

Circuit Note CN-0266



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Devices Connected/Referenced		
ADSP-BF527	Low Power Blackfin Processor with Advanced Peripherals	
ADMP441	Omnidirectional Microphone with Bottom Port and I ² S Digital Output	

High Performance Digital MEMS Microphone Standard Digital Audio Interface to Blackfin DSP

EVALUATION AND DESIGN SUPPORT

Circuit Evaluation Boards

ADMP441 Evaluation Board (EVAL-ADMP441Z)

ADMP441 Flex Evaluation Board (EVAL-ADMP441Z-FLEX)

System Demonstration Platform (SDP) (EVAL-SDP-CB1Z) Design and Integration Files

Schematics, Layout Files, Bill of Materials

CIRCUIT FUNCTION AND BENEFITS

The circuit shown in Figure 1 allows up to two digital MEMS microphones to be interfaced to a DSP on a single data line. The ADMP441 consists of a MEMS microphone element and an I²S output. This allows stereo microphones to be used in an audio system without the need for a codec between the microphones and the processor. Analog Devices, Inc., MEMS microphones have a high signal-to-noise ratio (SNR) and a flat wideband frequency response, making them an excellent choice for high performance, low power applications.



Figure 1. MEMS Microphone Connection to Blackfin DSP (Simplified Schematic: All Connections Not Shown)

Rev. 0

Gircuits from the Lab™ circuits from Analog Devices have been designed and built by Analog Devices engineers. Standard engineering practices have been employed in the design and construction of each circuit, and their function and performance have been tested and verified in a lab environment at room temperature. However, you are solely responsible for testing the circuit and determining its suitability and applicability for your use and application. Accordingly, in no event shall Analog Devices be liable for direct, indirect, special, incidental, consequential or punitive damages due to any cause whatsoever connected to the use of any Circuits from the Lab circuits. (Continued on last page) Up to two ADMP441 microphones can be input to a single data line on the ADSP-BF527 Blackfin[®] processor. The ADSP-BF527 can be set up with up to four serial data inputs; therefore, up to eight ADMP441s can connect to a single DSP.

CIRCUIT DESCRIPTION

The ADMP441 microphones are connected to the SPORT data input pins of the ADSP-BF527. The only necessary passive components in this circuit are a single 0.1 μ F bypass capacitor for each ADMP441 and a large pull-down resistor (100 k Ω) on the SD line to discharge it while the ADMP441 output drivers are tristated. Place the bypass capacitors as close to the ADMP441 V_{DD} pin (Pin 7) as possible.

Supply the microphones' V_{DD} from the same source as the 2.25 V to 3.3 V V_{DDEXT} of the ADSP-BF527. Even though the ADMP441 can operate with VDD between 1.8 V and 3.3 V, V_{DDEXT} on the ADSP-BF527 must be a minimum of 2.25 V.

There are three signals that must be connected between the ADMP441 and ADSP-BF527 for the I²S data stream: frame clock, bit clock, and data. The ADSP-BF527 is the system clock master and generates the two I²S clocks.

This circuit demonstrates the microphones connected to a single data input on the SPORT0 of the Blackfin. Each of the two SPORTs of the ADSP-BF527 has two sets of data receive pins that enable up to eight channels of I²S audio in. Table 1 shows the connections when using the serial SPORT0 of the ADSP-BF527.

Table 1. Hardware Signal Connections

Signal	ADMP441	ADSP-BF527	
Frame Clock	WS (Pin 3)	PF1/PPI_D1/RFS0 (Pin PF1)	
Bit Clock	SCK (Pin 1)	PF2/PPI_D2/RSCLK0 (Pin PF2)	
Serial Data	SD (Pin 2)	PF0/PPI_D0/DR0PRI (Pin PF0)	

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Set the L/R pin on the two ADMP441s to opposite levels—one pulled to V_{DD} and the other to GND. When pulled to GND, the microphone outputs its data on the left channel of the I²S stream, and when pulled to V_{DD} , it outputs its data on the right channel.

The ADMP441 is enabled by pulling the CHIPEN pin high. This pin can be tied either directly to the V_{DD} of the microphone, which keeps it always enabled while it is powered, or it can be connected to a GPIO on the ADSP-BF527, allowing the Blackfin to enable and disable the microphone.

The ADMP441 has a sensitivity of -26 dBFS. In most applications, the microphone outputs require some gain added in the signal path of the Blackfin. If gain is added to the signal in the DSP, the output of the processor must still be limited to 0 dBFS.

