

Evaluation Board for the AD7781 20-Bit, Pin-Programmable, Low Power, Sigma-Delta ADC

FEATURES

Full-featured evaluation board for the AD7781

Standalone USB interface

Various linking options

PC software for control of AD7781

GENERAL DESCRIPTION

This user guide describes the evaluation board for the [AD7781](#), which is a pin programmable, low power, 20-bit sigma-delta (Σ - Δ) ADC. The AD7781 is a complete analog front end for low frequency measurement applications such as bridge sensor systems. It contains one differential input and includes a low noise instrumentation amplifier. The output data rate can be programmed to 10 Hz or 16.7 Hz. The AD7781 also has an on-board clock, eliminating the need for an external clock. It employs a Σ - Δ conversion technique to realize up to 20 bits of no missing codes performance. The input signal is applied to an analog modulator. The modulator output is processed by

an on-chip digital filter. The analog input channel of the AD7781 accepts analog input signals of $\pm V_{REF}$ or $\pm V_{REF}/128$. With the update rate programmed to 10 Hz, the rms noise is 44 nV when the gain is 128. Simultaneous 50 Hz/60 Hz rejection is available at both output data rates.

Full data on the AD7781 is available in the AD7781 data sheet available from Analog Devices, Inc., and should be consulted in conjunction with this user guide when using the evaluation board.

The evaluation board interfaces to the USB port of an IBM-compatible PC. Software is available with the evaluation board that allows users to easily communicate with the AD7781.

Note that the AD7781 evaluation board software should be installed before connecting the AD7781 evaluation board to the PC.

Another component on the AD7781 evaluation board is the [ADP3303](#) high precision, low power, 3.3 V output voltage regulator, which is used to power the USB/SPI interface.

FUNCTIONAL BLOCK DIAGRAM

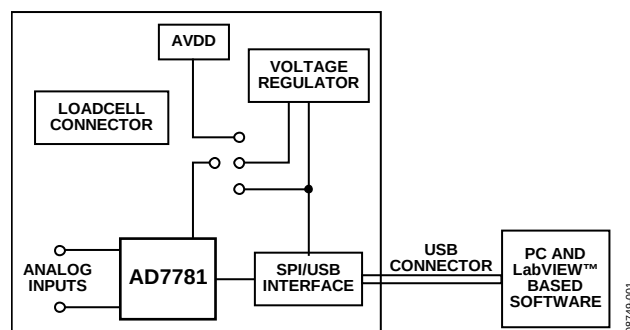


Figure 1.

TABLE OF CONTENTS

Features	1	Evaluation Board Software.....	6
General Description	1	Software Description	6
Functional Block Diagram	1	Installing the Software	6
Revision History	2	Using the Software	6
Evaluation Board Hardware.....	3	Main Window	7
Power Supplies	3	Weighscale Demo Window.....	8
Links	3	Evaluation Board Schematic and Artwork.....	9
Setup Conditions	4	Ordering Information.....	13
Sockets	4	Bill of Materials.....	13
Interfacing to the Evaluation Board.....	5		

REVISION HISTORY

2/10—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POWER SUPPLIES

The AD7781 evaluation board is powered via the 5 V supply from the USB connector, J1. This 5 V supply can be used to power the [AD7781](#) directly. A 3.3 V regulated voltage from the on-board [ADP3303](#) (a high precision, low power, 3.3 V output voltage regulator) can also be used. Alternatively, the AD7781 can be powered using an external 3 V or 5 V power supply via J2.

LINKS

There are sixteen groups of link options that must be set for the required operating setup before using the evaluation board. The functions of these link options are outlined in Table 1.

