Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 38: Fuel Cell Monitor
Final Presentation

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Project Summary

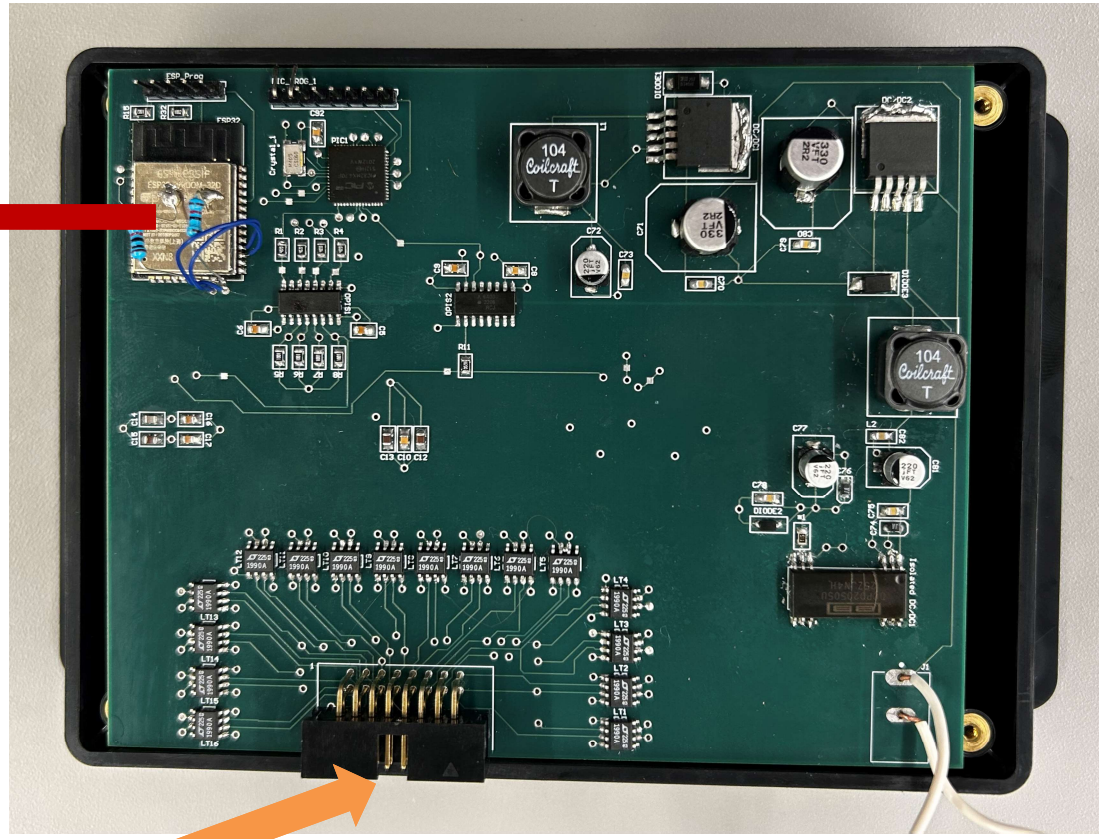
- Problem statement: A single fuel cell is an easy power source to monitor, but to achieve any level of real usable power they must be connected in a stack. If only monitored as a whole, each cell would have to be tested individually to determine the issue. This causes longer down times and more technician wages to trouble shoot.
- The Fuel Cell Monitor System will give the operator real time voltages of both the individual cells and stack. The voltages will be monitorable from an android based mobile app. In case of over or under voltage, the app will notify the operator of not only the error but which cell has fallen or risen outside of expected ranges. Saving both time and money for repairs.

Fuel Cell Monitor Integrated System Diagram

Fuel Cell Monitor Application

- Error Detection: No errors detected
- Set Error Markers
- Individual Fuel Cells
- Historical Trends
- Check Status

