Enhanced Beverage Coaster

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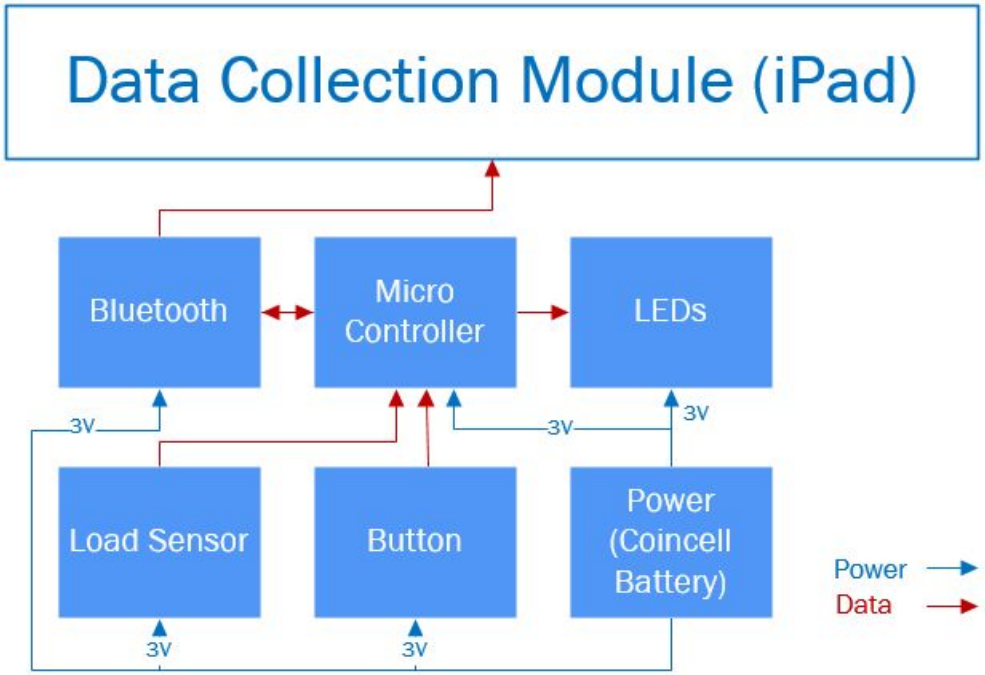
Group 31

Objective

- **Problem:** Present day beverage coasters have very limited functionality
- **Solution:** Improve functionality of coasters
    - Let servers know when customers need refills
    - Let customers call servers more easily

General Design



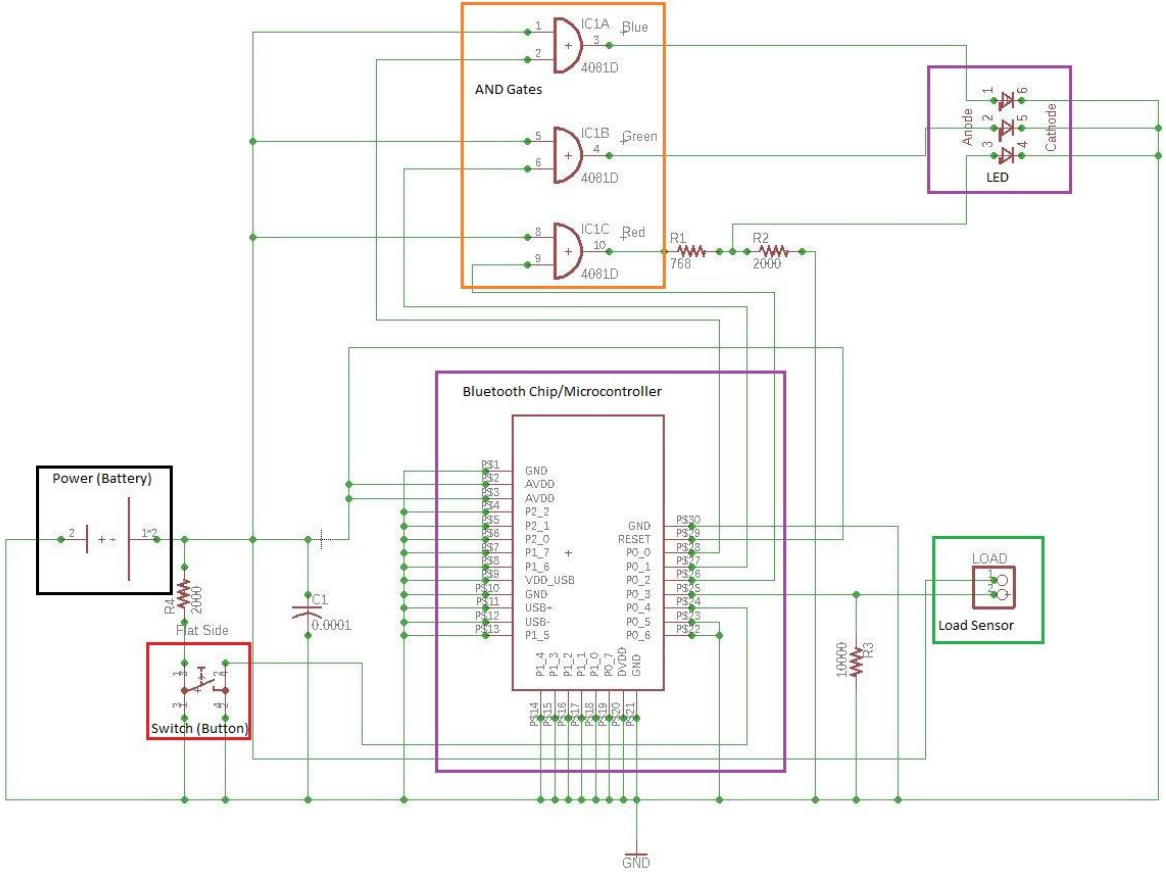
Coaster Design

- Bluetooth Chip
  - Send and receives data from data collection module
- Load Sensor
  - Gets current state of drink on sensor
- Button
  - To call server
- LED
  - Show status of server call
- Physical Model
  - Waterproof, Accessible battery door

