Group 39

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Motivation

- Extra hand in the kitchen
- More time for family and friends
- Good for tailgating
- Better tasting food
- No CO - indoor/outdoor
- Cost effective
- Easy to clean

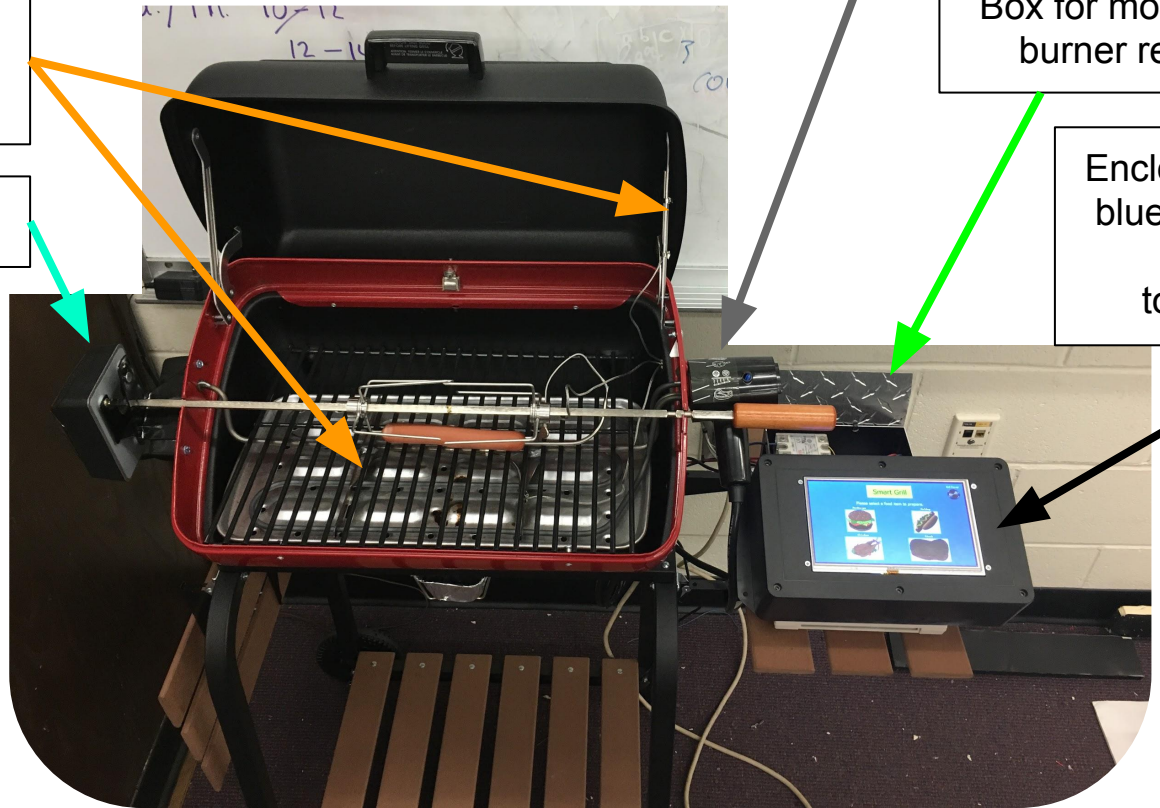
Specifications

Component	Parameter	Specification
Grill Burners	Max Temperature	500℉
LCD Screen	Current Draw	700mA
Grill Burners	Current Draw	12A
Rotisserie Speed	Revolutions per min	2 rpm
Temperature Sensors	Max Temperature	750℉
Mobile Wireless Link	Maximum Range	10 meters

Goals and Objectives

A. To accurately measure and display the appropriate temperature to cook food completely and safely using temperature sensors
B. Have user interface through LCD screen and mobile App
C. To time and send alerts to the user to let them know when to turn the food over to cook other side using LCD Screen as well as mobile app
D. To Let the user know when cooking is complete using the LCD Screen & mobile app

Grill Overview



Power System

Mission - Get variable-temperature for burner & ON/OFF (CW/CCW) control for rotisserie.

Solution - Use a Triac for switching power with simple pulse code for variable-temperature & ON/OFF (CW/CCW) rotisserie control.

- Constraint - use OEM burner & rotisserie features.

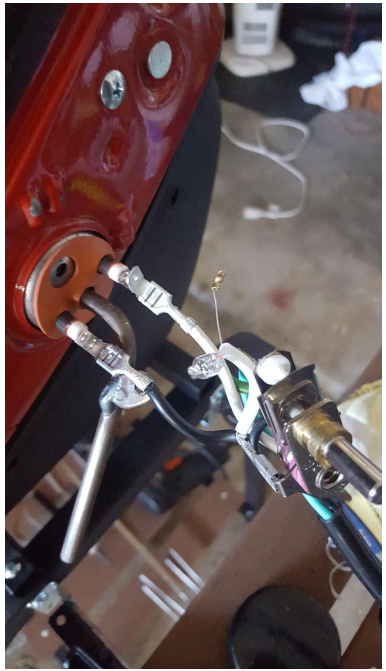
Power System

Burner Specs

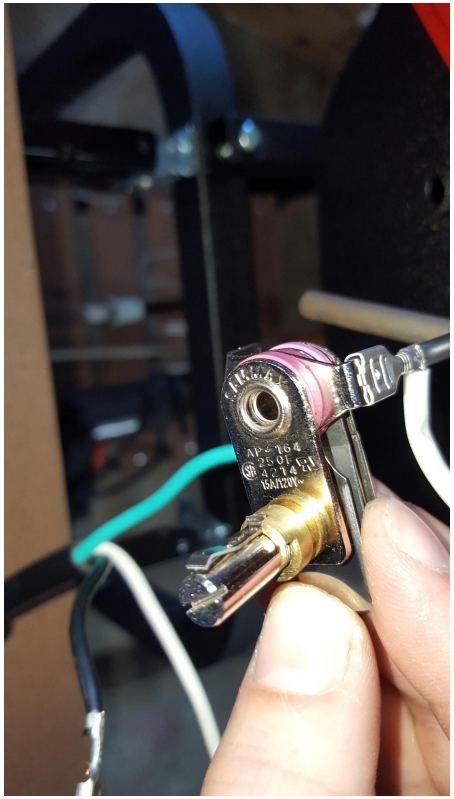
- ~11 Ohms
- rated @115VAC
- 1500W
- up to ~500F but regulated to 450F
- Food cooks 5F / 115s
- To increase ratio Vs=IR -> 2500W?