Firebase Realtime Databse

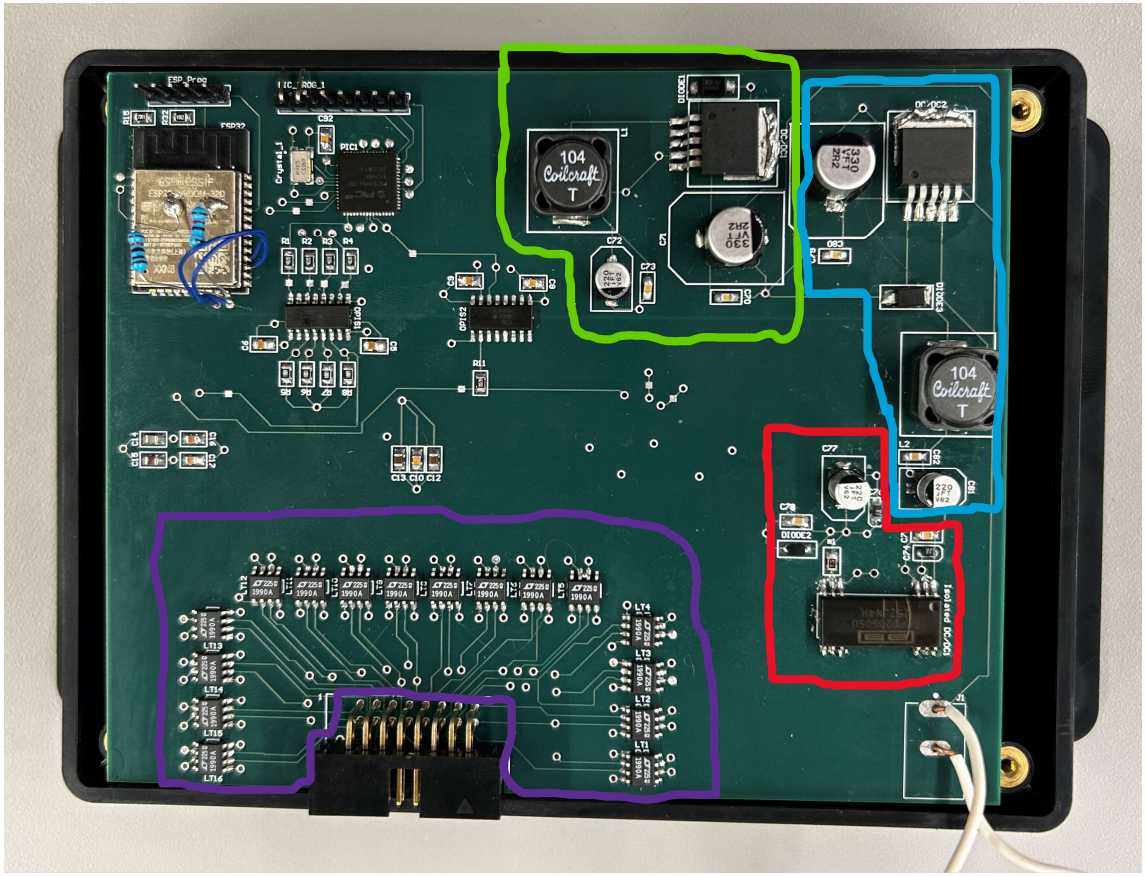


Fuel Cell Stack

Sameer Osama

- Designed:
- 3.3V DC/DC provides power to MCU and low side of opt-isolator
- 5V DC/DC converter provides power to isolated DC/DC
- Isolated DC/DC provides power to buffer system, ADC, high side of opto-isolator
- Buffer System takes signals from fuel cells

Sameer Osama



-5V DC/DC

-3.3V DC/DC

-Isolated DC/DC

-Buffer System

Sameer Osama

- E-load measurements:

3.3V DC/DC		5V DC/DC		Isolated DC/DC	
No Load	Max Load	No Load	Max Load	No Load	Max Load
0A → 3.27V	1A → 3.2V	0A → 5V	1A → 4.9V	0A →5.28V	.15A →4.53V

Challenges	Solutions
• Isolated DC/DC outputting high voltage • Differential op-amps not giving correct voltages	• Flipping the direction of diode • Resoldering buffer system

Russell Wells

Designed:

- Opto-Isolation Circuit which transfers digitals signals from the MCU (Low Side) to the Cell Input Side (High Side) of the PCB over an isolation line.
- Analog to Digital Conversion System which consist of two 8 input 16bit converters and a 4.096V voltage reference. This circuit reads voltages from the buffer system and converts to a digital signal readable by the PIC32.
- Designed the integrated PCB as seen in the system diagram and the updated board depicted in the below slide.