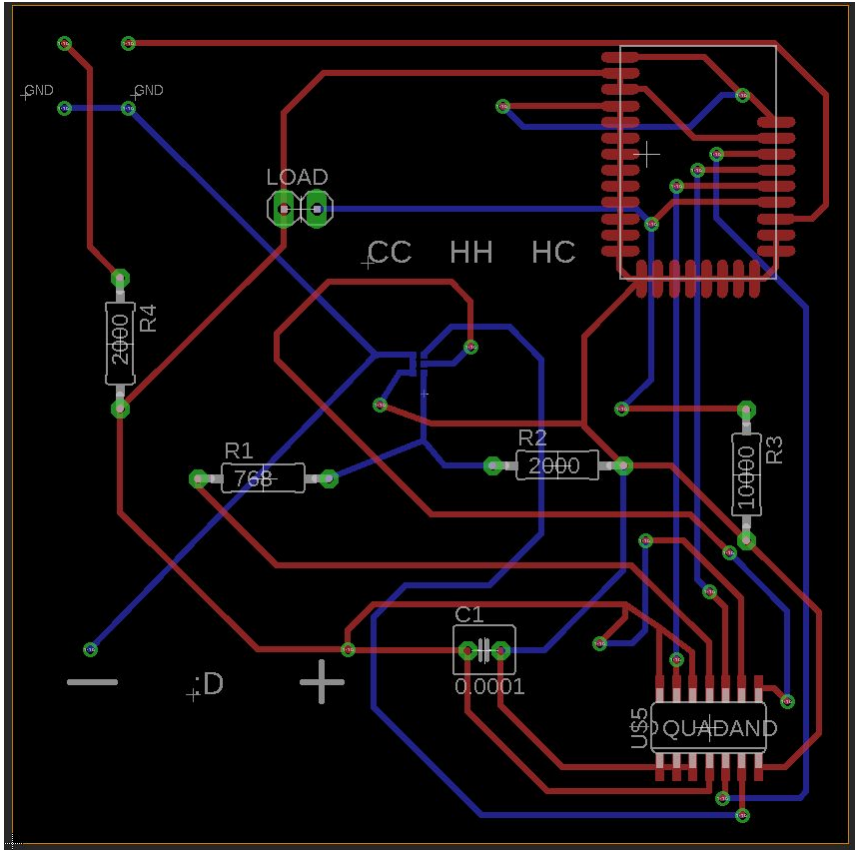
Data Collection Module Design

- Implemented on iPad
  - Wrote app to use bluetooth to receive and process data
- User Interface
  - Allows user to adjust parameters
  - Allows user to see data collected
- Bluetooth
  - Periodically ping the coaster to check current status of cup and server call
  - Turn off LED after server acknowledges call

Circuit Schematic

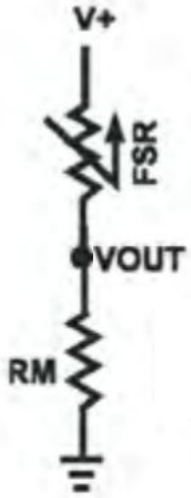


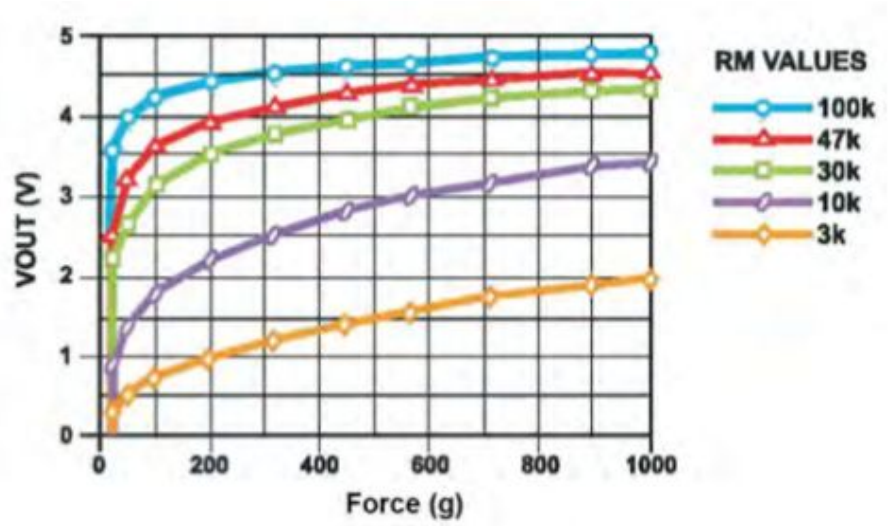
PCB Design


GND
GND
LOAD
CC HH HC
R4
2000
R1
768
R2
2000
R3
10000
C1
0.0001
:D
U$5
QUADAND

Load Sensor Module

- Able to sense a (relatively) standard weight of a beverage in a glass
- Able to have an accurate resolution when weight changes

