ENGR 1121 Lab 1
Introduction to Data Acquisition Using the Analog Discovery

January 27, 2014

This week, you will start to learn how to use the basic software (MATLAB's Data Acquisition Toolbox and WaveForms) and hardware (Analog Discovery) that you will be using throughout the course for data acquisition. This week, you will be acquiring data from a relatively simple sensor, a precision centigrade temperature sensor. You will also be constructing and collecting data from a simple first-order *RC* lowpass filter.

Before getting started, you will need to acquire and install the WaveForms software from the Digilent website and the Analog Discovery hardware support package for MATLAB's Data Acquisition Toolbox from the MathWorks website. Once you have acquired and installed this software, you should obtain an Analog Discovery and the sample MATLAB script called `DAQacquire.m` from the course website under "Codes." Start by just running it and making sure that you get no errors. Your plot will probably just look like noise because you have not hooked anything up to the Analog Discovery's analog input channels. Try modifying some aspects of the software, such as the number of channels acquired, the sample rate, the duration of the experiment, etc. The only point of this testing step is to get you familiar with the software and to make sure that everything is working.

Next, obtain an LM35DT temperature sensor. This chip is designed so that the output voltage is 0V at 0ºC and changes by 10mV/Cº above 0ºC. Connect your sensor to power and ground and to one of the analog input channels of the Analog Discovery. Using MATLAB, acquire some data from the temperature sensor. Do the values you acquired make sense given typical values for room temperature? Perform an extended acquisition during which you start the sensor at room temperature and then heat it (e.g., by pinching the tab with your fingers) for part of the experiment and then let it cool back down. Produce a plot for your report showing temperature versus time for your experiment.

Next, construct a first-order *RC* lowpass filter with a corner frequency of about 1kHz. Using the WaveForms software, apply a square wave to the input of your filter. Observe both the input signal using channel 1 and the output signal with channel 2. Adjust the frequency of the input and the timebase setting of the oscilloscope so that you can clearly see both the rising and falling step response of your filter circuit (i.e., the period of the square wave should be about ten times the filter's *RC* time constant). Export the input and output waveforms to a .csv file. Import these waveforms into MATLAB using (e.g. using `load -ascii`). Fit an exponential curve (e.g., using `polyfit` on the log of an appropriately offset version of the output waveform) to the rising and falling edges of the output waveform, extracting a value of the time constant for each transition. Produce a plot for your report showing the input and output waveforms, the exponential fits, and the values you extracted for the time constant. Do these values match what you expect from the *RC* product?

Finally, using the network analyzer instrument in the WaveForms software, measure the frequency response of your lowpass filter from 10Hz to 1MHz. Export the data to a .csv file. Import these data into MATLAB. Produce a Bode plot (both magnitude and phase) for your report showing your measured data (as discrete points) along with a theoretical curve (as a solid lines) for the frequency response of your filter. How well do the measured curves correspond to the theoretical ones? Does the corner frequency in the frequency response match the time constants that you extracted from the step response?

Deliverables and Grading

This lab is mainly to get you up to speed with the hardware and software. Nevertheless, make sure your plots are all readable, have appropriate axes labels (including units). There should also be a short description of what each plot shows. Your lab report should include the following:

1. A plot showing temperature vs. time for an experiment with the LM35 temperature sensor. (2 points)

2. A plot showing the step response of your *RC* lowpass filter, including the input waveform, the output waveform, along with exponential fits to the rising and falling portions of the output waveform. (3 points)

3. A Bode plot (both magnitude and phase) of the measured frequency response of your *RC* lowpass filter along with a theoretical curve. (3 points)

4. Brief comments responding to the questions posed in the handout. (2 points)

Your lab report is due one week after your lab section. You will hand your report in electronically as a .pdf file to the designated folder on the Public drive. There are no extensions unless approved in advance by the course instructors (your NINJA cannot grant you an extension). The graders will assign your lab report a grade out of 10 points. You will receive zero points for any deliverable that is not provided. You will receive full credit for deliverables that are correct and done well. You will receive partial credit for deliverables that are provided, but have some problems.