Photocell Music Board

Team 39

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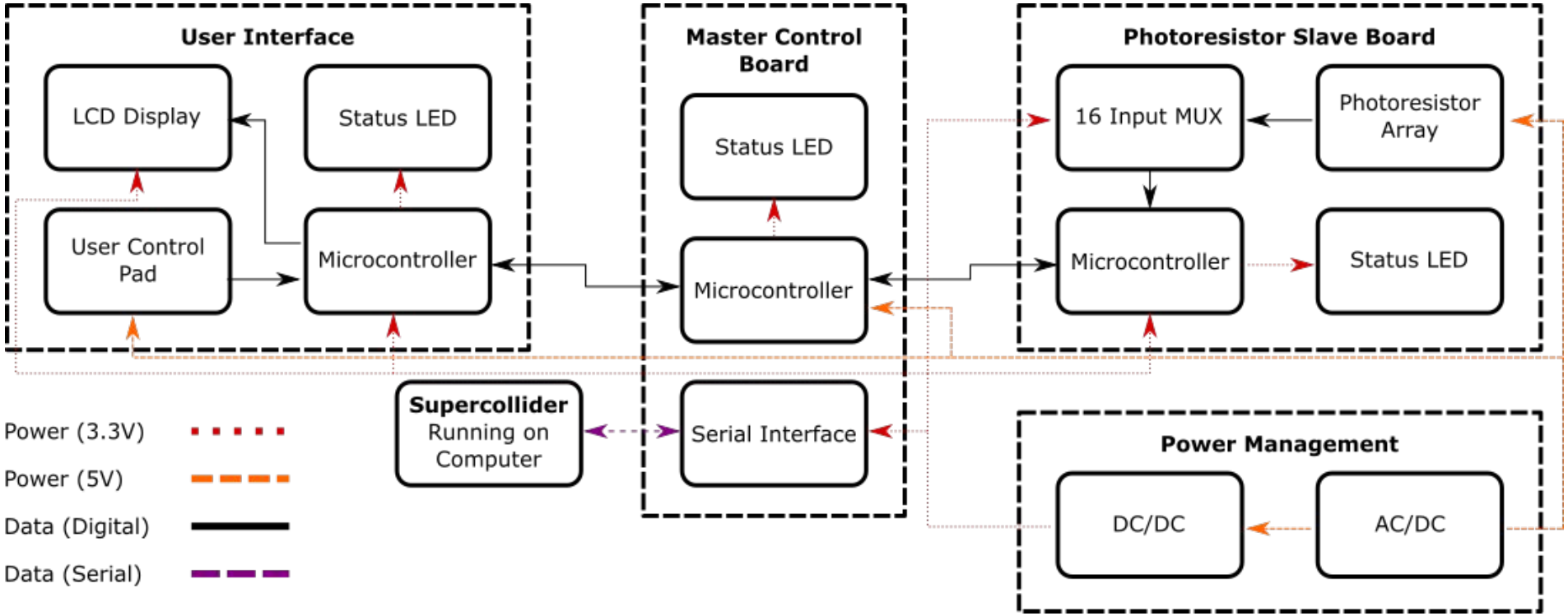
Introduction

- Unexplored potential of non-traditional music instruments
- Unprecedented control over sound with synthesizers and digital signal processing
  - SuperCollider audio synthesis programming language
- Prototype music board designed by Dr. Eli Fieldsteel