Burner Element

Power System



Burner
Terminals



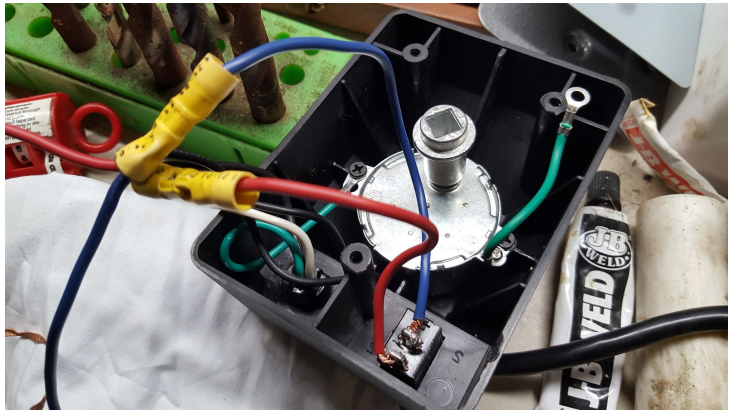
Bimetal
Thermostat

Making things fit
OK

Power System

Motor Specs

- ~2 RPM Synchronous 120VAC motor
- Magnetic Memory
- Triac to control CW/CCW
- 15s motor-relay cycle - 10s ON 5s OFF

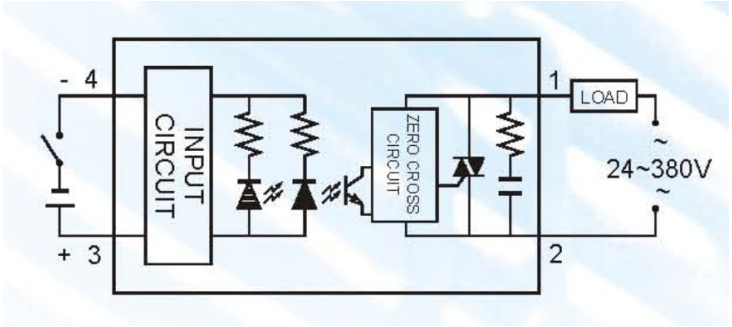


Rotisserie motor push switch

- Allowed us to figure out the rotisserie toggles CW/CCW

Power System

- SSR - TRIAC
- Longer lifetime
- Need Heatsink
- Need safety enclosure



FOTEK SSR-25 DA

Input = 3-32 VDC

Output = 24-380 VAC

Max Current = 25A

Op. J.Temp. = 80C = ~180F

Switching ON/OFF Speed = <10ms

Temperature Sensing

Temperature Measurement

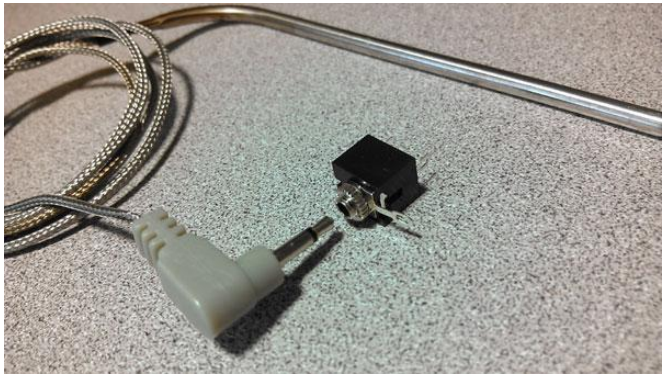
Requires (3) Temperature sensors rated to **750℉**

We chose the **Accuon ACU0235 Temperature Probes** for:

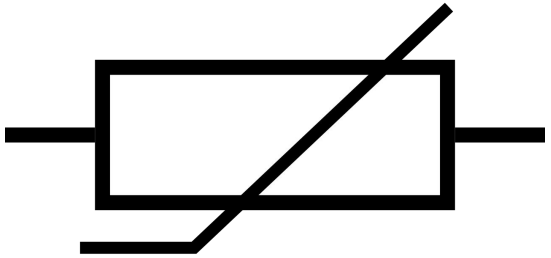
- Ambient Temperature
- Burner Food Temperature
- Rotisserie/Food Temperature

Temperature Sensing

- (3) Thermistor Temperature Sensors
- (3) 3/32” Panel Mount phone Jacks
- (3) 1MΩ Resistors



Temperature Sensing

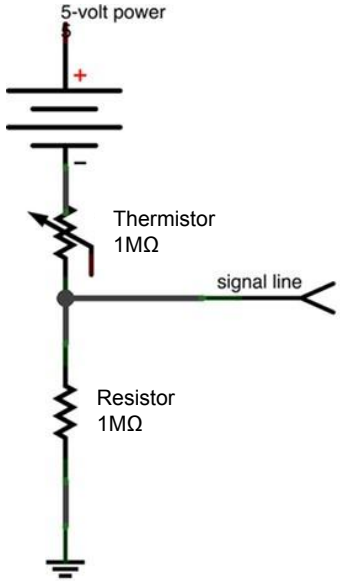


- For our project our Thermistor Temperature sensors are **Negative Temperature Coefficient** (NTC) sensors
- As the **Temperature ⇧ the Resistance ⇩**
- Linear relationship, Not very accurate, Small Temp ranges
- We found using the Steinhart-Hart equation in our coding gave us **Greater Accuracy** and **a Larger Temperature Range**