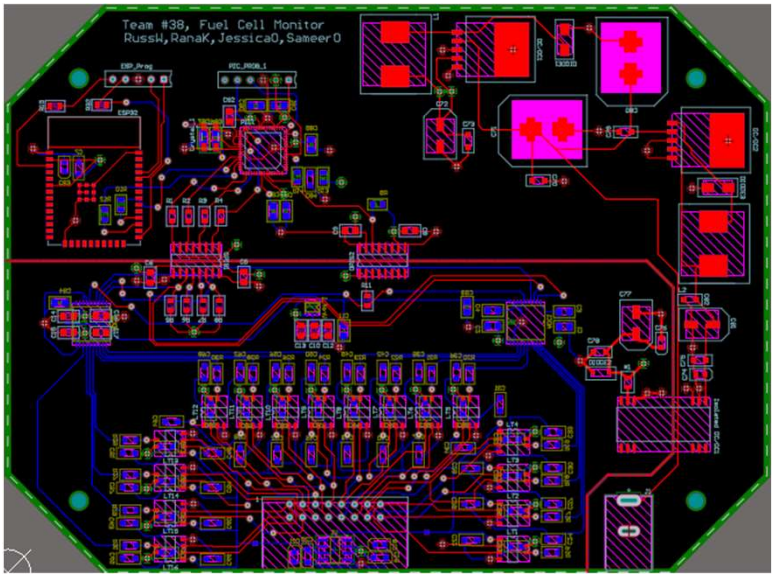
Russell Wells

OPTO-ISOLATOR	Required	Achieved	Explanation
Signal Transfer Rate	1MHz	2.4MHz	2.4 times the necessary Rate
Separate Input and Output Voltages	High Side = 5V Low Side =3.3V	High Side = 5.36V Low Side = 3.33V	A digital one input from either the High or Low side Produces the same digital signal at the appropriate voltage on the output
Transfers Readable Digital signal on both MISO and MOSI	N/A	Passed	Signal is readable by Internal Devices.

- Analog to digital converter results are shown in the integrated system results section.

Russell Wells

Challenges	Solutions
• Opto-Isolator signal rise time too long • Assigned ESP32 UART pins incorrect. • Board shape was not correct for enclosure	• Decrease pull up resistor from 10kΩ to 1kΩ • Board redesign with reassigned pins. • Board redesign for correct dimensions



Rana Kortam

- Designed:
  - The PIC32 to talk to the Analog to Digital converters through SPI
  - The PIC32 to communicate to the ESP32 through UART
  - The ESP32 to receive data from the PIC32 through UART
  - The ESP32 to communicate with the database to send data

Rana Kortam

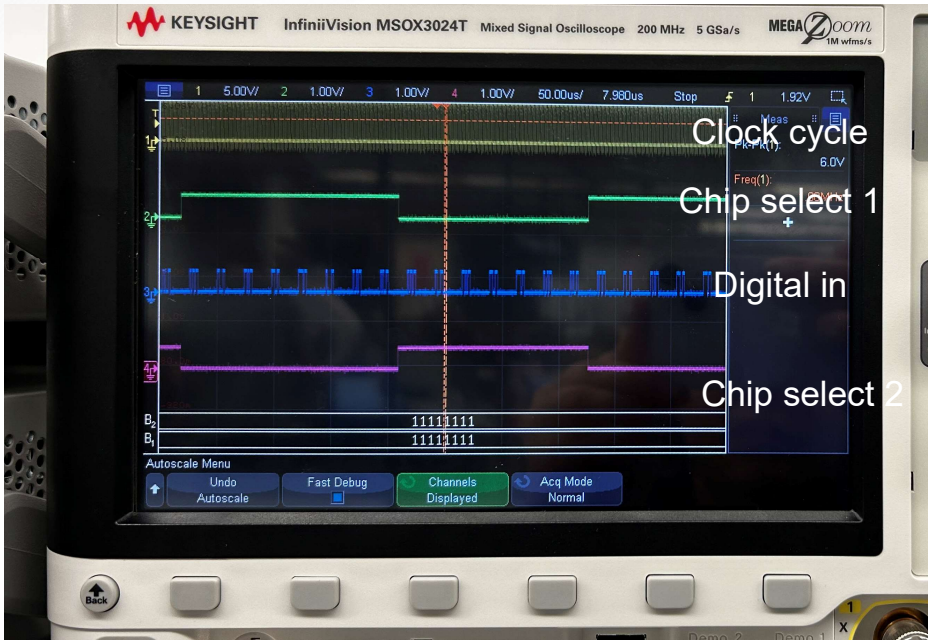
Challenges	Solutions
Chip select for SPI communication wasn't working properly	Instead of using SS1 pin, used GPIO and toggled it
Data wasn't sending data properly using Espressif IDE	Switched to Arduino IDE to send data to realtime firebase database
UART pins on the ESP32 were not correct	Assigned them to the right pins

