ECE445 Final Presentation

Enhanced Beverage Coaster

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TEAM 61

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THANK YOU!

To:
TA Dongwei Shi,
Professor Rakesh Kumar,
& all of the ECE 445 Course Staff!

Introduction

The HUB, Champaign IL

Unlimited Mimosa Pricing Dilemma

The Hub in Champaign offers unlimited Mimosas for brunch on the weekends.

How does the Hub price their unlimited mimosa?
How many drinks does an average participant drink?

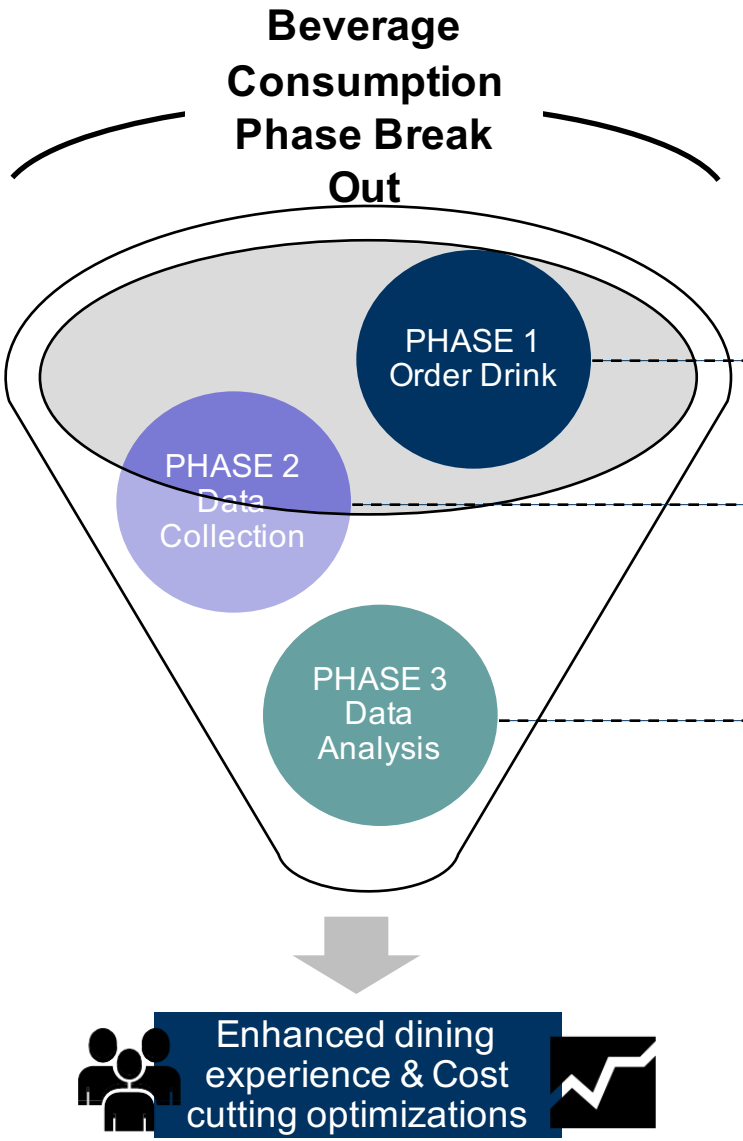
Extrapolated Examples

Buffalo Wild Wings:
Football season is a big time for beer sales.
During what part of the day is the rate higher? lowest? Happy Hour?

Large Scale Restaurants:
Large restaurants that deal with a big volume often benefit from cost cutting optimizations from data.
(Free refills & different sizes)

Hotels & Bars:
Staff is able to monitor customers and reject those who have had clearly drank to their limit.

