Smart Grill

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 Temp	500℉
Mobile Wireless Link	Maximum Range	18 meters
Voltage Regulator	Voltage Drop	9V to 5V
Rotisserie Speed	Revolutions per min	5rpm
Temperature Sensors	Temp Tolerance	∓ 5℉

Goals and Objectives

A. To accurately measure and display 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. Personalize by inputting user settings to preference of the food when it is done cooking (rare, med-rare, well-done) as well as amount of time to cook

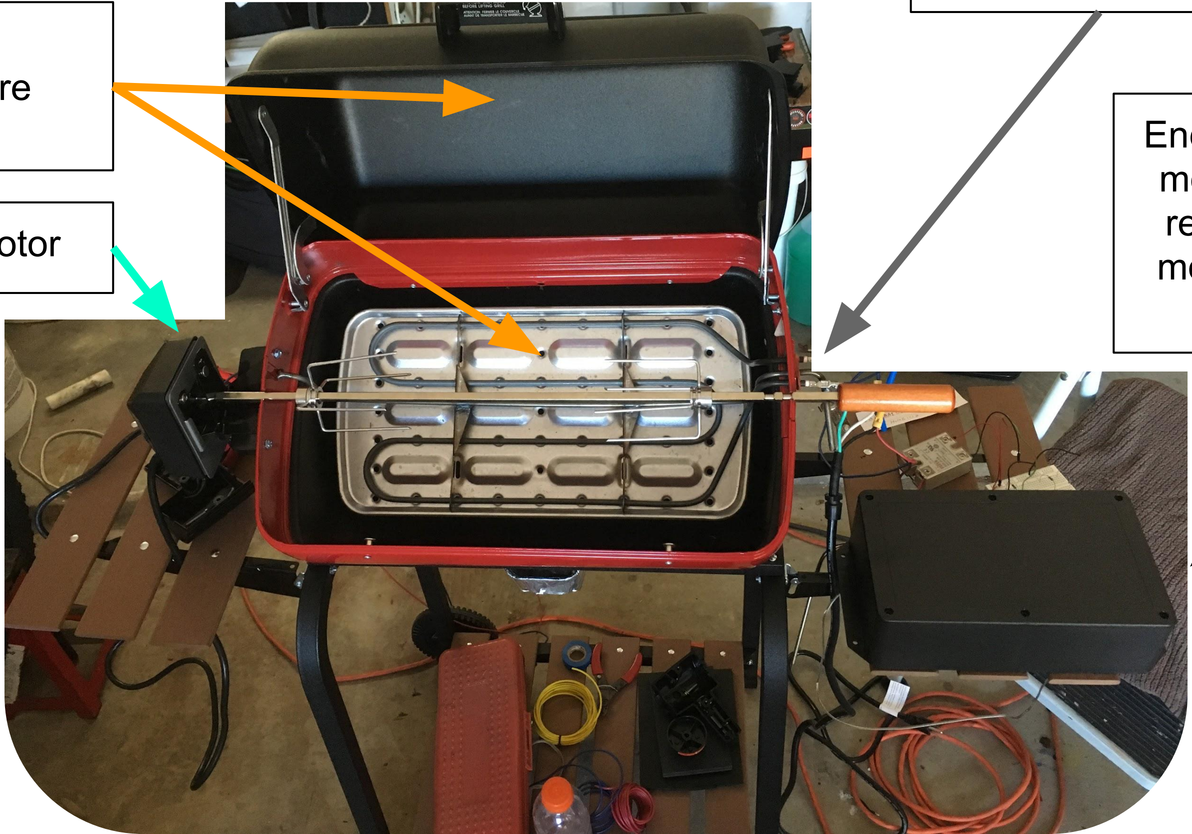
Grill Overview

Mounted Temperature Sensors

Rotisserie Motor

Burner Connection

Enclosure for PCB, motor and burner relays, bluetooth module, and LCD touchscreen



Power System

Mission - Get variable & ON/OFF control for burner temperature and rotisserie speed.

Solution - Use PWM phase-control signal on a relay for variable temperature/speed.

Constraint - use OEM temperature and rotisserie features each powered by separate single phase power supplies.