Table 1. Evaluation Board Link Settings

Link	Default	Description
LK1, LK2	In	These links are used to connect the AIN(+) and AIN(−) inputs to AV _{DD} /2. With this configuration, a noise analysis can be performed. With these links removed, an external voltage may be applied to AIN(+)/AIN(−) using the SMB connectors.
LK3, LK4	In	With LK3 and LK4 in place, AV _{DD} is used as the reference to the AD7781. REFIN(+) is connected to AV _{DD} and REFIN(−) is connected to GND. To use another reference source, remove LK3 and LK4.
LK5	3.3 V	LK5 is used to select the power source for AV _{DD} on the AD7781. In Position A, LK5 selects an external power supply, supplied via J2. In Position B, LK5 selects the 3.3 V regulated output from the on-board ADP3303 voltage regulator. In Position C, LK5 selects the 5 V supply from the USB connector, J1.
LK6 to LK11	In	These links connect the serial interface pins of the AD7781 to the SPI interface of the microcontroller. The links should be in place to use the AD7781 evaluation board software. With these links removed, the AD7781 can be interfaced to an external microcontroller.
LK12, LK13, LK14	In	These links are used for the bridge power-down switch. With LK12 inserted, the bridge power-down switch is connected to AV _{DD} through an LED. When the bridge power-down switch is closed, the LED turns on. LK13 should be open when LK12 is inserted. LK13 and LK14 are used when a load cell is connected to Header J4. LK12 should be left open. With LK13 inserted, the bridge power-down switch is connected to Header J4. The low side of the load cell can be connected to GND through the bridge power-down switch. With LK14 inserted, the low side of the load cell is connected directly to GND. The terminal REFIN(−) should be shorted to the GND/PSW terminal on Header J4 to enable the previous functions.
LK15	10 Hz	LK15 is used to select the output data rate for the AD7781. With LK15 in Position 10 Hz, the output data rate is set to 10 Hz. When LK15 is in Position 16.7 Hz, the output data rate is set to 16.7 Hz.
LK16	128	LK16 is used to select the gain of the AD7781. With LK16 in Position 1, the gain is set to 1. With LK16 in Position 128, the gain of the AD7781 is set to 128.

SETUP CONDITIONS

Take care before applying power and signals to the evaluation board to ensure that all link positions are set per the required operating mode. Table 2 shows the position in which all the links are initially set.

Table 2. Initial Links and Positions

Link No.	Position	Function
LK1, LK2	In	AIN(+) and AIN(–) are shorted to $AV_{DD}/2$.
LK3, LK4	In	The reference voltage is set to 3.3 V (AV_{DD}).
LK5	B	The 3.3 V supply is used as AV_{DD} for the AD7781.
LK6 to LK11	In	The AD7781 is interfaced to the on-board microcontroller.
LK12	In	The bridge power-down switch is connected to AV_{DD} .
LK13	Out	The bridge power-down switch is disconnected from Header J4.
LK14	In	Terminal GND/PSW of Header J4 is connected to GND.

SOCKETS

There are five sockets relevant to the operation of the [AD7781](#) on this evaluation board. The functions of these sockets are outlined in Table 3.

Table 3. Socket Functions

Socket	Description
AIN+	Subminiature BNC (SMB) connector. The analog input signal for the AIN(+) input of the AD7781 is applied to this socket.
AIN–	Subminiature BNC (SMB) connector. The analog input signal for the AIN(–) input of the AD7781 is applied to this socket.
REFIN+	Subminiature BNC (SMB) connector. This socket is used in conjunction with REFIN– to apply an external reference to the AD7781. The voltage for the REFIN(+) input of the AD7781 is applied to this socket.
REFIN–	Subminiature BNC (SMB) connector. This socket is used in conjunction with REFIN+ to apply an external reference to the AD7781. The voltage for the REFIN(–) input of the AD7781 is applied to this socket.
J4	6-pin terminal block. This is used to connect an external load cell to the AD7781 evaluation board.

INTERFACING TO THE EVALUATION BOARD

Interface to the evaluation board is via a standard USB connector, J1. J1 is used to connect the evaluation board to the USB port of a PC. A standard USB connector cable is included with the AD7781 evaluation board to allow the evaluation board to interface with the USB port of the PC. Because the board is powered via the USB connector, there is no need for an external power supply, although if preferred, one may be connected via J2.

Communication between the [AD7781](#) and the PC is via the USB/SPI interface. The on-board USB controller (U2) handles this communication.