Objective



Order A Drink

- Initial reading of cup and drink served
- Wait staff measures initial cup weight and assigns value to a particular coaster.
  - Track exact amount of fl oz in cup
  - Able to switch tracking to any other size cup or container using this method

Real Time Drink Consumption

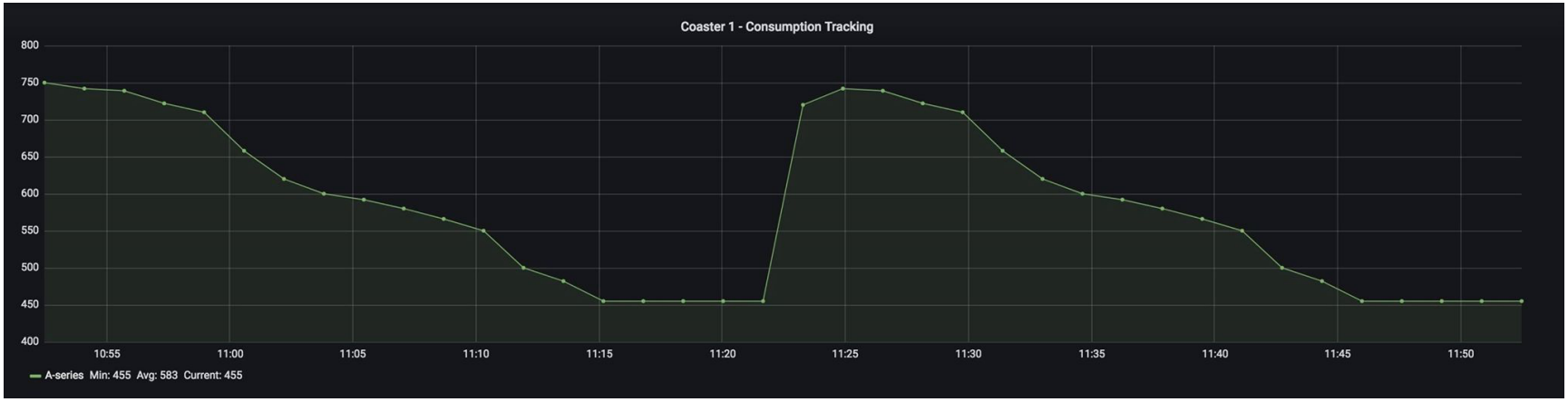
- Senses weight of cup throughout the consumption process.
