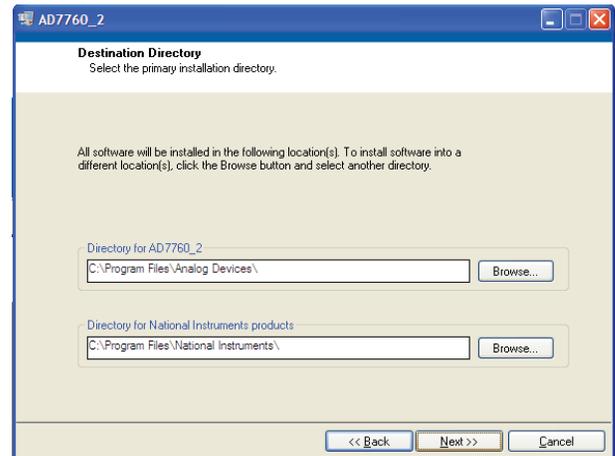
Figure 3. Choose the Destination for the Software

3. Accept the license agreement and click **Next** as shown in Figure 4.
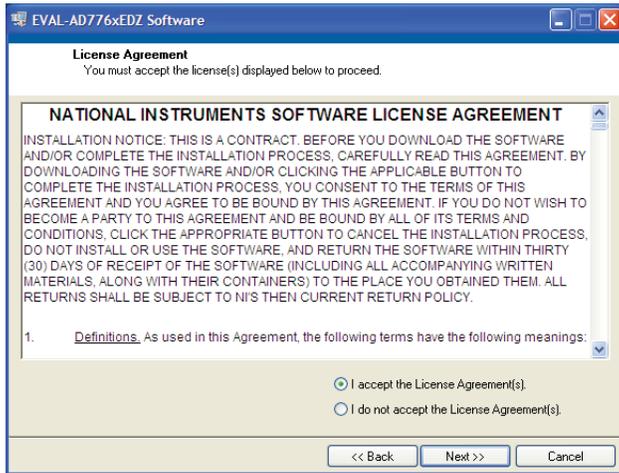
Figure 4. Accept License Agreement

4. To start the installation, click **Next** as shown in Figure 5. This window shows the installation actions being taken.
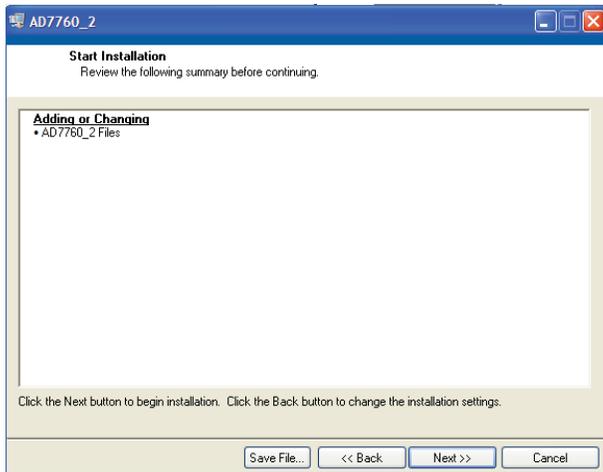
Figure 5. Install Steps

5. Follow the path chosen during installation to locate the software. If the default location was chosen, the location of the software (for the AD7760) is **Start** > **All Programs** > **Analog Devices** > **AD7760_2** > **AD7760_2**.
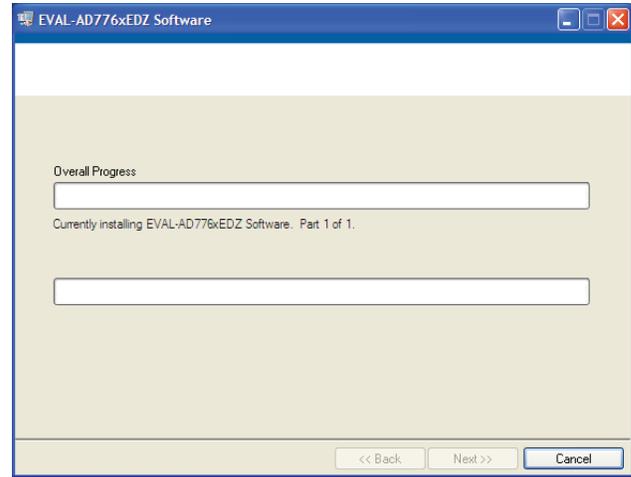
Figure 6. Default Location of AD7760/AD7762 Software

6. When the installation completes, the window as shown in Figure 7 displays. Restart the PC for the software to take full effect.
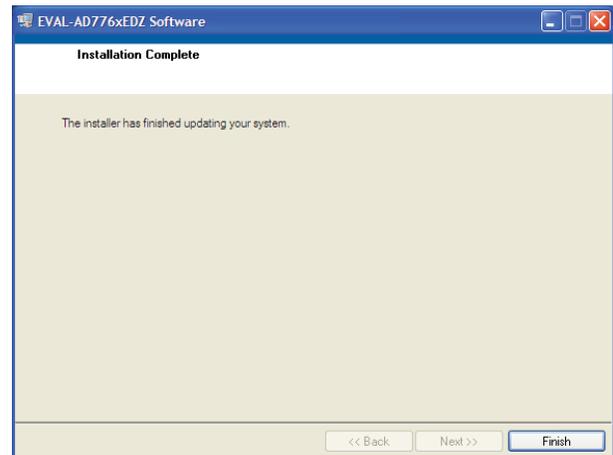
Figure 7. Install Completed

ABOUT THE EVALUATION HARDWARE

POWER SUPPLIES

The EVAL-AD7760EDZ/EVAL-AD7762EDZ must be powered using an external power supply that applies 7.5 V between the V+ and GND terminals of Connector J2.

This 7.5 V supply is then regulated on board using ADP3334 devices (U9 and U6) to provide the 2.5 V and 5 V signals required by the AD7760/AD7762. The AV_{DD2}, AV_{DD3}, and AV_{DD4} supplies are the 5 V supplies to the AD7760/AD7762. A voltage of 2.5 V supplies the AV_{DD1}, V_{DRIVE}, and DV_{DD} pins of the AD7760/AD7762.

A separately regulated 2.5 V supply powers all the digital functionality on the evaluation board excluding the AD7760/AD7762. An individually regulated 5 V supply also supplies the crystal oscillator and clock buffer devices on the EVAL-AD7760EDZ/EVAL-AD7762EDZ. Setting LK1 to A means that the MCLK buffer is powered by 5 V, enabling the ADC to be operated using an MCLK signal with an amplitude of 5 V.

DIFFERENTIAL INPUT

The differential input to the AD7760/AD7762 is applied through Connector J1, which is an XLR audio standard connector. The differential inputs are routed through the AD7760/AD7762 on-board differential amplifiers using the external circuit components as detailed in the AD7760 and AD7762 data sheets.

STANDALONE OPERATION

The evaluation board can be used in a standalone manner (that is, without using the EVAL-CED1Z). In this case, however, the user must provide all required interface communications and a means to acquire the output data from the board.