Temperature Sensing

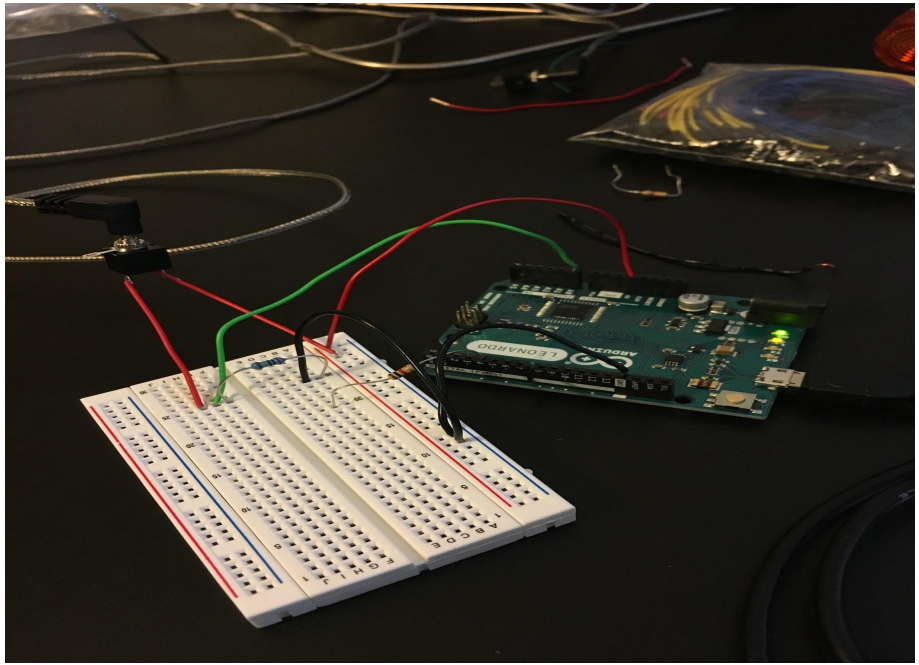
Why use 1MΩ Resistors?

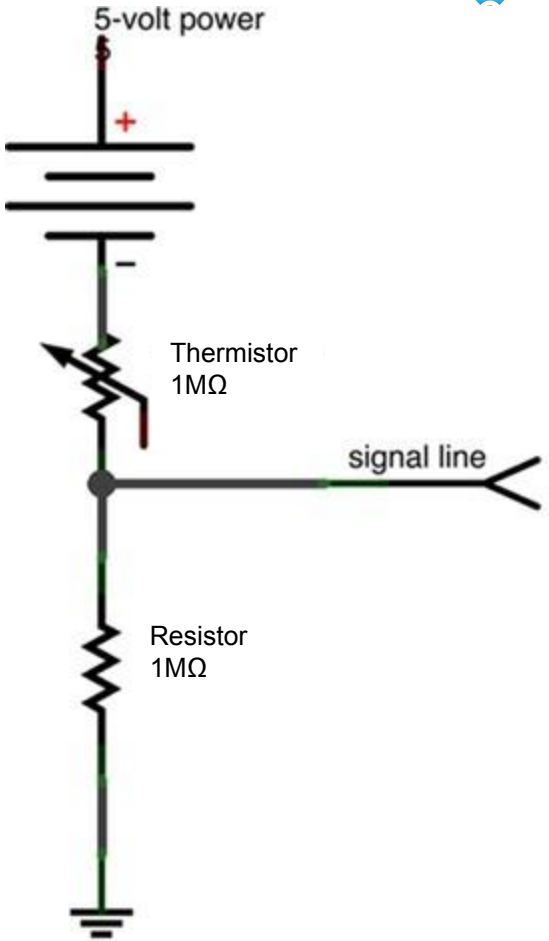
- **75℉** is room temperature
- At **75℉** the Thermistor Resistance measures **1MΩ**
- This is **Baseline** for most Thermistors to have resistance at **75℉** or room temperature
- A change in voltage between the **1MΩ resistor** and the **Thermistor Probe** is read on the analog pin at the **signal line**