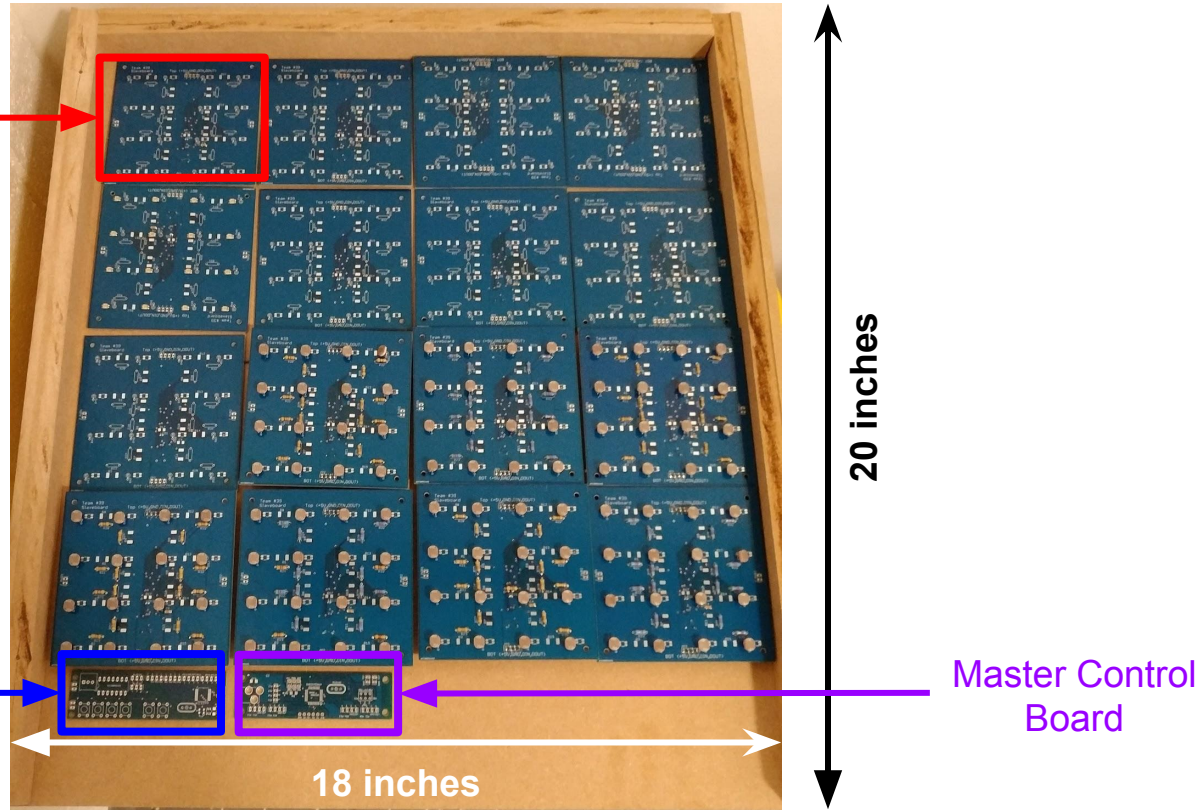
Objective

- Create improved version of Dr. Fieldsteel's prototype board
  - Must be able to withstand national travel
- Allow the use of different sensors
- Modular design
- Send data to computer via USB Serial

