TI Designs: TIDA-01470
PCM1864 Based Linear Microphone Board Reference Design

Description

The PCM1864 Linear Microphone Board (LMB) 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-01470	Design Folder
PCM1864	Product Folder
TIDEP-0077	Product Folder
TIDEP-0088	Product Folder

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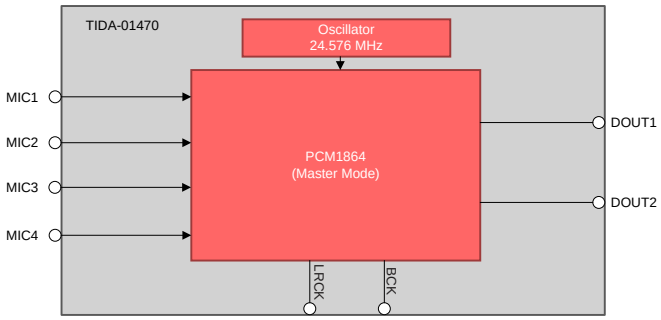
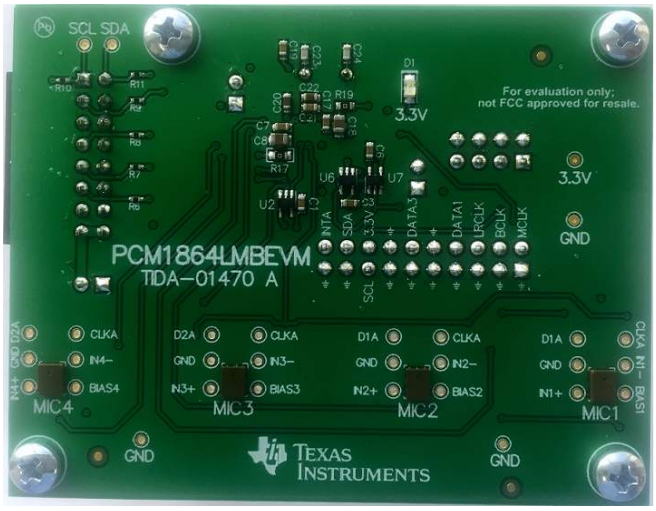
Features

- Uses PCM1864 (4-ch Audio ADC) to Interface With Four Microphone Arrays to Extract Clear Speaker Voice From Noisy Environments
- Energy-Sense Notification for Signal Presence and Loss—Can Be Central Part of 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 Linear 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.

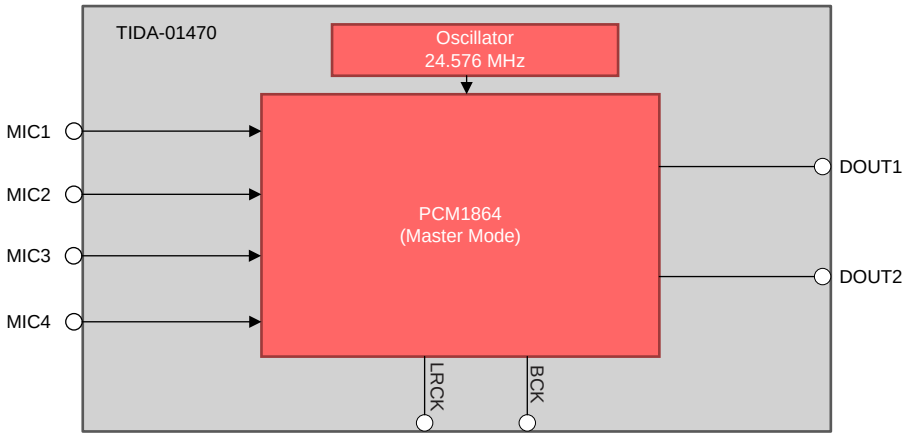

Figure 1. TIDA-01470 Block Diagram

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 Linear Microphone Board as Standalone Unit

See Table 1, Table 2, Table 3, and Table 4 to configure and test the Linear Microphone Board to interface as a standalone unit.

Table 1. Linear Microphone Board Power Connection

LMB	C5517	Description
DPS_Pin16	J10_Pin9	LMB_3.3V
DSP_Pin17	J10_Pin5	GND

Table 2. Linear Microphone Board Jumper Settings

Pin	Parameter	Description
J2	ON	Master mode
J6	ON	MIC BIAS

Table 3. Linear Microphone Board Interface With C5517 EVM (Mic 1 and 2)

CMB	C5518 EVM	Description
DPS_Pin15 (SCL)	J14_Pin16	LMB_I2C-SCL
DPS_Pin18 (SDA)	J14_Pin20	LMB_I2C-SDA
DSP_Pin4 (BCLK)	J27_Pin3 (no jumper)	LMB bit clock
DSP_Pin6 (LRCK)	J27_Pin4 (no jumper)	LMB frame clock
DSP_Pin8 (DATA1)	J30_Pin2 (no jumper)	LMB Data1
—	J29_Pin1-3 (jumper on)	—
—	J29_Pin2-4 (jumper on)	—
—	J30_Pin1-3 (jumper on)	—