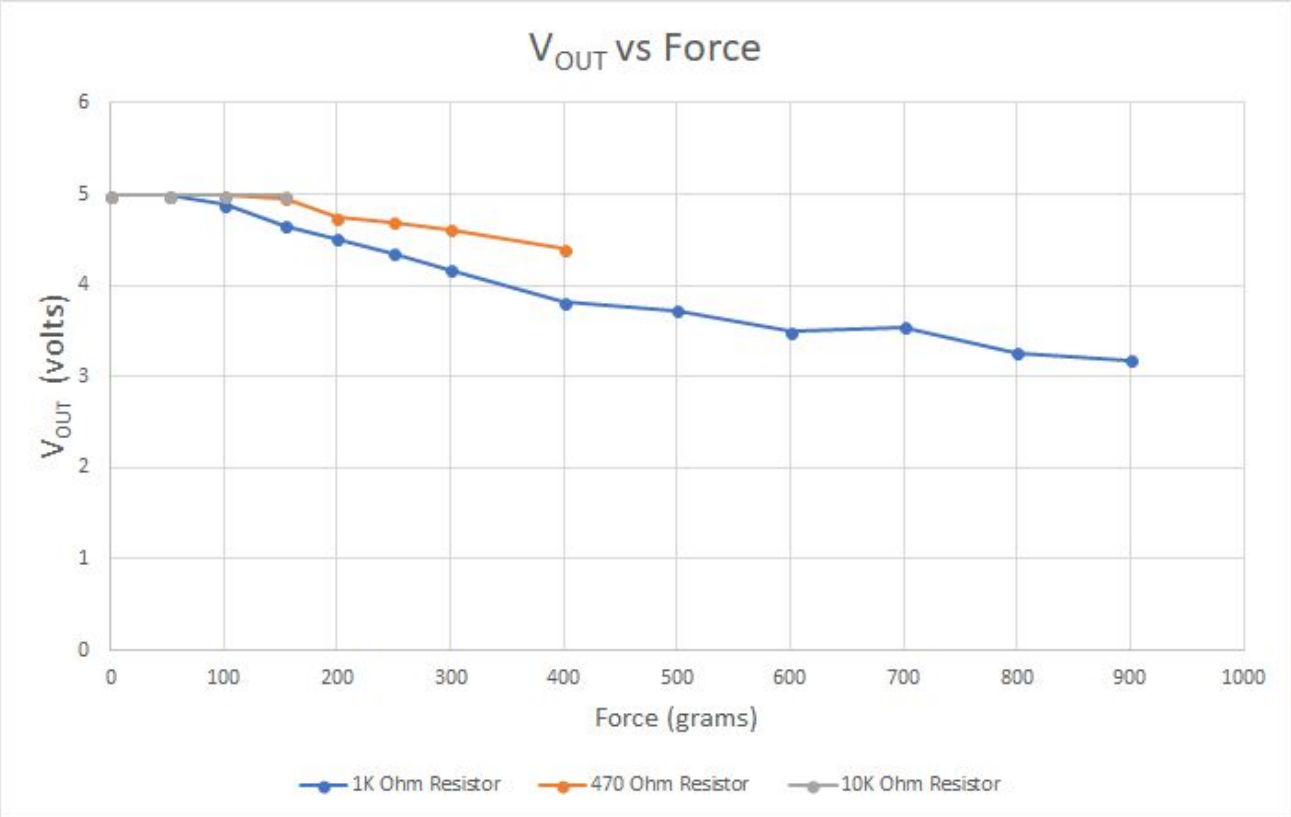




$$V_{out} = \frac{R_M V^+}{(R_M + R_{FSR})}$$

Load Sensor Figures

Load Sensor Testing and Calculations



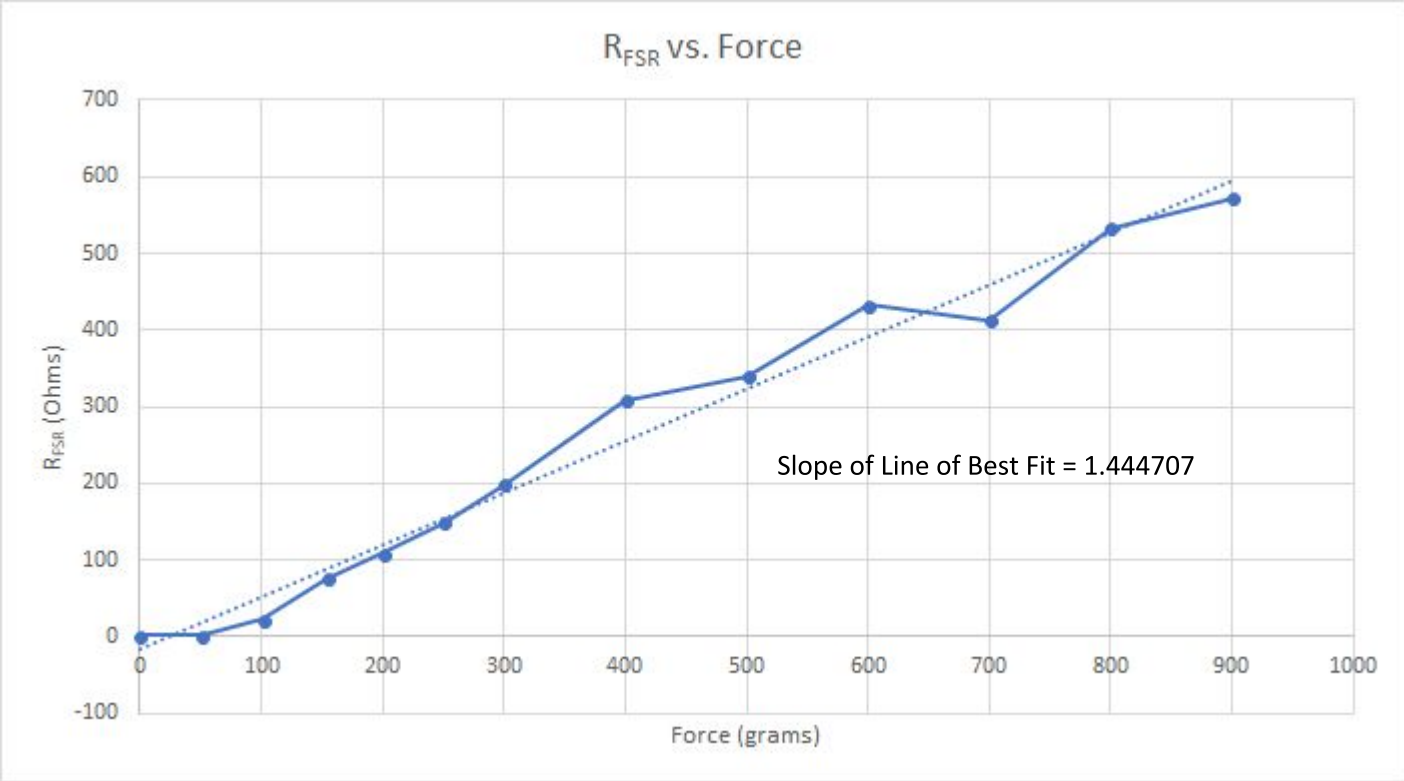
Load Sensor Testing and Calculations

$$V_{OUT} = \frac{R_M V^+}{(R_M + R_{FSR})}$$

$$R_{FSR} V_{OUT} + R_M V_{OUT} = R_M V^+$$

