ECE 3710 Lab 8 – Fall 2018

Due Date: Week of November 5 before the beginning of your lab section

Objectives

The student will interface a proximity sensor to the microcontroller's ADC and use the reading to control a DAC connected to the piezo-electric speaker.

Overview

In this lab we will write a C program that reads a proximity sensor and uses the reading to vary the frequency of a DAC-generated sine wave that drives the piezo-electric speaker.

Preparation

1. Come with the following:
    a. ECE 3710 Lab Kit
    b. STM32L476 Discovery Board
    c. Textbook
2. Read Chapters 20 and 21 of the textbook.
3. Become familiar with the operation of the STM32L476's onboard ADC and DAC by reading the appropriate sections of the datasheet.
4. Read the datasheets for the QED123 infrared LED and the QSD124 Phototransistor.

Requirements

1. Design a proximity sensor circuit that meets the following specifications
    a. Uses an ADC channel to read the voltage on the phototransistor.
    b. Uses a DAC channel to drive a sine wave to the piezoelectric buzzer.

c. The system should produce higher-frequency tones as an object gets closer to the proximity sensor.

d. HINT – optically isolate the LED and the phototransistor to allow only reflected light to reach the detector.

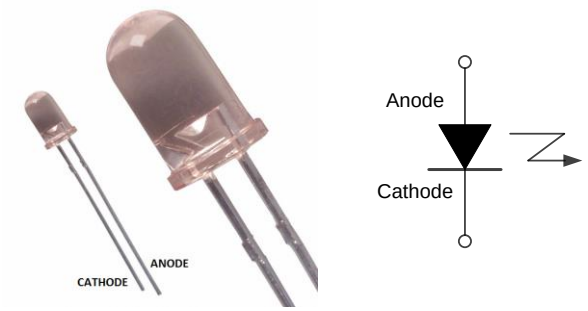

Figure 1. QED123 Infrared Light Emitting Diode (Infrared Transmitter)

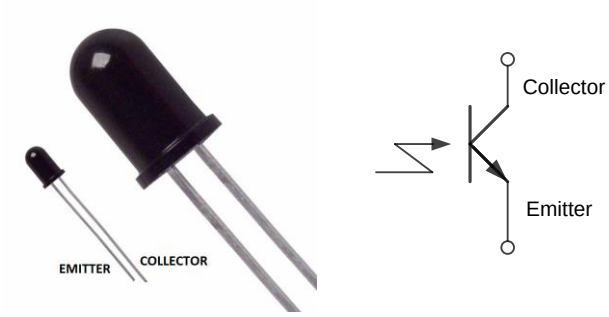

Figure 2. QSD124 Infrared Phototransistor (Infrared Receiver)

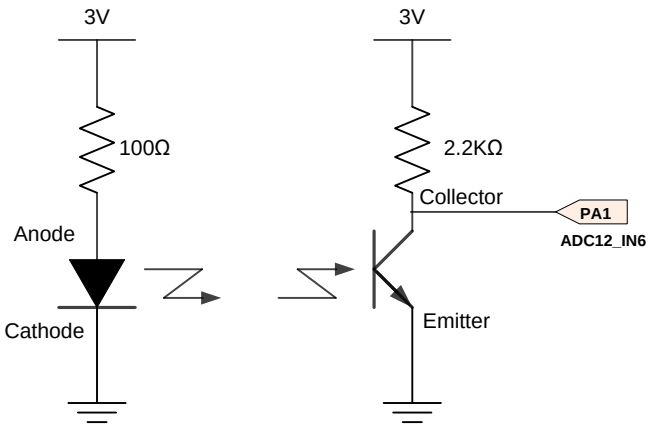

Figure 3. Basic Connection Diagram

Pre-Lab

1. Draw a schematic diagram of the circuit, including LED, phototransistor, ADC, DAC, and buzzer. Include any other needed components as well.

2. **Pass off** your schematic to the TA at the beginning of your lab section.

Procedure

1. Create pseudocode to implement the proximity sensor system

    a. Use a timer to configure the ADC to automatically sample the input line (i.e. initiate a conversion) every 2 ms.

    b. Make use of an interrupt (no polling) to copy the converted voltage value from the ADC's registers.

    c. Produce a sine wave using a look-up table with 40 entries.

    d. Update the sine wave generated by the DAC and a timer (auto-reload) using an interrupt. The frequency range is 100 Hz to 1000 Hz.

    e. Update the output frequency every 500 ms (giving you time to average ADC conversions to minimize front-end noise).

Timer / Interrupt needed	**Function**	**Frequency**
Timer A	Initiate ADC conversion	2 ms
ADC Interrupt	Copy voltage from ADC to appropriate place	2 ms
Timer B	Update the Timer C frequency using data from the ADC Interrupt	500 ms
Timer C + Interrupt	Update the output voltage of the DAC	Varies

Table 1: List of timers and interrupts

2. Pass off your pseudocode to the TA.

3. Implement your design.

4. Demonstrate your working proximity sensor to the TA.

Documentation

1. Prepare your lab report following the same style and rubric that you've followed in previous labs.
2. Include in your lab report a discussion of the transfer function you implemented to convert input voltage to output frequency.