The **EVAL-MICCANVASZ** Microphone Canvas Evaluation Board

**FEATURES**
- 15 MEMS microphones
  - Level-matched to within ±1 dB for accurate beam steering
  - Symmetrically arranged to create flexible array patterns
- 14 microphone indicator LEDs
  - Can be used to indicate beam direction, microphone activity, direction of incident sound, or other functions
- 8 LEDs in a bar graph meter orientation
- Seamless operation as a daughter card for **EVAL-ADAU1467Z**
  - Can be used with other processors via either two TDM8 or one TDM16 serial audio interface for the microphones and an SPI-compatible serial interface for the LEDs

**DOCUMENTS NEEDED**
- **ADAU1463** or **ADAU1467** data sheet
- **EVAL-ADAU1467Z** user guide

**SOFTWARE NEEDED**
- SigmaStudio software

**GENERAL DESCRIPTION**
The **EVAL-MICCANVASZ** microphone canvas provides a platform for the development and evaluation of microphone beamforming arrays. 15 microphones, arranged as a ring of eight, a ring of six, and a single in the center, provide flexibility and symmetry suitable to many applications (see Figure 1).
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REVISION HISTORY

11/2018—Revision 0: Initial Version
EVALUATION BOARD HARDWARE

INSTALLATION INTO THE EVAL-ADAU1467Z

The microphone canvas comes with one nylon screw and one nylon standoff. These are used to support the cantilevered weight of the board and avoid contact with test points on the EVAL-ADAU1467Z. To install the EVAL-ADAU1467Z, take the following steps:

1. Insert the screw up from the bottom of the board through-hole (SC3).
2. Thread the standoff tightly onto the screw hand.
3. Insert the microphone canvas board into Header J5 such that it rests on the nylon standoff.

SETTING SWITCHES ON THE EVAL-ADAU1467Z

On the EVAL-ADAU1467Z, ensure that the S2 switch is set to STANDALONE (down position) and that the S8 switch is set to MC XLAT (down position).
SOFTWARE CONFIGURATION

INSTALLING SigmaStudio

The programming environment for the ADAU1467 is SigmaStudio®. This graphical tool suite is available as a free download on the Analog Devices, Inc., website. The instructions for downloading and installing SigmaStudio are available in the EVAL-ADAU1467Z user guide.

LOCATING AND CONFIGURING THE LED DRIVERS

The brightness of each of the light emitting diodes (LEDs) is controlled by a dedicated pulse width modulation (PWM) controller on the microphone canvas. The drivers for this controller are available for download at www.analog.com/EVAL-MICCANVAS.

There are two blocks in the LEDs folder in the nesting list, as shown in Figure 5. The LED PWM Controller block controls the brightness of each of the LEDs. The bar graph meter simplifies use of LEDs D15 to D22 as an audio level meter.

The LED PWM controller block uses the MPxx pins to communicate with the controlled IC. MP16, MP17, MP18, MP19, MP24, and MP25 must be configured as shown in Figure 6. These settings can be found under the Hardware Configuration > Multipurpose1 tab. Additional functionality of each of these pins is detailed in Table 1.
INTERFACING THE MICROPHONE CANVAS TO THE EVAL-ADAU1467Z

The EVAL-MICCANVASZ evaluation board is used as a daughter card for the EVAL-ADAU1467Z evaluation board with the ADAU1467 SigmaDSP processor, controlling the microphone canvas. The connector includes provisions to power and stream the audio inputs from the 15 microphones, and also has dedicated pins and software to control the brightness of the LEDs. The functions of these pins are detailed in Table 1.

The audio interface uses Serial Input Port 1. The audio data uses two data pins, SDATA_IN1 and SDATAIO1, each in TDM8 format. Power to the microphones can be turned on and off with the digital signal processor (DSP).

