Evaluating the ADAU1781 SigmaDSP using the EVAL-ADAU1781Z

EVAL-ADAU1781Z PACKAGE CONTENTS
EVAL-ADAU1781Z evaluation board
EVAL-ADUSB2EBZ (USBi) communications adapter
USB cable with Mini-B plug
Evaluation board/software quick start guide

DOCUMENTS NEEDED
ADAU1781 data sheet
INMP401 data sheet
AN-1006 Application Note, Using the EVAL-ADUSB2EBZ

GENERAL DESCRIPTION
This user guide explains the design and setup of the EVAL-ADAU1781Z SigmaDSP® evaluation board.

This evaluation board provides full access to all analog and digital I/Os on the ADAU1781. The SigmaDSP is controlled by Analog Devices, Inc., SigmaStudio™ software, which interfaces to the board via a USB connection. This evaluation board can be powered either over the USB bus or by a single 3.8 V to 6 V supply, which is regulated to the voltages required on the board. The PC board is a 4-layer design, with a single ground plane and a single power plane on the inner layers. The board contains on-board microphones and speaker, and connectors for external microphones and speaker. The master clock can be provided externally or by the on-board 12.288 MHz active oscillator.
# TABLE OF CONTENTS

- EVAL-ADAU1781Z Package Contents .......................................... 1
- Documents Needed ..................................................................... 1
- General Description ................................................................ 1
- Evaluation Board Top Side and Bottom Side ............................. 1
- Revision History ...................................................................... 2
- Evaluation Board Block Diagrams ............................................. 3
- Setting Up the Evaluation Board ............................................. 5
  - SigmaStudio Software Installation ....................................... 5
  - Installing the USBi Drivers ............................................... 5
  - Default Switch and Jumper Settings .................................. 5
- Powering Up the Board .......................................................... 6
- Connecting the Audio Cables .................................................. 6
- Setting Up Communications in SigmaStudio ......................... 6
- Configuring the Registers ...................................................... 6
- Creating a Basic Signal Flow .................................................. 7
- Downloading the Program to the DSP ................................. 10
- Using the Evaluation Board ................................................... 11
  - Power .................................................................................. 11
  - Master Clock ...................................................................... 11
  - Inputs and Outputs .......................................................... 11
  - GPIO .................................................................................. 11
  - Serial Audio Interface ...................................................... 11
  - Communications Header ................................................. 11
  - Power-Down ..................................................................... 11
- Evaluation Board Schematics and Artwork ............................... 12
- Ordering Information ............................................................ 21
  - Bill of Materials ............................................................... 21
  - Related Links .................................................................... 22

# REVISION HISTORY

1/15—Rev. 0 to Rev. A
- Changed ADMP401 to INMP401 ................................................... Throughout
- Deleted Installing the SigmaStudio Software Section ............... 5
- Added SigmaStudio Software Installation Section .................. 5

7/10—Revision 0: Initial Version
EVALUATION BOARD BLOCK DIAGRAMS

Figure 3. Functional Block Diagram

Figure 4. Board Layout Block Diagram
Figure 5. Default Jumper and Switch Settings (A Solid Black Rectangle Indicates a Switch or Jumper Position)
SETTING UP THE EVALUATION BOARD

SigmaStudio SOFTWARE INSTALLATION

SigmaStudio must be installed to use the EVAL-ADAU1781Z. To download and install the SigmaStudio software, follow these steps:

1. Create or log into your myAnalog account at www.analog.com.
3. Install SigmaStudio by double-clicking ADI_SigmaStudioRel-<version>.exe and following the prompts. A PC restart is not required.
4. Consult the SigmaDSP Processors and SigmaStudio Development Tool page at EngineerZone for answers to any questions.

INSTALLING THE USBi DRIVERS

SigmaStudio must be installed to use the USBi. When SigmaStudio has been properly installed, connect the USBi to an available USB port with the included USB cable. At this point, Windows® XP recognizes the device and prompts the user to install drivers (see Figure 6).

Select **Install from a list or specific location (Advanced)** and click **Next >** (see Figure 7).

When the warning about Windows Logo testing appears, click **Continue Anyway** (see Figure 9).

The USBi drivers are now installed. Leave the USBi connected to the PC.

DEFAULT SWITCH AND JUMPER SETTINGS

By default, the evaluation board is configured for single-ended stereo analog input and headphone output.

The J1, J10, J11, J13, and J14 jumpers must be connected. The GPIO jumper (J7) can be connected as desired to use GPIO circuitry.

Switch S3 (MCKI SOURCE) should be in the up (OSC) position, and Switch S4 (IN SELECT) should be in the right (ST_IN) position.
POWERING UP THE BOARD

To power up the board, connect the ribbon cable of the USBi to J2 (CONTROL PORT) of the EVAL-ADAU1781Z.