  - Sends data to hub for further processing

Proprietary Data

- Using the data received from both the central hub and the peripheral coasters, we can do an in-depth analysis on consumption behavior
  - Allows for a data platform to visually display tracking real time

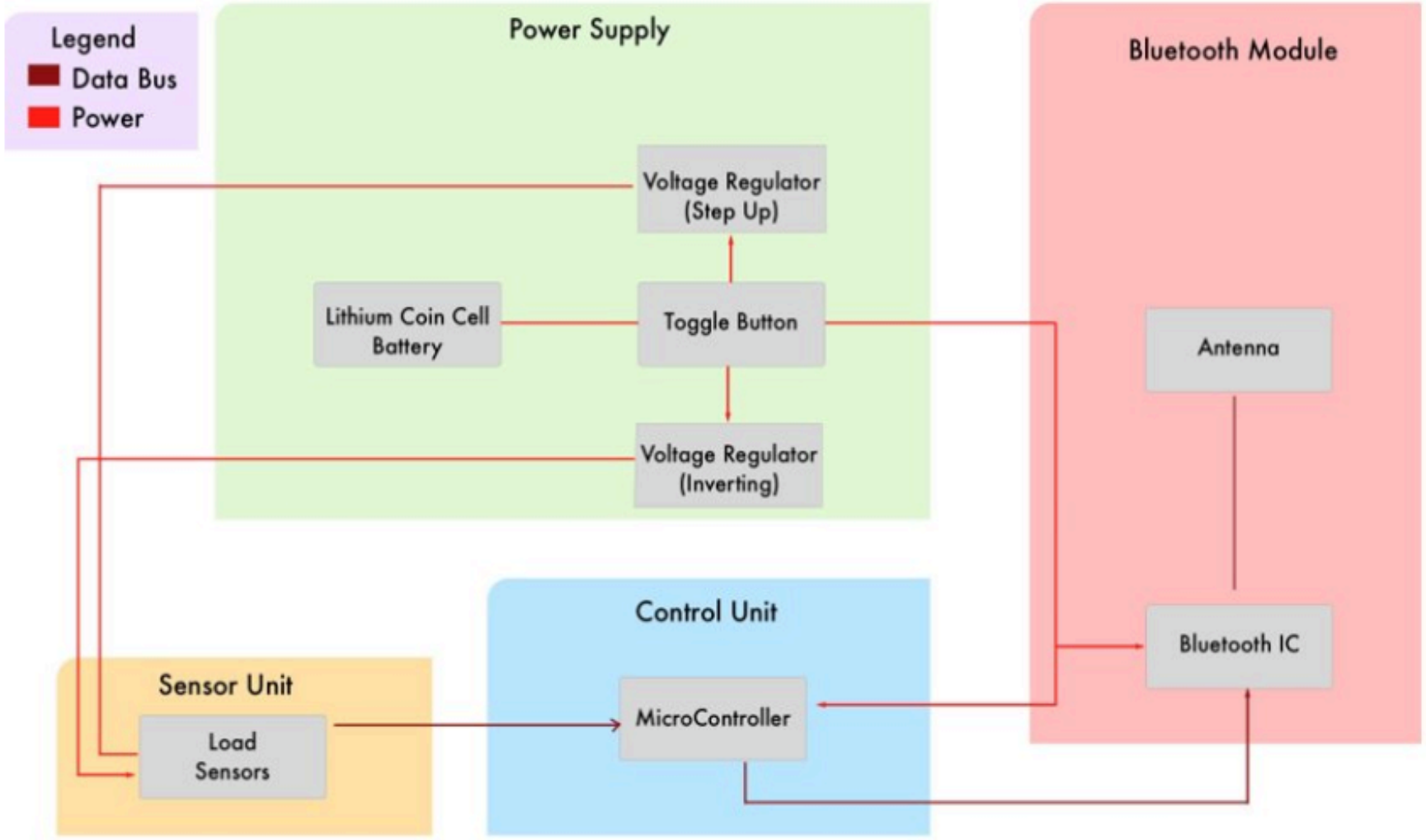
Basic Functionality *Objectives Continued…*