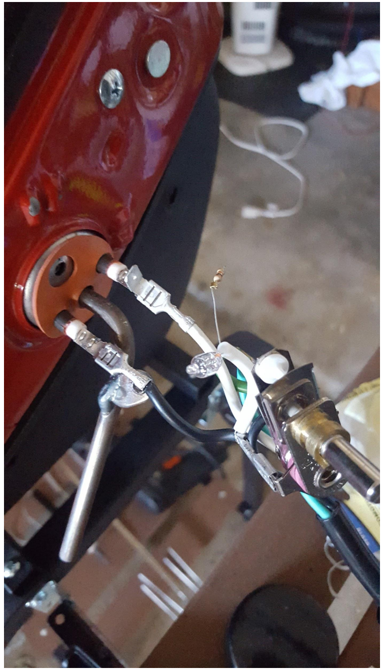
Power System

Burner

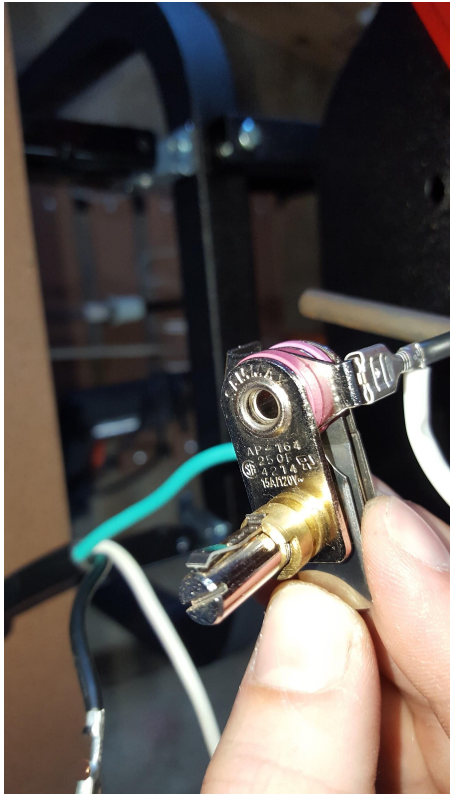
- rated @115VAC
- 1500W
- up to 500F
- Nichrome
- Vs=IR -> 2500W?

