ECE 3710 LAB V

Due Date: Week of November 11th 2013 (20 Points)

Objectives

The student should be able to operate an analog to digital converter (ADC) and a digital to analog converter (DAC) on the microcontroller to produce a varying frequency sine wave.

Overview

In this lab we will write a C program that generates a sinusoid using a DAC connected to the microcontroller at a frequency specified by the user—i.e. we'll turn the microcontroller into a sinusoidal waveform generator. The user will be able to select the frequency of the sine wave by varying the level of a voltage source connected to the ADC.

Preparation

1. Become familiar with the operation of your microcontroller's onboard ADCs (see the corresponding sections in the TM4C123GH6PM Data Sheet). You will find the ADC corresponding pins in section 13-2.
2. Also familiarize yourself with the external DAC module through the TLC5615 data sheet on the course wiki.
3. Also look over the analog test board schematic found on the wiki.
4. Prepare the following parts
    - Tiva C series development board
    - Analog test board module
    - LCD touch panel module
    - Jumpers and wires
    - 10nF capacitor
    - TLC5615CP 10-bit serial DAC (available free of charge from the ECE store)
    - Power Supply

Requirements

1. Use the external 16 MHz crystal with the PLL to set the system clock (configure the PLL to produce whichever frequency is most convenient). This is necessary to produce consistent output on the DAC.
2. Connect one of the analog board potentiometers to ADC0. Connect the output of the DAC to the analog test board (AIN or AUDIO_IN).

3. Use a timer to configure the ADC to automatically sample the input line (i.e. initiate a conversion) every 2 ms.
4. Make use of an interrupt (no polling) to copy the converted voltage value from the ADC's registers.
5. Produce a sine wave using a look-up table with 40 entries.
6. Output the selected frequency on the LCD display. You may truncate the frequency to be an integer. Display the frequency with units (xxx Hz). The frequency range is 100 Hz to 1000 Hz.
7. Use QSPI mode (16-bit SPI).
8. Configure the DAC to update as a result of a timer (auto-reload) using an interrupt.
9. Set the DAC output as a result of an interrupt.
10. Use the capacitor to filter the square edges of the DAC waveform.

You only need to check to see if the user has adjusted the voltage every 500 ms.

Verify Requirements

1. Demonstrate to your TA that you have met the above requirements
2. Include in your lab report a discussion of how the voltage is used to determine the frequency.
3. Use the oscilloscope to view the filtered waveform from the DAC and verify the frequency. Include a picture of the waveform from the oscilloscope in your lab report.
4. Show that the correct frequencies are produced for the following codes: 0, 1023, 2047, 3071, and 4095. Measure the voltages these correspond to. The frequencies must be accurate to within 2 Hz.

Notes and Tips

- The external DAC will require a separate power source; details can be found on page three of the DAC datasheet under the "Recommended Operating Conditions." You should use the recommend Vdd and Vref.
- By default, the SSICLK signal is low when idle (See pages 955,956 and 964 in the datasheet). Is this correct for the DAC?
- Since you are sampling the line 250 times as often as you're checking to see if the user wants to output a different frequency, you should use the extra samples to mitigate the effects of noise and power supply jitter on the measurements; i.e. you should average the ADC code values for the 250 samples to determine the actual ADC code to use for the frequency calculation.
- The DAC has an output buffer that changes the output impedance. This may be something to consider when filtering the rigid edges of the waveform.
- Several fonts have been provided for you on the lab supplements page.