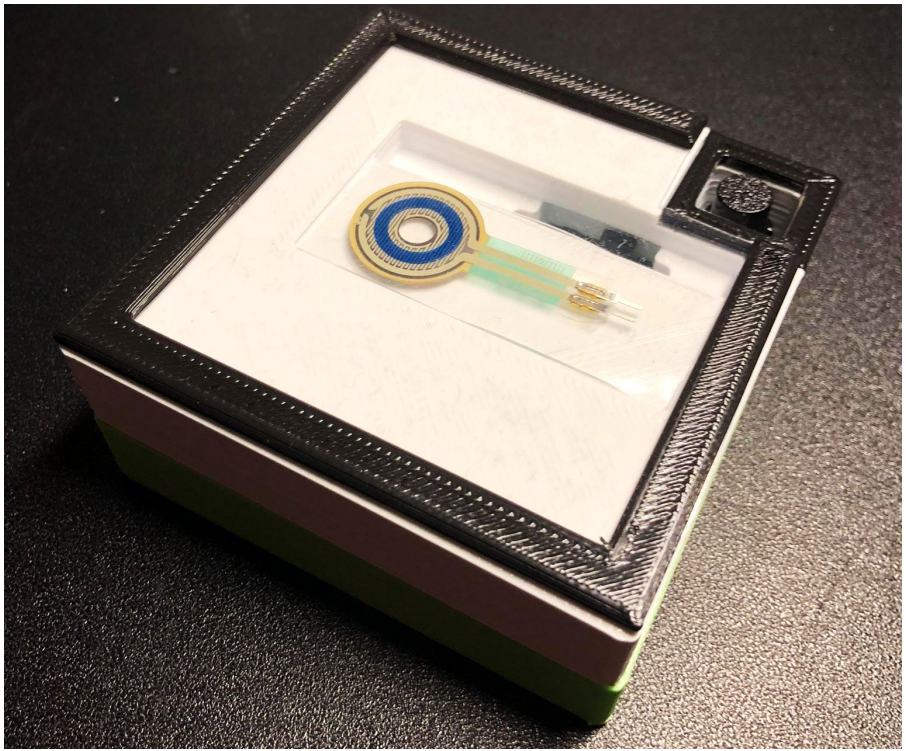
$$R_{FSR} = \frac{R_M V^+ - R_M V_{OUT}}{V_{OUT}}$$

Load Sensor Testing and Calculations

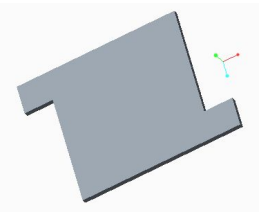


Physical Design

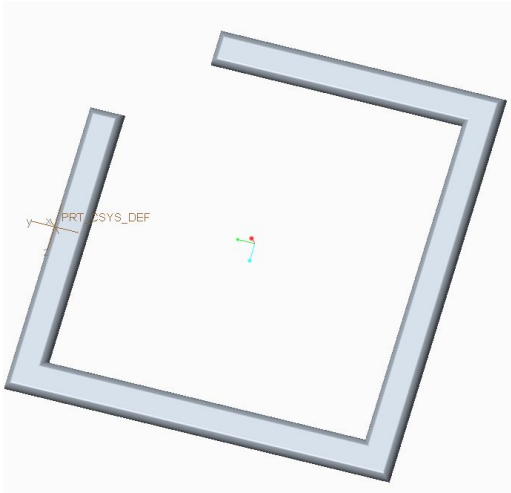
- Water-resistant
- Button
- Accessible battery door
- Reasonable dimensions
- PCB fully enclosed
- Transparent top