The brightness of each of the 22 LEDs can be controlled independently using a PWM controller on the microphone canvas. This controller has a flexible serial interface. A software block is provided that implements this serial interface using only four multipurpose pins. This controller block provides an abstraction layer that allows control of the LEDs within the audio signal flow of a SigmaStudio project.

USING EVAL-MICCANVASZ IN TDM16 MODE

By default, the EVAL-MICCANVASZ evaluation board is configured to work seamlessly with the EVAL-ADAU1467Z evaluation board using two data lines, each configured in TDM8 mode. However, the board can also be configured to use a single data line in TDM16 mode by making minor adjustments to the printed circuit board (PCB). To configure the board for operation in TDM16 mode,

1. Move Resistor R4 to the unpopulated site, R5. R4 is a 0 Ω jumper. Leave R4 unpopulated. R5 can be bridged with any piece of wire.
2. Move Resistor R7 to the unpopulated site, R6. R7 is a 0 Ω jumper. Leave R7 unpopulated. R6 can be bridged with any piece of wire.
3. Remove Resistor R3 and leave the site unpopulated.

With these modifications, the required frame synchronization signal remains the same, the required bit clock changes from 12.288 MHz (TDM8 at 48 kHz) to 24.576 MHz (TDM16 at 48 kHz), and the data output rate doubles to match the bit clock.

Table 1. ADAU1467 Pins Used to Control Microphone Canvas

<table>
<thead>
<tr>
<th>Microphone Canvas Connection</th>
<th>ADAU1467 Pin</th>
<th>Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microphone Power</td>
<td>SLC2_M/MP24</td>
<td>Powers the microphones</td>
<td>Assert SLC2_M/MP24 low to power the microphones</td>
</tr>
<tr>
<td>Microphone Bit Clock</td>
<td>BCLK_IN1</td>
<td>12.288 MHz, delayed by 1</td>
<td>Serial Input Port 1</td>
</tr>
<tr>
<td>Microphone Frame Synchronization</td>
<td>LRCLK_IN1/MP11</td>
<td>48 kHz, noninverted pulse</td>
<td>Serial Input Port 1</td>
</tr>
<tr>
<td>Microphone TDM8 Channel 0 to Channel 7</td>
<td>SDATA_IN1</td>
<td>Audio data, TDM8 format, 24-bit data, 32 bits per word</td>
<td>Serial Input Port 1 in TDM16 over 2 mode</td>
</tr>
<tr>
<td>Microphone TDM8 Channel 8 to Channel 15</td>
<td>SDATAIO1/MP17</td>
<td>Audio data, TDM8 format, 24-bit data, 32 bits per word</td>
<td>Serial Input Port 1 in TDM16 over 2 mode</td>
</tr>
<tr>
<td>Microphone TDM16 Channel 0 to Channel 15</td>
<td>SDATA_IN1</td>
<td>Audio data, TDM16 format, 24-bit data, 32 bits per word</td>
<td>Serial Input Port 1 in TDM16</td>
</tr>
<tr>
<td>SDATAIO1/MP17</td>
<td>SDATAIO1</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>LED Controller Blanking</td>
<td>SDA2_M/MP25</td>
<td>Enables PWM control of the LEDs</td>
<td>Assert SDA2_M/MP25 low to enable the use of the LED PWM controller</td>
</tr>
<tr>
<td>LED Controller XLAT</td>
<td>SDATAIO0/MP16</td>
<td>PWM controller latch input</td>
<td>S8 selects an alternate function for this pin</td>
</tr>
<tr>
<td>LED Controller SDATA</td>
<td>SDATAIO3/MP19</td>
<td>PWM controller data input</td>
<td></td>
</tr>
<tr>
<td>LED Controller SCLK</td>
<td>SDATAIO2/MP18</td>
<td>PWM controller clock input</td>
<td></td>
</tr>
</tbody>
</table>
MICROPHONE INPUTS ON THE EVAL-ADAU1467Z

The microphone canvas uses microphones that output audio in time division multiplexed (TDM) format, which eliminates the need for decimator interfaces, as are required with pulse density modulation (PDM) output microphones. Use of TDM format also eliminates the need for analog-to-digital converters (ADCs), as are required with analog output microphones.