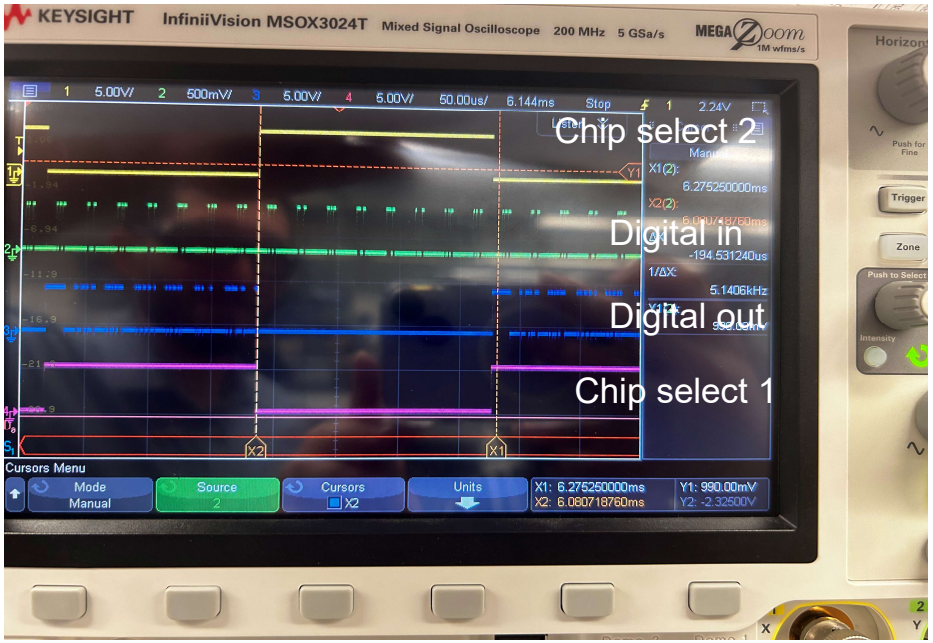
Rana Kortam

Item	met
Communication with ADC	Yes
Connection to Wi-Fi	Yes
Sending data to the database and being able to be seen on app	Yes
UART communication between PIC32 and ESP32	In progress

