Introduction:

The main goal of this lab is to understand how to use and control the A/D and D/A capabilities of the EZ-Kit Lite hardware and the VisualDSP++ software to send audio signals to the board and play them back through a speaker. Note that this process involves sampling and quantization of the analog audio signal, at a given sampling rate, and storing it on the board, to perform the A/D operation, and reconstruction of an analog signal from a sampled, quantized digital signal, again at a given sampling rate, to perform the D/A operation.

To accomplish this goal we will use a program supplied by Analog Devices called the Talkthrough program. This program is structured so that it accomplishes the A/D and D/A operations for us by taking a pair of samples from the left and right input port channels and delivering them to the appropriate channels of the output port. In addition, there is a place in the program where the user can put his or her own processing program. In this lab you will learn how the Talkthrough program accomplishes its tasks by controlling registers for the Blackfin 535 processor and the AD1885 stereo codec on the board. You will modify some of the default values supplied and listen to the result to make sure you understand the Talkthrough operation. It is important to understand the scope of these registers as improper settings may cause unexpected results. In subsequent labs, you will design and code some different digital signal processing functions to modify the audio signals between the A/D and D/A operations. Thus the Talkthrough program will serve as a basic initialization structure for later labs.

Some Preliminaries:

The target system, ADSP-BF535 EZ-KIT LITE, is already predetermined within certain parameters for its operational mode. It contains the programmable stereo codec connected to the serial port of the BF535 processor, through which left and right channel data is acquired. You will need to learn some basics about the codec and processor, operation.

Exercise 0:

The manual for the AD1885 codec can be found at the following site: http://www.analog.com/Analog_Root/productPage/productHome/0%2C2121%2CAD1885%2C00.html

Click on the link for “Data Sheets” in the left-hand frame to see the manual. In the manual, read the description for the “Indexed Control Registers” from page 11 to 21, paying particular attention to the “Reg Num” rows. Also look at the following registers: “Master Volume”, “MIC Volume”, “Line in Volume”, “PCM out volumn”, “PCM DAC Rate(SR0)” and PCM DAC Rate(SR1)"
Then look at the manual for the BF535 processor, which you can find it within the VisualDSP++ help. The path is “help”—“contents”—“Manuals”—“ADSP-BF535 Blackfin Processor Hardware Reference”.

Read and make sure you understand the description for “SPORT Registers”, and take a look at the registers of “SPORTx_TX_CONFIG”, “SPORTx_RX_CONFIG”, “SPORTx_TX” and “SPORTx_RX”. Understanding the functions of these registers is important to understand the Talkthrough program.

Comment in your notebook on what you learn from both manuals.

Note again that this material is only needed as you begin to use the lab, to understand and control the A/D and D/A operations. Once this is done then in subsequent experiments we will concentrate on the other processing features while the initialization procedure will always be a part of your future programs.

**Exercise 1. Understanding the Talkthrough program structure:**

You can find the Talkthrough program within your own folder. First make a backup copy of the Talkthrough program so that you can always return to the original source after making modifications.

Open the project file with the VisualDsp++ software and then look over the source files and try to understand the program structure clearly. We recommend you begin from the “main.c” file. Pay attention to the array for codec registers, referring to the AD1885 codec manual as needed. Note the current settings for those registers. Don’t forget to look at the “main” function. What’s the function of the “while(1) {...}” instruction? Record this in your notebook.

Also look at the header file “Talkthrough BF535.h”, paying attention to the symbolic constants of “eCodec_Registers”, Record any relationship you notice between this definition and the descriptions for the codec in the manual on page 11?

Also look at the other source files, especially the “Process Audio Data.c” program. Where do you think your later DSP operations will be inserted? Most later experiment programs will be modified within this file.

Note: Please pay careful attention to the comments in each source files, as they are very useful hints to understand the program.

Again, don’t forget to make a backup copy of the Talkthrough program before you modify it.

**Exercise 2. Running the Talkthrough program:**
Build and run the Talkthrough program, make sure you have chosen the option of “Dsp executable file” in “Project—Project options—Target type” and the last session from the “Session—Session List” menu. Look at the Assembly code using Mixed-mode format to see how the C code is translated to Assembly. Check the Talkthrough program operating on the EZ-Kit Lite board using the monaural microphone and record whether it is working properly or not (and what it does).

**Exercise 3. Understanding the codec registers:**

Modify the values of the codec registers mentioned above, such as “PCM out volume”, “MIC Volume”, etc. Rebuild and run the program on the board. Make notes on each register that you modify and what you observe. By doing this you should be able to verify that the Talkthrough program is working properly and that you understand the function of the various registers.

**Exercise 4. Audio effects of the Sampling Frequency:**

The default setting for the sampling frequency is 48KHz, and the range we can use goes from 7040Hz to 48KHz in 1 Hz increments. Modify the sampling frequency (Codec registers “PCM DAC Rate(SR0)” and PCM DAC Rate(SR1)” ) and qualitatively describe the sound quality when you use different sampling frequencies. Include any guidelines you think appropriate for future use in terms of useful ranges of sampling frequencies for different kinds of audio inputs.

**Exercise 5. Stereo input:**

If you have access to stereo input (a Walkman or a Discman, for instance), you can run the Talkthrough program with stereo input. Test the program with different sampling frequencies and qualitatively describe your observations.

**Exercise 6. EZ-Kit- Lite LED control (if time permits):**

The EZ-Kit Lite board has 4 LED’s that are software controllable. The programs in the “c_delay” folder illustrate how to control these LED’s. Find these programs (with Mr. Fei’s help), look over the code, build and run them, and describe the results in your notebook. See if you can figure out how to change the blinking pattern so that the two outside LED’s blink together alternating with the two inside LED’s. Then modify it so that the LED’s blink one at a time, in effect counting to 4 over and over. Finally, try to understand how to modify the speed with which the LED’s blink. If you can, determine the fastest speed at which you can actually see the LED’s blinking. This is a kind of ‘sampling rate’ for your visual perception system; based on this lab, can you speculate how it compare to the ‘sampling rates’ at which your auditory system can respond?