DECOUPLING AND LAYOUT RECOMMENDATIONS

The AD7760 and AD7762 data sheets contain specific information about the decoupling and layout recommendations required to achieve optimum specifications.

The EVAL-AD7760EDZ/EVAL-AD7762EDZ adhere to these recommendations completely and are designed as the blueprint for users of the AD7760 and AD7762. The Gerber files for the evaluation board are available for download from the AD7760 and AD7762 product pages.

The EVAL-AD7760EDZ/EVAL-AD7762EDZ are 4-layer boards. One layer is a dedicated ground plane. All supplies to the devices on the EVAL-AD7760EDZ/EVAL-AD7762EDZ are decoupled to this ground plane. In addition to the printed circuit board (PCB) top and bottom layers, there is also a layer for routing power signals. All layers of the boards are detailed in the Evaluation Board Schematics and Artwork section.

In addition, the exposed paddle of an AD7760 or AD7762 is connected by multiple vias to this ground plane. The exposed paddle is not connected to any of the ground pins on the device.

LINK OPTIONS

The link options on the evaluation board are factory set for the required operating setup. The functions of these links are described in Table 1.

Table 1. Link Options

Link No.	Function	Position Descriptions	Default
LK1	Link option for power mode of the crystal oscillator	Removing this link places the crystal oscillator (Y1) in standby mode.	Inserted
R23, R12, R31	Sets the MCLK source for AD7760/AD7762 and EVAL-CED1Z	R23: a 0 Ω link routes the on-board oscillator to two parallel clock buffers in which one goes to MCLK and the other output goes to EVAL-CED1Z board to allow data acquisition using the supplied software. R12, R31: populate R31 to select external MCLK source through Connector J8. R12 may be use for termination of any external MCLK source.	R23

CONNECTING THE EVALUATION HARDWARE

Connecting the hardware is a five step process.

1. Apply power to the EVAL-CED1Z via the +7 V, 15 W power supply provided with the EVAL-CED1Z board. The green LED (labeled Power) on the EVAL-CED1Z lights up to indicate that the EVAL-CED1Z is receiving power. The USB cable can then be connected between the PC and the EVAL-CED1Z.
2. Connect the USB cable between the PC and the EVAL-CED1Z. A green LED positioned beside the USB connector on the EVAL-CED1Z board lights up, indicating that the USB connection has been established.
3. Power up the EVAL-AD7760EDZ/EVAL-AD7762EDZ through Connector J2. Connect a wire from the connector labeled V+ to 7.5 V of an external power supply. In addition, ensure that there is a GND connection between the GND of J2 and the power supply GND connection.
4. Connect the female connector (J3, marked CED1Z PPI), which is on the underside of the evaluation board, to the PPI header of the EVAL-CED1Z board.
5. Start the evaluation software.

The differential input to the AD7760/AD7762 device can be connected to the black XLR connector (J1) marked Differential Input. This differential input is routed to the inputs of the on-board differential amplifier for the device. Because the software powers up the device, do not apply an analog input until the device is fully powered up.

When the hardware is set up, use the software to control the EVAL-CED1Z and the EVAL-AD7760EDZ/EVAL-AD7762EDZ.

Launch the software from the **Analog Devices** menu: from the **AD7760_2** submenu, click the **AD7760_2** icon.

Note that if an error message appears, click **OK** and restart the application after checking the connection between the adapter board and the USB port on the PC. Also check that the USB device is identified by the **Device Manager**, as detailed in the Installing the Software section.

USING THE EVALUATION SOFTWARE

After the hardware is initially installed, follow the instructions to set up the evaluation software each time the system is used. Note that the hardware must be powered up as described in the About the Evaluation Hardware section.
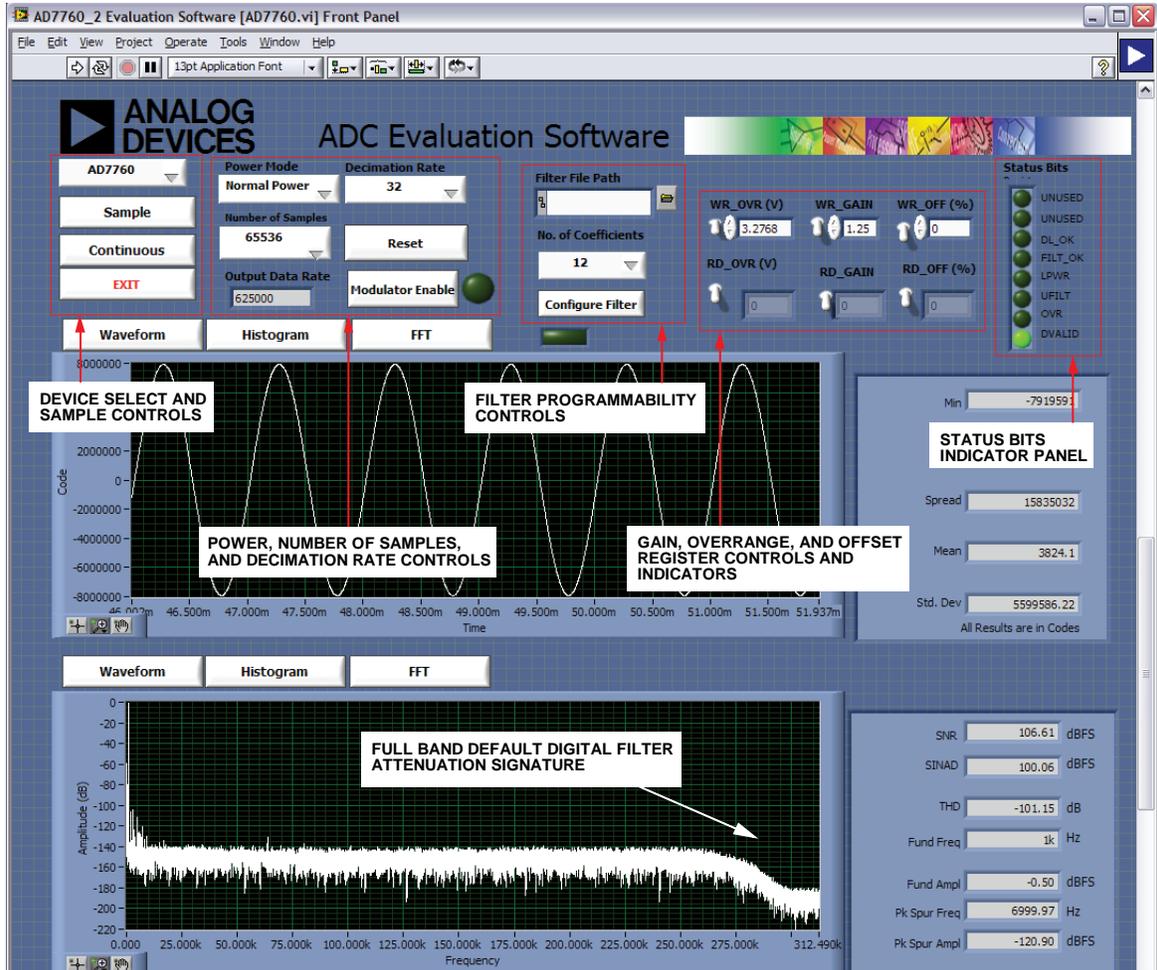
Figure 8. Front Panel Showing Control and Indicator Information and the Performance with a −0.5 dB, 1 kHz Input Tone in Decimate by 32 Mode when Running with the Default 40 MHz MCLK

OVERVIEW OF THE MAIN WINDOW

Refer to the front panel shown in Figure 8 when following these steps.

