

15-348 Embedded Systems

Spring 2017

Assignment 1

This is a programming homework. You should also demo your code on or before **Monday February 6** and submit your code to autolab by **10pm** on the same day.

Goal: Make sure that you can use IO ports on the microcontroller by programming in C.

Task 1 (30 points):

1. Configure Ports F0 and F4 to be inputs to enable the onboard push buttons
 1. Port F is special, you will need to set bits 0 and 4 on the GPIOPUR register for port F.
 2. These buttons are referred to as push button 1 and push button 2 respectively in the write up.
2. Configure Ports E1 to be input
3. Configure Ports D0-D3 and E2 to be outputs
4. Connect Ports D0 - D3 to the provided LEDs
5. Connect Ports E1 to the provided push button.
 1. This button is referred to as push button 3.
6. Implement the following functionality in C:
 1. The program when executed runs in an infinite loop.
 2. If Push Button 1 is pressed and then released, the LEDs 1 turns on, stays on for a little bit (long enough for an observer to notice that its on) and then turns off. As soon as LED1 turns off, LED2 should turn on, stay on for a short time and then turn off. Repeat this for all 4 LEDs so that you see a pulse of light going from LED 1 to LED 4. After LED4 turns off, the process should continue from LED1.
 3. If Push Button 2 is pressed and then released, repeat the previous step but this time the pulse of lights should move from LED4 - LED 1 (backwards)
 4. If Push Button 3 is pressed, the current pulse should be paused. Pressing the Push Button 3 again should unpause the light pulse (continue moving from the point where it was paused).

Task 2 (20 points):

1. Connect Port E2 to the motor provided. (instructions below)
2. You can read the specifications of the motor on the course website at:
<https://www.pololu.com/product/1248>

3. Add the following functionality to your program written in Task 1:
 1. If the motor is in stopped state, and if Push Button 1 is pressed and then released, the motor starts moving in clock-wise direction. The motor starts at its lowest speed. Pressing button 1 repeatedly should increase the speed of the motor at each press until the max speed is reached.
 2. If the motor is in stopped state, and if Push Button 2 is pressed and then released, the motor should start moving in counter-clock-wise direction. The motor starts at its lowest speed. Pressing button 2 repeatedly should increase the speed of the motor at each press until the max speed is reached.
 3. If motor is moving in clockwise direction and Button 2 is pressed, the motor should stop. Similarly, if the motor is moving in counter-clockwise direction and button 2 is pressed, the motor should stop.

Task 3 (10 points):

1. Read the following instructables article – follow all steps except steps 19 and 20.
Demo Step 18 to get points for this task:
<http://www.instructables.com/id/Basic-Electronics/>

Connecting LEDs:

- Connect the pin from the board to the longer end connect the ground (GND) from the board to the shorter end.
 - LED (Light Emitting Diode), like all diodes, only allows current to flow in one direction so if you connect it the wrong way it will not work.
- DONOT try to test the LEDs by connecting them directly to the 3.3V pin, it will burn the LED!

Connecting the Push Button

- Look at this image:
<https://cdn.instructables.com/FKR/XEB3/IADH24QW/FKRXEB3IADH24QW.LARGE.jpg>
- The image is of an Arduino but the method is the same.
- Ignore the LED in the image
- The Arduino has a 5v output, our board has a 3.3v output, use that.
- Connect the orange wire (in the diagram) to port E1
- The button is based on negative polarity i.e. when it is not pressed port E1 should be high (1) when it is pressed, it should make Port E1 low (0).
- You do not need to use a 10 Kohm resistor, a 220 ohm resistor works fine

Connecting the Motor

- The motor works on 6V and our board works on 3.3v so we'll need to use an external power source
 - You will be provided with two battery packs that each hold 2 AA batteries and connecting them in series will give you $4 \times 1.5 = 6$ Volts.
 - Do not use any other power source, such as a 9v battery, it will fry the motor!

- Connect the battery packs in series to the red wire of the motor
(<https://www.batterystuff.com/images/knowledge-base/Series.jpg>)
 - Connecting the batteries in series sums the voltages of the individual batteries.
 - The basic idea is that you connect the positive on one battery pack to the negative of the other.
 - Connect the negative of the first battery pack to GND on the board and the black wire on the motor
 - Connect the positive of the second battery pack to the red wire of the motor
- Connect the white wire of the motor to port E2
- Making the motor spin requires providing it a signal that oscillates between low and high. The length of time the signal remains high is the pulse width. Details about controlling the speed and direction of the motor as give in the link above.