- Basic Functionalities:
  - Coaster component had data transmit to the hub
  - Had a central hub on the table as well that would keep track of empty cup value.
  - Data plots out story line seen and tracked below



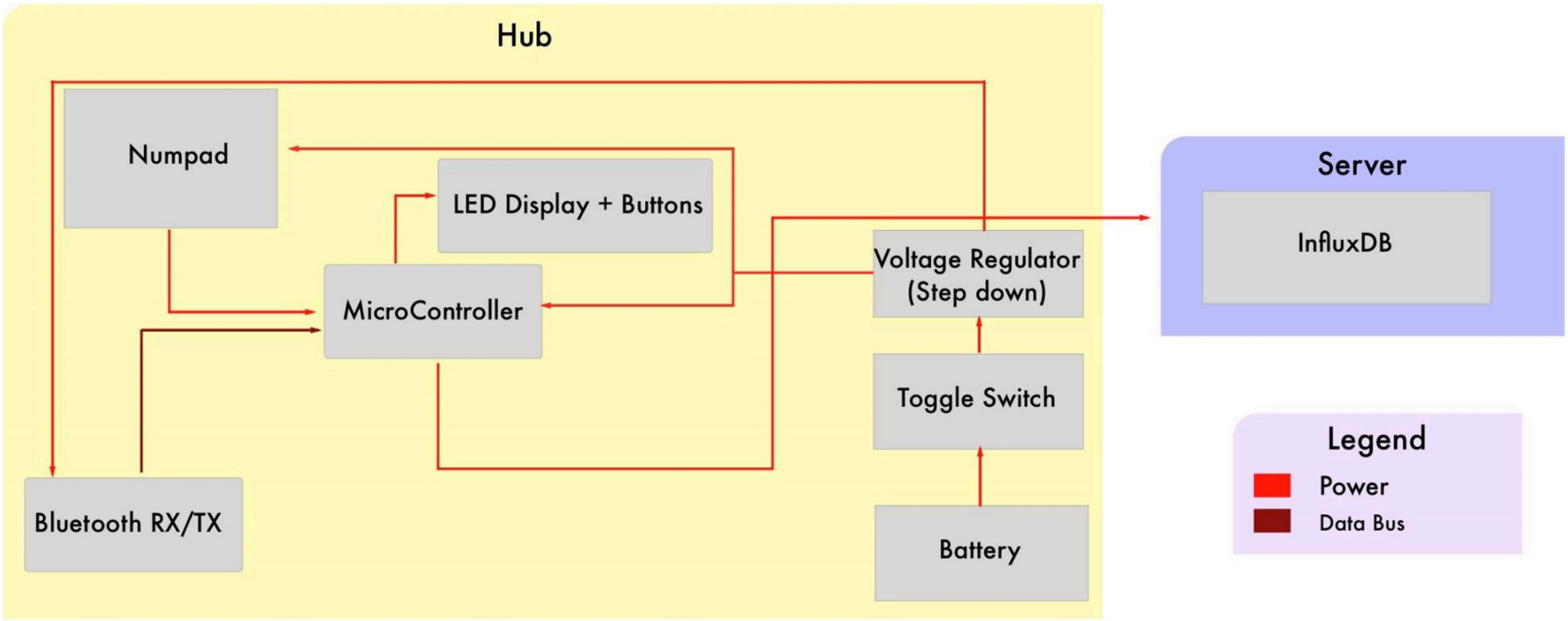
Design: Block Diagram – Coaster

Coaster Block Diagram:



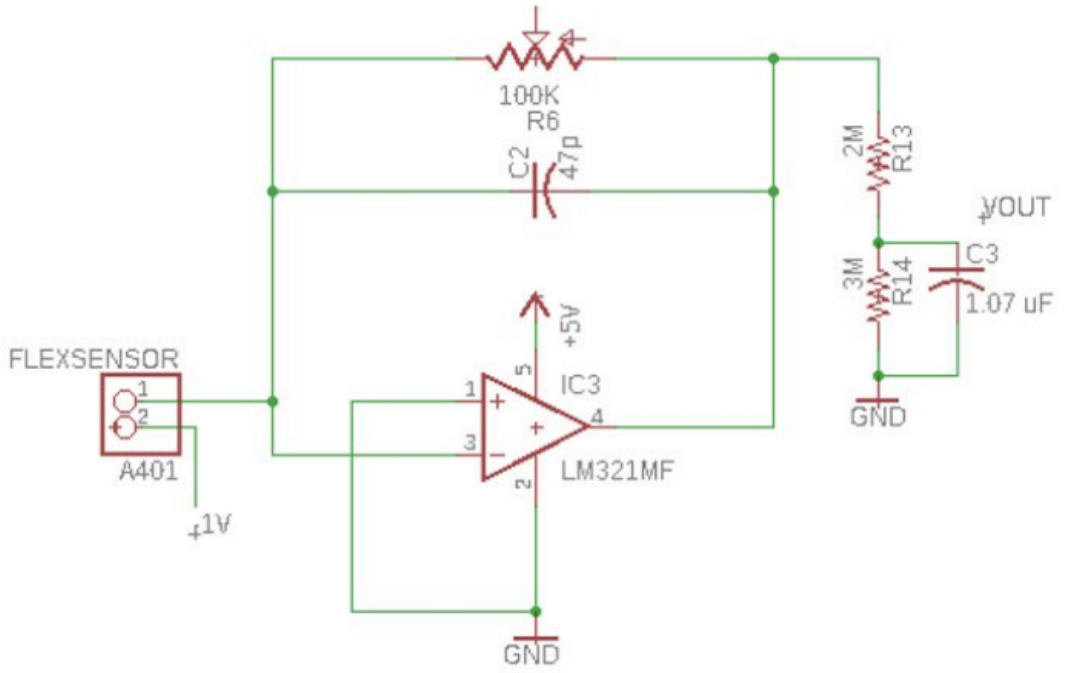
Design: Block Diagram – Hub

Hub:



Design: Load Sensor and Op Amp

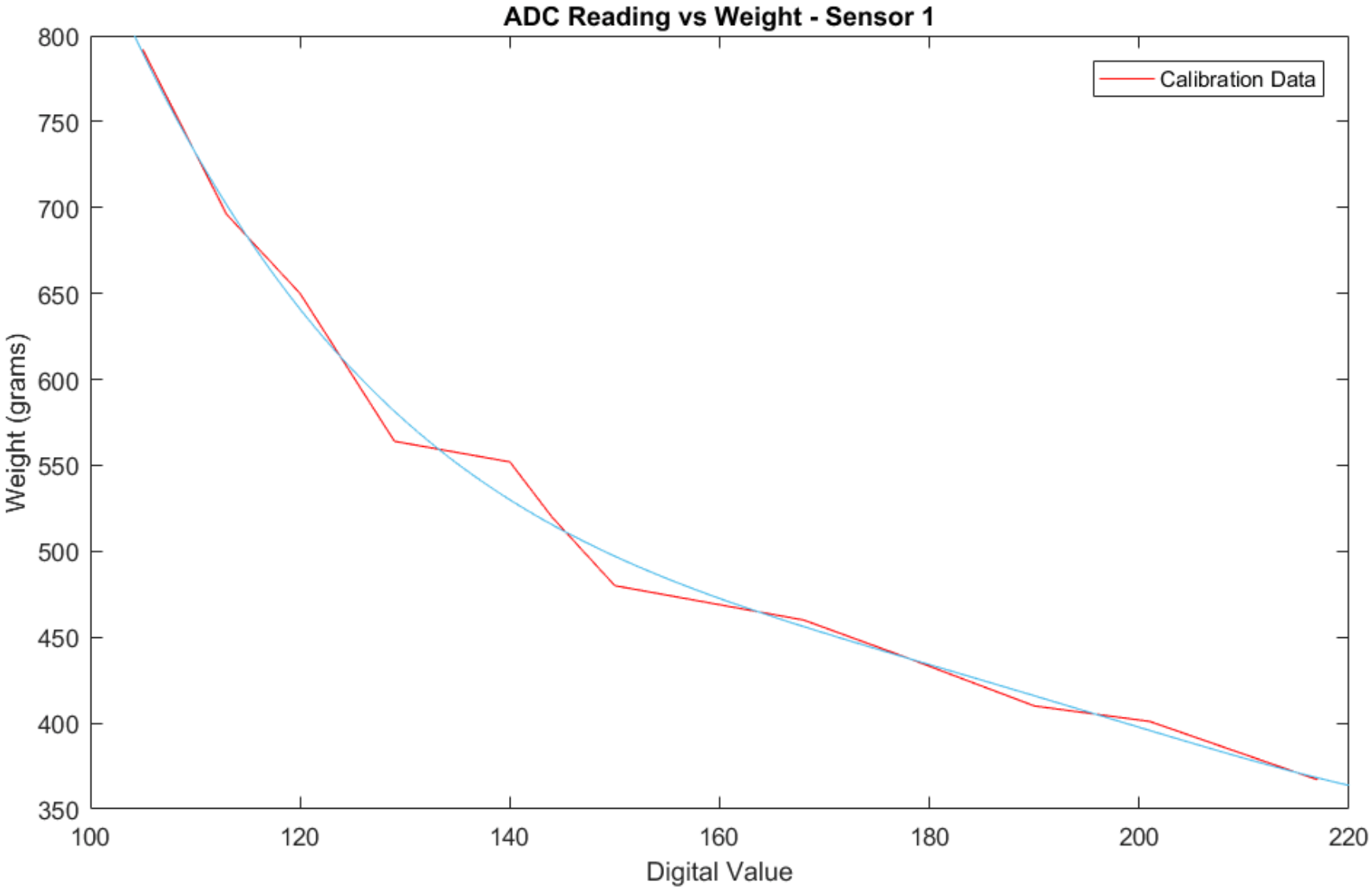
Circuit Layout



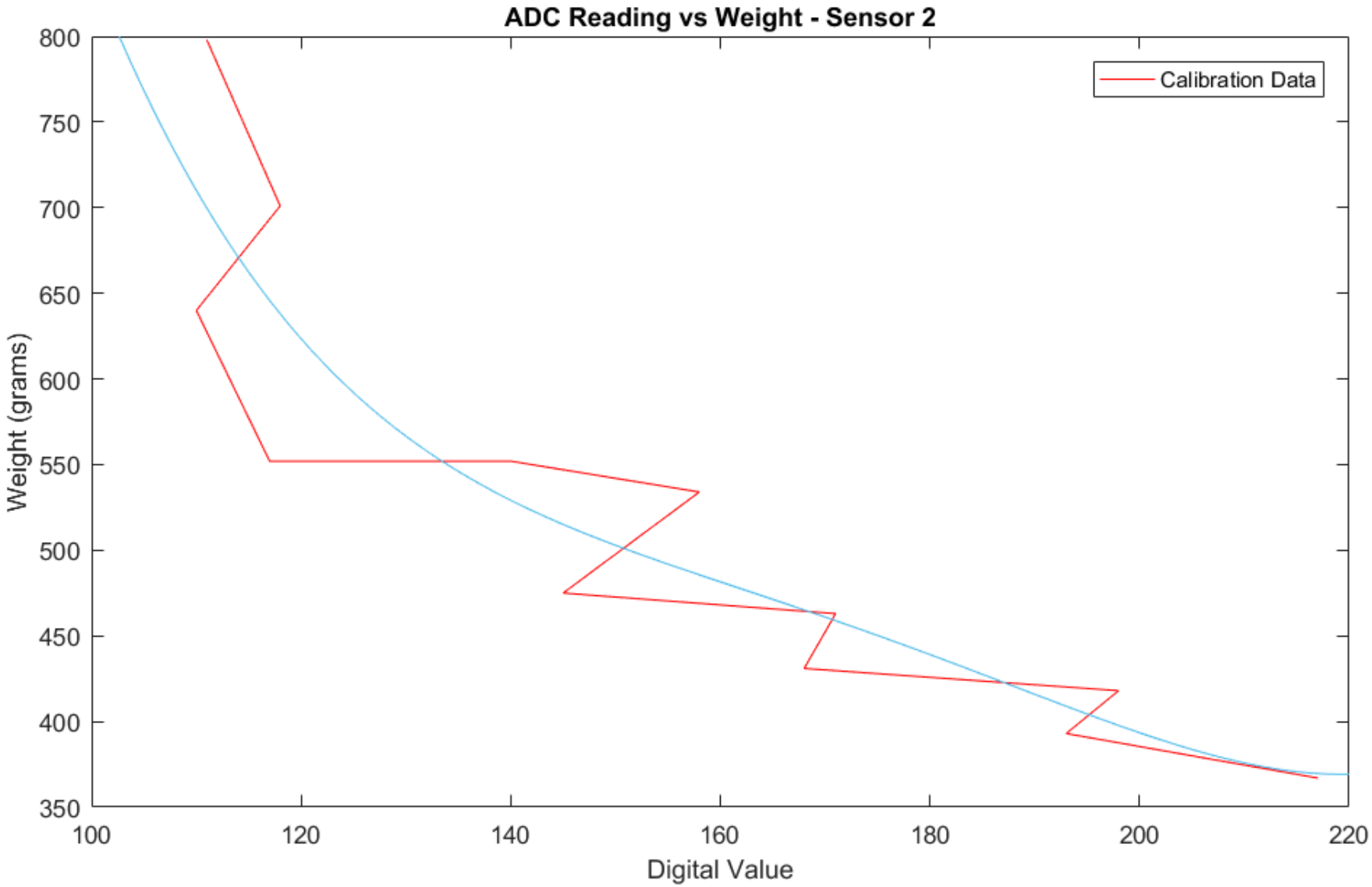
Design:

- Op Amp regulates pressure sensor input → output result.
- Measured voltage drop across resistor when taking reading from microcontroller
- $V_{OUT} = \frac{2M\Omega}{5M\Omega} * \frac{-V_T * R_{SENSOR}}{R_{POT}}$