1. Find the default download location for the evaluation software by clicking **Start** > **All Programs** > **Analog Devices** > **AD7760_2** > **AD7760_2**. For a location other than the default, follow the path entered during setup. The evaluation software GUI appears (see Figure 8).
2. Select the correct device: AD7760 or AD7762.
3. To power up the device under evaluation, click the **Power Mode** drop-down menu, and select **Low Power** or **Normal Power**. This prompts the EVAL-CED1Z to write to the AD7760/AD7762 registers and power up the device.
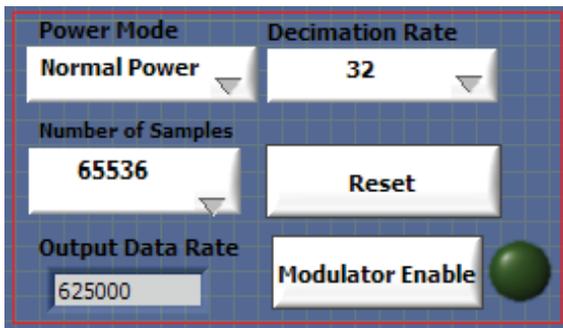
Figure 9. Powering Up

4. Note that the external voltage supply connected to the EVAL-AD7760EDZ/EVAL-AD7762EDZ shows ~240 mA in **Normal Power** mode and ~170 mA in **Low Power** mode. Seeing the current draw levels change when switching between the power modes also verifies that communication between the evaluation board and CED1 board is operational.
5. Change the decimation rate setting by clicking the **Decimation Rate** drop-down menu as shown in Figure 9. Note that the device powers up in a default decimation setting of 32. Changing the rate allows the user to vary the oversampling rate and implement the five on-chip decimation options offering output data rates ranging from 78 kHz to 2.5 MHz output for the AD7760.

6. Specify the **Power Mode**, **Decimation Rate**, and **Number of Samples** to be acquired (typically 65,536 samples) by using the drop-down menus on the software front panel. The software allows the number of samples specified by the user to be viewed as a waveform, histogram, or FFT.
7. Choosing the different decimation rates in the software controls writes to the AD7760/AD7762 Control Register 2 to change the amount of decimation used in the second internal FIR filter of the AD7760. This filter can be completely bypassed to enable decimate ×8 mode, or otherwise set to decimate from ×2 to ×32 to enable an overall decimation rate of 16 to 256 for the AD7760. Note that the AD7762 only operates in decimation rates of 32, 64, 128, and 256.
8. Click **Sample** or **Continuous** to show samples output by the evaluation board. **Sample** gives one set of samples, the length of which is determined by the **Number of Samples** selection on the software front panel. Clicking **Continuous** shows continuously updated samples of the analog input to the device.
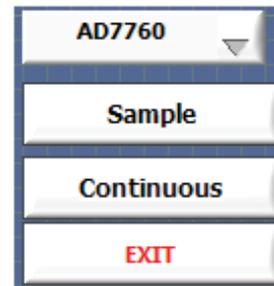
Figure 10. Showing Samples

9. Check the frequency of the $\overline{\text{DRDY}}$ pulse on an oscilloscope (test point marked $\overline{\text{DRDY}}$) and ensure that it matches the frequency shown in the **Output Data Rate** text box in the software front panel.
10. Observe if the frequencies match. If at any stage these frequencies do not match, reset the EVAL-AD7760EDZ/EVAL-AD7762EDZ evaluation board by pressing the $\overline{\text{RESET}}$ push button on the evaluation board. Then, set the **Decimation Rate** in the software front panel to the correct default value.

WORKING IN MODULATOR MODE

To enter modulator mode,

1. Click **Modulator Enable** as shown in Figure 9. When in modulator mode, the green indicator beside the control button appears lit.
2. Evaluation of the AD7760 device when using this hardware and software allows the user to look at the direct raw modulator output from the device bypassing all of the internal FIR filtering.

3. Running in modulator mode allows the user to see the noise shaping provided by the AD7760 Σ-Δ modulator as shown in Figure 11.
4. Click **Modulator Enable** to exit modulator mode; the green indicator light goes off. Reset by clicking **Reset** and then set the **Decimation Rate** as desired to run with the internal default FIR filters.
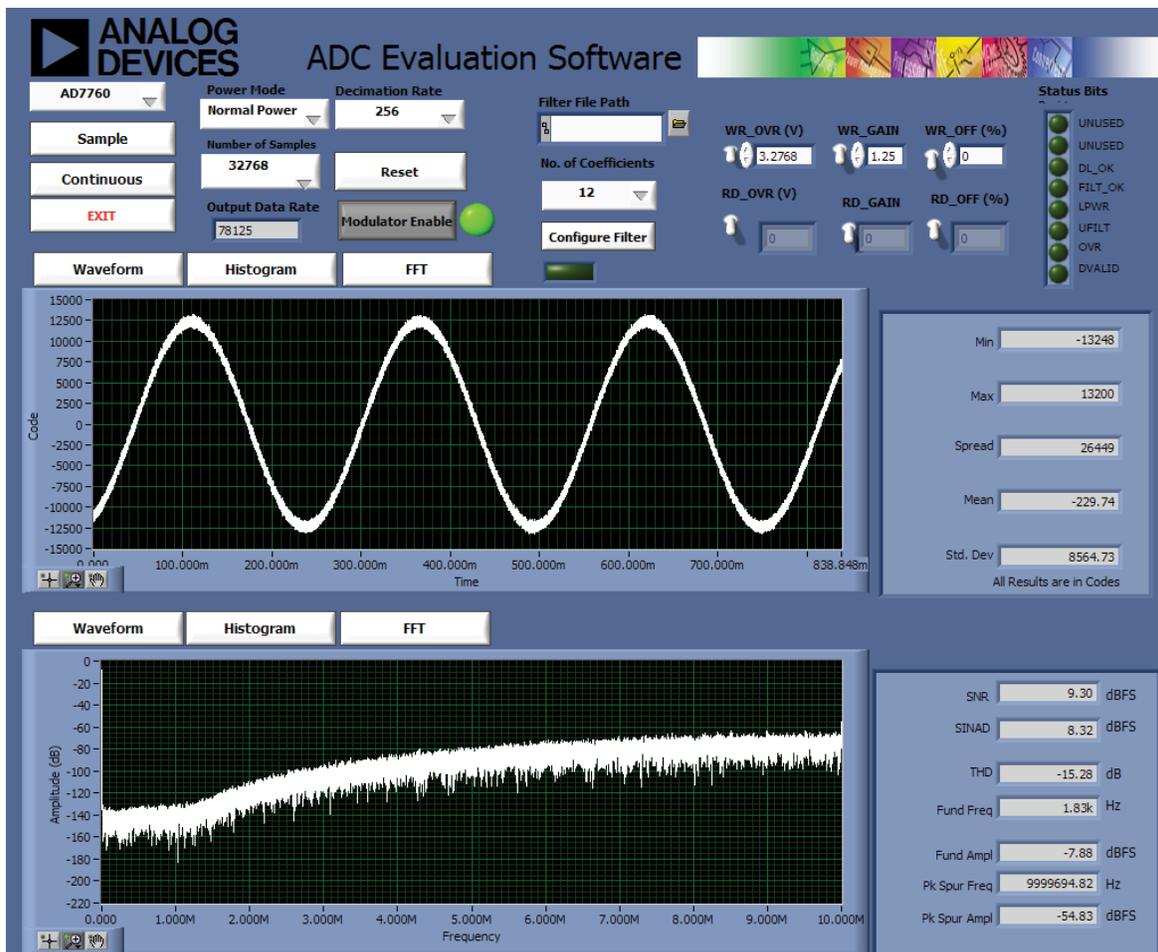
Figure 11. Modulator Mode Example of Noise Shaping Provided by the AD7760; the High Frequency Content of the Modulator Output Leads to the Coarse Nature of the Waveform Shown