Temperature Sensing

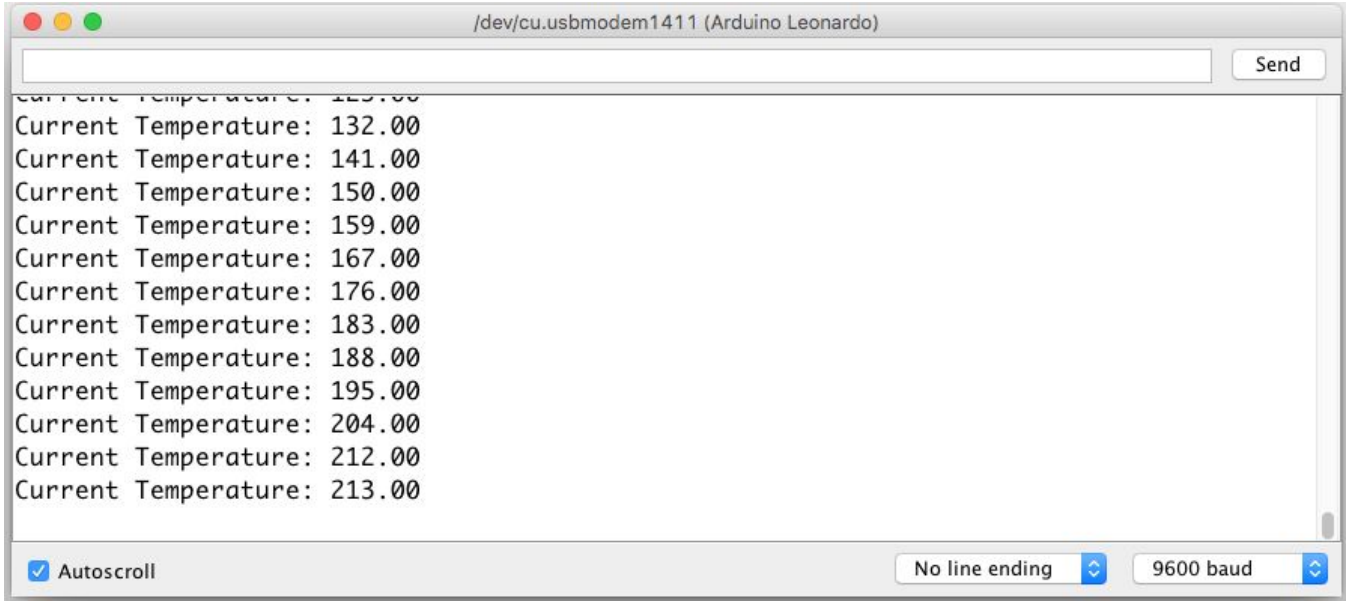
Prototyping Temperature Sensor Circuit





Temperature Sensing

- When test measurements were taken results very accurate



Temperature Sensing

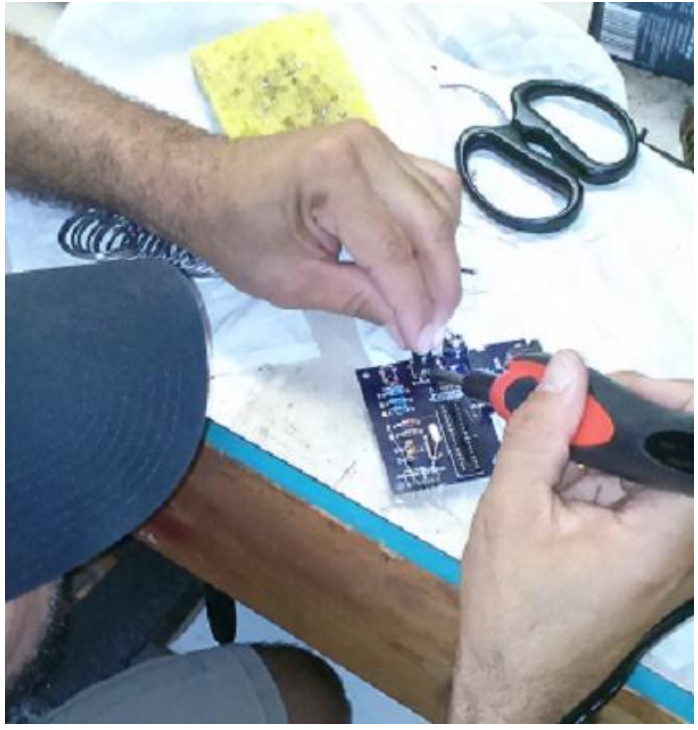
Temperature Sensor Placement

Rotisserie/Food Temp Sensor

Burner & Ambient Temp Sensors

Temperature Sensing

Temperature Sensor PCB Placement



Temp Sensor Issues

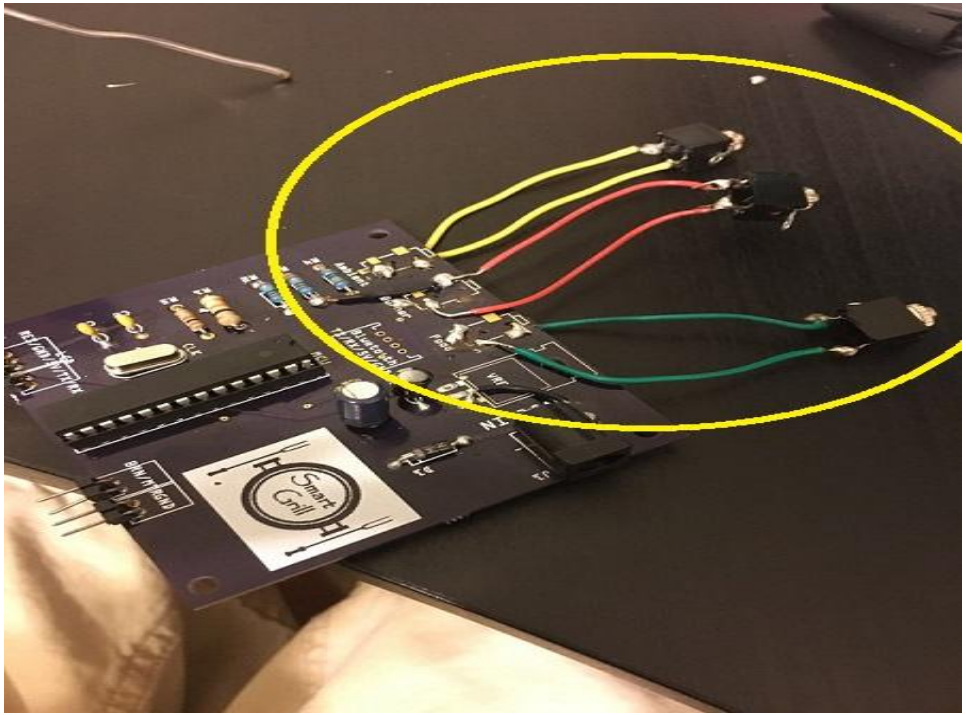
- 3/32” phones jacks difficult to solder to board directly
- Movement caused solder to disconnect jack from board
- Limited space on PCB

Solution

Soldered wires to jacks then soldered wires to board for better connection

Temperature Sensing

Temperature Sensor PCB Placement



Yellow

Ambient Temp Sensor

Red

Burner Temp Sensor

Green

Rotisserie/Food Sensor

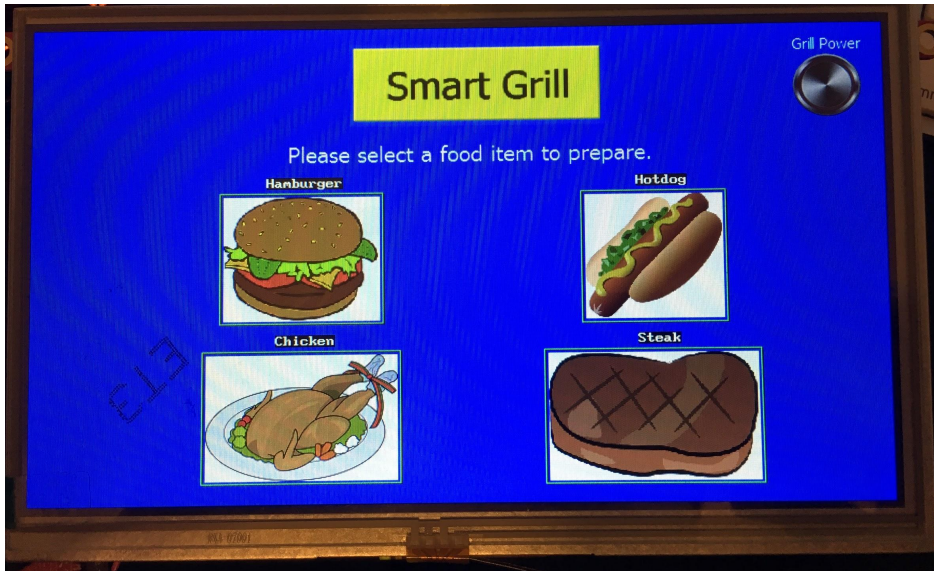
LCD Touchscreen

-Primary way for user to interact with the Smart Grill.