Rana Kortam

SPI communication from the PIC





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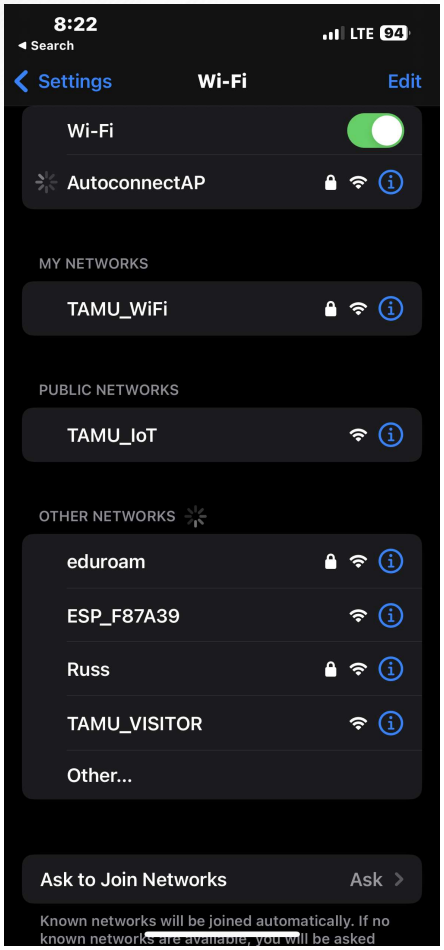
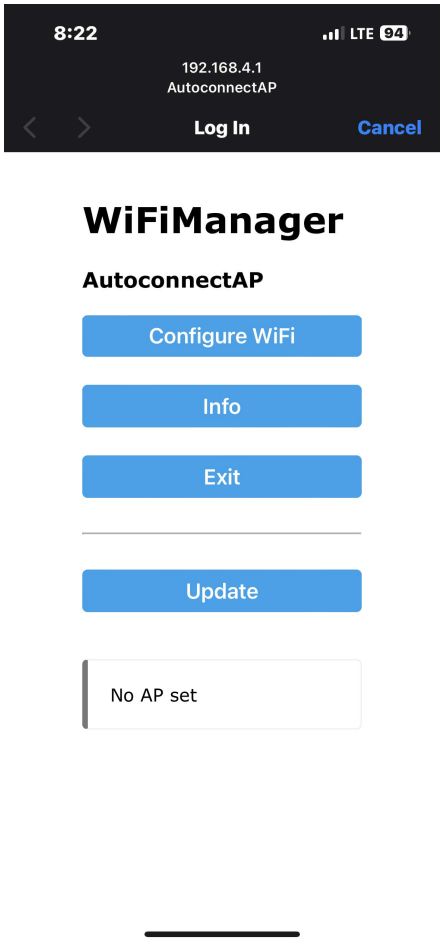
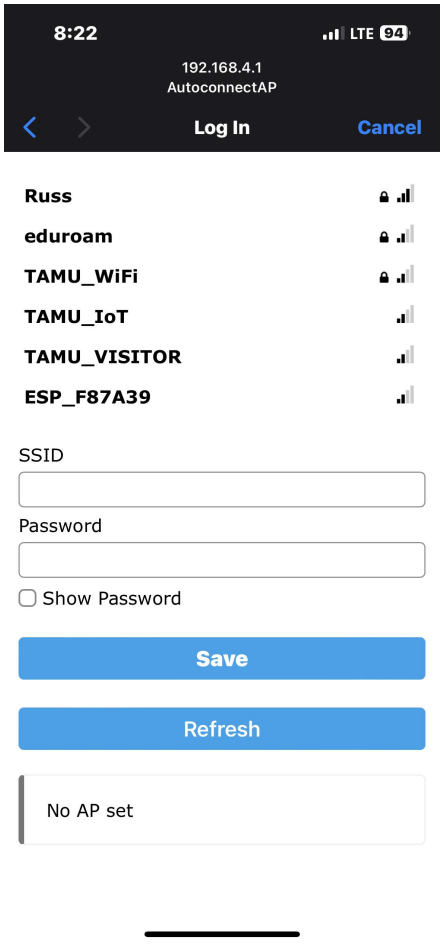
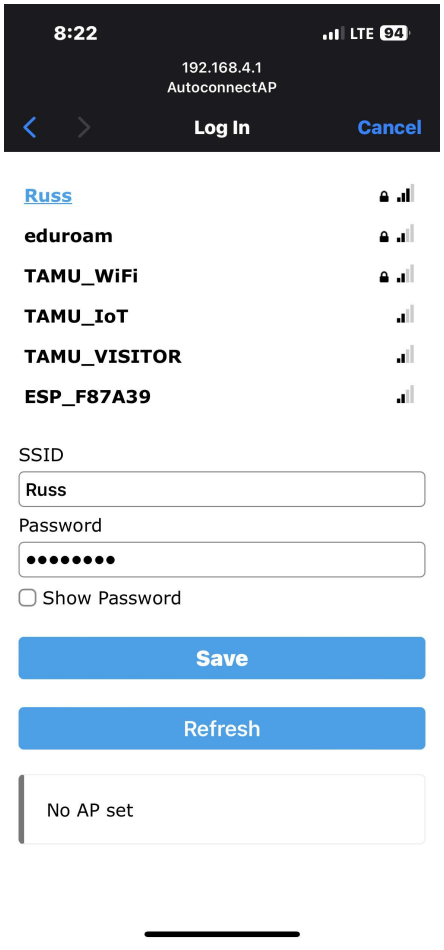
Rana Kortam

Setting up Wi-Fi on ESP32









Rana Kortam

ESP connection to Wi-Fi and send data to the database

```
*wm:Connecting to NEW AP: Russ
*wm:connectTimeout not set, ESP waitForConnectResult...
*wm:Connect to new AP [SUCCESS]
*wm:Got IP Address:
*wm:192.168.205.87
*wm:config portal exiting
connected...yay :)
Serial Txd is on pin: 17
Serial Rxd is on pin: 16
ok
```