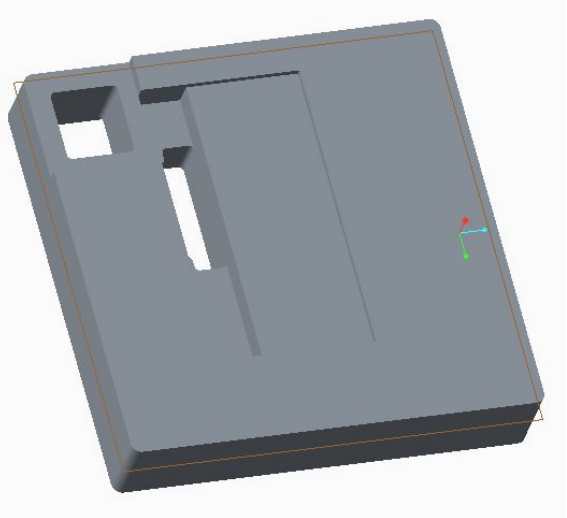
Button Cover



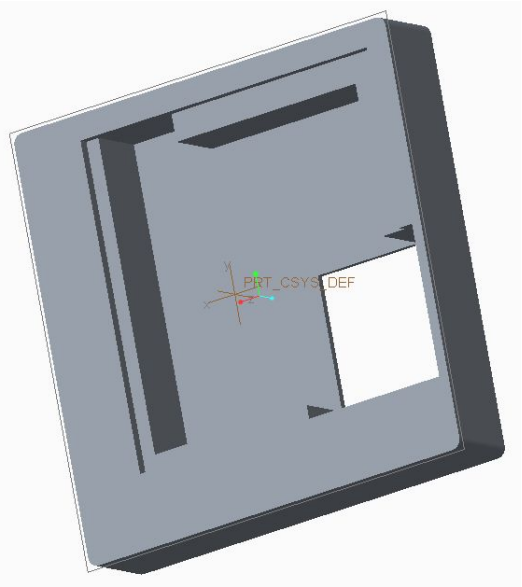
Battery Door



Top Layer

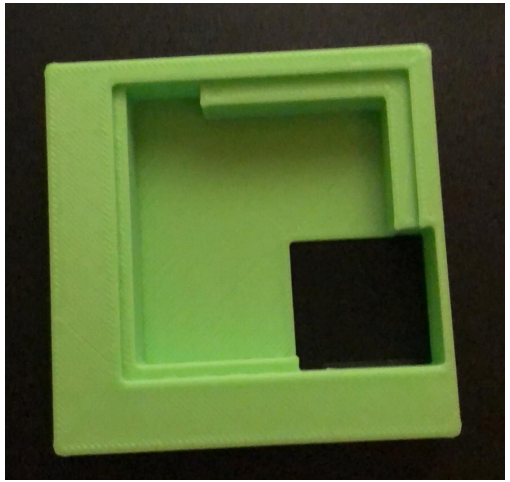


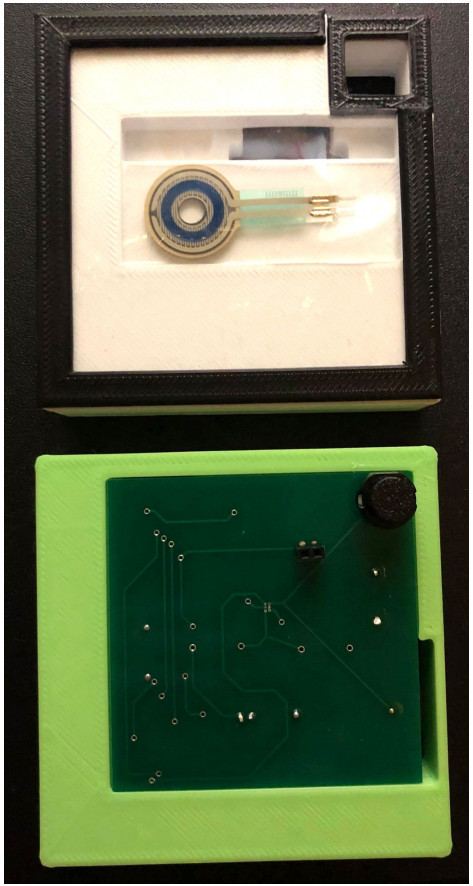
Middle Layer

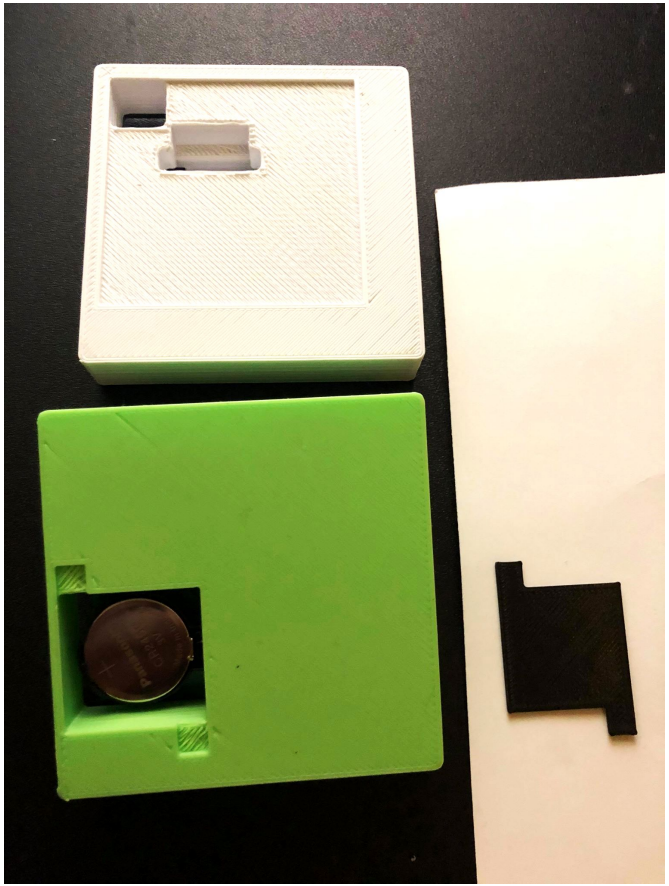


Bottom Layer

Final Product







Software Design: Microcontroller/Bluetooth

Microcontroller

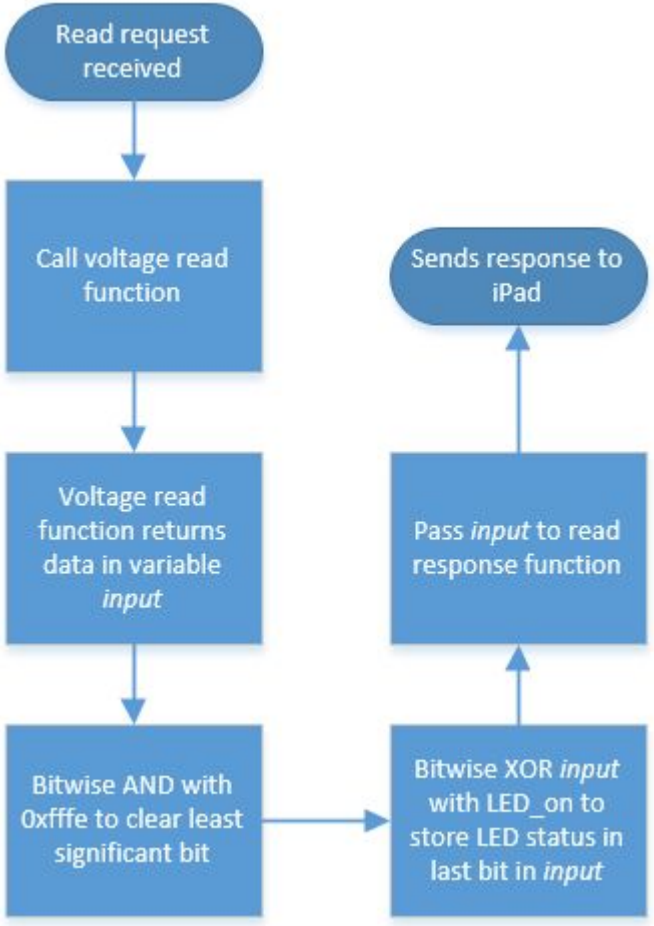
- Respond to read requests
- Register Button Press
- Control LED status