Design: Data Plots - Load Sensors

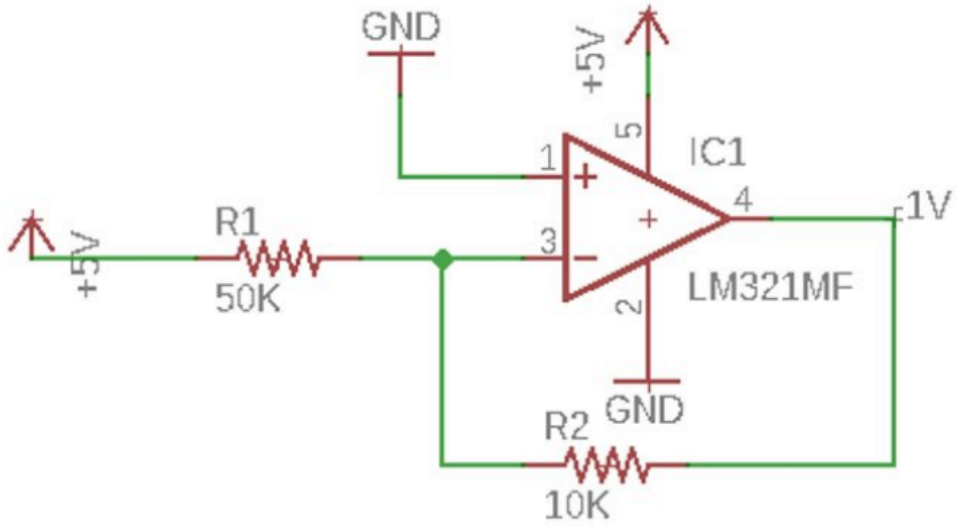


Design: Data Plots - Load Sensors *Continued…*



Design: Power Circuitry

Circuit Layout

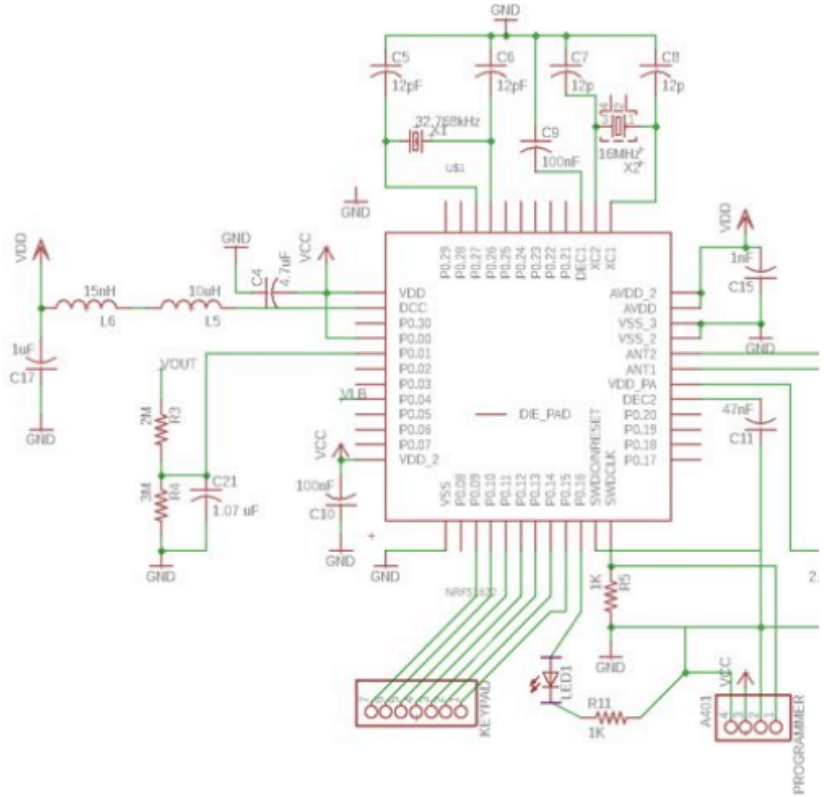


Design:

- Convert Coin Cell or 9V battery voltage to 5 V to properly operate and set limit for op amp
- Invert Voltage to help calibrate sensor and control range of weights read