Each of the 15 microphones outputs appear as 24-bit data, left aligned in 32-bit words with I²S framing on Channel 0 through Channel 14 of Serial Input Port 1 of the SigmaDSP. TDM8 format is used, rather than TDM16 format, to reduce the required bit clock rate. An SDATAIOx pin is used to input a second data stream without requiring a second serial port. Configure Serial Input Port 1 and SDATAIO1 in SigmaStudio, as shown in Figure 7 and Figure 8. See the Using EVAL-MICCANVASZ in TDM16 Mode section for information on operating using a single audio data line.

DRIVING THE LEDS WITH THE EVAL-ADAU1467Z

The LED PWM controller block provides a graphical interface to the hardware PWM controller, as shown in Figure 9. The top eight inputs correspond to LEDs D15 to D22, which make up the bar graph meter adjacent to the microphone canvas connector. The remaining 14 pins correspond to the LEDs adjacent to the rings of blue LEDs adjacent to the microphones. Each input provides control over the brightness of an LED. Ensure that the brightness is in the range 0.0 to (1.0 − 1 LSB).

USING THE BAR GRAPH METER

The bar graph meter block shown in Figure 10 provides a means of implementing a common audio level meter.

The top input accepts any standard audio signal. The bottom input provides control over the brightness of the meter. Ensure that the brightness is in the range 0.0 to (1.0 − 1 LSB).
Figure 11. Example LED Control SigmaStudio Schematic
MICROPHONE USE FOR BEAMFORMING APPLICATIONS

Beamforming applications require precise spacing and level calibration of the microphones in the array. The microphone array on the microphone canvas consists of an outer ring of eight microphones placed in a circle with diameter of 40 mm, a concentric inner ring of six microphones placed in a circle with diameter of 20 mm, and a single microphone in the center. This arrangement provides symmetry for steering a virtual microphone beam around a circle and a selection of angles for evaluating microphone spacing and orientation.

Figure 12 shows examples of useful microphone spacing and angles.

Figure 12. Example 3-Microphone Combinations
Figure 13. Connector Schematics
Figure 14. LED Schematics
Figure 15. Microphone Schematics
Figure 16. Top Layer Assembly and Silkscreen
Figure 17. Layer 1 (Copper)
Figure 18. Layer 2 (Ground)
Figure 19. Layer 3 (Copper)
Figure 20. Layer 4 (Copper)
Figure 21. Bottom Silkscreen (View from Top)
ORDERING INFORMATION

BILL OF MATERIALS

Table 2.

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Reference Designator</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>U1 to U15</td>
<td>Microelectro mechanical systems (MEMS) microphones</td>
<td>TDK Invensys</td>
<td>ICS-52000</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>U16</td>
<td>PWM LED Driver IC</td>
<td>Texas Instruments</td>
<td>TLC947</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>C1 to C17</td>
<td>0.1 µF, 16 V, 10%, ceramic capacitors</td>
<td>TDK</td>
<td>CGA281X7R1C104K050BC</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>D1 to D14</td>
<td>Blue, bottom mount, LEDs</td>
<td>Diaglight</td>
<td>597-6601-607F</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>D15</td>
<td>Red, bottom mount, LED</td>
<td>Diaglight</td>
<td>597-6601-607F</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>D16, D17</td>
<td>Yellow, bottom mount, LEDs</td>
<td>Diaglight</td>
<td>597-6401-607F</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>D18 to D22</td>
<td>Green, bottom mount, LEDs</td>
<td>Yageo</td>
<td>RC040FR-070KL</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>R1 to R3</td>
<td>10 kΩ, 1%, resistors</td>
<td>Panasonic</td>
<td>ERJ-2GE0R00X</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>R4, R7</td>
<td>0 Ω, resistors (jumpers)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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