To set up the USB/SPI interface, use the following procedure:

1. Install the AD7781 evaluation board software using the supplied AD7781 evaluation board CD before connecting the board to the PC.
2. After the AD7781 evaluation board software is installed, connect the board to the PC via J1 on the AD7781 evaluation board and via the USB port on the PC using the supplied USB connector cable. The PC automatically finds the new USB device and identifies it as the **AD779x Evaluation Board**.
3. Follow the on-screen instructions that appear. During the installation process if the **Hardware Installation Wizard** appears as shown in Figure 2, click **Continue Anyway** to successfully complete the installation of the AD7781 evaluation board.



Figure 2. Hardware Installation Window

08749-002

EVALUATION BOARD SOFTWARE

SOFTWARE DESCRIPTION

The AD7781 evaluation board is shipped with a CD containing software that can be installed onto a standard PC to control the AD7781. The software communicates with the AD7781 through the USB cable, which accompanies the board. The software allows you to read conversion data from the AD7781. Data can be read from the AD7781 and displayed or stored for later analysis. For further information, see the [AD7781](#) data sheet available from Analog Devices.

INSTALLING THE SOFTWARE

Use the following steps to install the software:

1. Start Windows® and insert the CD.
2. The installation software should launch automatically. If it does not, use Windows Explorer to locate the **setup.exe** file on the CD. Double-click this file to start the installation procedure.

3. At the prompt, select a destination directory, which is **C:\Program Files\Analog Devices\AD7781** by default. Once the directory is selected, the installation procedure copies the files into the relevant directories on the hard drive. The installation program creates a program group called **Analog Devices** with the subgroup **AD7781** in the **Start** menu of the taskbar.
4. Once the installation procedure is complete, double-click on the **AD7781** icon to start the program.

USING THE SOFTWARE

Figure 3 shows the main window that is displayed when the program starts. The Main Window section briefly describes the various menu and button options in the main window.

The data that has been read can be exported to other packages, such as MathCAD™ or Microsoft® Excel, for further analysis.

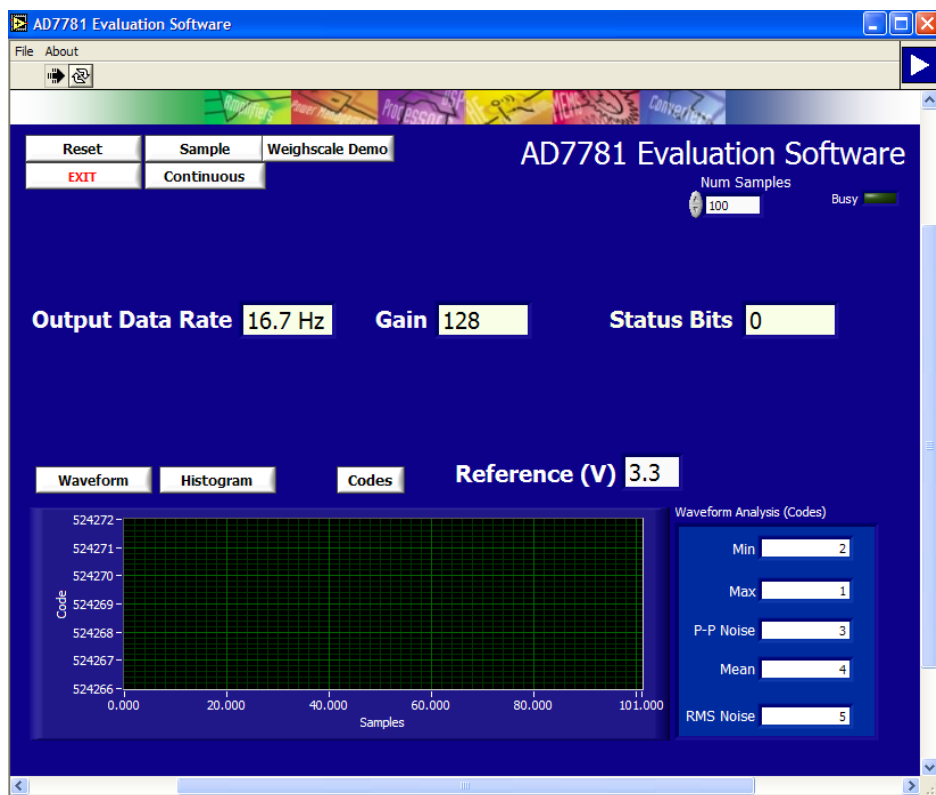


Figure 3. AD7781 Evaluation Software Main Window

MAIN WINDOW

Menu Bar

File

The **File** menu allows you to read previously stored data for display or analysis, write the current set of data to a file for later use, and exit the program.