-Main Menu allows user to choose from a variety of food options

-3 Steps: Preheat/Prep/Cook

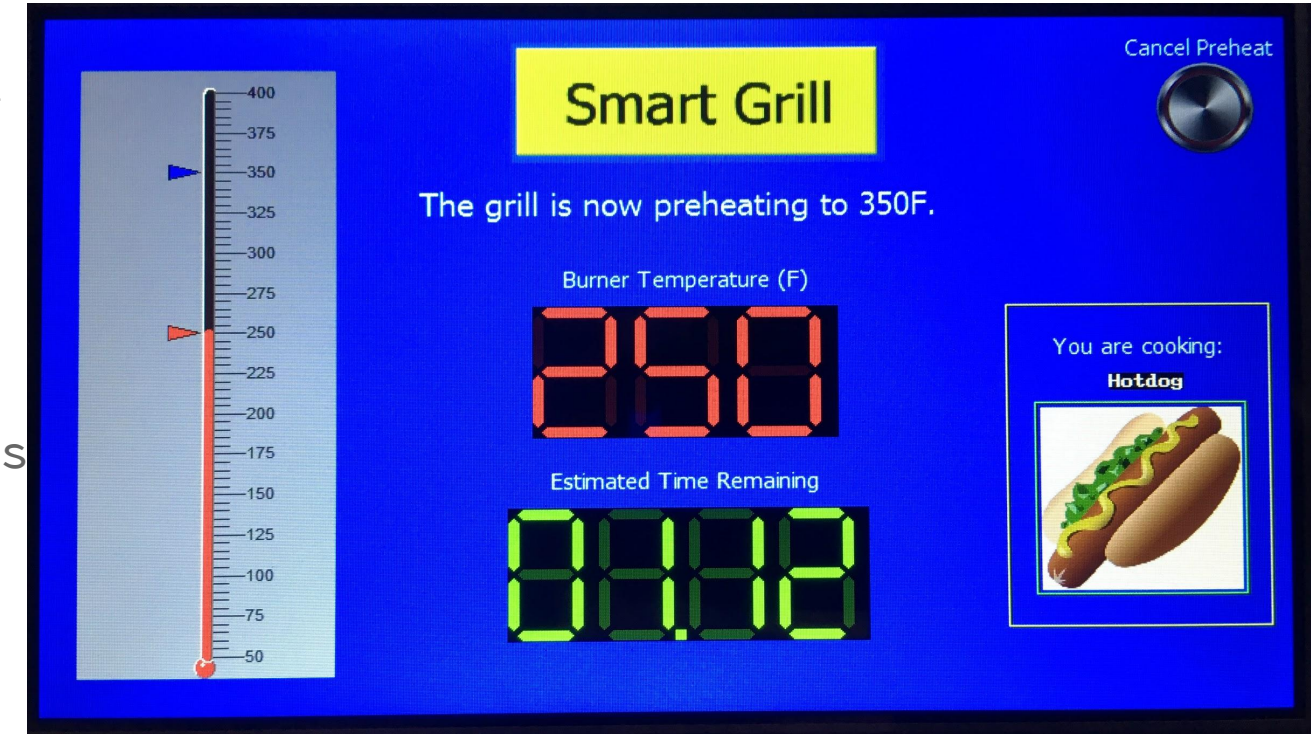
Part Number	uLCD-70DT
Price	$179.95
Supplier	www.sparkfun.com
Screen Size	7in



LCD Touchscreen

Grill Preheating

-Thermometer and red LED digits display burner temperature
-Green LED digits display time remaining for preheating



LCD Touchscreen

Grill Prep

-Enable/Disable rotisserie
-Adjust final cooking temp for food being made
-Place food on grill with temp probe inserted

LCD Touchscreen

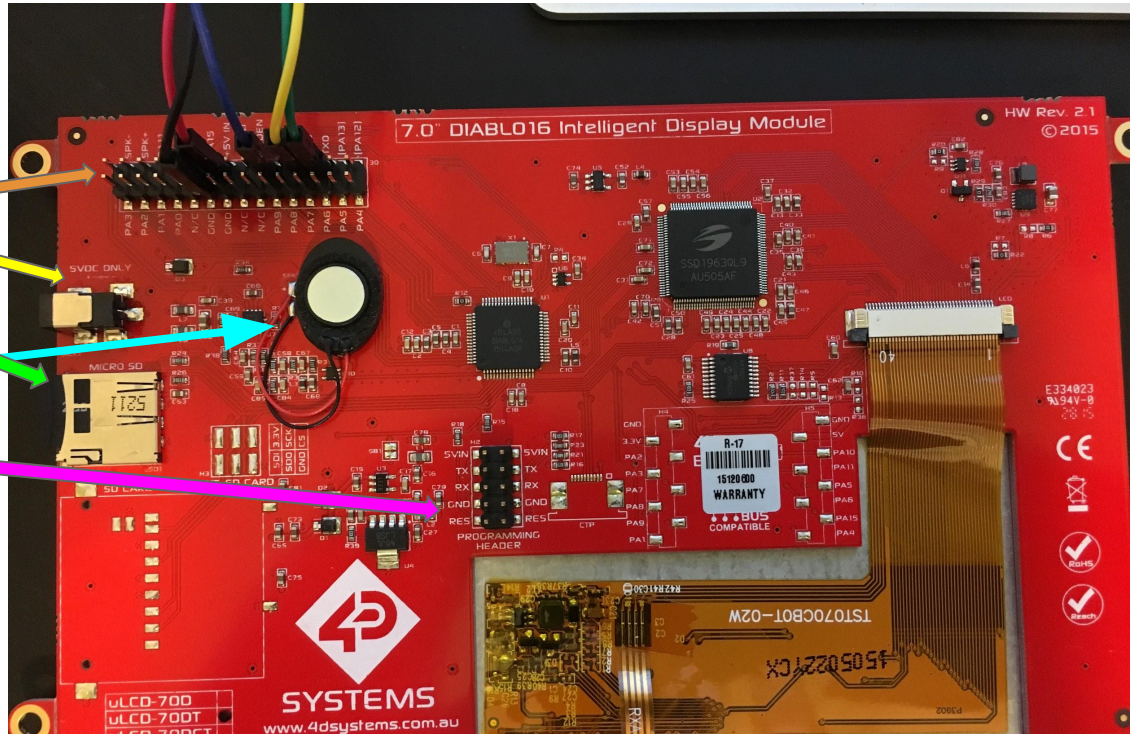
Grill Cooking

-Monitor current ambient, burner, and food temperatures
-Estimated time until food needs turned over or is finished