DOWNLOADING A USER DEFINED FILTER

The final stage of the AD7760/AD7762 FIR filters can be programmed to suit the specific requirements of the user. The filter designed must correspond with the requirements listed in the data sheet; it must be a symmetrical filter with an even number of coefficients. The number of coefficients can range from 12 to 96.

Keep the following points in mind:

- Due to the symmetry of the filter, the coefficients repeat. Therefore, only half of the coefficients are required to be sent to the AD7760/AD7762.
- The device software reads the coefficients from a text file and writes each coefficient to the AD7760/AD7762. The filter file must contain the correct checksum, which is also written to the ADC, and the file must be in the correct format.

An example of this format is shown in Figure 12. This example corresponds to the example digital filter in the device data sheet.

Each of the 32-bit words (in this case, there are 12 words for the coefficients and the checksum) are in a hexadecimal format—there must be no spaces between the characters and no text, spaces, or notation before or after any of the hexadecimal words to be written. The software implements a text read from each line of the file and then translates this value to the correct binary 32-bit word to be written to the AD7760/AD7762 as per the description in the data sheet.
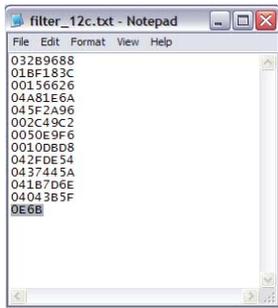
Figure 12. Example of Format for Filter Coefficients for Download

To download a filter,

1. Select the number of coefficients for download—this is half the filter length. Therefore, for example, for a 24 tap filter, select 12 from the drop-down selection shown in Figure 13.
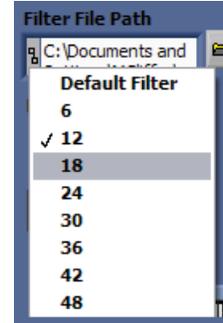
Figure 13. Number of Coefficients

2. Click the folder icon and browse to the location of the filter text file. The installation placed a copy of the data sheet example at **Program files/Analog Device/AD7760_2**; this file is called **filter_12c.txt**.
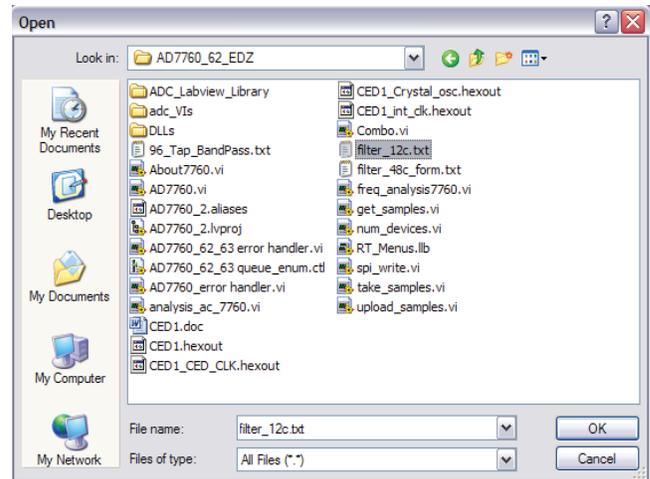
Figure 14. Browse to Select the Specific Text File

3. Click **Configure Filter** to download the user defined filter.
4. Click **Sample** to acquire a batch of samples from the device.

The filter example used in the device data sheet shows a slower transition band. The FFT of this filter implementation is shown in Figure 15. As highlighted, the status bits output by the ADC show whether the filter file was downloaded correctly.

The indicators for the DL_OK, FILT_OK and UFILT are all asserted to show a successful filter download.
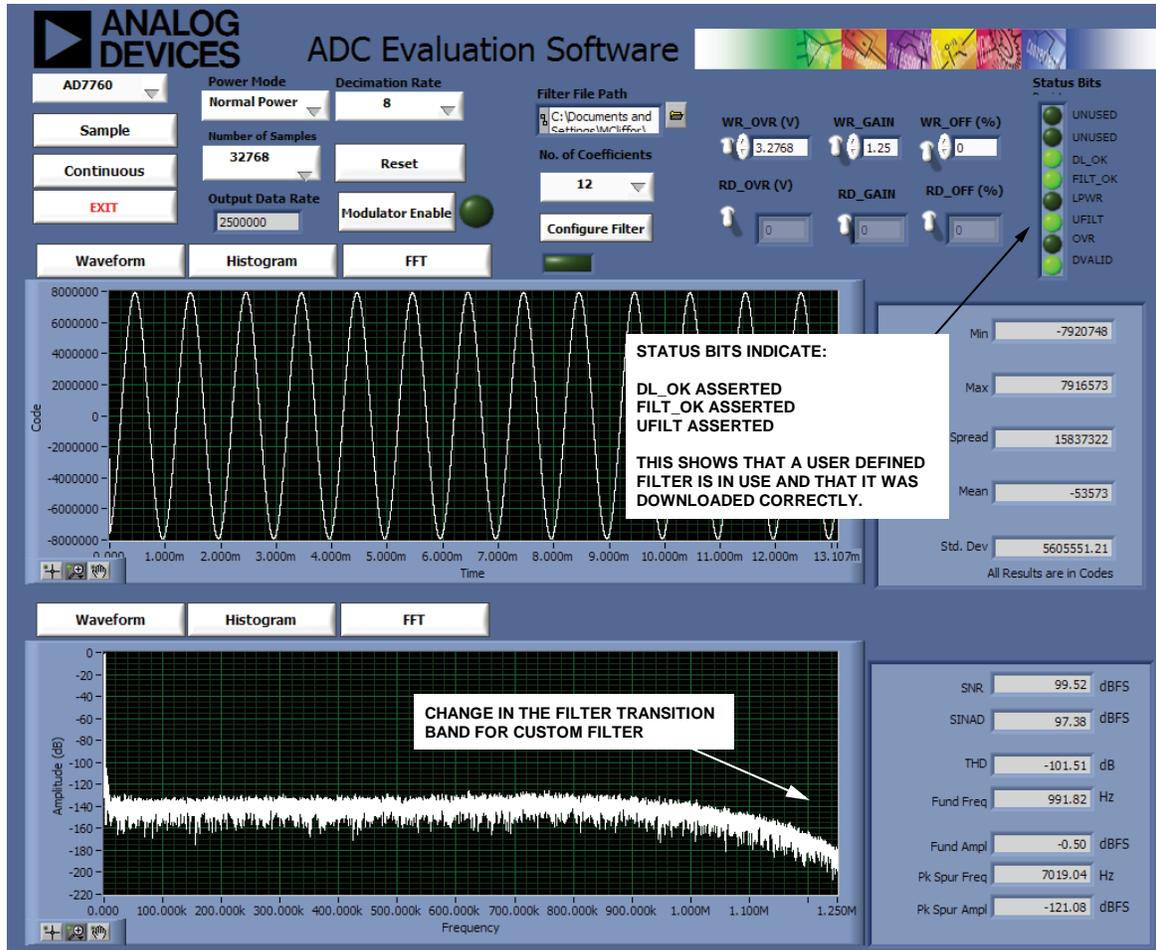
Figure 15. User Defined Filter Example Implemented on Evaluation Board, Note Illuminated Indicators and Custom Filter Transition Band