About

The **About** menu provides information on the revision of software used.

Buttons

Reset

This button allows you to reset the [AD7781](#) software.

Exit

This button allows you to exit the software. It serves the same purpose as **Quit** in the **File** pull-down menu.

Sample

This button allows you to read a number of samples from the AD7781. Noise analysis is then performed on the samples. These samples can be stored for further analysis. The sample size is entered in the **Num Samples** text box.

Continuous

This button allows you to read a number of samples continuously. The software gathers a number of samples as specified by the **Num Samples** text box, performs noise analysis on the samples, and gathers the next group of samples.

Weighscale Demo

This button allows you to access the weighscale demonstration software.

Output Data Rate

This text box displays the output data rate of the AD7781.

Gain

This text box displays the gain of the AD7781.

Status Bits

This text box displays the status bits of the AD7781.

Waveform

The gathered conversions are displayed in graph form.

Histogram

The gathered samples are used to generate a histogram.

Codes

The gathered samples can be displayed in codes or in voltage format. When the **Codes** button is selected, the values are displayed as code. The **Codes** button changes to **Volts**. To display the information in volts, click **Volts**.

Reference

Enter the value of the external reference in the **Reference (V)** text box.

WEIGHSCALE DEMO WINDOW

Click **Weighscale Demo** (in the main window) to access the weighscale demo window (see Figure 4). The AD7781 evaluation board has a header, J3/J4, which allows you to interface the ADC to a load cell. To connect a load cell to the AD7781 evaluation board, LK1, LK2, LK3 and LK4 must be removed. A 6-wire load cell can be connected to J3/J4. With the load cell connected to the evaluation board, click the **RUN** button (the button changes to a **STOP** button after being clicked). The software then begins reading conversions from the AD7781. The output data rate and gain are continuously monitored so you can change either the gain or output

data rate within the weighscale demo window. The output data rate and gain being used by the AD7781 are reflected in the **Output Data Rate** and **Gain** windows. The maximum weight being applied to the load cell must be entered in the **Full-Scale Weight (Kg)** window. The **Zero-Scale Calibration** button performs an offset calibration, which is useful to remove the load cell TARE. With the full-scale weight placed on the load cell, a full-scale calibration is performed by clicking the **Full-Scale Calibration** button.