Bluetooth

- Serial No. Service
- Read Request Service
- LED Toggle Service

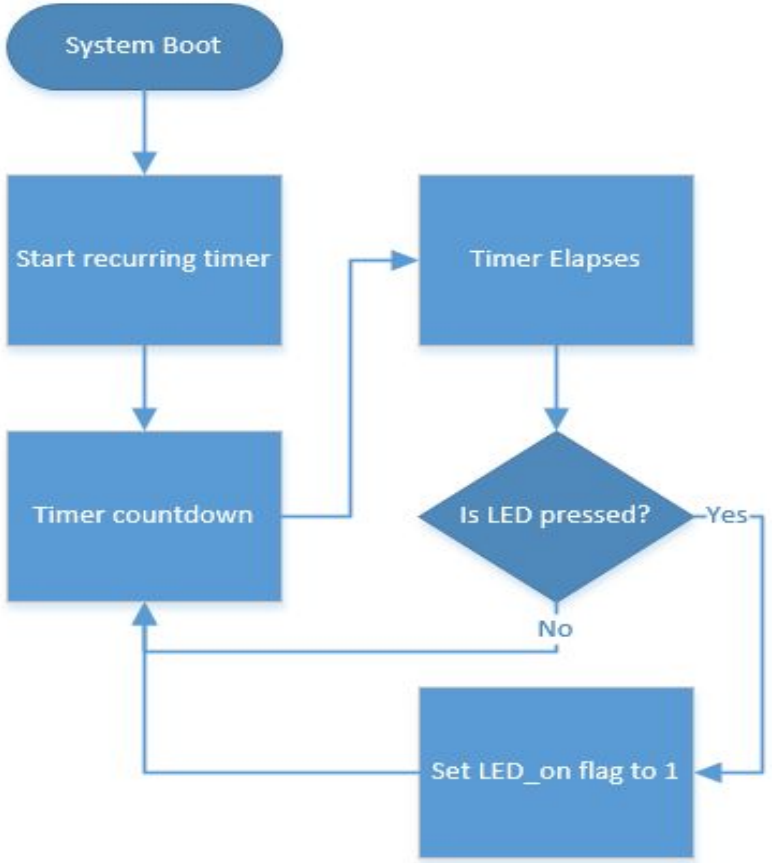
Read Request

- Goal is to send data to iPad
  - Send load sensor status
  - Send LED status
- Starts reading data after request is received from iPad



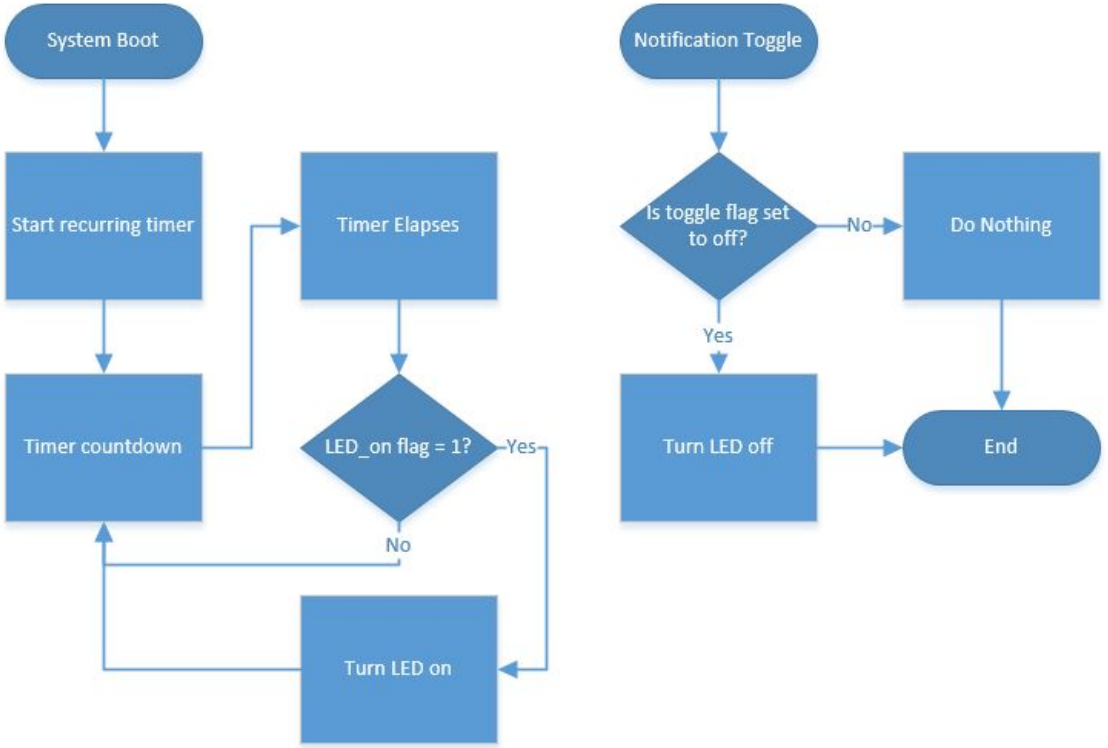
Button Press

- Periodically checks if button is pressed
- Sets LED_on flag if button is pressed



