

# **Using the Digital Microphone Function on TLV320AIC33 With AIC33EVM/USB-MODEVM System**

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## ABSTRACT

This application report discusses the digital microphone input function on the TLV320AIC33 codec device, and provides an example and step-by-step details for applying the function with AIC33EVM/USB-MODEVM System .

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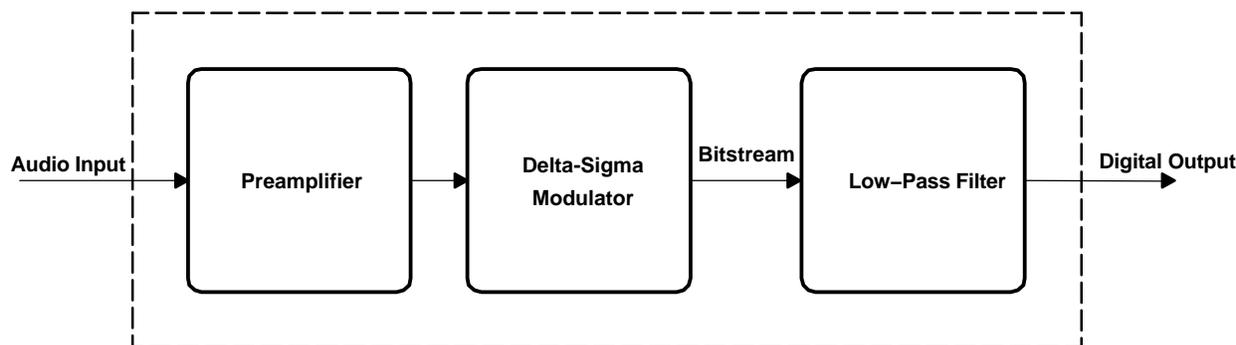
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## 1 Introduction

This application report discusses the digital microphone function supported on the TLV320AIC33 (AIC33) codec device with emphasis on how to apply the function. An example is provided with step-by-step details to help users to set up TI's AIC33EVM and USB-MODEVM system, and to test and evaluate the function.

## 2 AIC33 Digital Microphone Function

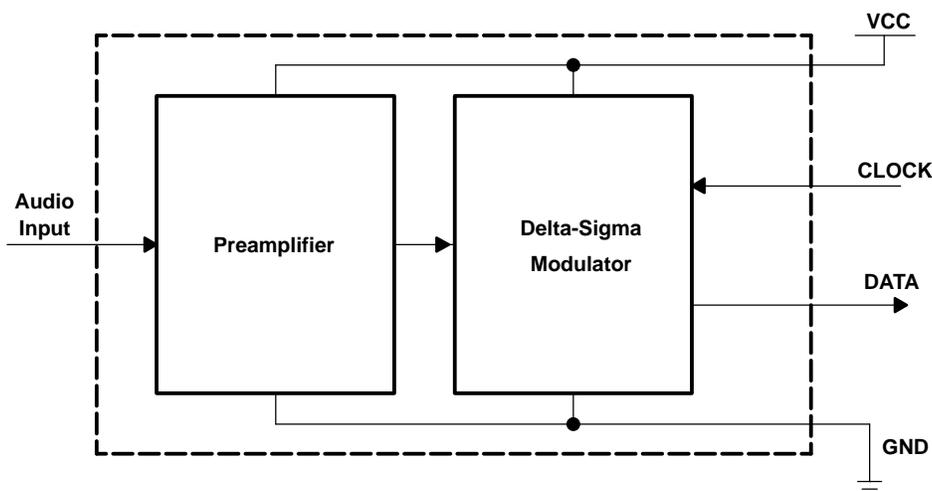
A Delta-Sigma ADC for audio input signal can be simply illustrated in [Figure 1](#).



**Figure 1. Block Diagram of an Audio Delta-Sigma ADC**

By replacing the JFET with a digital microphone IC ([Figure 2](#)) in a conventional electret condenser microphone (ECM), the ECM outputs a fully digital bit-stream signal. That is, the *preamplifier* and the *delta-sigma modulator*, as shown in [Figure 1](#), have been integrated into the conventional analog ECM to produce a digital microphone that outputs a 1-bit stream digital audio signal.

A digital microphone usually has four connection pins, which are VCC (power supply), GND (ground), CLOCK (clock), and DATA (bit-stream data), as illustrated in [Figure 2](#).



**Figure 2. Block Diagram of a Digital Microphone IC Inside an ECM**

The AIC33 supports the digital microphone input. The digital signal from a digital microphone can be directly routed to AIC33, where it is filtered and down-sampled by the digital decimation filter, and the digital output is provided to an external host processor over the audio data serial bus (such as the I<sup>2</sup>S).

When the AIC33 digital microphone mode is enabled, the digital decimation filter in its audio ADC switches OFF from its delta-sigma modulator and opens to the external bit stream from a digital microphone. With the corresponding control registers settings, the AIC33 outputs an oversampling clock to the digital microphone, through its GPIO1 pin; the bit-stream data from the digital microphone is fed into AIC33 through its GPIO2 pin. This process is illustrated in the function block diagram of [Figure 3](#).