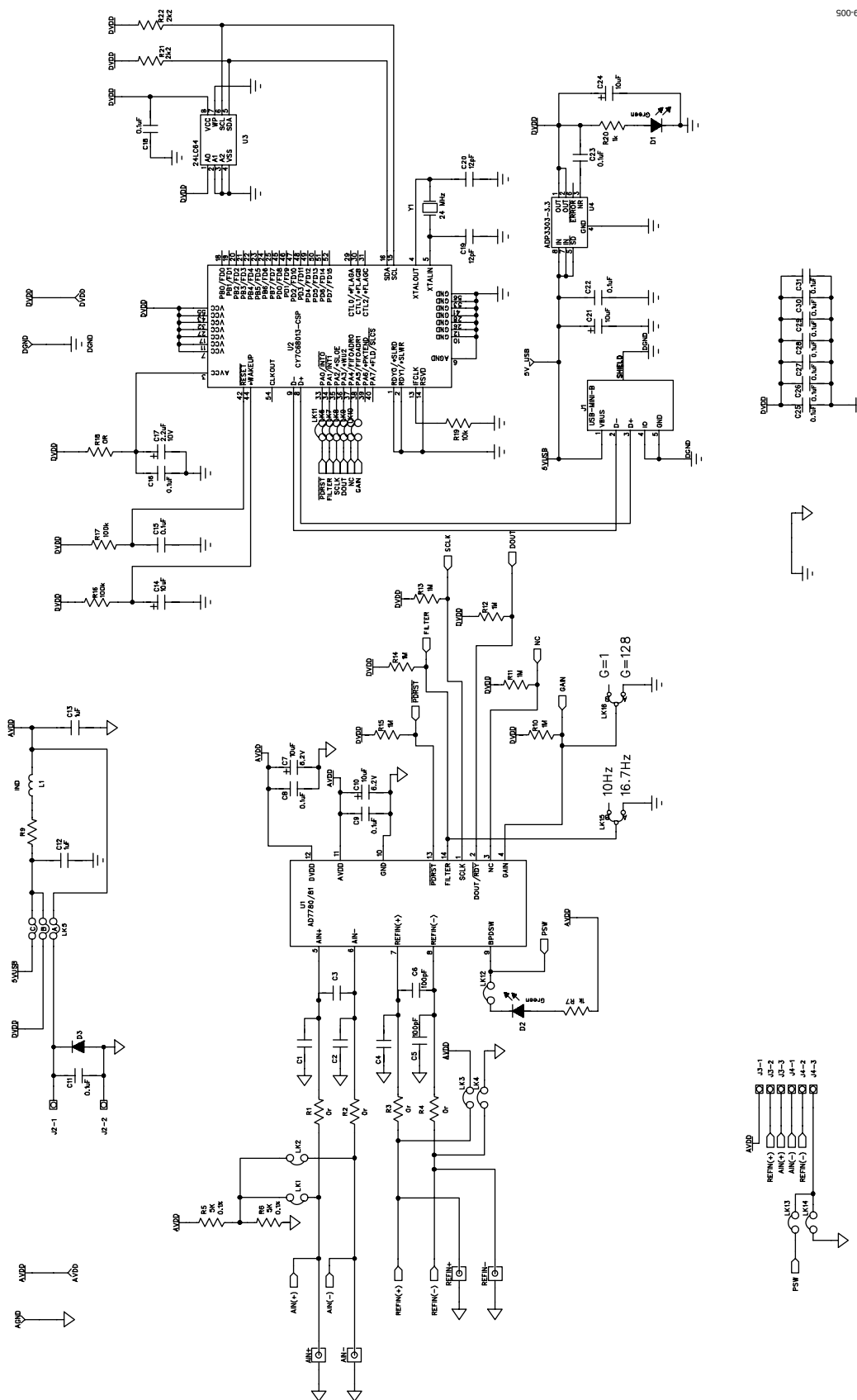
To stop conversions, click the **STOP** button. To exit the **Weighscale Demo**, click the **BACK** button.