CONNECTING THE AUDIO CABLES

Connect a stereo audio source to J19 (ST IN). Connect headphones or powered speakers to J18 (HP OUT). The labels for J18 and J19 are only visible on the bottom of the board.

SETTING UP COMMUNICATIONS IN SIGMASTUDIO

Start SigmaStudio by double-clicking the shortcut on the desktop. Click File…New Project or press Ctrl+N to create a new project. The default view of the new project is called the Hardware Configuration tab.

To use the USBi in conjunction with SigmaStudio, first select it in the Communication Channels subsection of the toolbox on the left side of the Hardware Configuration tab, and add it to the project space by clicking and dragging it to the right (see Figure 10).

If SigmaStudio cannot detect the USBi on the USB port of the computer, the background of the USB label will be red (see Figure 11). This may happen when the USBi is not connected or when the drivers are incorrectly installed.

If SigmaStudio detects the USBi on the USB port of the computer, the background of the USB label changes to orange (see Figure 12).

To add an ADAU1781 to the project, select it from the Processors (ICs / DSPs) list and drag it to the project space (see Figure 13).

To use the USB interface to communicate with the target IC, connect it by clicking and dragging a wire between the blue pin of the USBi and the green pin of the IC (see Figure 14). The corresponding drop-down box of the USBi automatically fills with the default mode and channel for that IC.

CONFIGURING THE REGISTERS

To access the graphical register control window, click the IC 1 – SigmaLP2 Register Controls tab near the bottom of the window (see Figure 15).

Within the register control view, there are several tabs at the top for easy navigation. Start with the Codec Setup tab (see Figure 16).

Figure 10. Adding the USBi Communication Channel

Figure 11. USBi Not Detected by SigmaStudio

Figure 12. USBi Detected by SigmaStudio

Figure 13. Adding an ADAU1781

Figure 14. Connecting the USB Interface to an ADAU1781 IC

Figure 15. Register Control Tab

Figure 16. Codec Setup Register Tab
In the **Automatic Startup** section, click **Load Preset** (see Figure 17).

![Load Preset Button](image1.png)

**Figure 17. Load Preset Button**

If the board is connected and powered and the USBi drivers are installed correctly, the **PLL Lock Bit** indicator to the left of the **Load Preset** button changes to green to indicate that it is **Locked** (see Figure 18).

![PLL Lock Indicator](image2.png)

**Figure 18. PLL Lock Indicator**

Click the **Record Input Signal Path** tab (see Figure 19).

![Record Input Signal Path](image3.png)

**Figure 19. Record Input Signal Path**

In the **Record Gain Left (PGA)** and **Record Gain Right (PGA)** sections, the **Single ended Input Enable** controls are disabled by default. Click each button once to enable the single-ended input (see Figure 20).

![Record Path Controls](image4.png)

**Figure 20. Record Path Controls**

The rest of the register settings can remain at their default values.

**CREATING A BASIC SIGNAL FLOW**

To access the **Schematic** tab, where a signal processing flow can be created, click the **Schematic** tab at the top of the screen (see Figure 21).

![Schematic Tab](image5.png)

**Figure 21. Schematic Tab**

The left side of the schematic view includes the **Tree Toolbox**, which contains all of the algorithms that can run in the SigmaDSP. Select the **Input** cell from within the **IO > Input** folder (see Figure 22).

![Input Cell Selection](image6.png)

**Figure 22. Input Cell Selection**

Click and drag the **Input** cell into the blank schematic space to the right of the **Tree Toolbox** (see Figure 23).

![Input Cell](image7.png)

**Figure 23. Input Cell**
Navigate to the IO > Output folder and select the Output cell (see Figure 24).

Click and drag an output cell to the schematic. Do this again to create two outputs (see Figure 25).

Click and drag this cell to the schematic (see Figure 27).

Navigate to the Volume Controls > Adjustable Gain > Single/Multiple Controls/Clickless SW Slew folder and select the Growable Single Vol Ctrl cell (see Figure 26).

By default, this cell only has one input channel and one output channel, as indicated by the green input and right output dots. To add a channel, right-click in the blank white part of the cell and select Grow Algorithm > 1. Gain (RC slew) Growable DP > 1 from the menu (see Figure 28).

The cell should now have two inputs and two outputs (see Figure 29).
Navigate to the Filters > Second Order > Single Precision > Optimized > 2 Ch folder and select the Medium Size Eq cell (see Figure 30).

![Figure 30. EQ Cell Selection](image)

Click and drag the cell to the schematic (see Figure 31).

![Figure 31. Single-Band Stereo EQ Cell](image)

By default, the EQ only has one band. To increase the number of bands, right click in the blank white part of the cell and select Grow Algorithm > 1. 2 Channel - Single Precision, Optimized > 4 to increase the EQ to five bands (see Figure 32).