LCD Touchscreen

Back of LCD Overview

-5V,GND,TX,RX,Reset
-Optional 5V DC Jack
-2GB Micro SD Card
-Speaker
-Programming Header



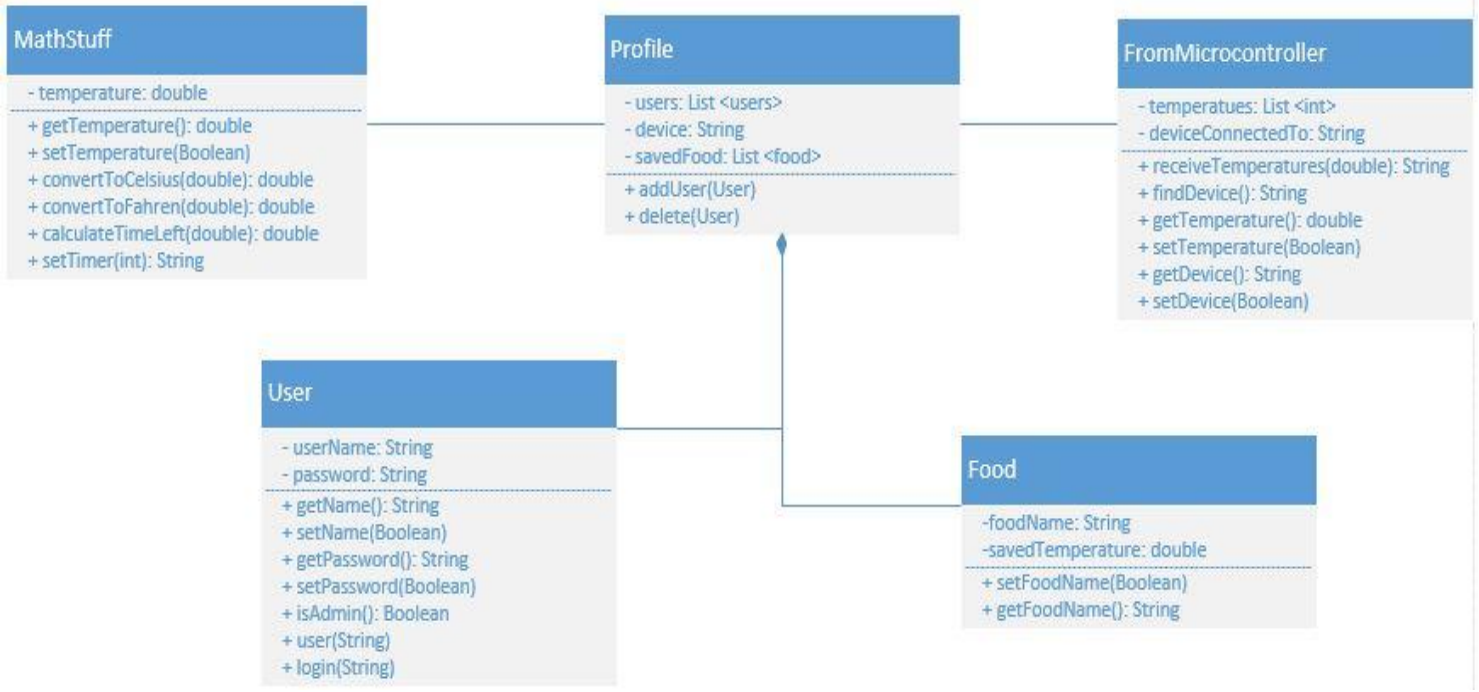
Mobile Application

- Which mobile operating system: ~~Windows,~~ Android, or iOS
  - Winner: Android
- Wireless Connections: ZigBee, Bluetooth,and/or Wi-Fi
  - Winner: Bluetooth
- Features
  - Display Temperatures
  - Display Timers
  - Set emergency alerts
  - Create User Accounts: Using ~~Parse~~ Firebase

Why Android over iOS ... and others

- Android makes it easier to constantly update apps
  - Quick feedback from users
- Developer entry
  - Already paid $25 fee to register for Google Play Store
  - iOS requires $99 annual fee
- iOS requires a Mac for development
- Android dominate the market share

Class Diagram



Bluetooth Module

Device: BlueSMirf Silver

- FCC Approved Class 2 Bluetooth Radio Modem
- Extremely small radio - 0.15x0.6x1.9"
- Very robust link both in integrity and transmission distance (18m)
- Hardy frequency hopping scheme - operates in harsh RF environments like WiFi, 802.11g, and Zigbee
- Encrypted connection
- Frequency: 2.4~2.524 GHz
- Operating Voltage: 3.3V-6V
- Serial communications: 2400-115200bps
- Operating Temperature: -40 ~ +70C
- Built-in antenna