Figure 4. AD7781 Evaluation Software Weighscale Demo Window

08749-004

08749-005



Rev. 0 | Page 9 of 16

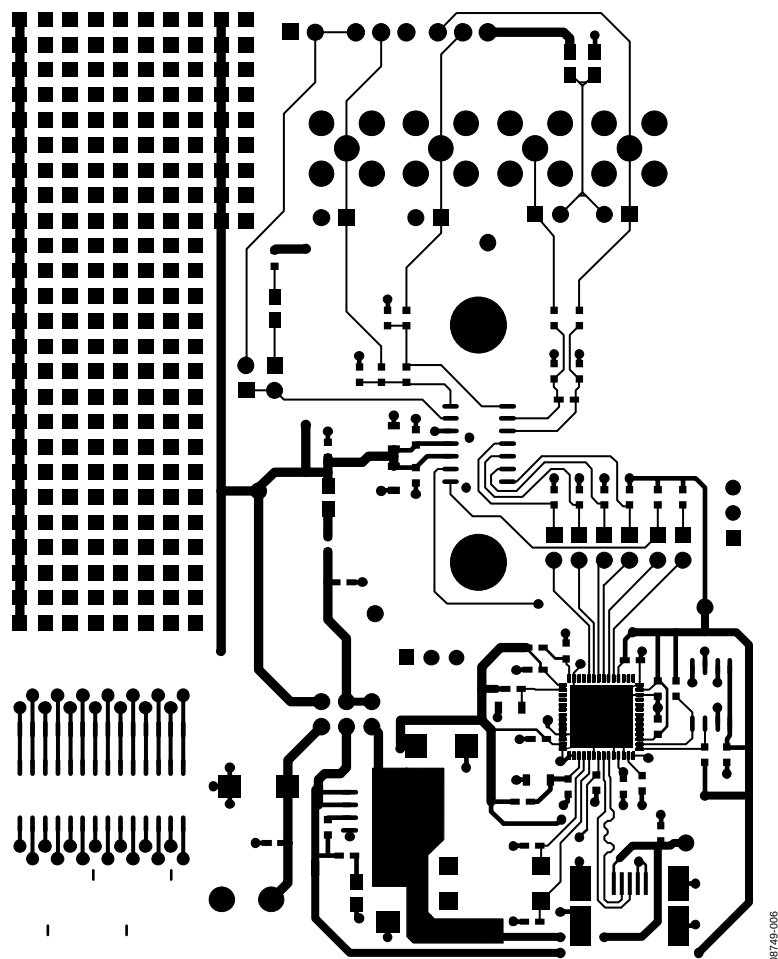


Figure 6. AD7781 Evaluation Board—Solder Side View

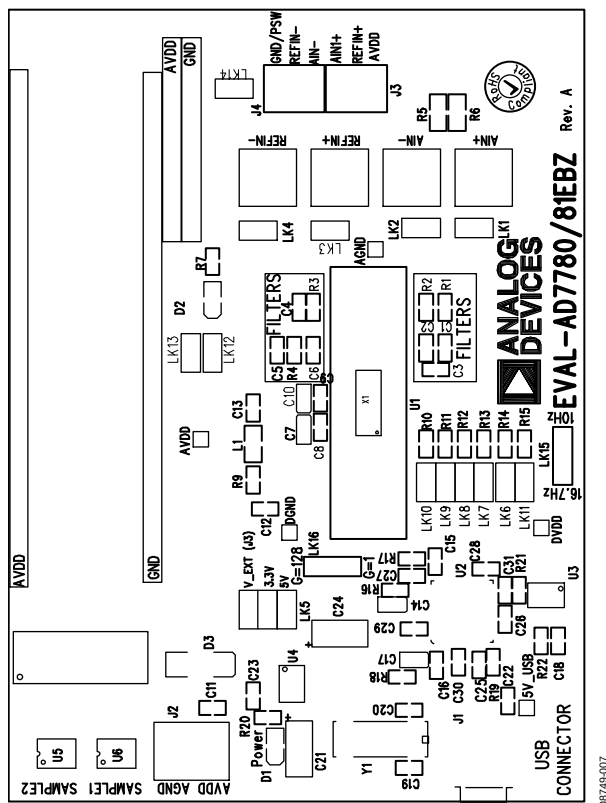


Figure 7. AD7781 Evaluation Board—Component Side View

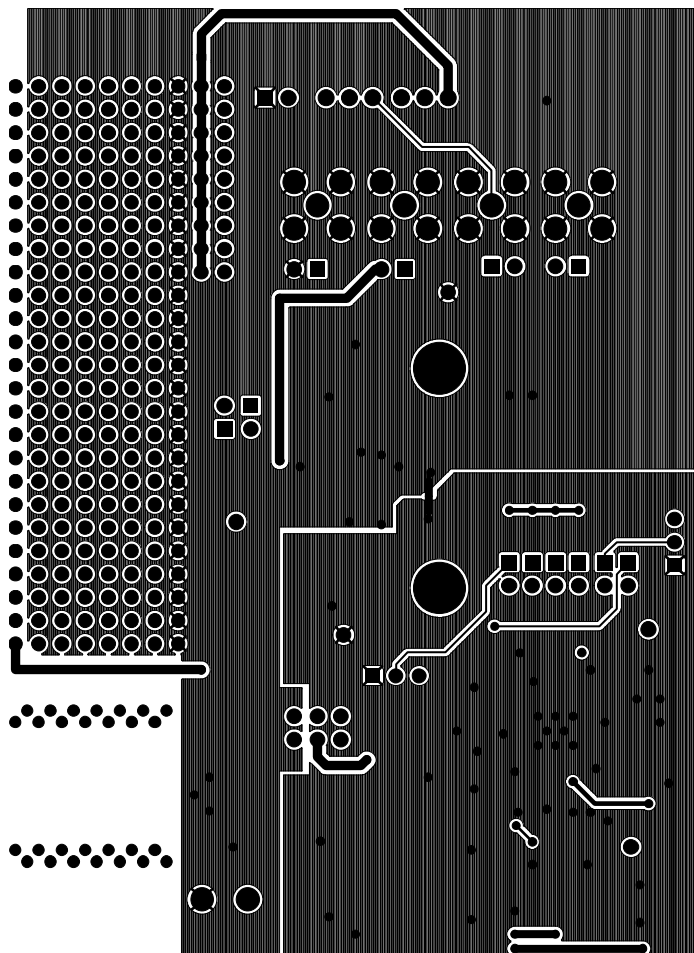


Figure 8. AD7781 Evaluation Board—Component Layout Diagram

ORDERING INFORMATION

BILL OF MATERIALS

Table 4.

Qty	Reference Designator	Description	Manufacturer, Part No.
	Integrated Circuits		
3	U1, U5, U6	24-bit Σ - Δ ADC	Analog Devices, AD7781BRZ
1	U2	USB controller	Cypress Semiconductor Corporation, CY7C68013A-56LFXC
1	U3	EEPROM	Microchip Technology, Inc., 24LC64-I/SN
1	U4	3.3 V Regulator	Analog Devices, ADP3303ARZ-3.3
1	Y1	24 MHz crystal	AEL Crystals, X24M000000S244
2	D1, D2	Green LED	Kingbright, Elec. Co., Ltd, KP-2012SGC
1	L1	Ferrite bead	Meggitt Sigma, BMB2A0300AN1
1	D3	Diode	Micro Commercial Components Corp., DL4001-TP
	Capacitors		
4	C1 to C4	Capacitors	Not inserted
2	C5, C6	100 pF ceramic	AVX Corporation, 06035A101JAT2A
15	C8, C9, C11, C15, C16, C18, C22, C23, C25 to C31	0.1 μ F $\pm$ 10% ceramic	AVX Corporation, CM105X7R104K16AT
3	C7, C10, C14, C21, C24	10 μ F tantalum	AVX Corporation, TAJA106M016R
2	C12, C13	1 μ F ceramic	Yageo Corporation, 2238 246 19863
1	C17	2.2 μ F tantalum	EPCOS AG, B45196E2225K109
2	C19, C20	12 pF ceramic	Phycomp, 2238 867 15129
	Resistors		
7	R1 to R4, R9, R18	0 Ω resistor	Phycomp, 232270296001
