University of North Texas, College of Engineering
Department of Electrical Engineering

EENG 3910: Project V - Digital Signal Processing System Design

Assignment 4

Lab Session: Monday, 02/22/2016
Due: Monday, 02/29/2016

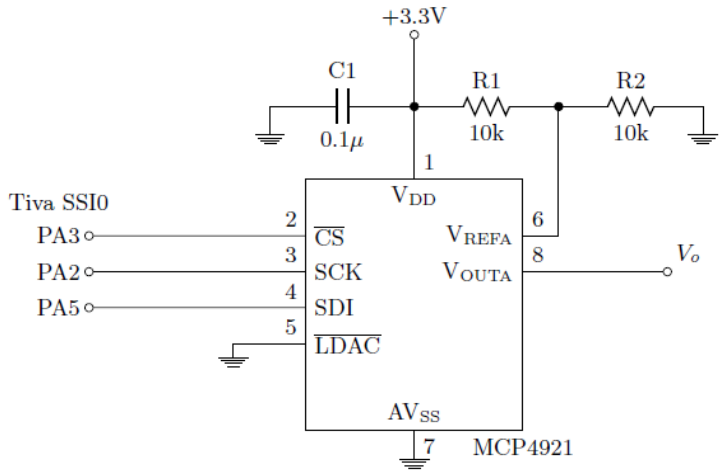
Student Name: _____

Important:

- Please create a new assignment folder in your working directory for each assignment, and a new problem folder in the assignment folder for each problem.
- Please backup your files in your own USB drive or your own network drive at the end of each class because the workbench computers may be reimaged without prior notice.

Problem 1. Generate a single-tone sine signal from LaunchPad with a SPI DAC chip.

- Follow the Getting Started document "Getting_Started_CCS6.pdf" to create a new CCS project for Tiva C Series LaunchPad. You may name the new CCS project as Lab4_1.
- Delete the "main.c" file if you have generated that file automatically when you were creating your new CCS project.
- Copy the source code file "Lab4_1_main.c" into your project folder.
- Build, load, and run your project on Tiva LaunchPad.
- Verify that the program is running by changing LED colors through UART terminal.
- Turn off the power of your LaunchPad.
- Build the following circuit on a breadboard, and connect to your Tiva LaunchPad.
  Important: the Ground and 3.3V power source shown in the circuit should be directly connected to the GND and 3.3V pins on Tiva LaunchPad. Do not use a separate power supply.

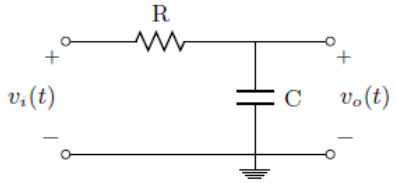


- Connect the probe of an oscilloscope to the Ground and V_O to measure the output from the DAC chip MCP4921.
- Turn on the power of your LaunchPad. Your Lab4_1 program should be running in the LaunchPad now. Observe the output signal on the oscilloscope monitor. Record what you have observed on the scope. What is the frequency of the signal shown on the scope screen?

- Study the source code line-by-line by referencing to the document "SW-TM4C-DRL-UG-2.1.0.12573.pdf" and the data sheet document "MCP4921.pdf" that is available in the assignment folder in Blackboard. Explain in the report how to program MCP4921 to interface it with LaunchPad. Point out the lines in the source code that is related to the configuration of the MCP4921 chip.

- In the source code, change the SAMP_FREQ to the following values one at a time: 2000, 4000, 8000, 16000, and change the SIG_LEN to SAMP_FREQ/SIG_FREQ accordingly. Then, monitor and capture the output signal waveform on the oscilloscope screen. Explain what you have observed.

- Build the following RC low-pass filter circuit on the same breadboard and connect the output from MCP4921 to the input of this filter. In this circuit, $R = 10\text{k}\Omega$, C = 0.01uF. Then monitor the output signal of this filter on oscilloscope.



- Again, change the SAMP_FREQ to the following values one at a time: 2000, 4000, 8000, 16000, and change the SIG_LEN to SAMP_FREQ/SIG_FREQ accordingly. Then, monitor and capture the output signal waveform on the oscilloscope screen. In the report, determine the cutoff frequency of the low-pass filter and explain what you have observed.

Problem 2. Signal pass through with ADC and DAC.

- Create a new CCS project with the name of Lab4_2.
- Write a program to do the following:
  - Blink LEDs at the rate of 2Hz using Timer0.
  - Enable UART to accept user command and display messages.
  - Configure the pin PD0 as analog input and sample with ADC0.
  - Enable Timer1 to interrupt at the rate of SAMP_FREQ=16000. Define SAMP_FREQ as in Problem 1.
  - Configure SSI0 and interface with the SPI DAC chip MCP4921 as in Problem 1.
  - On Timer1 interrupt, sample data from PD0, then output the same data to DAC through SSI0 (through which to the DAC chip).
  - Build and run your program on LauchPad.
- Tunr off the power of your LaunchPad.
- Configure a function generator to generate a sine wave with 3Vpp, 1.5V DC offset, and 1kHz frequency. Connect the function generator output to the analog input pin PD0 on LaunchPad. Connect an oscilloscope to the DAC output to monitor the output signal from DAC on the scope screen.
- Turn on the power of your LaunchPad. Your Lab4_2 program should be running in LaunchPad now.

- Observe and record the display on the scope screen.
- Adjust the frequency of the signal on function generator while your LauchPad is running. Observe the signal on the scope screen while you adjust the frequency on the function generator.
  Important: Be very careful with the voltage level of the output signal from function generator. Do not let the voltage level go beyond the range [0, 3.3V]. If you do, your LauchPad may be damaged.

Problem 3. Signal pass through with ADC, DAC and UART user command.

- Modify your Lab4_2 program directly to add the following functionality to the program:
  - Implement two new UART user commands "S" and "P", where "S" is to start sampling and "P" is to pause sampling. Upon user command "S", LauchPad will sample signal on PD0 and output the data direct to DAC. Upon user command "P", LaunchPad will stop sampling and stop outputting signal.
  - The commands "S" and "P" can be used repeatedly to start and stop the sampling and outputting in arbitrary sequence in real-time without powering off the LaunchPad.

Assignment Deliverables:

- Compile your report with pictures, plots, and the codes that you have written or modified.
- Explain in detail what you have done, why you have done in that way, and what you have learnt. Follow the report format outlined in the Introduction lecture notes.
- Email your report and source codes for grading. For source code submission, you will need to zip your working directory and send the zipped file to your TA at VeenaChidurala@my.unt.edu.
- Printout of your source code should be attached to your lab report as appendix. If your source code goes beyond two pages, please only print the part of the source code where you have newly written or modified.