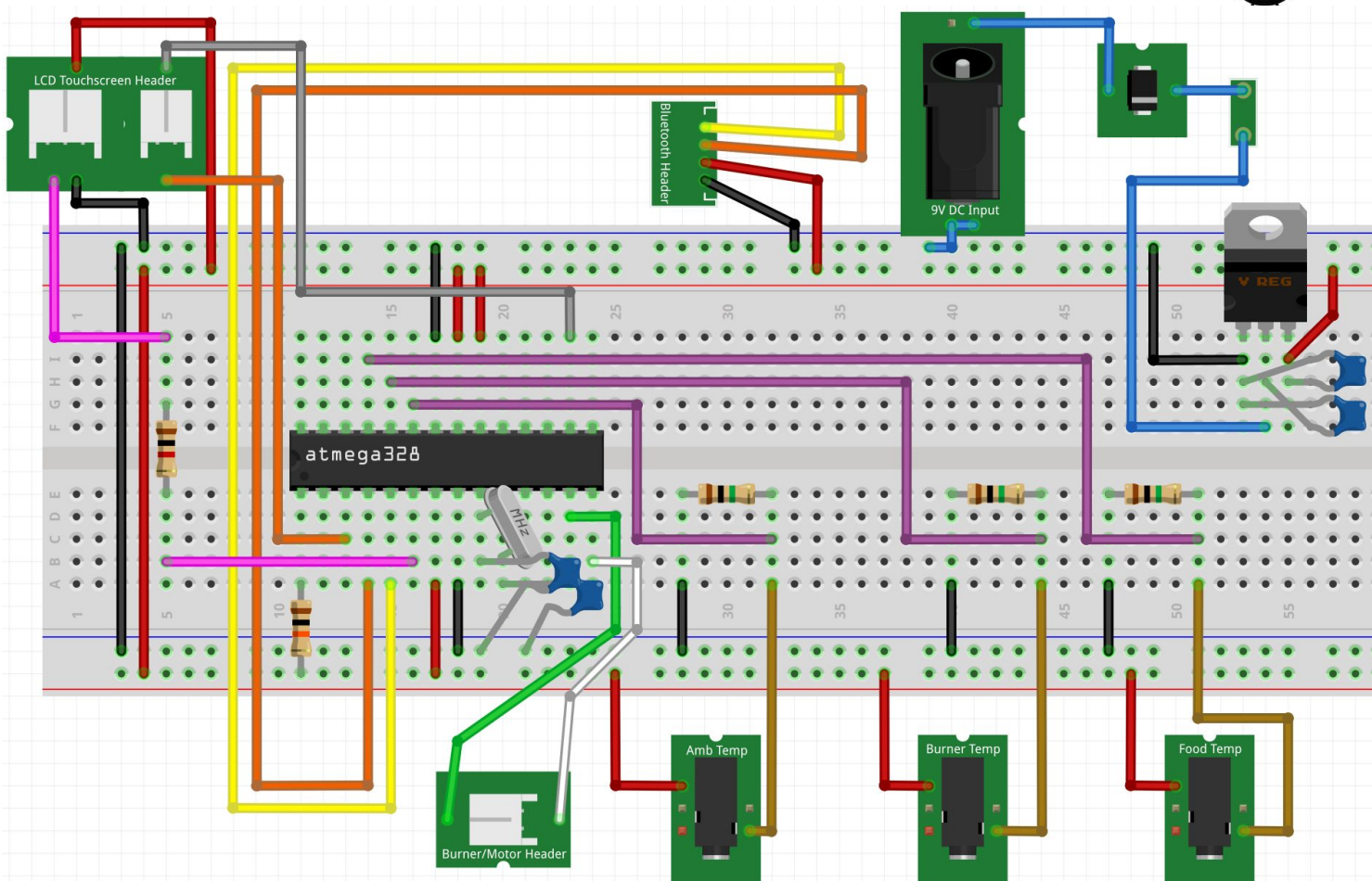
Dimensions: 45x16.6x3.9mm

Alternative Module

- HC-06 RS232 TTL
- BLE Mini
- ITEAD BT
- BlueFruit EZ-Link

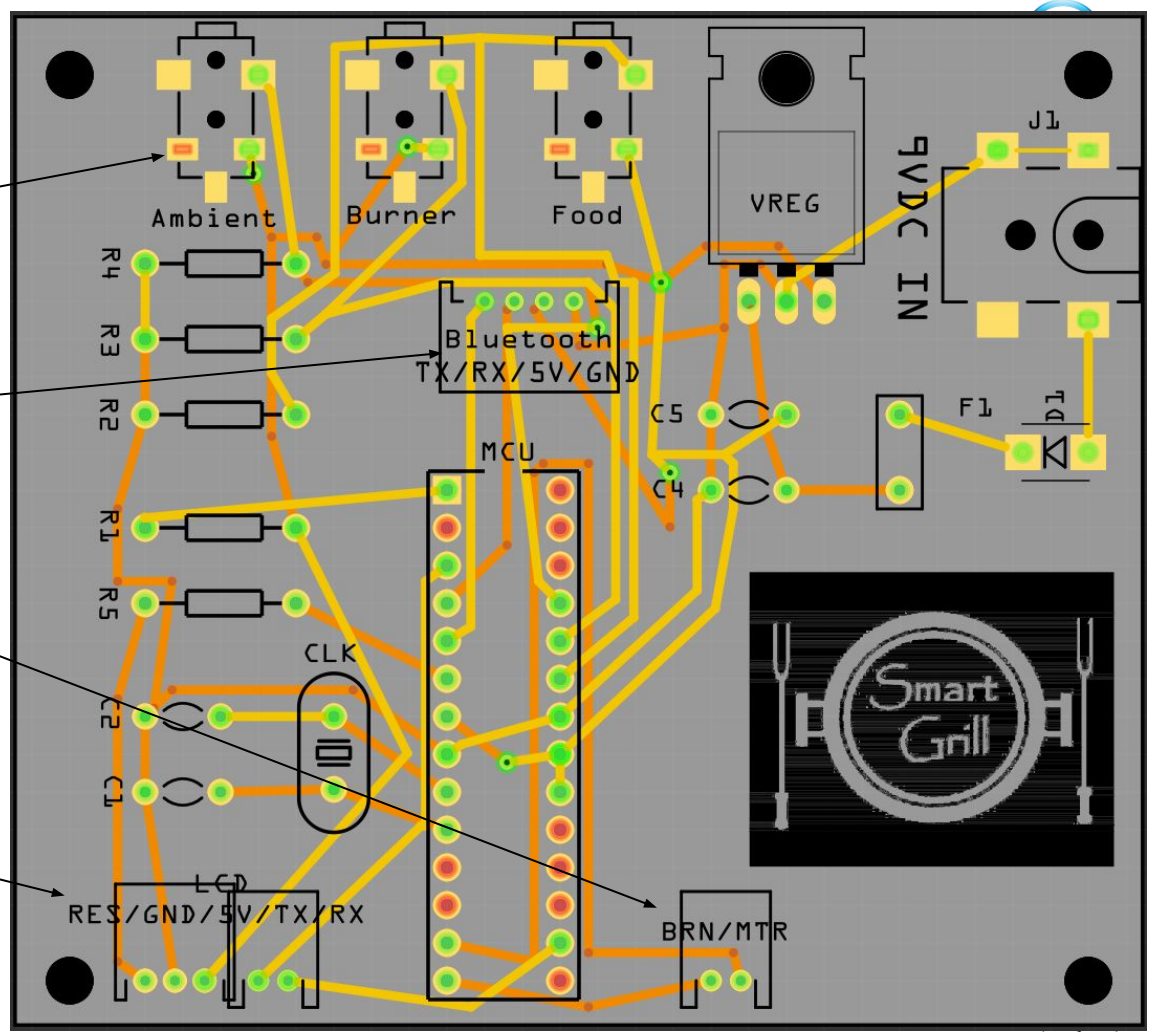
PCB Layout

Breadboard Prototype View

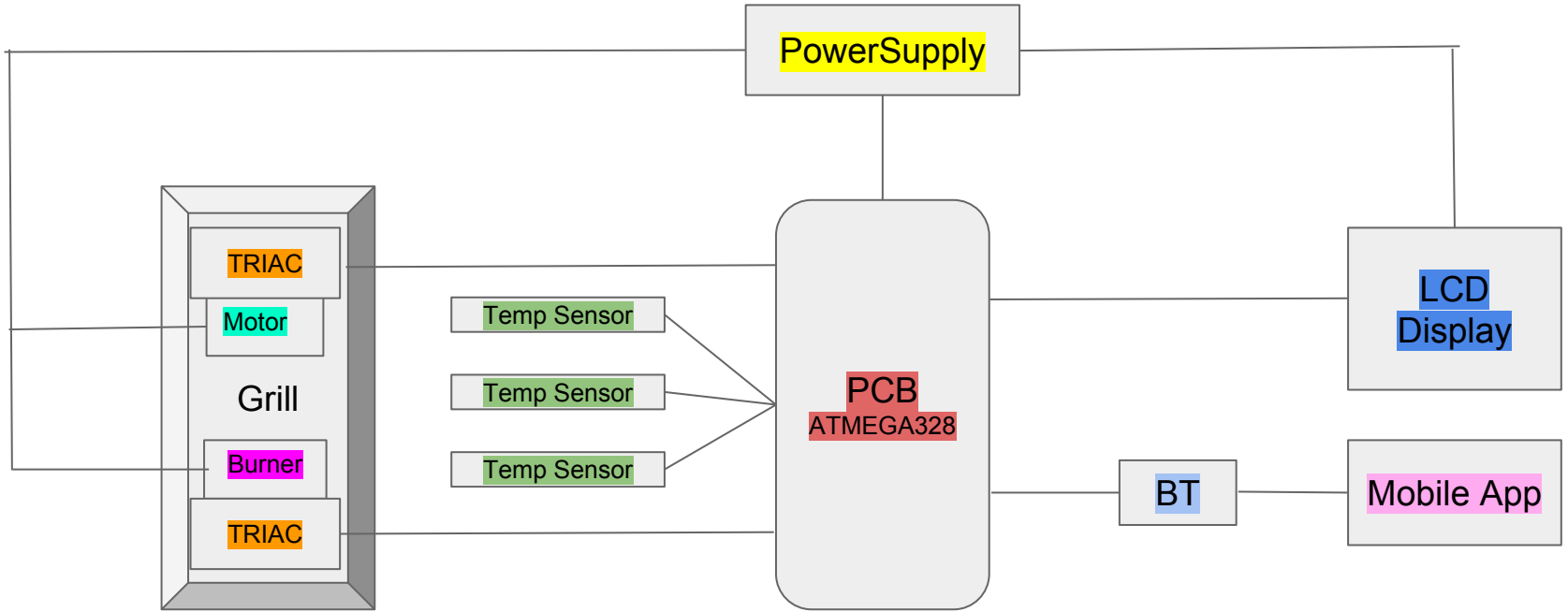


PCB Layout

PCB View



Block Diagram



Testing

- For **testing purposes** we **cooked a hotdog** on the rotisserie using the Rotisserie/Food Temperature probe

- We used a **stopwatch to measure the time required to cook the hotdog** at a specific temperature interval.

- We started cooking the hotdog at **65°F** and set the cooking temperature to **100°F**

Testing

- The LCD Temperature value reads in **5℉** increments
- Code was written to round the Temperature value up or down to the nearest **5℉.**
- Started cooking hotdog at **65℉** and set final Temperature at **100℉**
- At this rate we determined it takes **1 minute 15 seconds to increase 5℉** and it takes **8 minutes and 45 seconds** to reach **100℉**

Measured Temp & Cook Time

Grill Temperature (℉)	Cook Time (min:sec)
65	0:00
70	1:15
75	2:30
80	3:45
85	5:00
90	6:15
95	7:30
100	8:45

Testing

- Test the BlueSMiRF by changing the device name and searching with a Bluetooth enable device
- Test one sensor and display temperature on arduino serial monitor
- Test mobile connection by changing the text to indicate if connection was successful

Work Distribution

Group Member	Primary Focus	Secondary Focus
Jeff Mueller	Power Management	PCB
Jon Graff	Temperature Sensing	Assembly