![Figure 32. Growing the EQ Cell](image)

The EQ should now have five bands (see Figure 33).

![Figure 33. Five-Band Stereo EQ Cell](image)

To change the properties of a filter, click its corresponding blue filter icon once (see Figure 34).

![Figure 34. Filter Properties Button](image)

Configure each filter as required. As an example, create a low shelf at 50 Hz, peaking filters at 200 Hz, 500 Hz, and 2000 Hz, and a high shelf at 10 kHz (see Figure 35).

![Figure 35. Configured Five-Band EQ Cell](image)
Connect the cells together by left-clicking a blue output dot and clicking and dragging to the green output dot of the next cell. Continue until the signal flow is completed from input to output for each channel (see Figure 36).

The basic signal flow is now complete with stereo I/O, a five-band equalizer, and a clickless volume control.

DOWNLOADING THE PROGRAM TO THE DSP

To compile and download the code to the DSP, click Link-Compile-Download once in the main toolbar of SigmaStudio (see Figure 37). Alternately, press the F7 key.

The signal flow should now be running on the evaluation board, and audio should pass from input to output. The controls for filters and volume can be changed in real time by clicking and dragging them with the mouse.
USING THE EVALUATION BOARD

POWER

Power can be supplied via the USB bus by connecting the EVAL-ADUSB2EBZ (USBi) to Header J2, by a battery connected to J15, or by a tip-positive 3.8 V dc to 6 V dc power supply on Connector J16. In the case of power over the USB bus, connect Jumper J1. The on-board regulator generates the 3.3 V dc supply for the on-board circuitry. LED D1 lights up when power is supplied to the board. To connect the output of the regulator to the ADAU1781, connect the J10 and J11 jumpers. Optionally, J9 can be connected if the speaker outputs are used.

MASTER CLOCK

The master clock to the ADAU1781 can be supplied either by an on-board active 12.288 MHz oscillator or over the serial port connectors. Setting the MCKI source selector switch to the OSC position connects the active oscillator to the master clock input pin of the ADAU1781. Setting this switch to the I2S position connects the master clock input of the ADAU1781 to Pin 3 on Serial Audio Interface Header J4, which is labeled MCKI.

INPUTS AND OUTPUTS

The board has multiple audio input and output options, including digital and analog. The analog beep channel is always enabled. The input select switch, S4, chooses among the remaining audio input options: stereo line input, digital microphones, and analog microphones.

Stereo Line Input

The stereo input jack, J19, accepts a standard stereo TRS 1/8-inch mini-plug with two channels of audio.

Digital Microphones

Digital microphones can be connected to Header J12.

Analog Microphones

Two INMP401 MEMS analog microphones in a single-ended configuration are mounted on the underside of the board. External analog microphones, in both differential and single-ended input configurations, can be connected to the input jacks, J20 and J21. If plugs are connected into the J20 and J21 jacks, the on-board MEMS microphones are automatically disconnected. A bias should be applied to external differential microphones by connecting the J13 and J14 jumpers.

Beep Input

The analog beep input accepts a mono TS 1/8-inch mini-plug with one channel of audio.

Headphone Output

The headphone output connects to any standard 1/8-inch mini-plug stereo headphones. The output power varies depending on the impedance of the headphones.

Speaker Outputs

To use the speaker output, SVDD Power Jumper J9 must be connected. The speaker output of the ADAU1781 can drive an external speaker or an on-board speaker. In the case of an external speaker, it should be connected to the Speaker Output Connector J8 and the J5 and J6 jumpers should be disconnected. To use the on-board speaker, disconnect J8 and connect J5 and J6.

GPIO

The GPIO jumper header J7 allows the GPIO circuitry, consisting of switches and LEDs, to be connected to the GPIO pins of the ADAU1781. If the GPIO circuitry is connected, the corresponding pins cannot be used for the serial audio interface.

SERIAL AUDIO INTERFACE

Serial audio signals in I2S or TDM format can be connected to the Serial Audio Interface Header J4. This header also includes master clock input and output connection pins.

COMMUNICATIONS HEADER

The Communications Header J1 connects to the EVAL-ADUSB2EBZ. More information about the USBi can be found in the AN-1006 Application Note.

The ADAU1781 uses I2C communications protocol by default. An SPI can be used by moving several resistors on the bottom side of the board. To use SPI mode, move Resistor R35 to the R36 pads, move Resistor R37 to the R38 pads, move Resistor R39 to the R41 pads, and move Resistor R43 to the R42 pads.

