TI Designs: TIDA-01454
PCM1864 based Circular Microphone Board Reference Design

Description

The PCM1864 Circular Microphone Board (CMB) is a low-cost, easy-to-use reference design for applications that require clear spoken audio, such as voice triggering and speech recognition. This TID uses microphone array to capture voice signal and converts it to digital stream that can be used by DSP system to extract clear audio from noisy environments.

Resources

TIDA-01454	Design Folder
PCM1864	Product Folder
TIDEP-0077	Product Folder
TIDEP-0088	Product Folder

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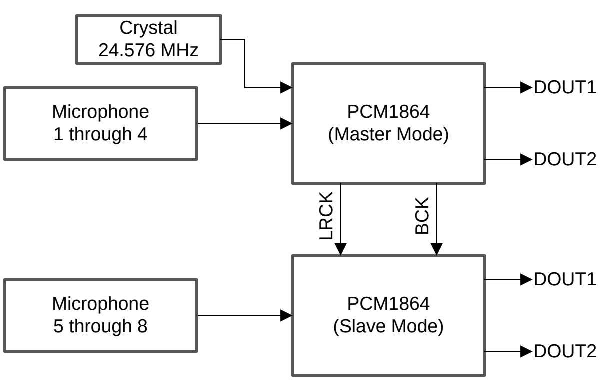
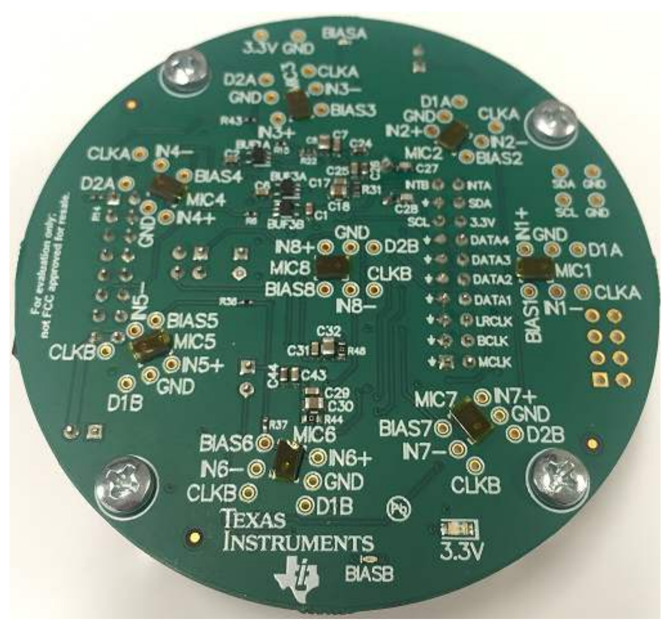
Features

- Uses Two PCM1864 (4-ch Audio ADC) to Interface With Eight Microphone Arrays to Extract Clear Speaker Voice from Noisy Environments
- Energy-Sense Notification for Signal Presence and Loss – Can be a Central Part of a Low-Power, High-Performance Audio Solution
- Offers Complete System Reference Design Using Microphone Array, Texas Instruments™ Provided Software, and Evaluation Module

Applications

- Interface-to-Cloud-Based Voice Recognition for Voice-Activated Digital Assistant Applications
- Interface-to-Cloud-Based Voice Recognition for Smart Home Applications
- Local (Limited Dictionary) Voice Recognition for Voice-Based Appliances Control
- Voice and Speech Applications (Such as Video Conferencing)





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1 System Description

This TI Design uses TI hardware and sophisticated field-proven software algorithms to obtain clear speech and audio from noisy environments. This Circular Microphone Board provides the streaming of multiple data inputs to the processor, which implements a beamforming algorithm to form a virtual directional microphone that points at the direction of the speaker or the desired audio source and then amplifies the speech signal from the desired direction, which attenuates all signals from all other directions.

The PCM1864 device is a highly flexible audio front end that supports input levels from small-mV microphone inputs to 2.1-VRMS line inputs without external resistor dividers. Without requiring a 5-V supply or an external programmable-gain amplifier, smaller, smarter products are feasible at reduced cost.

2 System Overview

2.1 Block Diagram

Figure 1 shows the TIDA01454 block diagram.

