6.115 Final Project Proposal: Becoming A Pianist!

Introduction

I have always admired people who are musically talented. Ever since my lazy younger self gave up on playing piano, I have wanted to pick up learning piano again. Inspired by apps that teaches people to play the piano, I am interested in creating a physical piano that teaches the user how to play itself. The project consists of two main physical parts: first, the sound output part is like a normal piano where each key press will generate a sinewave of appropriate frequency. Second, I want to make a music box like component where the user can insert a punch card where each hole represent a key to be pressed. The punch card will be moved across a column of phototransistors; whenever a phototransistor is uncovered, it will cause the LED on the appropriate key to light up, indicating where the user should press. Finally, if time allows, I would like to link both functions to keep track of if the user is pressing the correct key to provide instant feedback, e.g. lighting up a different color LED to indicate wrong key press.

Project Scope and Management:

The basic part of the project is to develop the system controlled by the PSoC that converts key presses to sound waves, like a traditional piano. Each of the keys will be connected to a press switch, so whenever a user presses a key, a digital high will be sent to the PSoC, which is constantly checking which keys are pressed. The PSoC software keeps a local time to calculate the appropriate sine value based the frequency associated with each key that's pressed (see Appendix A for frequency values for the fourth octave). At each time step, it then sums up all the values (if there are key presses) and output the sum to a digital-to-analog converter which then feed the voltage to a speaker to produce sound.

The second part of the project is to incorporate the educational aspect: the "music-box" takes punch cards and light up LEDs on the keys that should be pressed. A punch card is attached to a cylinder rotated by a motor, which causes the stripe of punch card to move over a column of phototransistors. Each transistor writes to a 8255 port whenever it is uncovered (i.e. there's a hole in the punch card); this will cause 8051 to light up the LED at the piano key corresponding

to that phototransistor. Additionally, the user can select the speed the servo rotates through a keypad.

Finally, if time allows, I want the the 8051 and PSoC to communicate with each other to keep track of if the user is pressing the right keys as indicated by the LEDs. In addition to having the 8051 light up the LEDs, it will also tell the PSoC which LEDs are lit up. The PSoC will then check if keys that do not have their LEDs lit up are pressed by the user, and light up different color LEDs at the wrong keys that are pressed.

Special Component Needs:

1. Speaker to output sounds
2. Press switches for keypress detection
3. LEDs: 12 green, 12 red
4. Phototransistors: 12 pieces

Timetable:

Week of April 24 - April 28: Key Press to Sound Function
Due: 04/25 Final Project Proposal Due in Lecture
Create PSoC hardware design and code to generate sine waves based on key press
Lay out breadboard circuit for piano keys

Week of May 1 - May 5: Punch Card Music to LED lights Function; Keypad to Select Speed
Due: 05/01 Final Project Mid-Course Interviews
Create circuit with phototransistors to read punch card music to light up LEDs
Add keypad to select speed to read punch card

Week of May 8 - May 12: Tracking User Input Function
When the user is using the learning mode, keep track of if correct key is pressed
Set up serial communication between 8051 and PSoC

Week of May 15 - May 18: Aesthetic Design
Due: 5/18 Final Demo and Final Project Writeup Due in Lab
3D print piano keys and body to enclose circuits