WRITING TO GAIN, OFFSET, AND OVERRANGE REGISTERS

The evaluation board allows the user to write to the on-board registers for control of gain correction, offset correction, and the setting of the overrange flag.

For example, the default value of the gain correction register, 1.25, can be changed to a value of 1.00 by setting the value in the **WR_GAIN** box to 1.00. Click the white **WR_GAIN** switch on the front panel to write to the gain register.

To check that the value has been written correctly, click the white **RD_GAIN** switch on the front panel. The value of the gain register is shown in the **RD_GAIN** indicator box.

Figure 16. Writing to the On-Board Registers

EVALUATION BOARD SCHEMATICS AND ARTWORK
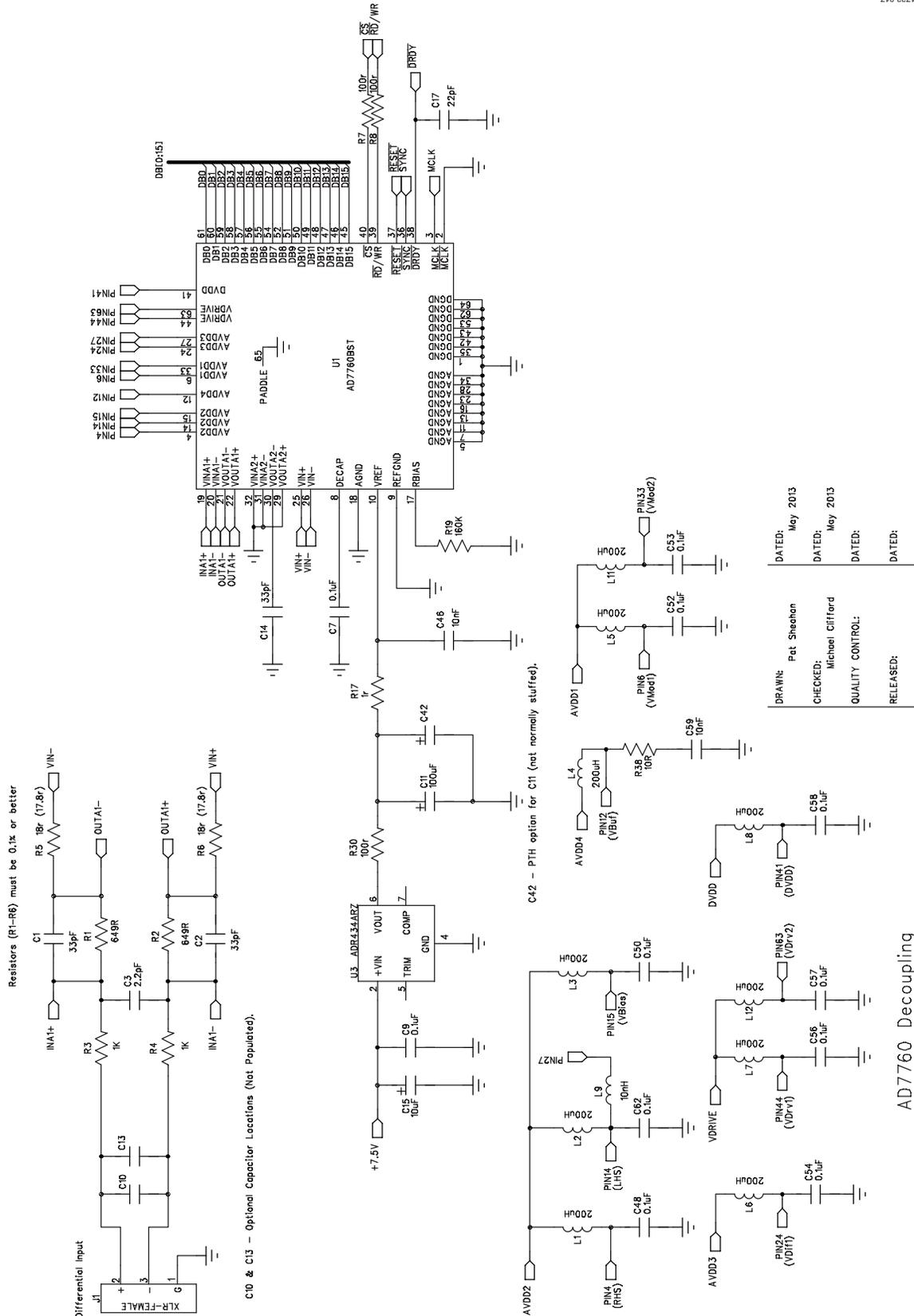
Figure 17. EVAL-AD7760EDZ/EVAL-AD7762EDZ Schematic—Analog Section
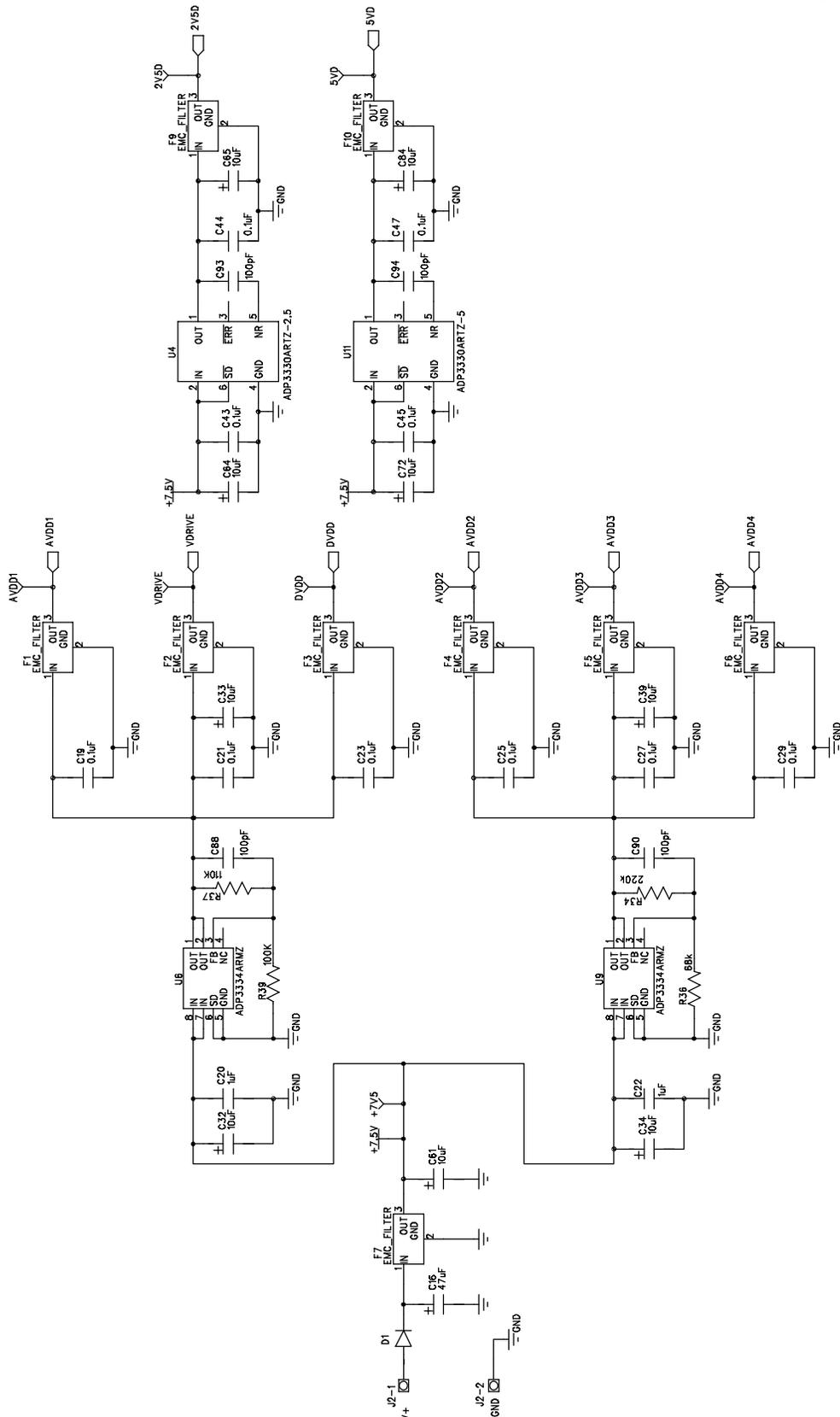
Figure 18. EVAL-AD7760EDZ/EVAL-AD7762EDZ Schematic—Power Supply Section
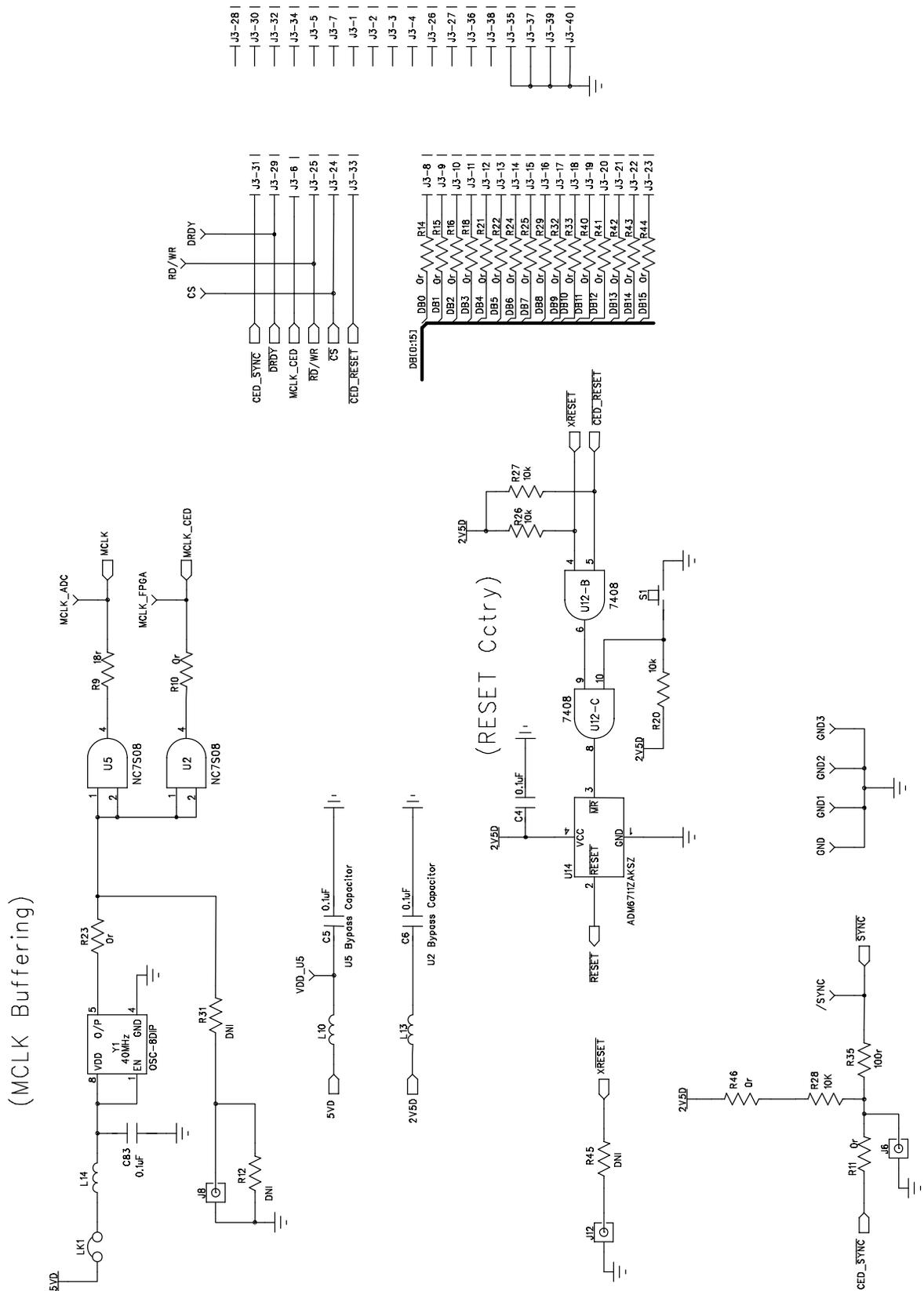