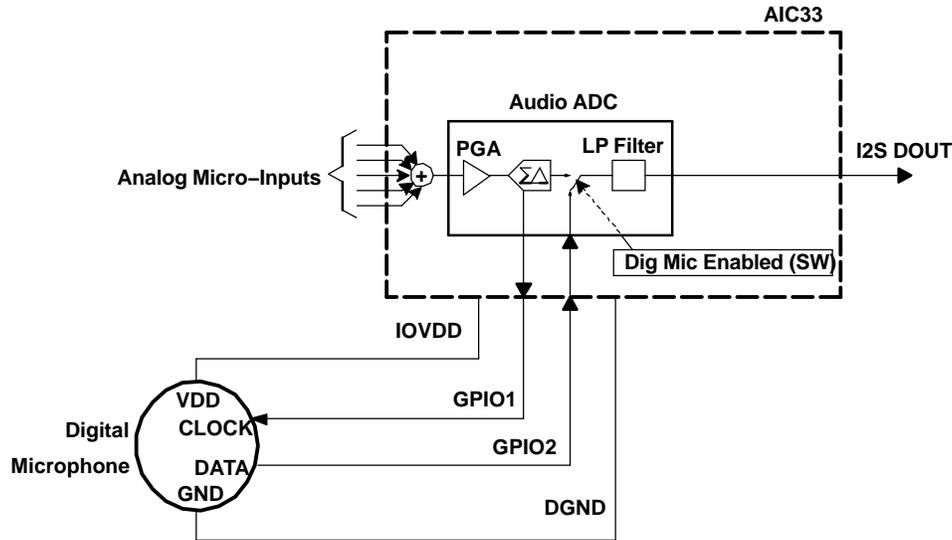


Figure 3. AIC33 and Digital Microphone Interface

### 3 Program AIC33 Digital Microphone Function

To set up the AIC33 into the digital interface mode, the control registers must be programmed as that shown in Table 1.

Table 1. Configuring AIC33 to Operate at Digital Microphone Mode

Step#	Control Register Bits	Description	Values
1	Page0/Reg8/D1–D0	Digital Microphone Functionality Control	00: Dig Mic support is disabled
			01: Dig Mic Support is enabled with oversample rate of 128
			10: Dig Mic Support is enabled with oversample rate of 64
			11: Dig Mic Support is enabled with oversample rate of 32
2	Page0/Reg19/D2 or/and Page0/Reg22/D2*(1)	Power down/up Left ADC	0: ADC channel Powered Down
		Power down/up Right ADC	1: ADC channel Powered Up
3	Page0/Reg98/D7–D4	GPIO1 Function Selection	1010: Select GPIO1 as Dig Mic Modulator clock
4	Page0/Reg99/D7–D4	GPIO2 Function Selection	0101: Select GPIO2 as Dig Mic Input, sampled on CLOCK rising edge
			0110: Select GPIO2 as Dig Mic Input, sampled on CLOCK falling edge
			0111: Select GPIO2 as Dig Mic Input, sampled on CLOCK both edges(2)

(1) For mono digital microphone function, power up left or right ADC; for stereo digital microphones, power up both left and right ADCs.

(2) For stereo digital microphone function, set Page0/Reg99/D7-D4 to 0111b.

### 4 An Application Example

The following example is provided to assist in understanding how to apply the AIC33 digital microphone function. Users may following the step-by-step instruction to test and evaluate the digital microphone and AIC33's digital microphone function.

#### 1. Test Devices/Boards

## An Application Example

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- USB-MODEVM board (see [SBAU114](#))
- TLV320AIC33EVM board (see [SBAU114](#))
- A laboratory power supply with 2.6-Vdc output
- A digital microphone (an LMV1024 was used in this application)

### 2. Hardware Settings

- *On the USB-MODEVM board*, all settings are at the manufacturer's default except:
  - Remove the jumper on JMP7
  - Cut the connection or wires between the two pins on JMP14 and on JMP13.

That is:

Switch	Setting
SW1	SW1-1 ON
	SW1-2 ON
SW2	SW2-1 ON
	SW2-2 ON
	SW2-3 ON
	SW2-4 ON
	SW2-5 ON
	SW2-6 ON
	SW2-7 ON
	SW2-8 OFF

Jumper	Setting
JMP1	Installed
JMP2	Installed
JMP3	Removed
JMP4	Removed
JMP5	Connect 2 to 3
JMP6	Connect 1 to 2 (USB)
JMP7	Removed (all 6 pins open)
JMP13	Cut the wire between the 2 pins
JMP14	Cut the wire between the 2 pins

- **On the AIC33EVM board:** cut the pin 9 of J15 on the bottom of the board, which is called J15B, to disconnect 3.3V from the USB-MODEVM to AIC33EVM. *Important:* be sure the cut is clean.
- **On the laboratory power supply:** with the output unconnected to anything, turn on the power supply and adjust the output to 2.6 Vdc.
- **On the digital microphone** (such as LMV1024): solder four wires on the microphone's VDD, GND, CLK, and OUT; the other ends should be ready for connection to the pins on J15A and J16A of AIC33EVM board.