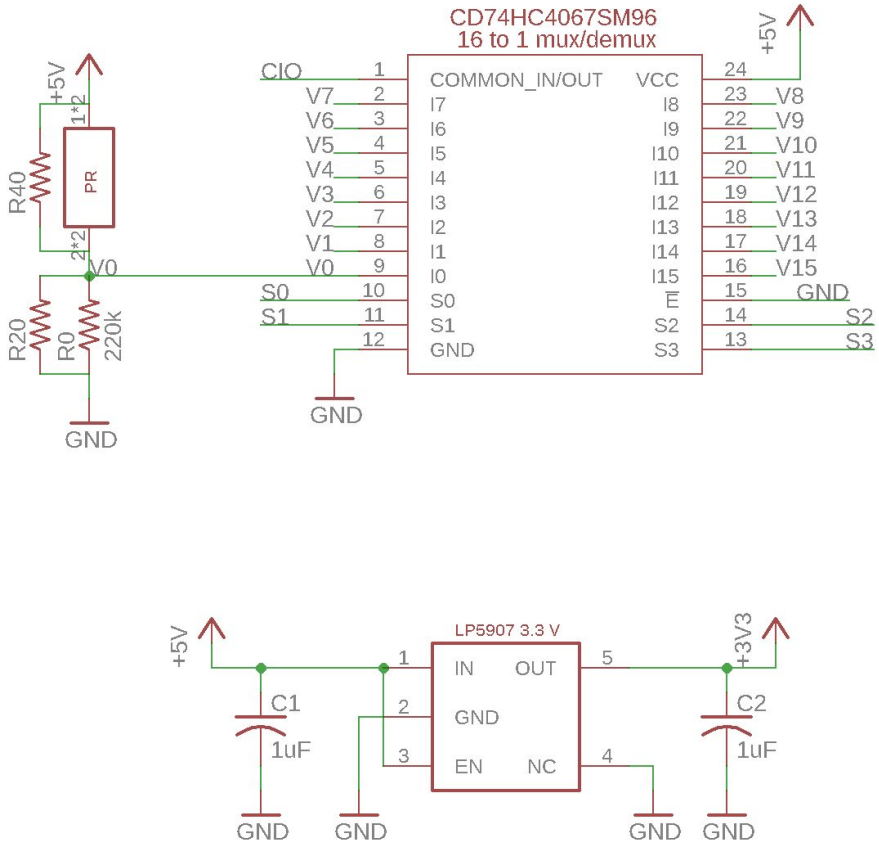
Block Diagram



Final Product

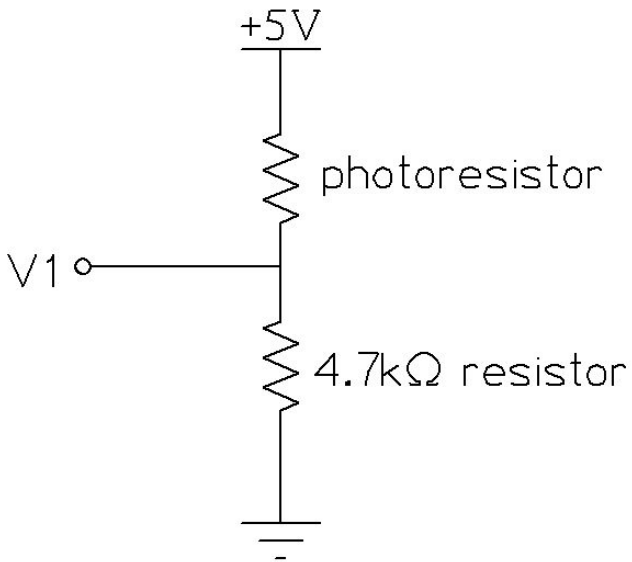


Photocell Slave Board



Voltage Divider Circuit

Lighting	Photocell Resistance	V1 Node
Direct Light	< 1k Ohms	> 4.5 V
Normal Light	~ 2k Ohms	~ 3.5 V
Completely covered	> 50k Ohms	< 2.5 V