Figure 19. EVAL-AD7760EDZ/EVAL-AD7762EDZ Schematic—Interface Section
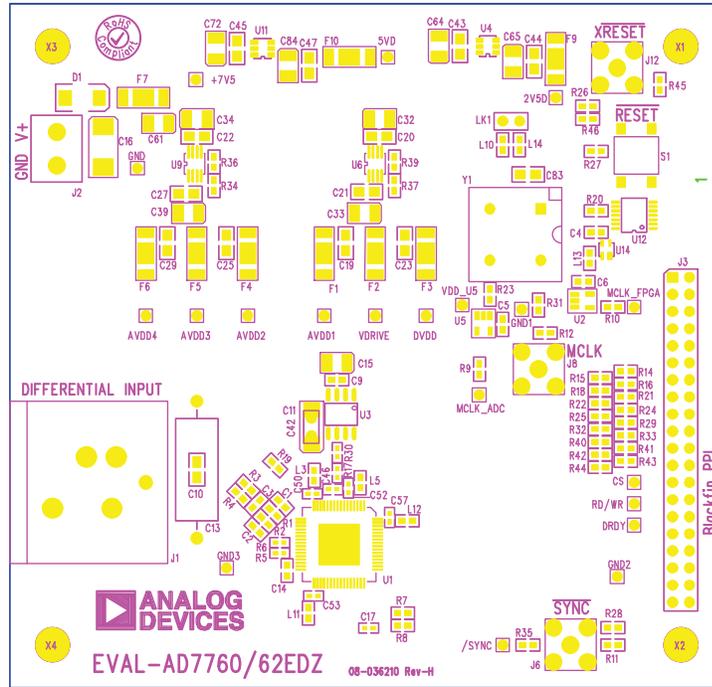
Figure 20. *EVAL-AD7760EDZ/EVAL-AD7762EDZ Component Side Top Silkscreen Artwork*
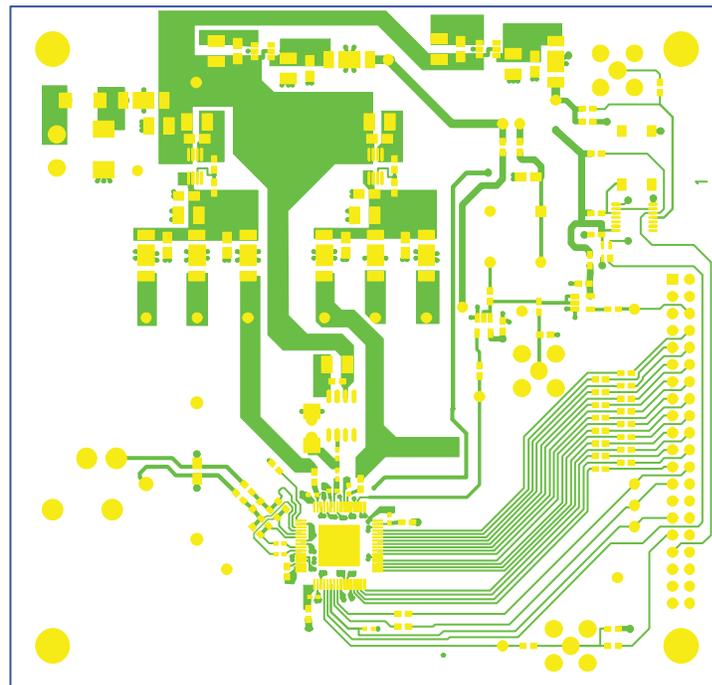
Figure 21. *EVAL-AD7760EDZ/EVAL-AD7762EDZ Component Side Layer 1 Artwork*
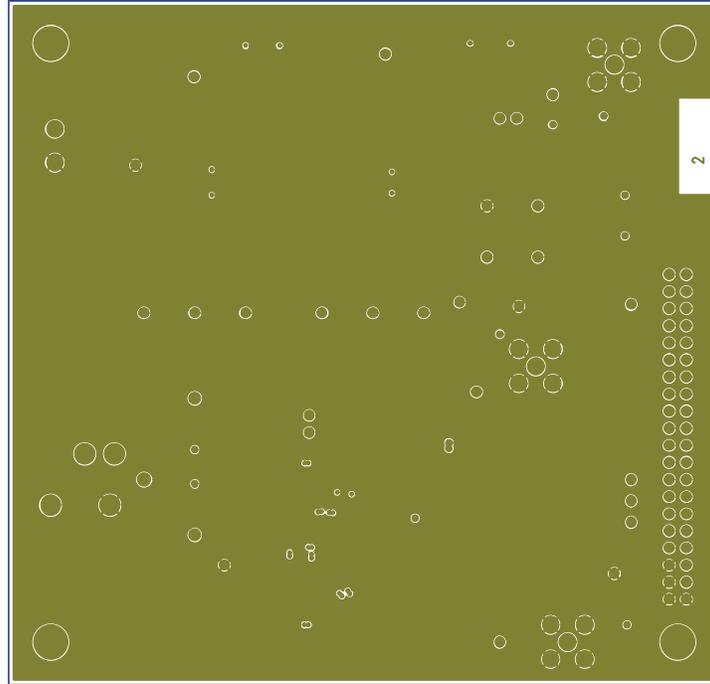
Figure 22. EVAL-AD7760EDZ/EVAL-AD7762EDZ Ground Plane Layer 2 Artwork
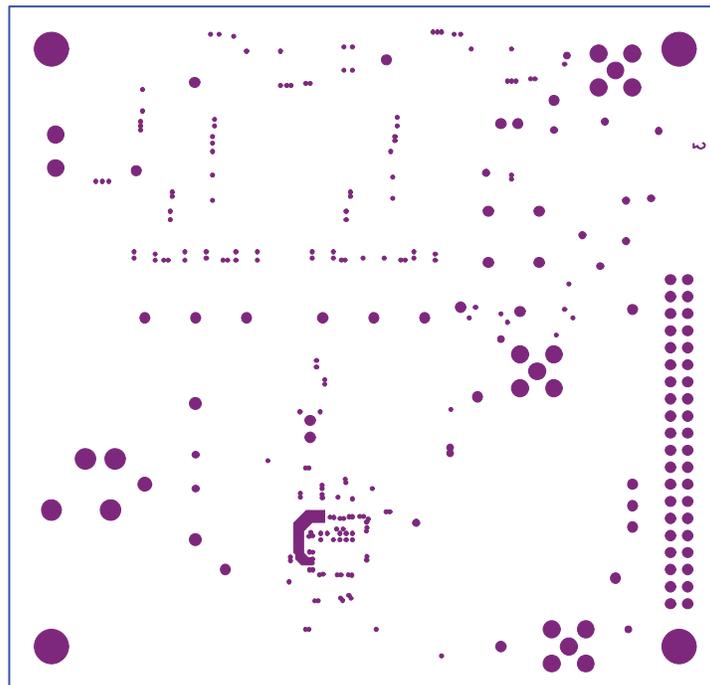
Figure 23. EVAL-AD7760EDZ/EVAL-AD7762EDZ Power Plane Layer 2 Artwork