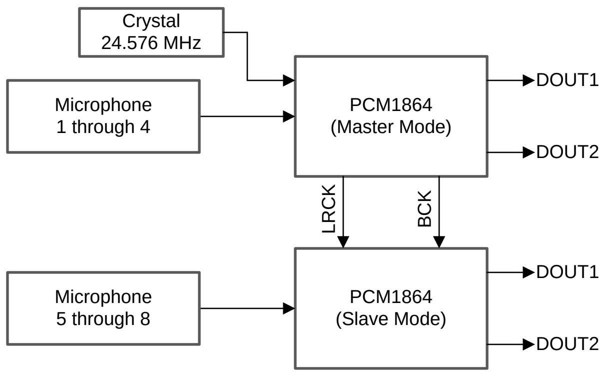

Figure 1. TIDA-01454 Block Diagram

2.2 Highlighted Products

2.2.1 PCM1864

The PCM1864 device is a highly integrated, high performance audio analog-to-digital converter (ADC) with four mono ADC channels and 103-dB SNR. It is a software controlled device with integrated PLL that provides audio master clocks for the entire system. PCM186x supports EnergySense, which allows easy-to-implement power-down and wake-up scenarios to meet the European Ecodesign Directive.

See the PCM1864 product folder for a full description of this device.

3 Getting Started Hardware and Software

3.1 Hardware and Software Setup

3.1.1 Circular Microphone Board as Standalone Unit

See Table 1 and Table 2 to configure and test the Circular Microphone Board to interface as a standalone unit.

Table 1. Circular Microphone Board Jumper Settings

Pin		Parameter
J3		ON
J8	Pins 1 and 2	ON
	Pins 3 and 4	OFF
J10		ON
J11		ON

Table 2. Host Processor Interface With CMB

Host Processor	CMB Pin
HOST_DOUT1	CMB_DSP_DATA1
HOST_DOUT2	CMB_DSP_DATA2
HOST_DOUT3	CMB_DSP_DATA3
HOST_DOUT4	CMB_DSP_DATA4
HOST_SDA	CMB_DSP_SDA
HOST_SCL	CMB_DSP_SCL
HOST_GND	CMB_DSP_GND

After the hardware setup is complete, each PCM1864 device must be configured as listed in the following code snippet to set up the operation mode, sampling frequency, PLL clock reference, and more by using the I^2C interface.

Device U1 can be configured by using device address 0x94 to run in master mode with the following register writes.

```
0x94 0x00 0x00           // Change to Page 0
0x94 0x01 0x40        // PGA CH1_L to 32dB
0x94 0x02 0x40        // PGA CH1_R to 32dB
0x94 0x03 0x40        // PGA CH2_L to 32dB
0x94 0x04 0x40        // PGA CH2_R to 32dB
0x94 0x05 0x86        // Enable SMOOTH PGA Change; Independent Link PGA;
0x94 0x06 0x41        // Polarity: Normal, Channel: VINL1[SE]
0x94 0x07 0x41        // Polarity: Normal, Channel: VINR1[SE]
0x94 0x08 0x44        // Polarity: Normal, Channel: VINL3[SE]
0x94 0x09 0x44        // Polarity: Normal, Channel: VINR3[SE]
0x94 0x0A 0x00        // Secondary ADC Input: No Selection
0x94 0x0B 0x44        // RX WLEN: 24bit; TX WLEN: 24 bit; FMT: I2S format
0x94 0x10 0x03        // GPIO0_FUNC - SCK Out; GPIO0_POL - Normal
0x94 0x11 0x50        // GPIO3_FUNC - DOUT2; GPIO3_POL - Normal
0x94 0x12 0x04        // GPIO0_DIR - GPIO0 - Output
0x94 0x13 0x40        // GPIO3_DIR - GPIO3 - Output
0x94 0x20 0x11        // MST_MODE: Master; CLKDET_EN: Disable
```

Device U2 can be configured by using device address 0x96 to run in slave mode with the following register writes.

```
0x96 0x00 0x00        // Change to Page 0
0x96 0x01 0x40        // PGA CH1_L to 32dB
0x96 0x02 0x40        // PGA CH1_R to 32dB
0x96 0x03 0x40        // PGA CH2_L to 32dB
0x96 0x04 0x40        // PGA CH2_R to 32dB
0x96 0x05 0x86        // Enable SMOOTH PGA Change; Independent Link PGA;
0x96 0x06 0x41        // Polarity: Normal, Channel: VINL1[SE]
0x96 0x07 0x41        // Polarity: Normal, Channel: VINR1[SE]
0x96 0x08 0x44        // Polarity: Normal, Channel: VINL3[SE]
0x96 0x09 0x44        // Polarity: Normal, Channel: VINR3[SE]
0x96 0x0A 0x00        // Secondary ADC Input: No Selection
0x96 0x0B 0x44        // RX WLEN: 24bit; TX WLEN: 24 bit; FMT: I2S format
0x96 0x10 0x00        // GPIO0_FUNC - GPIO0; GPIO0_POL - Normal
0x96 0x11 0x50        // GPIO3_FUNC - DOUT2; GPIO3_POL - Normal
0x96 0x12 0x00        // GPIO0_DIR - GPIO0 - Input
0x96 0x13 0x40        // GPIO3_DIR - GPIO3 - Output
0x96 0x20 0x01        // MST_MODE: Slave; CLKDET_EN: Enable
```