POWER-DOWN

The Power-Down Header J3, labeled PDN on the silkscreen of the board, provides access to the power-down pin on the ADAU1781. On this 3-pin header, a 2-pin jumper can be used to connect the power-down pin to either the USBi or to ground.
Figure 38. Evaluation Board Schematic—SigmaDSP, Analog I/O, and Master Clock Generation
Figure 39. Evaluation Board Schematic—Digital Microphone Interface

Figure 40. Evaluation Board Schematic—Serial Audio Data Interface

Figure 41. Evaluation Board Schematic—Power Supply
Figure 42. Evaluation Board Schematic—GPIO Interface

Figure 43. Evaluation Board Schematic—Communications Interface
Figure 44. Evaluation Board Layout—Top Assembly
Figure 45. Evaluation Board Layout—Top Copper
Figure 46. Evaluation Board Layout—Power Plane
Figure 47. Evaluation Board Layout—Ground Plane
Figure 49: Evaluation Board Layout—Bottom Assembly
### ORDERING INFORMATION

#### BILL OF MATERIALS

Table 1.

<table>
<thead>
<tr>
<th>Qty.</th>
<th>Designator</th>
<th>Description</th>
<th>Value</th>
<th>Manufacturer</th>
<th>Part Number</th>
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<td>C1, C2, C4 to C6, C9, C12, C30, C31, C33, C35 to C37, C41 to C44, C47, C49</td>
<td>Multilayer ceramic, 16 V, X7R (0402)</td>
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<td>Panasonic EC</td>
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<td>Do not insert</td>
<td>Do not insert</td>
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<td>10 kΩ</td>
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<td>301 Ω</td>
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<td>Panasonic EC</td>
<td>ERJ-6ENF10R0V</td>
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<td>Chip resistor, 1%, 0.1 W, thick film, 0402</td>
<td>1 kΩ</td>
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<td>Chip resistor, 0.1 W, thick film, 0402</td>
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<td>SP1</td>
<td>Speaker, 8 Ω, 0.5 W, 87 dB, 15 mm, SMD</td>
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<td>Projects Unlimited</td>
<td>SMS-1508MS-R</td>
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<td>Analog Devices</td>
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<td>ADP1711AUJZ-1.8-R7</td>
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<td>InvenSense</td>
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<td>Tact switch long stroke (normally open)</td>
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<td>E-Switch</td>
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<td>2P3T slide</td>
<td>E-Switch</td>
<td>EG2305</td>
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<td>L1</td>
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<td>600 Ω at 100 MHz</td>
<td>TDK Corp.</td>
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<td>8</td>
<td>J1, J5, J6, J9 to J11, J13, J14</td>
<td>2-pin header unshrouded jumper, 0.10&quot;, use shunt Tyco 881545-2</td>
<td>2-pin jumper</td>
<td>Sullins Connector Solutions</td>
<td>PBC02SAAN or cut PBC36SAAN</td>
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<td>J2</td>
<td>10-way shroud polarized header</td>
<td>2 × 5</td>
<td>3M</td>
<td>N2510-6002RB</td>
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<td>STX-3150-5C</td>
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<td>2</td>
<td>D1, D4</td>
<td>Red diffused, 6.0 millicandela, 635 nm, 1206</td>
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<td>Lumex Opto</td>
<td>SML-LX1206IW-TR</td>
</tr>
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<td>1</td>
<td>D2</td>
<td>Green diffused, 10 millicandela, 565 nm, 1206</td>
<td>Green diffused</td>
<td>Lumex Opto</td>
<td>SML-LX1206GW-TR</td>
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<td>1</td>
<td>D3</td>
<td>Yellow diffused, 4.0 millicandela, 585 nm, 1206</td>
<td>Yellow diffused</td>
<td>CML Innovative Tech</td>
<td>CMD15-21VYD/TR8</td>
</tr>
<tr>
<td>3</td>
<td>D5 to D7</td>
<td>Schottky, 30 V, 0.5 A, SOD123 diode</td>
<td>Schottky</td>
<td>ON Semiconductor</td>
<td>MBR0530T1G</td>
</tr>
<tr>
<td>13</td>
<td>TP1 to TP13</td>
<td>Mini-test point, white, 0.1&quot; OD</td>
<td>5002</td>
<td>Keystone Electronics</td>
<td>5002</td>
</tr>
</tbody>
</table>

**RELATED LINKS**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADAU1781</td>
<td>Product Page, SigmaDSP Low-Noise Stereo Audio Codec for Portable Applications</td>
</tr>
<tr>
<td>INMP401</td>
<td>Product Page, Omnidirectional Microphone with Bottom Port and Analog Output</td>
</tr>
<tr>
<td>AN-1006</td>
<td>Application Note, Using the EVAL-ADUSB2EBZ</td>
</tr>
</tbody>
</table>
NOTES

I2C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

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