Figure 24. EVAL-AD7760EDZ/EVAL-AD7762EDZ Solder Side Layer 4 Artwork

Figure 25. EVAL-AD7760EDZ/EVAL-AD7762EDZ Component Side Bottom Silkscreen Artwork

BILL OF MATERIALS

Table 2.

Name	Value	Part Number	Part Description	Stock Code[1]
+7V5, /SYNC, 2V5D, 5VD, AVDD1, AVDD2, AVDD3, AVDD4, CS, DRDY, DVDD, GND, GND1 to GND3, MCLK_ADC, MCLK_FPGA, RD/WR, VDD_U5, VDRIVE			Test point, holes must be left free of solder	Do not insert
C1, C2, C14	33 pF	06035A330JAT2A	50 V, NPO, multilayer ceramic capacitor	FEC 498555
C3	2.2 pF	CC0603CRNPO9BN2R2	50 V, NPO, multilayer ceramic capacitor	FEC 721888
C4 to C6, C9, C56, C58, C62	0.1 µF	B0603R104KCT	16 V, X7R, multilayer ceramic capacitor	FEC 9406140
C7, C48, C50, C52 to C54, C57	0.1 µF	CC0402ZRY5V7BB104	16 V, Y5V, multilayer ceramic capacitor	FEC 3019482
C10, C13	DNI	Not applicable	Optional capacitor footprint (0805)	Do not insert
C11	100 µF	TAJC107K010RNJ	10 V, tantalum capacitor	FEC 197180
C15, C32 to C34, C39, C61, C64, C65, C72, C84	10 µF	TAJB106K020RNJ	20 V, tantalum capacitor	FEC 197427
C16	47 µF	TAJD476K020RNJ	20 V, tantalum capacitor	FEC 197464
C17	22 pF	GRM1555C1H220JZ01D	50 V, C0G, multilayer ceramic capacitor	FEC 8819629
C19, C21, C23, C25, C27, C29, C43 to C45, C47, C83	0.1 µF	U0805R104KCT	50 V, X7R, multilayer ceramic capacitor	FEC 9406387
C20, C22	1 µF	GRM21BR71C105KA01L	16 V, X7R, multilayer ceramic capacitor	FEC 9527710
C42	DNI	Not applicable	PTH capacitor location	Do not insert
C46	10 nF	CM05X7R103K16AH	16 V, X7R, multilayer ceramic capacitor	FEC 578149
C59	10 nF	CC0603KRX7R8BB103	25 V, X7R, multilayer ceramic capacitor	FEC 3019561
C88, C90, C93, C94	100 pF	U0603C101JCT	50 V, NPO, multilayer ceramic capacitor	FEC 9406115
D1		S2M	2 A, rectifier diode	FEC 9843876
F1 to F10		NFE61PT102E1H9L	1 nF, 3-terminal capacitor	FEC 9528202
J1		NC3FAH1-1	XLR female audio connector	FEC 724518
J2		CTB5000/2	2-pin, terminal block (5 mm pitch)	FEC 151789
J3		M20-7832046	40-pin (2 × 20) DIL vertical socket	FEC 7992033
J6, J8, J12		R114426000	50 Ω, SMB jack	FEC 4194512
L1 to L8, L10 to L14	200 µH	74279266LF	Inductor	
L9	10 nH	B82496C3100J	Inductor	FEC 3877024
LK1		M20-9990246	2-pin (0.1" pitch) header and shorting shunt	FEC 1022247 and 150-411
R1, R2	649 Ω	RN73C1J649RBTG	Precision SMD resistor	FEC 1140503
R3, R4	1 kΩ	RN73C1J1K0BTG	Precision SMD resistor	FEC 1140509
R5, R6	18 Ω (17.8 Ω)	RN73C1J17R8BTG	Precision SMD resistor	FEC 1140429
R7, R8, R35	100 Ω	MC 0.063W 0603 1% 100 Ω	SMD resistor	FEC 9330364
R9	18 Ω	MC 0.063W 0603 5% 18 Ω	SMD resistor	FEC 9331840
R10, R11, R14 to R16, R18, R21 to R25, R29, R32, R33, R40 to R44, R46	0 Ω	MC 0.063W 0603 0R	SMD resistor	FEC 9331662
R12, R31, R45	DNI	Not applicable	SMD resistor	Do not insert
R17	1 Ω	RC0603FR-071RL	SMD resistor	FEC 9238123
R19	160 kΩ	MC 0.063W 0603 1% 160 kΩ	SMD resistor	FEC 9330682
R20, R26 to R28	10 kΩ	MC 0.063W 0603 1% 10 kΩ	SMD resistor	FEC 9330399
R30	100 Ω	RC0402FR-07100RL	SMD resistor	FEC 9239111
R34	220 kΩ	MC 0.063W 0603 1% 220 kΩ	SMD resistor	FEC 9330836
R36	68 kΩ	MC 0.063W 0603 1% 68 kΩ	SMD resistor	FEC 9331468
R37	110 kΩ	MC 0.063W 0603 1% 110 kΩ	SMD resistor	FEC 9330461
R38	10 Ω	MC 0.063W 0603 1% 10 Ω	SMD resistor	FEC 9330429

Name	Value	Part Number	Part Description	Stock Code[1]
R39	100 kΩ	MC 0.063W 0603 1% 100 kΩ	SMD resistor	FEC 9330402
S1		B3S-1000	SMD push button switch (sealed 6 mm × 6 mm)	FEC 177-807
U1		AD7760BSVZ/AD7762BSVZ	AD7760/AD7762 analog-to-digital converter	AD7760BSVZ/ AD7762BSVZ
U2, U5		NC7SZ08M5	Single AND gate	FEC 1013807
U3		ADR434ARZ	Ultralow noise XFET voltage references	ADR434ARZ
U4		ADP3330ARTZ-2.5	Low dropout regulator	ADP3330ARTZ-2.5
U6, U9		ADP3334ARMZ	Adjustable LDO regulator	ADP3334ARMZ-REEL7
U11		ADP3330ARTZ-5	Low dropout regulator	ADP3330ARTZ-5
U12		SN74LVC08APWR	Quad, two-input, positive AND gate	FEC 1102978
U14		ADM6711ZAKSZ	Reset generator	ADM6711ZAKSZ
X1 to X4		Not applicable	PCB standoff (0.156" hole)	Do not insert
Y1	40 MHz	MX045HS40M0000	HCMOS/TTL clock oscillator	Digi-Key CTX175-ND
Y1 (alternate)	40 MHz	MS06122	40.0 MHz, GXO-U100H/B, 5 V, half size, ±50 ppm stability, 0 + 70°	Second source P/N for Y1

[1] The FEC stock code notation refers to the stock order code for that component from Farnell Element 14.

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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