Thierry Alerte	Mobile App/Bluetooth	LCD User Interface
Jonathan Schooley	LCD User Interface/PCB	Temperature Sensing

Budget and expenses

Part	#	Price/Unit	Total Cost
Grill Housing	1	$188.00	$188.00
Sunfounder UNO	1	$60.00	$60.00
7” LCD Touchscreen	1	$179.95	$179.95
BlueSmirf Module	1	$24.95	$24.95
Thermistor	3	$12.00	$36.00
PCB	1	$60.00	$60.00
Food for Testing	3	$2.00	$6.00
PCB Components	1	$15.65	$15.65
USB to LCD Port	1	$24.95	$24.95

Part	#	Price/Unit	Total Cost
Android Phone	1	n/a	n/a
LCD Enclosure	1	$24.12	$24.13
Relays	2	$30.00	$60.00
Misc Parts	1	$25.00	$25.00
2GB SD Card	1	$5.49	$5.49
3/32” Temp Jacks	10	$3.00	$30.00
Super Glue	1	$9.00	$9.00
Proposed Budget		**Actual Cost**	
$1000.00		$756.12	

Issues

-Food temperature sensing without cable getting tangled around rotisserie rod

> **Solution:** Change rotisserie motor direction at certain interval so cable never gets wrapped around too far

-Providing accurate estimated cooking times and temperatures to user

> **Solution:** Timed how long it takes for food to increase 5 degrees in temperature then coded it from there

Issues

-Sending three temperatures from microcontroller to app

- Serialization: Send as struct or Array or FlatBuffer
- Send temperature one at a time and use a semaphore to correct place in textview
- Convert integers into a binary string,append a character, concatenate and have the app decode it

-Having the bluetooth work along the LCD screen

-Parse getting shut down and trying to learn Firebase

Questions