Table 4. Linear Microphone Board Interface With C5517 EM (Mic 3 and 4)

CMB	C5517 EVM	Description
IS2_Pin3 (BCLK)	J31_Pin3	Bit clock
IS2_Pin5 (LRCK)	J31_Pin2	Frame clock
DSP_Pin12 (DATA3)	J31_Pin1	LMB Data3
—	UART_EN (no jumper)	—

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 0x0C // TX WLEN: 16 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 0x3E // MST_MODE: Master; CLKDET_EN: Disable
0x94 0x21 0x02 // XTAL to DSP1 Divide value = 1/3
0x94 0x22 0x05 // XTAL to DSP2 Divide value = 1/6
0x94 0x23 0x0B // XTAL to ADC Divide value = 1/12
0x94 0x25 0x17 // PLL to SCK Divide value = 1/24
0x94 0x26 0x03 // PLL to BCK Divide value = 1/4
0x94 0x29 0x03 // P Divide value = 1/4
0x94 0x2A 0x00 // R Divide value = 1
0x94 0x2B 0x10 // J Divide value = 16
0x94 0x28 0x01 // PLL_REF_CLK = SCK; PLL_EN=Enable
0x94 0x29 0x03 // PLL to BCK Divide value = 1/4
0x94 0x29 0x03 // PLL to BCK Divide value = 1/4
0x94 0x29 0x03 // PLL to BCK Divide value = 1/4
0x94 0x29 0x03 // PLL to BCK Divide value = 1/4