ADSP-BF527 Register Settings

The SPORT register settings to set the ADSP-BF527 into I²S master mode follow. A more detailed description of these register settings can be found in the ADSP-BF52x Blackfin Processor Hardware Reference.

Configure SPORT_RCR1, the primary receive configuration register, with the following nondefault settings:

- RCKFE: Drive internal frame sync on falling edge of RSCLK
- RFSR: Require RFS for every data-word
- IRFS: Internal RFS used
- IRSCLK: Internal receive clock select

Configure SPORT_RCR2, the secondary receive configuration register, with the following nondefault settings:

- RSFSE: Receive stereo frame sync enable
- SLEN: 32-bit word length

Set SPORT_RCLKDIV, the SPORT receive serial clock divider register, to 17 (0x0011) and set SPORT_RFSDIV to 31 (0x001F). This sets the proper clock frequencies for a 48 kHz frame clock and 3.072 MHz bit clock with a 120 MHz Blackfin system clock (SCLK).

The registers settings described can be applied to either SPORT0 or SPORT1 on the ADSP-BF527, depending on which is being used.

COMMON VARIATIONS

DSPs

This circuit can also be set up with other parts from the Blackfin family instead of an ADSP-BF527. See the appropriate data sheets for details on the differences in number of SPORT channels and other variations. Consult the Blackfin family product page at: http://www.analog.com/blackfin.

Microphones

By removing one of the ADMP441 microphones, a mono microphone circuit using a single ADMP441 can be set up. The other connections remain the same in this mono configuration.

Additional ADMP441 microphones can be connected to the SPORT inputs of the ADSP-BF527 in the same way as the first stereo pair.

CIRCUIT EVALUATION AND TEST

The easiest way to evaluate a system with the ADMP441 MEMS microphone connected via I²S to the ADSP-BF527 Blackfin DSP is to use the EVAL-ADMP441Z evaluation board and the Blackfin SDP. These boards are designed to work together and include code to enable the digital audio connection. When connected to the USB port of a PC, the system is identified as a standard USB audio interface and enables streaming of stereo audio from the microphones to the PC.

Equipment Needed

The two evaluation kits needed include the following:

- EVAL-ADMP441Z: includes one EVAL-ADMP441Z-FLEX board and an interface PCB.
- EVAL-SDP-CB1Z: includes SDP-B controller board

For correct operation of the SDP board, the PC must have the following minimum configuration:

- Windows XP Service Pack 2, Windows Vista (32-bit), or Windows 7 (32-bit).
- USB 2.0 port

A second EVAL-ADMP441Z-FLEX can be connected to the interface board to enable stereo audio capture.

Getting Started

The microphone FLEX PCBs connect to the interface board with ZIF headers, J1 and J2, and the EVAL-ADMP441Z connects to the SDP-B with 120-pin header, J3.

The documentation for the SDP-B controller board and EVAL-ADMP441Z describes the system setup and gives complete schematics of the boards. The only external connections required are the USB connection to the PC and system power to the ADMP441 evaluation board.

Complete documentation for the EVAL-ADMP441Z evaluation board can be found in the UG-362 user guide.

Complete documentation for the SDP-B controller board can be found in the SDP-B User Guide, UG-277.

LEARN MORE

CN0266 Design Support Package: http://www.analog.com/CN0266-DesignSupport

- Elko, Gary W. and Kieran P. Harney, "A History of Consumer Microphones: The Electret Condenser Microphone Meets Micro-Electro-Mechanical-Systems," *Acoustics Today*, April 2009.
- Nielsen, Jannik Hammel Nielsen and Claus Fürst, "Toward More Compact Digital Microphones," *Analog Dialogue*. September 2007.
- Lewis, Jerad, "Microphone Specs Explained," Application Note AN-1112, Analog Devices.
- Lewis, Jerad, "Common Inter-IC Digital Interfaces for Audio Data Transfer," Technical Article MS-2275, Analog Devices.

Data Sheets and Evaluation Boards

ADSP-BF527 Data Sheet

ADSP-BF52x Blackfin Processor Hardware Reference

ADSP-BF527 Evaluation Board (ADZS-BF527-EZLITE)

ADMP441 Data Sheet

ADMP441 Evaluation Board (EVAL-ADMP441Z)

ADMP441 Flex Evaluation Board (EVAL-ADMP441Z-FLEX)

System Demonstration Platform (EVAL-SDP-CB1Z)

REVISION HISTORY

1/12—Revision 0: Initial Version

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