### 3. Connections and Power Test

- System Connection:
  - Plug AIC33EVM on top of USB-MODEVM as the EVM user's guide ([SBAU114](#)) describes.
  - Wire AIC33EVM J15A pin 9 to USB-MODEVM JMP7 pin 6.
  - Turn OFF or disable the laboratory power supply, connect the negative to AIC33EVM DGND(TP41), and connect the positive to USB-MODEVM JMP7 pin 6 or 4 or 2, whichever is convenient.
  - Double check the three preceding steps and make sure of the connection.
- Power Test:
  - Turn ON or enable the 2.6-V power, and plug in the USB cable between the USB-MODEVM J7 and your PC.
  - All LEDs on USB-MODEVM should be ON (except for the D6/-5VA), and ensure that the yellow-colored D2 is ON.

- Use a voltage meter to measure the power test points on AIC33EVM and you should get the following readings:
  - JMP4 (IOVDD) = 2.6 V
  - JMP6 (DVDD) = 1.8 V
  - JMP7 (DRVDD)= 3.3 V
  - JMP8 (AVDD)= 3.3 V.
- Digital Microphone Connection
  - If all the preceding is working correctly, then unplug the USB and disable the 2.6-V output.
  - Ensure that no power is on the USB-MODEVM and AIC33EVM system.
  - Connect the digital microphone to the system by connecting:
    - The microphone's GND to J16A pin 4 (DGND)
    - The microphone's VDD to J15A pin 9 (IOVDD)
    - The microphone's CLK to J16A pin 2 (GPIO1)
    - The microphone's OUT to J16A pin 6 (GPIO2)

#### 4. Digital Microphone Function Test

- Turn on or enable the 2.6V power and plug in the USB cable between the USB-MODEVM J7 and your PC.
- On your PC, run the USB-Serial Commander or AIC33EVM GUI SW.
- Load the software script, provided in the appendix of this application report to the *Command Buffer*.
- Execute the code in *Command Buffer*, and
- Both recording (through the digital microphone) and playing back (from AIC33 J7) functions are now ready to use.

## 5 References

1. *TLV320AIC33, Low Power Stereo Audio Codec for Portable Audio/Telephony* data sheet ([SLAS480](#))
2. *TLV320AIC33EVM User's Guide* ([SBAU114](#))

## 6 Appendix

The following script can be loaded and run on the AIC33 EVM.

```

#####
# Wendy Fang, 2005.09.14
#
# setup AIC3x for Digital Microphone Application:
#
# Mono ADC --
# (with either left or right or both ADCs Powered up)
# Input from a LMV1024 Digital Mic with 64*FsSample rate
#
# Stereo DACs --
# Output stereo/single-ended/cap-less to headphone
#####
#####
# ADC Control (for working with Digital Microphone)
#####
# reg 07 - codec datapath
# Fsref=44.1K, and
# L-DAC plays DIN left data and R-DAC plays right one
w 30 07 8A
# reg 08 - set bit-clk and word-clk to inputs, dmic enabled with 64*Fs sample rate
w 30 08 02
r 30 07 2
b
# regs 15/16 - ADC volume, unmute and set to 0dB
w 30 0F 00 00
r 30 0F 2
b
# reg 19 - MIC1_LINE1_L for Left ADC 01111100 (Powerup Left ADC)

```

## Appendix

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```

w 30 13 7C
# reg 22 - MIC1_LINE1_R for Right ADC (Powerup Right ADC)
w 30 16 7C
r 30 13 4
b

#####
# Digital Microphone Setting
#####
# reg 98 - set GPIO1 output to dmic clock output
w 30 62 A0
# reg 99 - set GPIO2 output to dmic data input
# use value 50 for LMV1024 (rising edge)
# use value 60 for LMV1026 (falling edge)
# use value 70 for stereo mic (LMV1026+LMV1026) system
w 30 63 50
r 30 62 2
b

#####
# DAC Control (This is set for playing-back dig-mic recorded audio signals)
#####
# reg 37 DAC POWER CONTROL/ reg 38 HPCOM CONFIG
# Power up L and R DACs
# HPCOML/R as Headphone COM for Cap-Less mode
w 30 25 D0 08
r 30 25 2
b
# regs 43/44 - DAC L/R VOLUME - 0dB
w 30 2B 00 00
# reg 42 - driver power ON Pop Control
w 30 2A 6C
r 30 2A 3
b

#####
# Headphone Outputs
#####
# reg 47 - HPLOUT Routing and Volume
# Left DAC routed to HPLOUT @ 0dB
w 30 2F 80
r 30 2F 1
b
# reg 51 - HPLOUT LEVEL
# HPLOUT not muted, powered up
w 30 33 0D
r 30 33 1
b
# reg 64 - HPROUT Routing and Volume
# Right DAC routed to HPROUT @ 0dB
# reg 65 - HPROUT LEVEL
# HPROUT not muted, powered up
w 30 40 80 0D
r 30 40 2

```

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