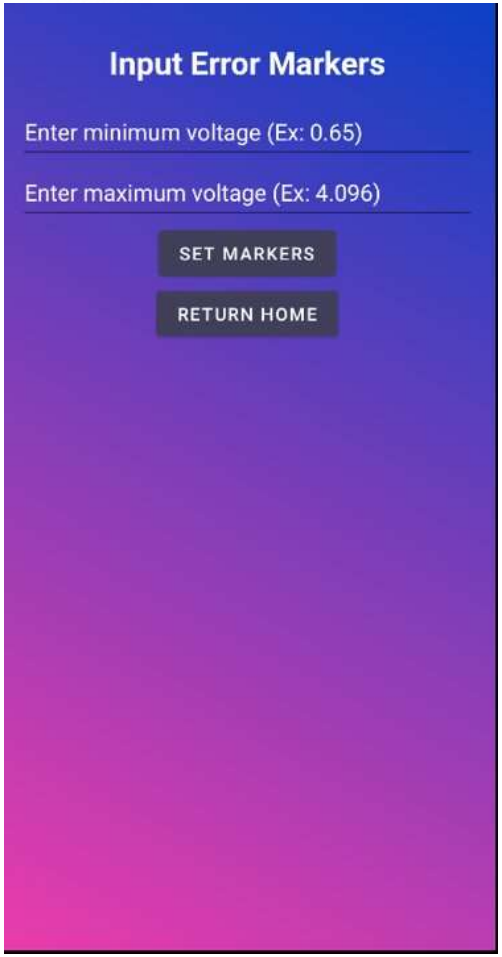
```
PASSES
PATH: /fuelcells/fuelcell10/voltageLevel
TYPE: string
PASSES
PATH: /fuelcells/fuelcell10/voltageLevel
TYPE: string
PASSES
PATH: /fuelcells/fuelcell10/voltageLevel
TYPE: string
PASSES
```

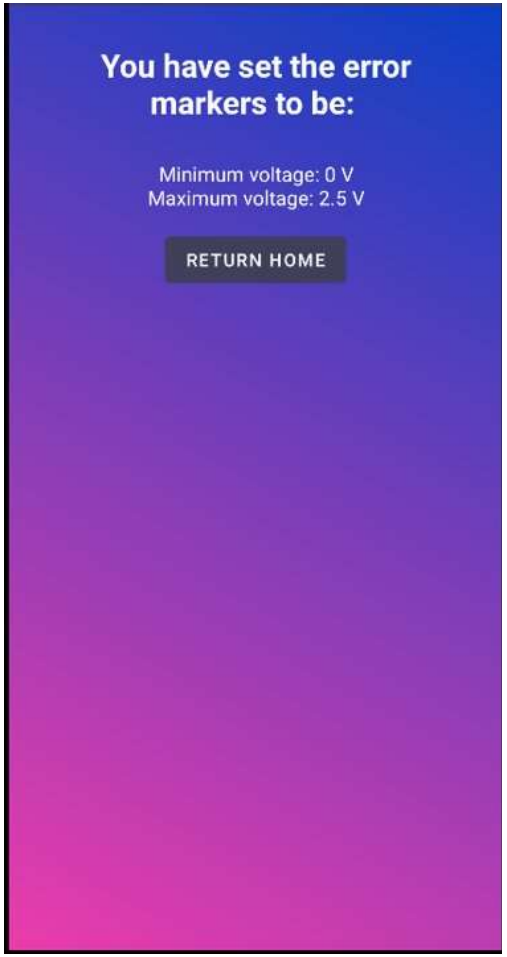
Jessica Odutola

- Designed:

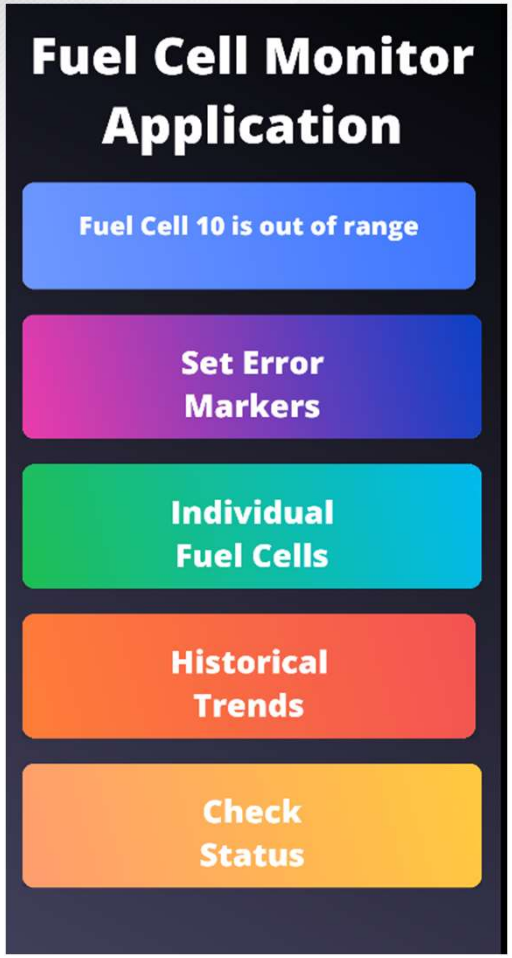
- Android Application that displays fuel cell data in both graphical/tabular format to users and informs users of any errors
- Firebase Database