3.1.2 Circular Microphone Board With TMDSEVM5517 Evaluation Module

To configure and test the Circular Microphone Board by interfacing with the 66AK2Gx or C5517 EVM, see *Audio Pre-Processing Reference Design for Voice-Based Applications* and *K2G-Based Voice Recognition Audio System Design Guide*.

4 Testing and Results

Testing the Circular Microphone Board to validate the device configuration and proper microphone bias can be achieved by:

- Ensuring the BIASA abd BIASB LEDs are ON once the devices are configured
- Evaluating the digital data stream from both PCM1864 devices

Figure 2 shows the FFT plot for the DOUT data streaming using the an AP2722 device when playing a 1-kHz monotone.

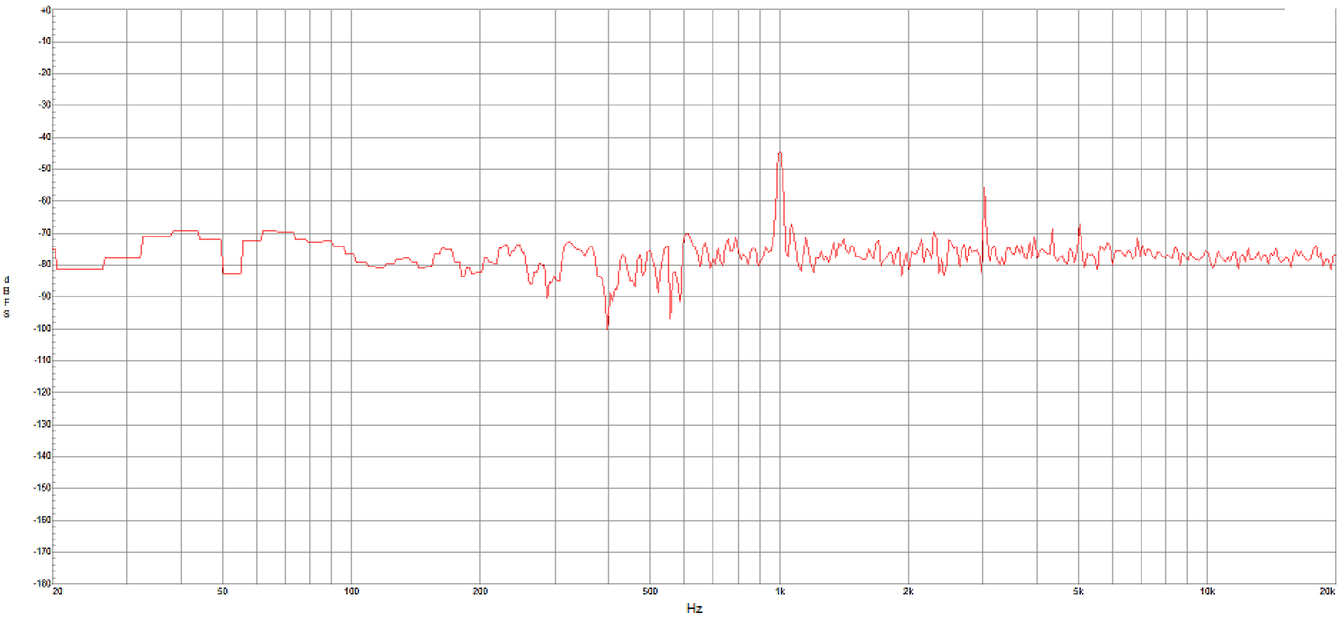

Figure 2. FFT Plot

Figure 3 shows the LRCK and I2S data stream on DOUT1 and DOUT2 on both devices in time domain.