LED Status

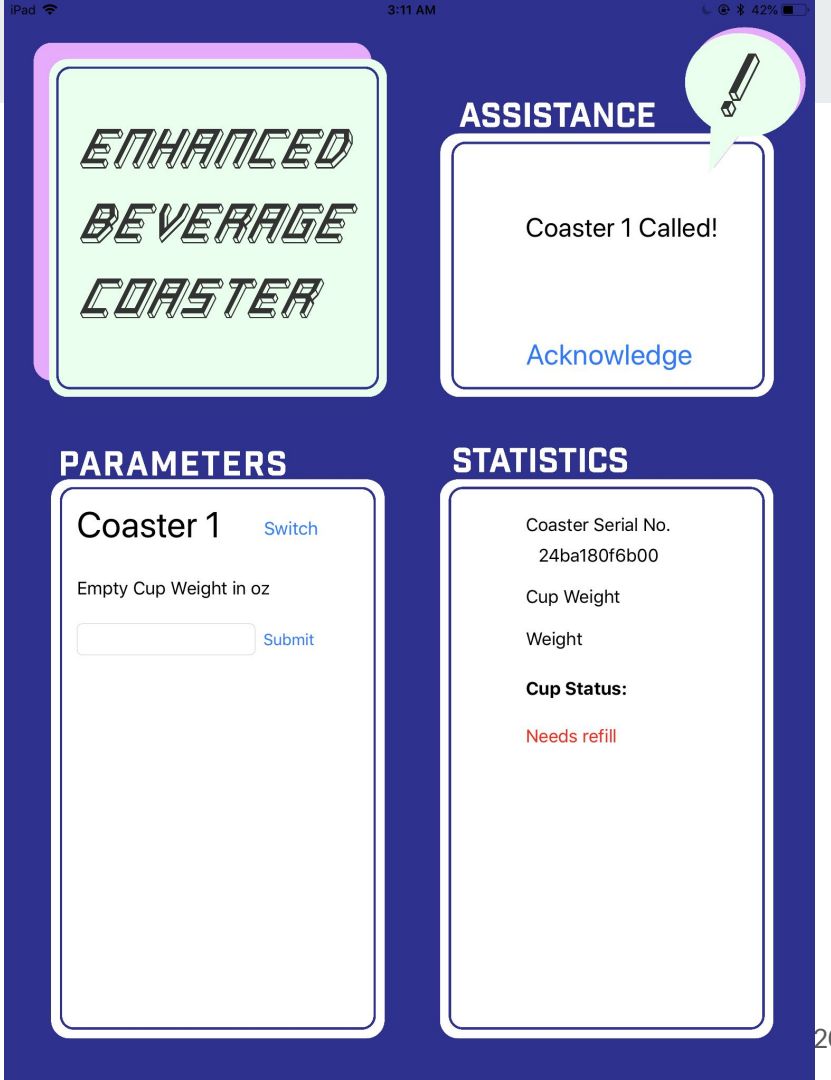
- Checks LED_on flag periodically
- Responds to notification toggle call from iPad



Software Design: Data Collection Module

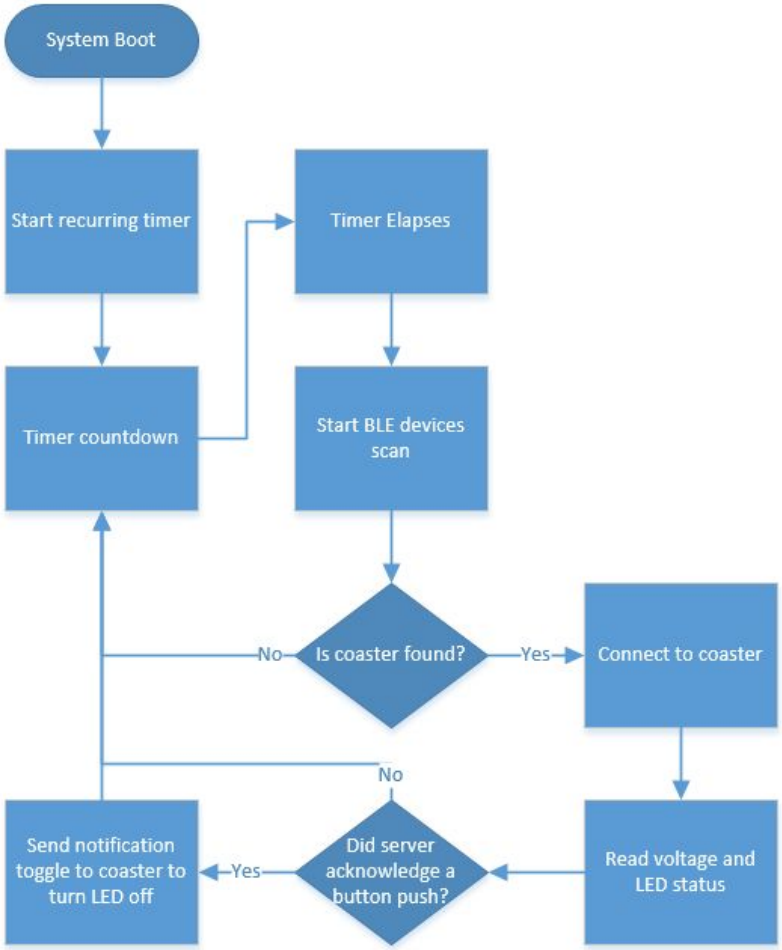
Goals

- Read data from coaster
- Process data
- Present it to the user in a readable manner
- Send data to the coaster