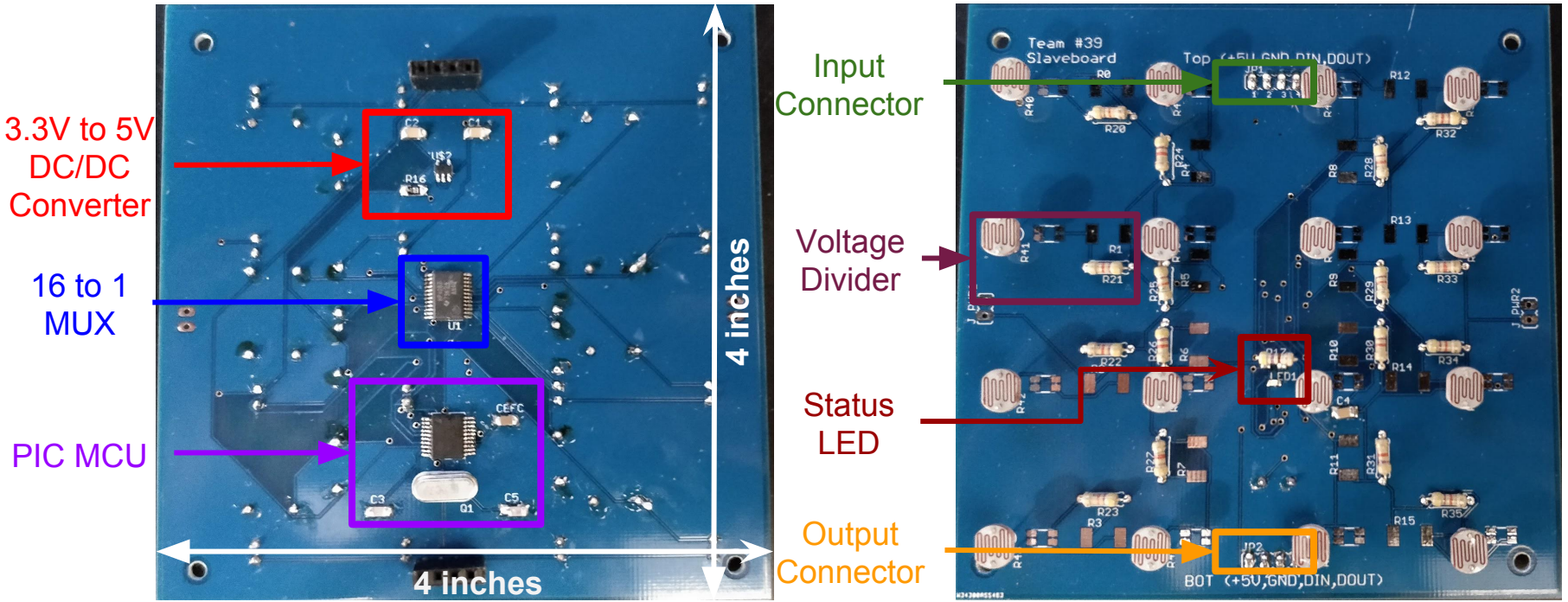


- Series resistor: 4.7k Ohms
  - Values between 1k and 50k considered
- Active Range between 2.5 V and 4.5 V

Slave Board

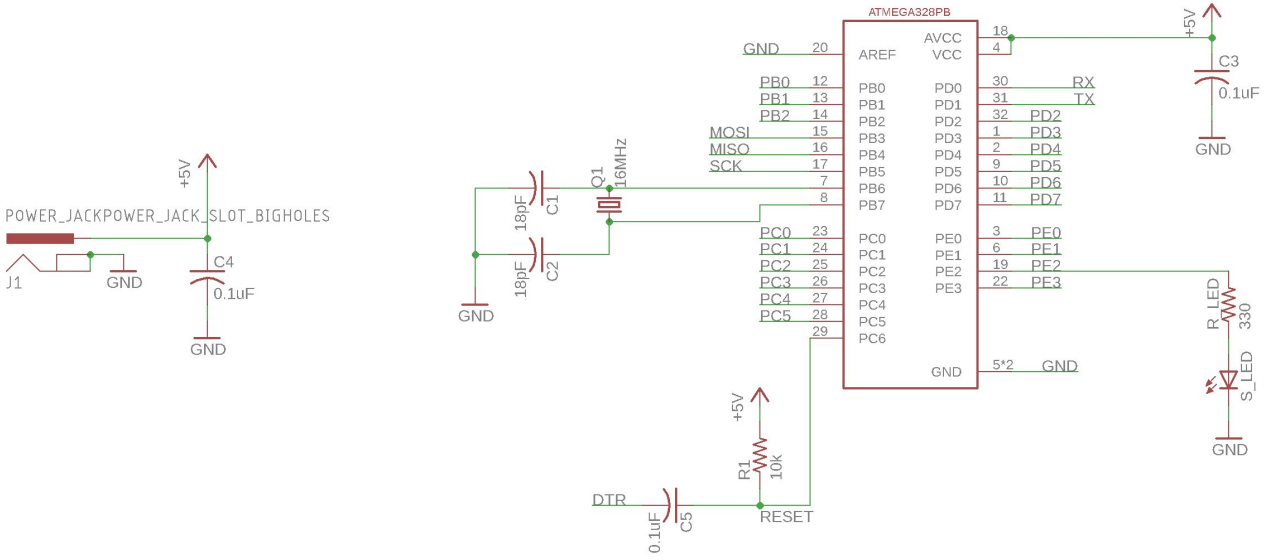
Bottom of Board

Top of Board



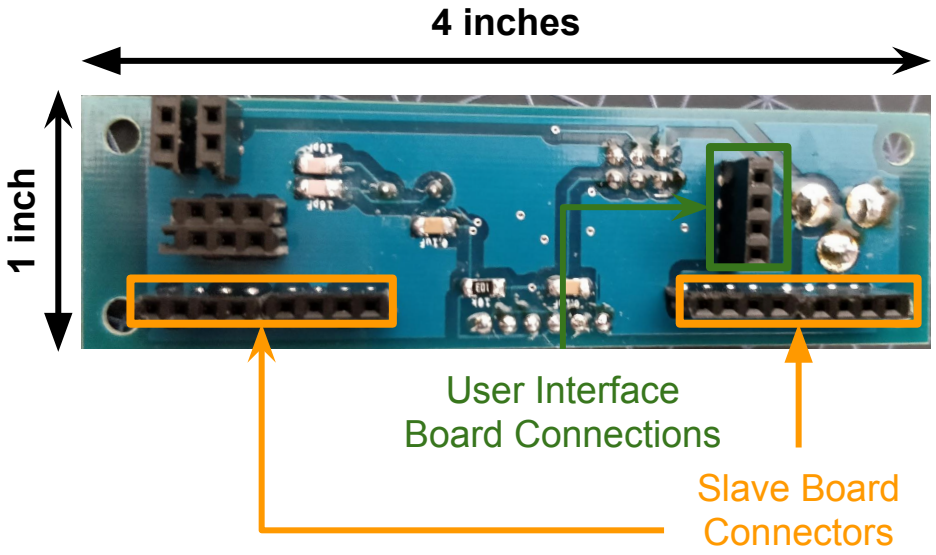
Master Control Board

- ATmega328PB microcontroller
- USB to Serial connection with computer
- Collects photoresistor data from all boards
- Status LED shows cross-board connection