Design: nRF51822

Circuit Layout

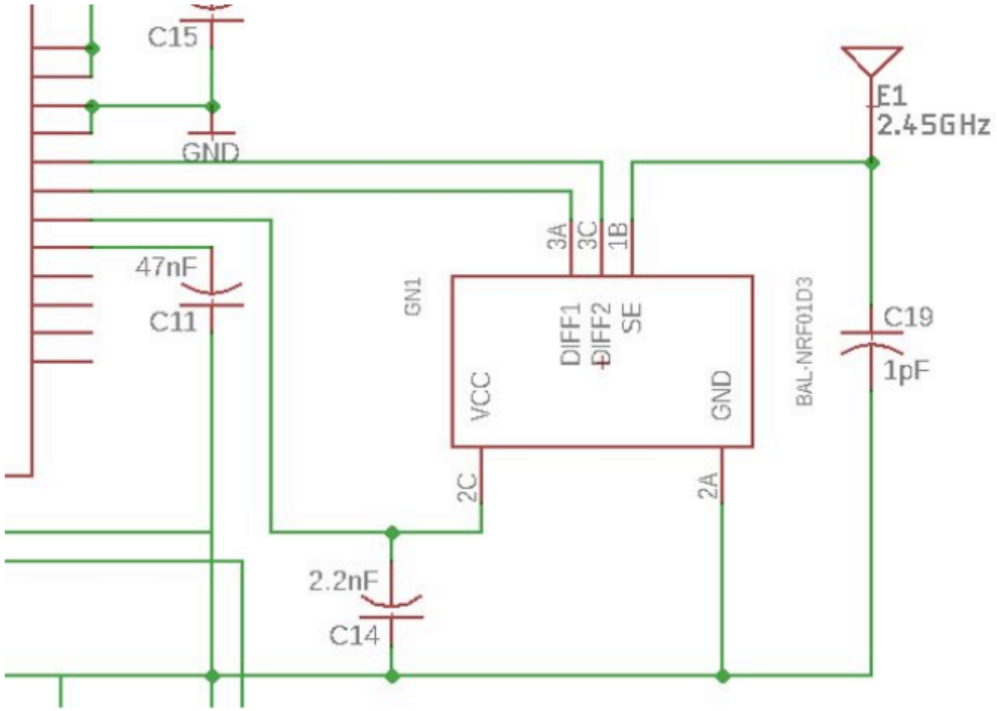


Design:

- 256 kB Flash Memory, 48 pins
- Can actively read and write to antenna via Bluetooth
- MCU ADC read at pin 1 from load sensor
- MCU GPIO input pins 9 – 15 from keypad
- MCU GPIO output pin 16 to LED
- Operated on 3 V coin cell
- Operates using external clock at frequencies of 16 MHz and 32 kHz

Design: RF Transmitter/Receiver

Circuit Layout



Design:

- Microcontroller stores average reading from coaster
- Transmits and receives through ANT Pins 1 and 2 to antenna.
- Balun between antenna and MCU to match network

Design: Power Consumption

Coaster

- Coin Cell: 3V - (240 mAh)
- MCU idle (2.6 µA), RF Transmission (6.3 mA)
- Should be transmitting once every minute : Average (.527 mA)
- 240 mAh * .7 / (0.527 mA) = 321.22 hours

Hub

- 9V Battery (500 mAh)
- 4 LED’s (1 mA), RF Receiver (13 mA)
- 500 mAh * .7 / (1 mA + 13 mA) = 25 hours

R&V

Requirements	Verifications
Load Sensor Reading – Load Sensor accurately reading data and conversion from voltage to weight accurate	✓ Weighed items using sensor and compared output from relation between weight and voltage to digital scale reading
Microcontroller - Read data from input sensor or keypad and write to LEDs if necessary	✓ Input pins and output pins had correct values as seen on an oscilloscope. UART confirmed that values sent via Bluetooth were
Bluetooth Range – Bluetooth message is still receive and transmit at distances of 75 - 100 meters away	Were able to receive message within Apartment with length of 50 meters and multiple walls in the way. Did not test full 75-100 meters
RF Transmitter/Receiver - Control words are consistently sent and caught between the pair	✓ Receiver is verified to have the same data as the output pins on the MCU, indicating successful transmission
Power Supply - Deliver sufficient voltage to power all components and enough wattage to keep it powered for a significant amount of time	✓ Consistently provides 3 Volts of VCC to coaster and necessary conversions and inversion were made

Strengths & Weaknesses

Strengths:

1. Modularization – A coaster and hub can be interchanged and both can send & receive
2. Utilized sensors with low power consumption
3. Minimized circuits as a foundation for building additional features
4. Platform is open to any kind of use

Weaknesses:

1. No Wi-Fi capability, which minimizes the versatility of the data
2. Were unable to integrate keypad for designating cup weight

Challenges

- MCU Programming
  - Pins spacing was not standard and had to require special connections to SDIO/SDCLK, VCC & GND.
  - Handling compatible software packages that were capable of our hardware constraints.
  - Appropriate Tools to flash hardware
    - Segger J-Link & BLE-400 Waveshare Board

- PCB
  - Had trouble programming PCB using design from nRF51822 User Manual
  - Some Components such as balun were very small and hard to solder

Future Work

- Implement WiFi on hub to better stream data to server
- Fix Known PCB issues such as op amp voltages
- Change Power Source of Hub to LiPo Ion battery or from a wall source.
- Design more Coasters
- Have a live feed for visual assistance

References

Citations

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THANK YOU

Questions?