FFT Experiment

Introduction

In this experiment, several composite audio signals will be measured with a data acquisition unit at various sampling frequencies. The sampled data will then be analyzed to determine the frequency components of the signal. The audio signals are contained in mp3 files which are embedded in a Power Point file and will be played on the laboratory PC. As shown in Figure 1, the PC headphone output will be connected to the NI USB-6003 analog input using an audio breakout box.

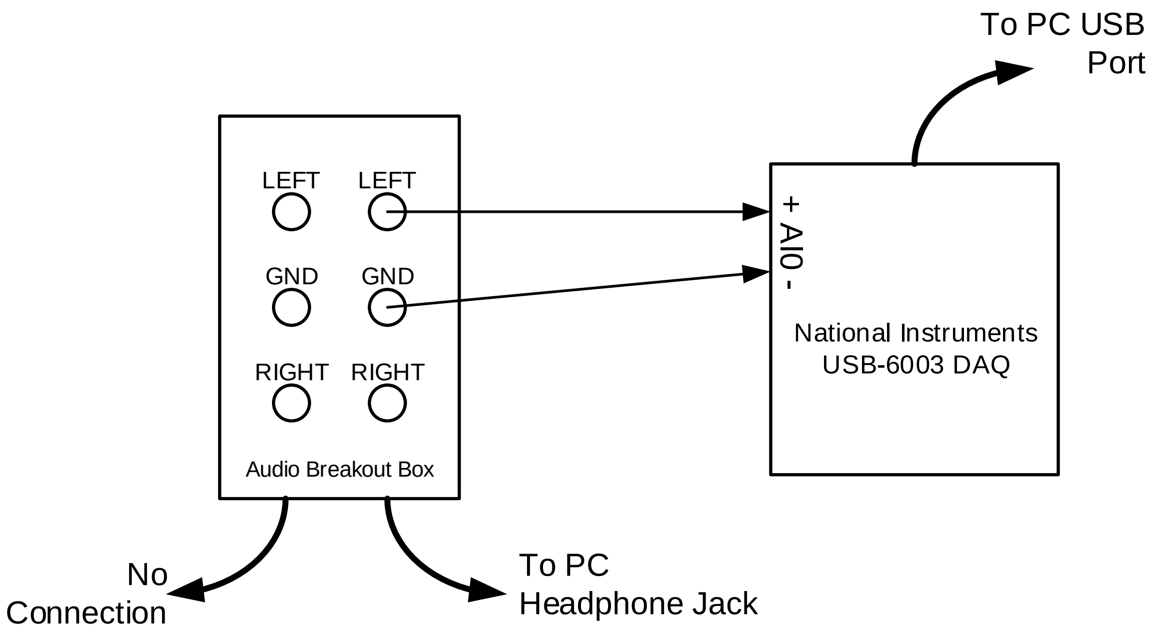

Figure 1. FFT Experiment Test Setup

The data will be obtained using LabVIEW software to control the USB-6003. A LabVIEW virtual instrument, “Audio Data Sampling.vi” is available on Canvas for use in this experiment. When run, the vi will record the specified number of samples at the specified sampling rate. The embedded audio objects each contain a 30 second clip of the signal to be analyzed:

- FFT_Lab_Signal_1
- FFT_Lab_Signal_2
- FFT_Lab_Signal_3

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Simplified Test Procedure

1. Connect the circuit as shown in Figure 1.
2. Open the LabVIEW vi, "Audio Data Sampling.vi".
   - Set the "Sampling Frequency" to 5000 Hz.
   - Set the "Number of Samples" to 5000.
3. Download the Power Point file, "FFT Lab Signals" onto the PC desktop and open the file.
4. In the Power Point slide, click on the speaker icon to the right of the "FFT_Lab_Signal_1" label. A sound control toolbar should appear.
5. Click the play arrow to start the signal then quickly click the LabVIEW VI run button to acquire the signal. Adjust the PC volume such that the peak amplitude of the recorded signal is between about 0.4 and 0.8V as shown on the VI graph. Repeat as necessary to obtain a properly sized waveform.
6. Copy (Export) the plotted frequency index data by right clicking on the plot and choosing Export > Export Data to Excel. Save the data file with an appropriate name.
7. In Excel, use the "Cluster Columns" format to make a chart of the data. Show this chart to the lab instructor before continuing.
8. Determine what frequency components are present in the chart and populate the table below.
9. Repeat the above steps for the other two signals, "FFT_Lab_Signal_2" and "FFT_Lab_Signal_3".
10. Repeat the above steps for "FFT_Lab_Signal_3" with a sampling frequency of 10000 Hz and the number of samples set to 10000.
11. Repeat the above steps for "FFT_Lab_Signal_3" with a sampling frequency of 20000 Hz and the number of samples set to 20000.
12. Repeat the above steps for your bench specific mystery waveform, "FFT_Lab_Bench_x_Signal.wav". Use a sampling frequency of 5000 Hz and the number of samples set to 5000.

To summarize, a total of 6 data files should be obtained as follows:

- FFT_Lab_Signal_1 sampled at 5000 Hz
- FFT_Lab_Signal_2 sampled at 5000 Hz
- FFT_Lab_Signal_3 sampled at 5000 Hz
- FFT_Lab_Signal_3 sampled at 10000 Hz
- FFT_Lab_Signal_3 sampled at 20000 Hz
- FFT_Lab_Bench_x_Signal.wav sampled at 5000 Hz

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Table 1.

Waveform	Sampling Frequency (Hz)	1st FFT Frequency	2nd FFT Frequency	3rd FFT Frequency
FFT_Lab_Signal_1	5000			
FFT_Lab_Signal_2	5000			
FFT_Lab_Signal_3	5000			
FFT_Lab_Signal_3	10000			
FFT_Lab_Signal_3	20000			
FFT_Lab_Bench_x_Signal_1	5000			

Homework Submission

1. Table 1.
2. Why are the FFT frequencies different when FFT_Lab_Signal_3 is sampled at 5000 Hz and 10000 Hz?
3. Why are the FFT frequencies the same when FFT_Lab_Signal_3 is sampled at 10000 Hz and 20000 Hz?
4. The FFT plot of the mystery waveform for your bench.
5. State which frequencies are present in the FFT plot for your mystery waveform.
6. State which DTMF number is represented by the frequencies in your mystery waveform. The following links might be useful:

   https://en.wikipedia.org/wiki/Dual-tone_multi-frequency_signaling

   http://www.genave.com/dtmf.htm