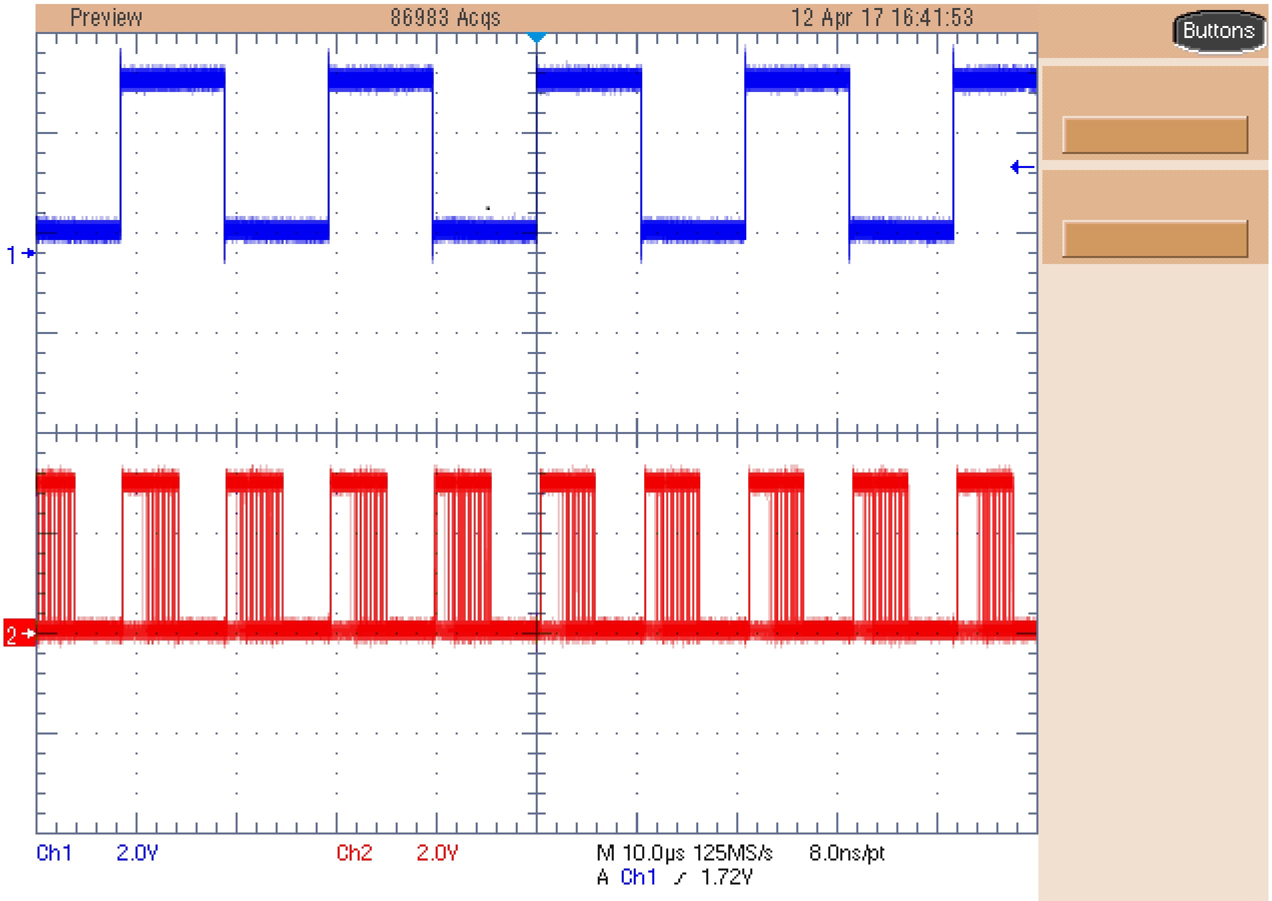

Figure 3. I2S Plot

5 Design Files

5.1 Schematics

To download the schematics, see the design files at TIDA-01454.

5.2 Bill of Materials

To download the bill of materials (BOM), see the design files at TIDA-01454.

5.3 PCB Layout Recommendations

5.3.1 Layout Prints

To download the layer plots, see the design files at TIDA-01454.

5.4 Altium Project

To download the Altium project files, see the design files at TIDA-01454.

5.5 Gerber Files

To download the Gerber files, see the design files at TIDA-01454.

5.6 Assembly Drawings

To download the assembly drawings, see the design files at TIDA-01454.

6 Software Files

To download the software files, see the design files at TIDA-01454.

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