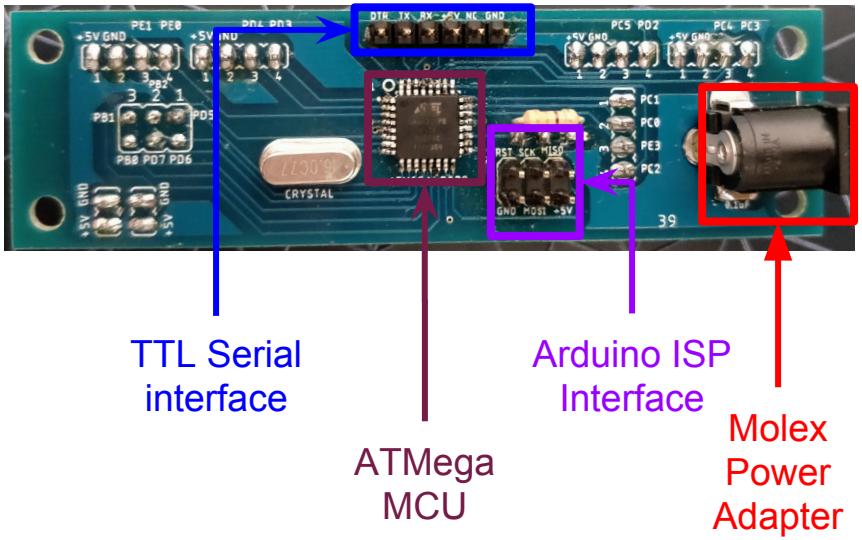


Master Board

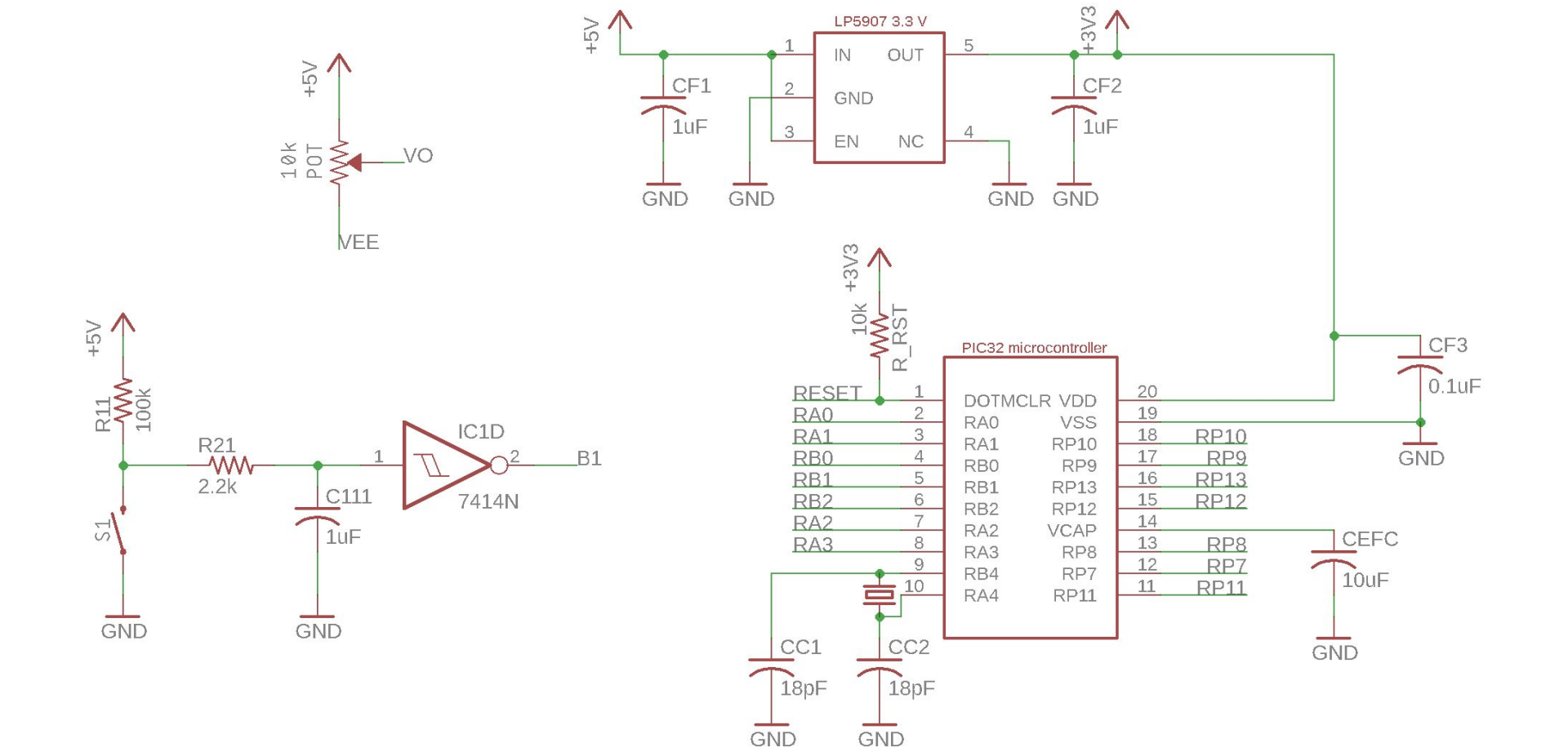
Back of Board



Front of Board

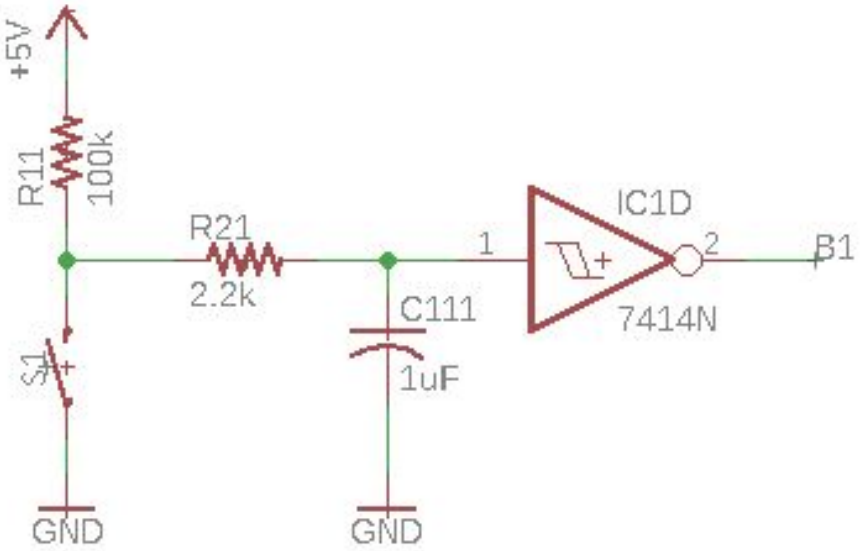


User Interface Board