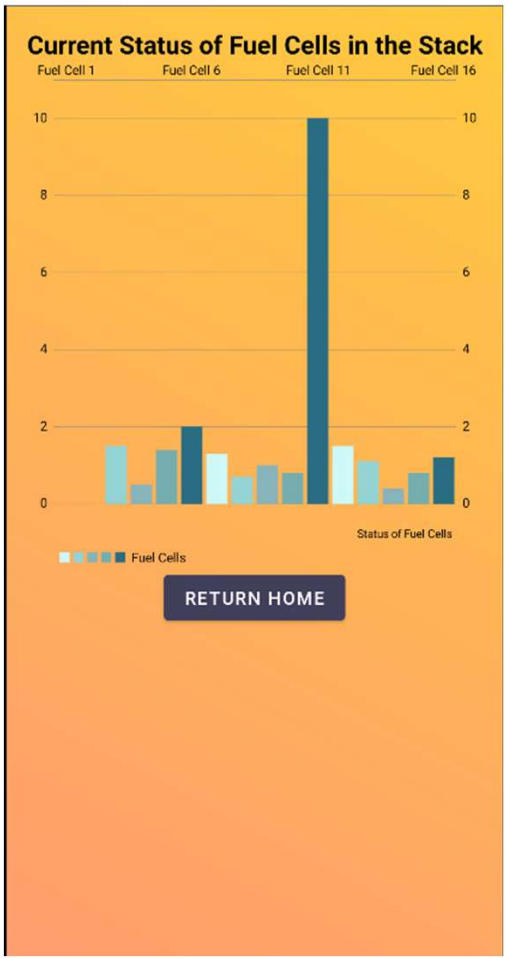
Jessica Odutola

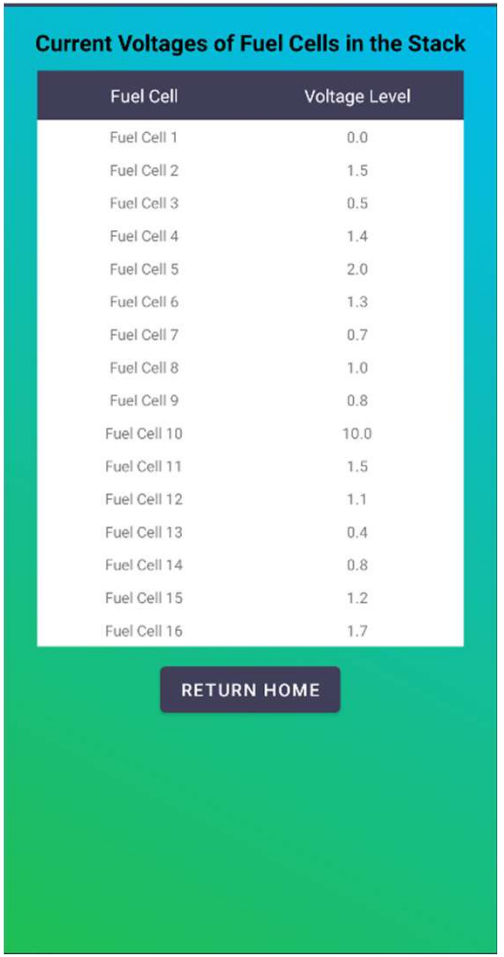




Jessica Odutola







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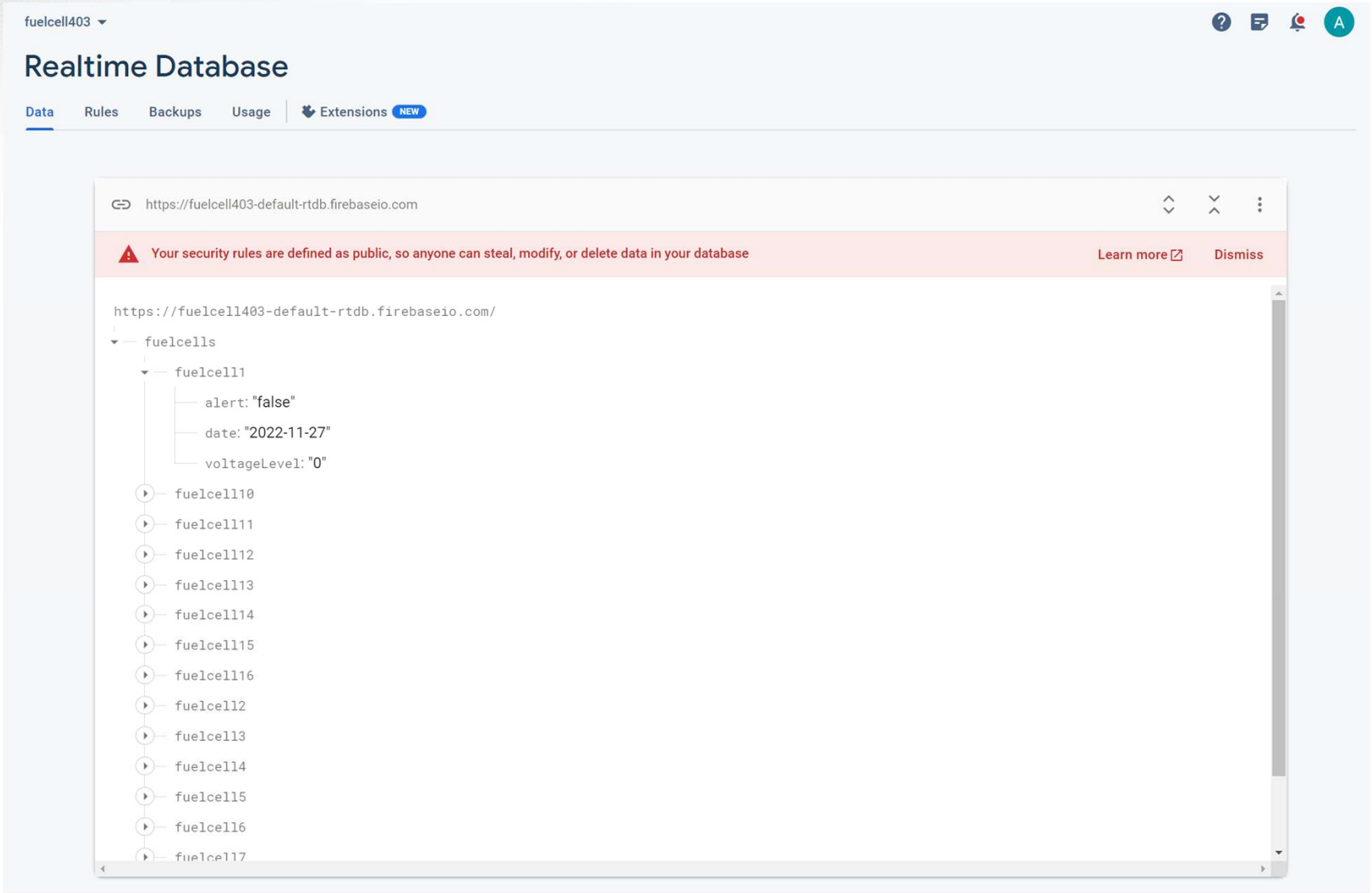
Jessica Odutola



Jessica Odutola

Challenges	Solutions
• Asynchronous timing reading from the database • Allowing users to manually set error markers for fuel cells within app • Reading accurate data and updating automatically in app	• Delayed creation of graphs/table in app to allow values to be read from database • Created separate page for user to input desired error markers and updates any errors on home page. • Used a value event listener to update changes automatically in app

Integrated System Results

Input Voltage	Output	Expected Output	Error (Based on voltage reading)
0	0	0	0%
1	16334	16000	2.1%
2	32402	32000	2.5%
2.5	40298	39999	1.9%
3	48317	47999	1.9%
4.096	65535	65535	0%

Due to communication errors between the PIC32 and the ESP32, the values above were measured from oscilloscope and not read from the database or app. Further testing and validation of the results pending full system functionality.

Conclusions

- Current Status
  - The UART between the PIC32 and ESP32 is not working properly. PIC32 is not sending cell values.
    - Trouble Shooting and testing currently in progress
  - Current PCB is not shaped to fit inside the enclosure.
    - New PCB is on order.
  - Power system, signal transfer and conversion, ESP32 to database communication, app data pulls, app visuals, and app error notifications work as expected.