0x94 0x2A 0x00 // R Divide value = 1
```

3.1.2 Linear Microphone Board With TMDSEVM5517 Evaluation Module

To configure and test the Linear 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 Linear Microphone Board to validate the device configuration and proper microphone bias can be achieved by:

- Ensuring the BIASA LED is ON once the devices are configured
- Evaluating the digital data stream from thePCM1864 device

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

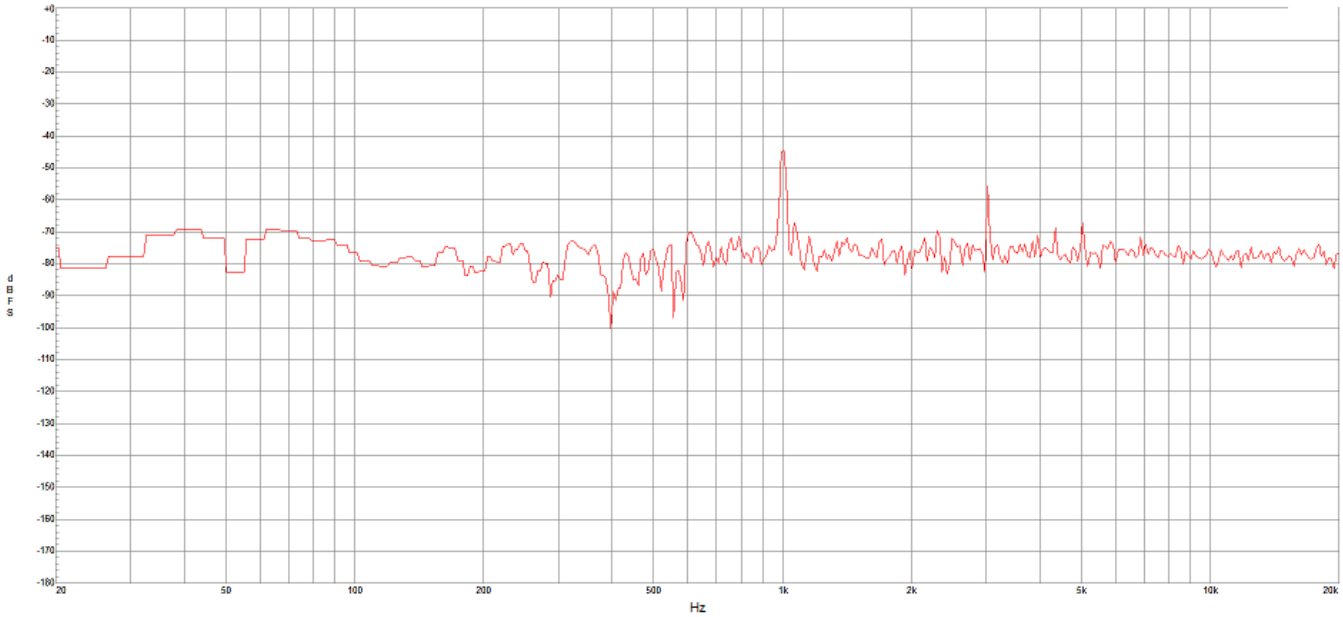

Figure 2. FFT Plot

Figure 3 shows the LRCK and I²S data stream on DOUT1 and DOUT2 on the PCM1864 device in time domain.

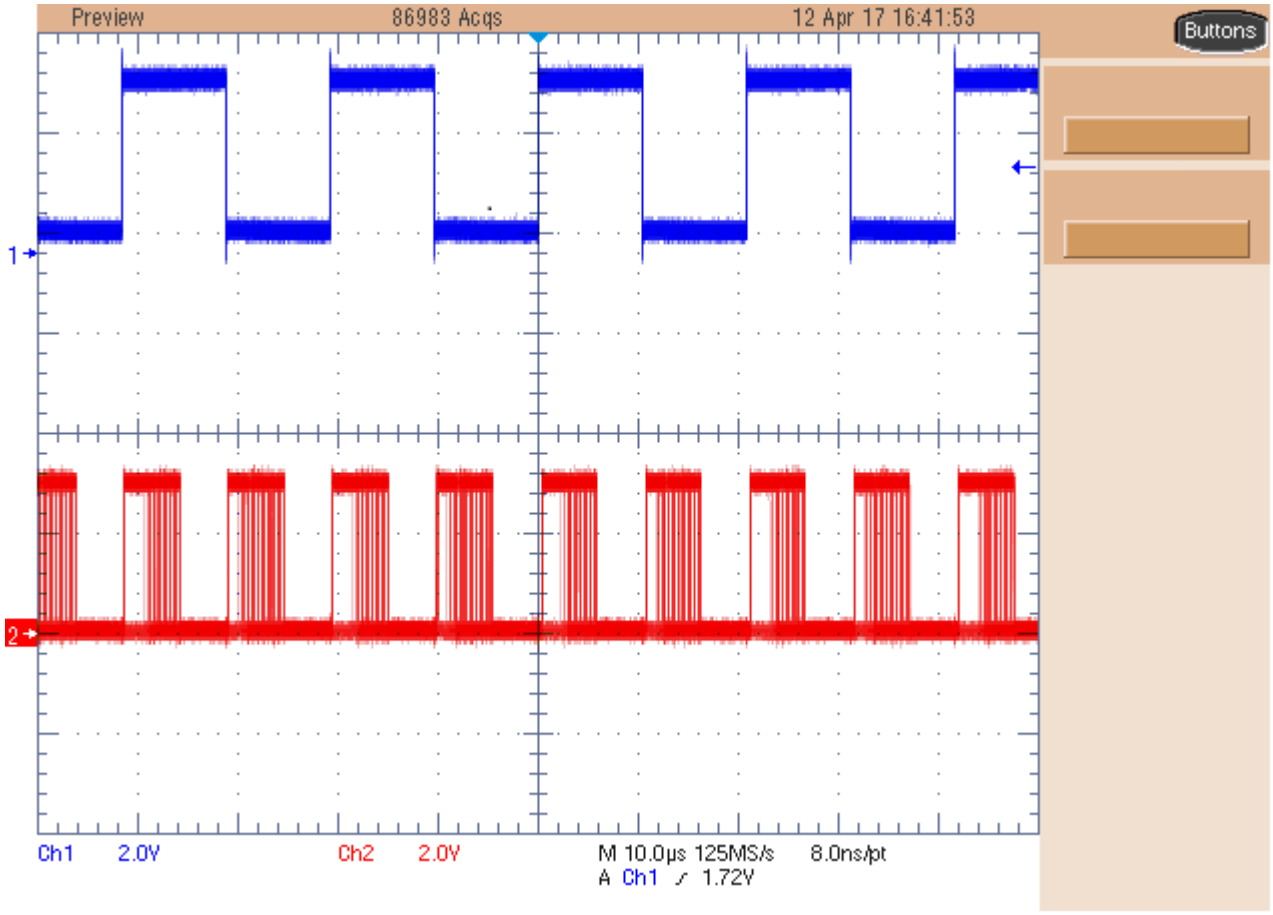

Figure 3. I²S Plot

5 Design Files

5.1 Schematics

To download the schematics, see the design files at TIDA-01470.

5.2 Bill of Materials

To download the bill of materials (BOM), see the design files at TIDA-01470.

5.3 PCB Layout Recommendations

5.3.1 Layout Prints

To download the layer plots, see the design files at TIDA-01470.

5.4 Altium Project

To download the Altium project files, see the design files at TIDA-01470.

5.5 Gerber Files

To download the Gerber files, see the design files at TIDA-01470.

5.6 Assembly Drawings

To download the assembly drawings, see the design files at TIDA-01470.

6 Software Files

To download the software files, see the design files at TIDA-01470.

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