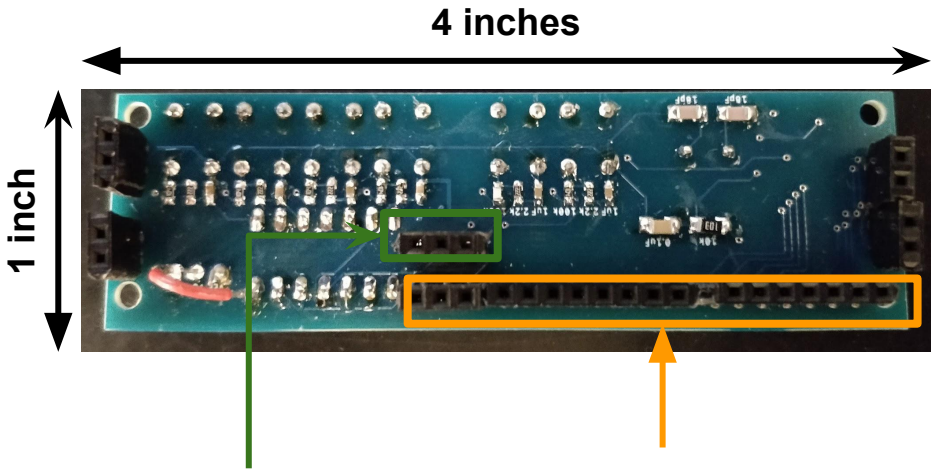
User Interface - Buttons

- Six buttons to select presets
  - RC debounce circuit
  - Inverting Schmitt Trigger
- Button presses sent to SuperCollider