2	R5, R6	5 k Ω resistor	Tyco Electronics, RN73C2A4K99BTG
4	R10 to R15	1 M Ω resistor	Multicomp, MC 0.063W 0603 1% 1M
2	R16, R17	100 k Ω resistor	Multicomp, MC 0.063W 0603 1% 100K
4	R19	10 k Ω resistor	Multicomp, MC 0.063W 0603 1% 10K
1	R7, R20	1 k Ω resistor	Multicomp, MC 0.063W 0603 1% 1K
2	R21, R22	2.2 k Ω resistor	Multicomp, MC 0.063W 0603 1% 2K2
	Links		
13	LK1 to LK4, LK6 to LK14, (2 $\times$ 1 way)	Pin headers	Harwin Plc, M20-9990246
2	LK15, LK16 (3 $\times$ 1 way)	Pin headers	Harwin Plc, M20-9990246
1	LK5 (3 $\times$ 2 way)	Pin headers	Harwin Plc, M20-9980346
16	At LK1 to LK16	Shorting plugs	Harwin Plc, M7566-05
	Connectors		
4	AIN+, AIN-, REFIN+, REFIN-	SMB connector	Not inserted
1	J1	USB Mini-B connector	Molex, 565790576
2	J3, J4	3-way terminal block	Phoenix, 1725672
1	J2	2-way terminal block	Camden Electronics Ltd., CTB5000/2

NOTES

NOTES

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.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. **CONFIDENTIALITY.** This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. **ADDITIONAL RESTRICTIONS.** Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. **TERMINATION.** ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. **LIMITATION OF LIABILITY.** THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NONINFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). **EXPORT.** Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. **GOVERNING LAW.** This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.