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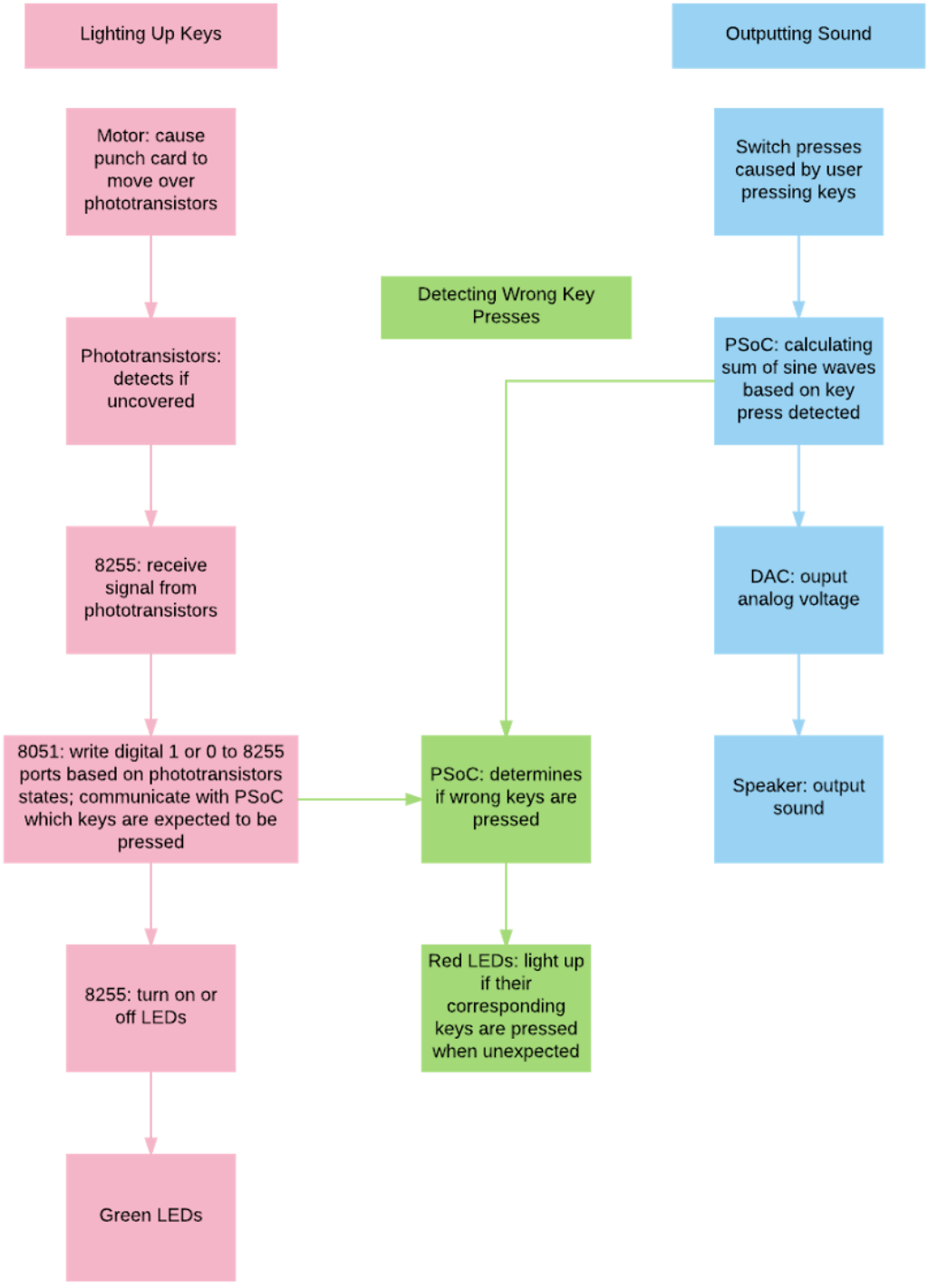
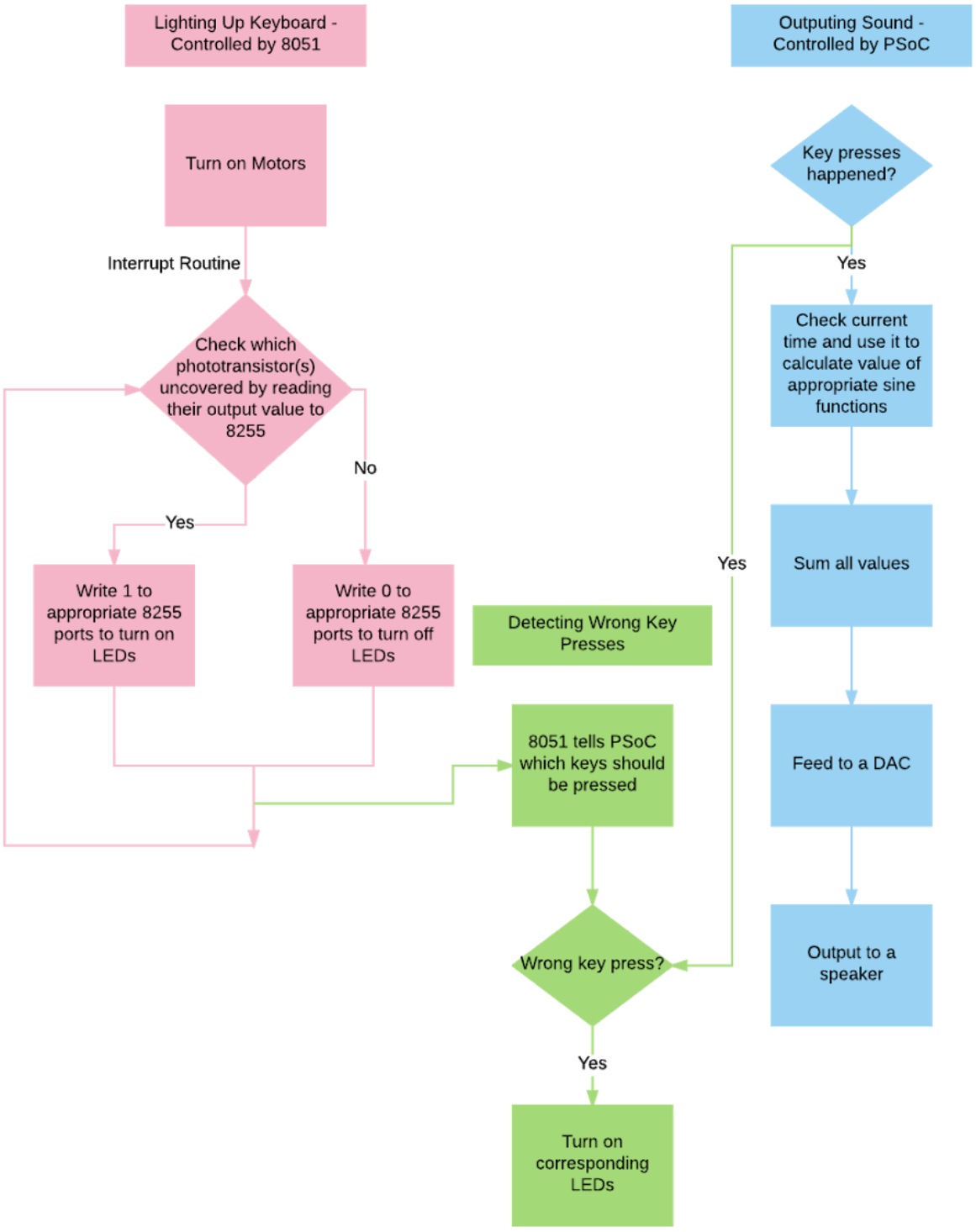
Hardware Description:



Software Description:



Appendix A: Frequency of the n^{th} key on a piano:

$$f(n) = 2^{(n-49)/12} \times 440\ Hz$$ [1]

Key Number	Scientific Name	Frequency
51	B_4	493.883
50	$A\sharp_4/B\flat_4$	466.164
49	A_4 A440	440.000
48	$G\sharp_4/A\flat_4$	415.305
47	G_4	391.995
46	$F\sharp_4/G\flat_4$	369.994
45	F_4	349.228
44	E_4	329.628
43	$D\sharp_4/E\flat_4$	311.127
42	D_4	293.665
41	$C\sharp_4/D\flat_4$	277.183
40	C_4 Middle C	261.626

[1] https://en.wikipedia.org/wiki/Piano_key_frequencies