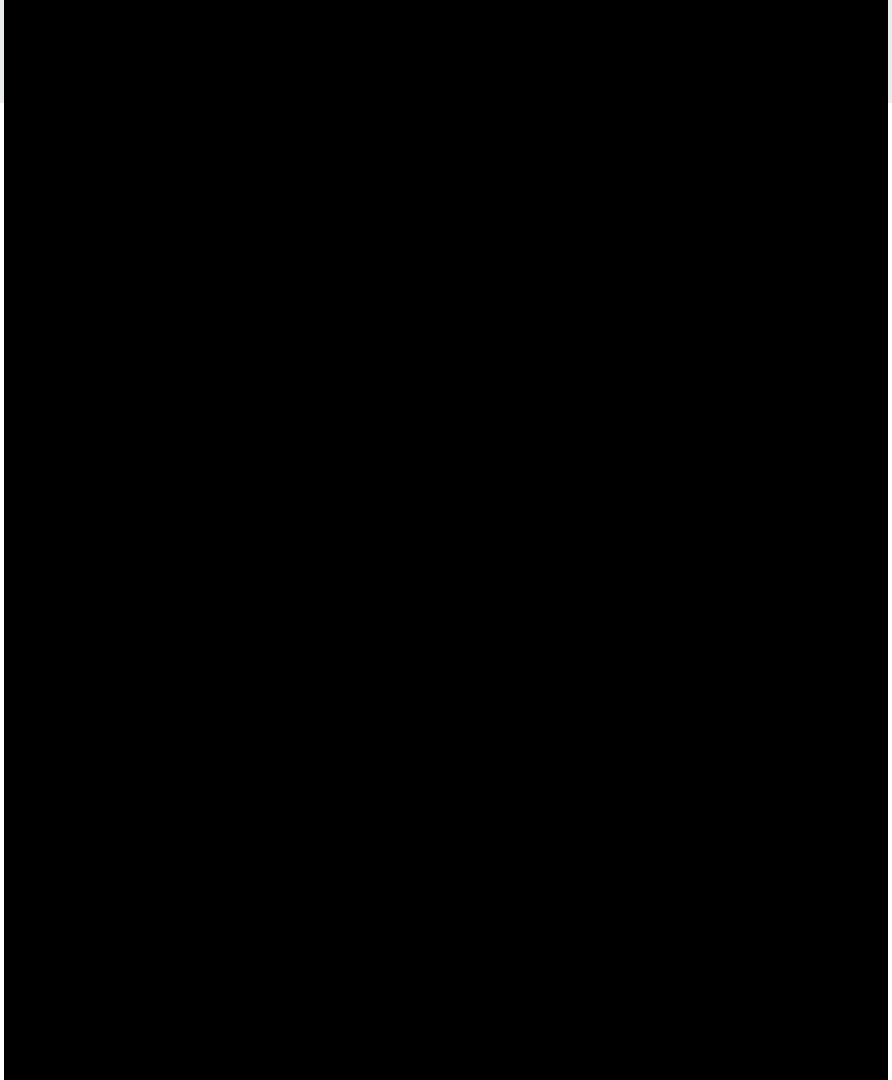
iPad/Coaster Interaction

- Periodically connect to coaster
- Read and write data every time connection is established



Interaction Demo

- LED lights up
- LED status gets sent to iPad
- iPad is able to toggle LED off



Data Processing

- Threshold = (Cup weight)*1.25
- Determining if cup needs to be refilled
  - Read voltage from coaster
  - Compare with threshold
  - Set label accordingly

$$\frac{V_{LS}}{3V} = \frac{R_{LS}}{1K\Omega + R_{LS}}$$

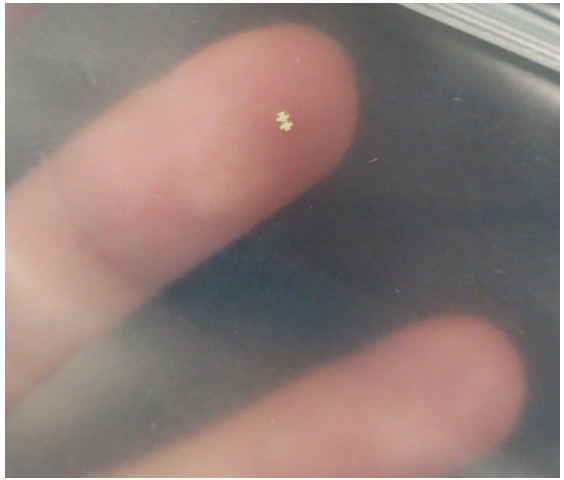
$$R_{LS} = 1.444707 * F_{LS}$$

$$1g = .035274\ oz.$$

$$\Rightarrow \frac{.035274\ oz * V_{LS}(1K\Omega + R_{LS})}{3V * 1.444707} = F_{LS}$$

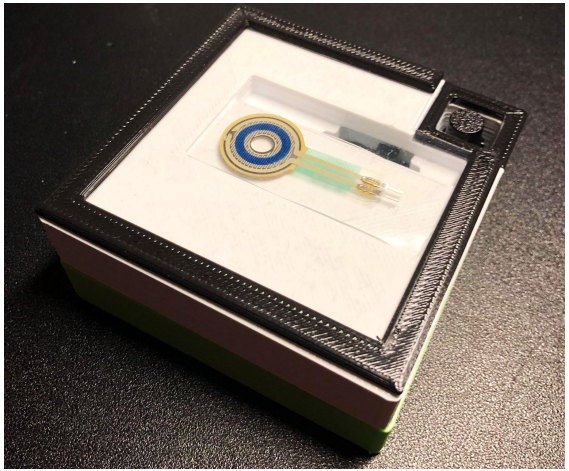
Challenges Faced: Circuitry

- PCB not fully compatible with parts
- First Bluetooth Chip was burned
- LED was too small to solder
- Load sensor finicky



Challenges Faced: Physical Design

- Silicone cover provided transparency but difficult to use
- Parts on PCB did not fit as expected
- 3D printing needed tolerance
- Button needed to be reasonably placed
- Coaster thickness needed to be reasonable



Challenges Faced: Software

- iOS caches GATT profiles
- Microcontroller/Bluetooth chip doesn’t have different read request handlers
- Voltage reading was buggy
- Proprietary scripting language

Conclusion

- **Wrap-Up:**
  - Bluetooth communication between the coaster and the iPad was successful
  - Coaster prototype of physical design provided good visual aid and sense of practicality
- **Future work:**
  - Complete a fully functional smaller physical model that encloses the circuit
  - Use larger pad-like load sensor that doesn't require focused pressure
  - Implement rechargeable batteries
  - Connect multiple coasters to the iPad
  - Connect coasters to multiple iPads