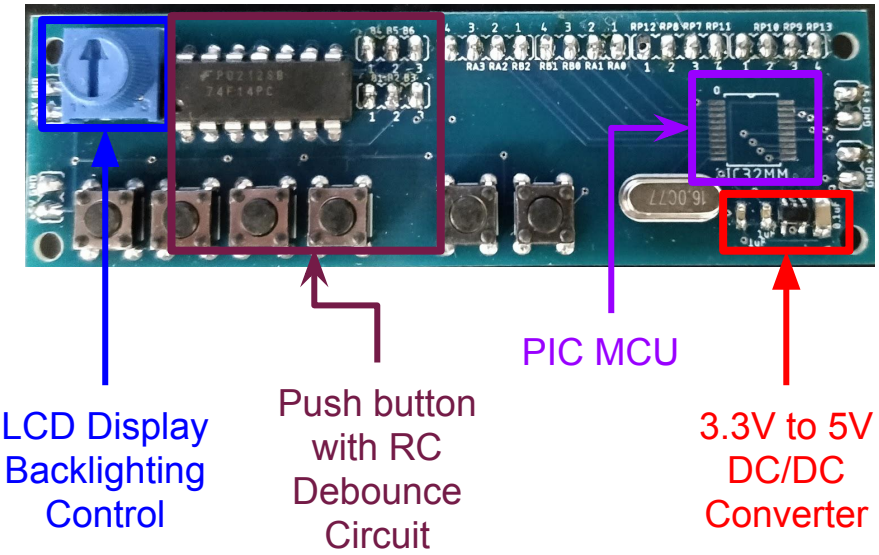


User Interface Board

Back of Board



Front of Board

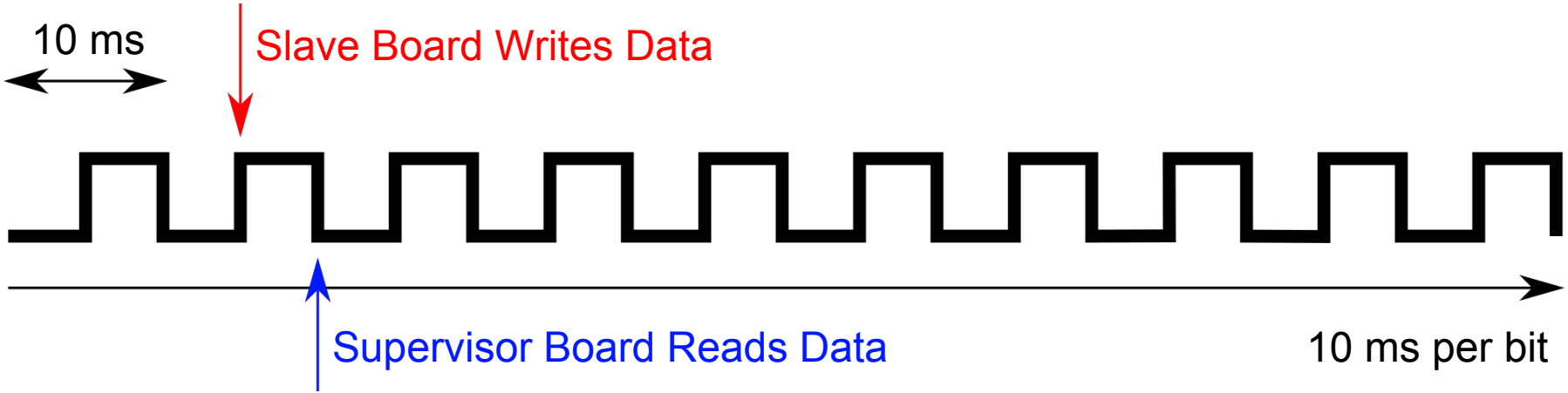


Controlling the LCD Screen

- Powered with 5V supply
- LCD uses the SBN1661G controller
  - 8 data pins; digital control
  - SPI interface
- Adjustable contrast
- LED backlight

Image from:
https://www.crystalfontz.com/product/cfag12232dyyhva-transflective-graphic-lcd-122x32

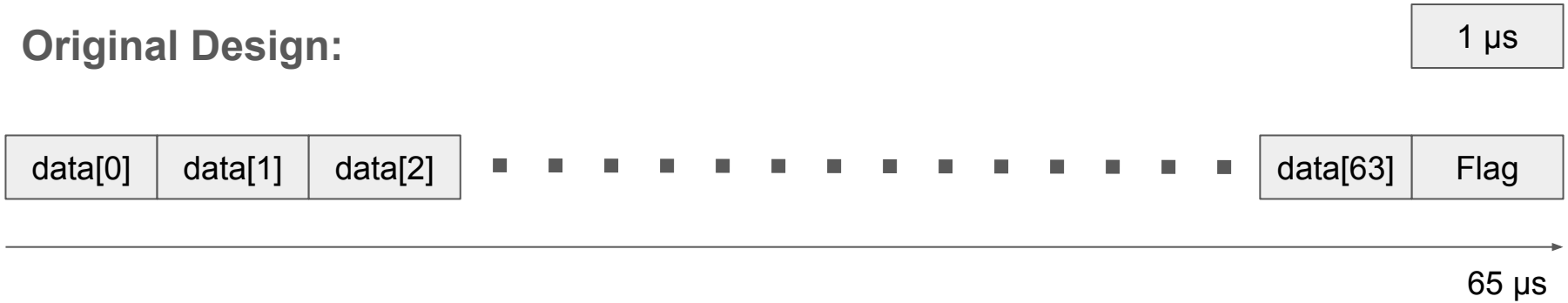
I²C Algorithm Design



- Clock signal generated by supervisor board
- Each data value is 10 bits long
- Each data value requires 1 µs to send to supervisor board

I^2C Algorithm Problems

Original Design:



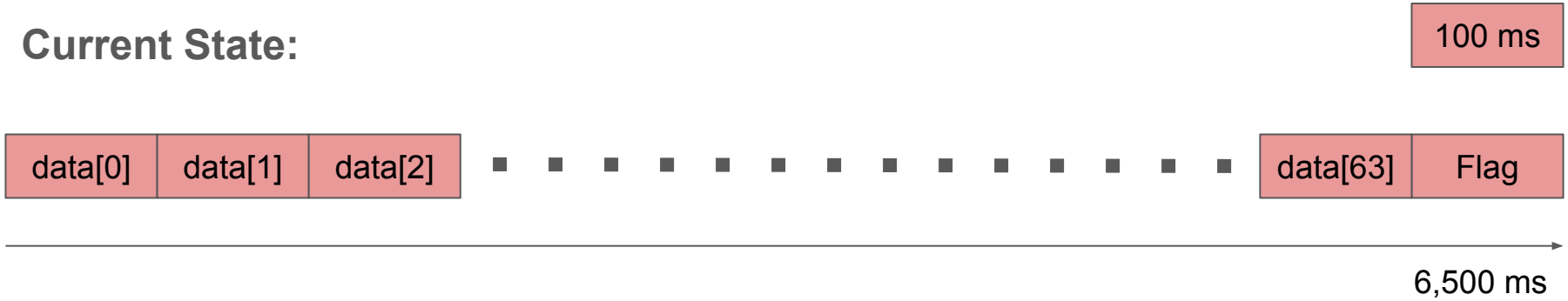
For each slave board subset read to master

Timing of Full Masterboard operation:

- Reading each 4 slave board subset = 4 reads in 65 µs
- one package to user interface = 1 read/write in 1 µs
- one serial output = 8224 bits at 115200 bits per second
- **Total = 71.65 ms → 13.96 Hz**

I^2C Algorithm Problems

Current State:



We have only managed to achieve a 10 ms clock cycle

Timing of Full Masterboard operation:

- Reading each 4 slave board subset = 4 reads in 6.5 s
- one package to user interface = 1 read/write in 100 ms
- one serial output = 8224 bits at 115200 bits per second
- **Total = 26.17 s → 0.038 Hz**

Conclusion

- Photoresistor voltage divider circuits and MUX worked reliably
- Choose LCD screen with more support
- PIC32 ADC conversion - reference voltage mismatch
- I^2C style algorithm for board to board communication

Future Work and Revision 3

- Test different sensors, like flex sensors
- Design a higher speed communication protocol

Revision 3:

- Remove PIC microcontrollers from each slave board
- Use master board and extra 16 to 1 MUX to read all 16 slave boards in less time