Element

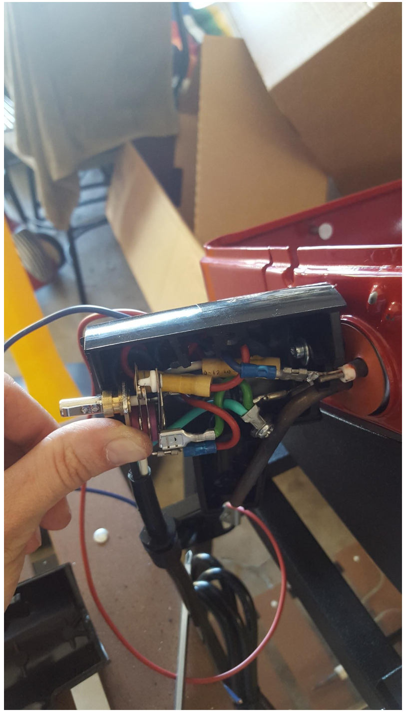
Power System



Burner Terminals



Bimetal Thermostat



Making things fit OK

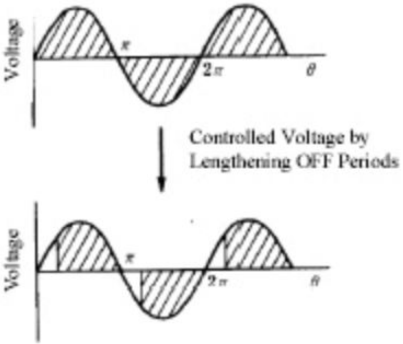
Power System

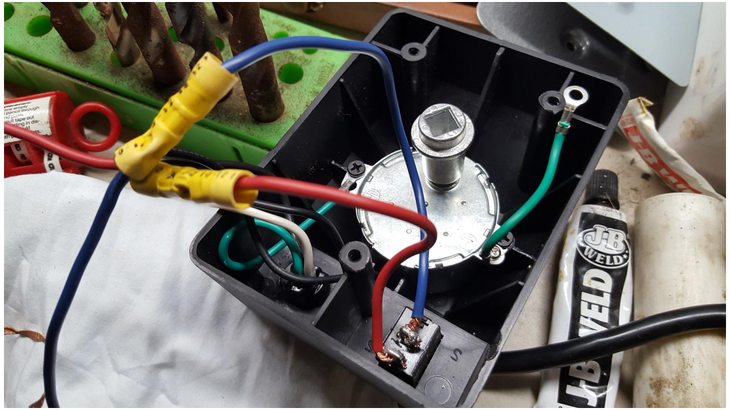
Motor Requirements

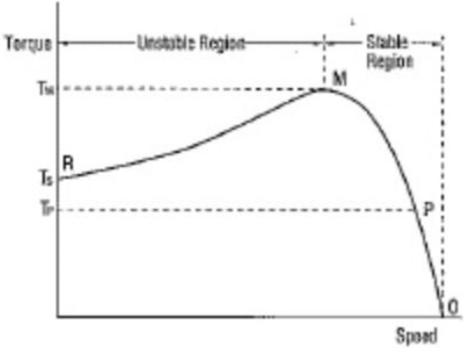
- 1 - 5rpm with phase control
- CW/CCW
- Synchronous

Rotisserie motor push switch

- toggles direction every time turned OFF

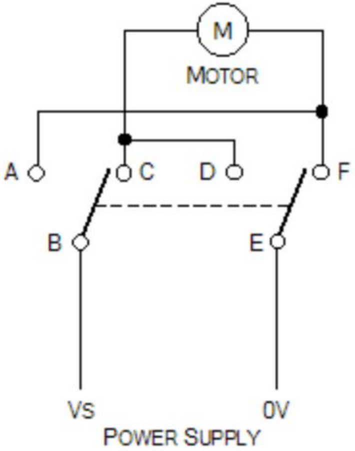


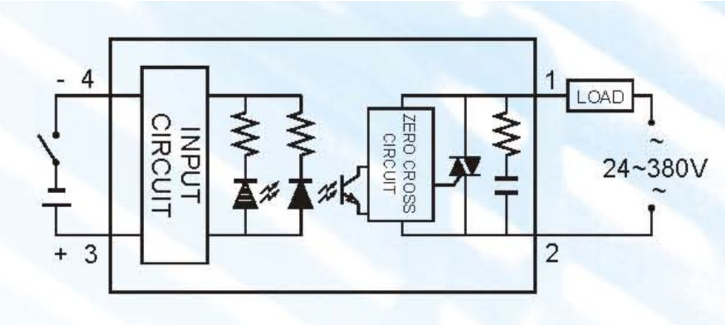




Power System

- SSR - TRIAC
- faster but hotter
- DPDT





<u>FOTEK SSR-25 DA</u>

Input = 3-32 VDC

Output = 24-380 VAC

Max Current = 25A

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

Switching ON/OFF Speed = <10ms

Temperature Sensing

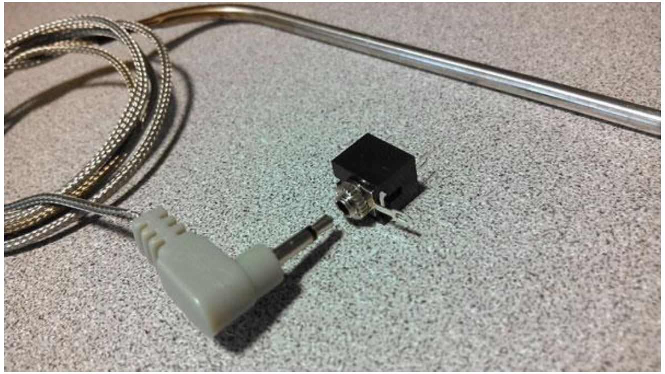
Temperature Measurement - Requires 3 Temperature sensors

(3) Accuon ACU0235 Temperature Probes

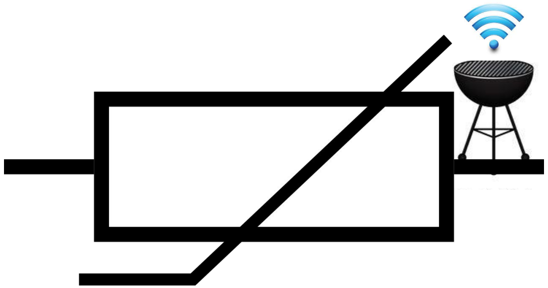
A. Ambient Temperature
B. Burner Food Temperature
C. Rotisserie Food Temperature

Temperature Sensing

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



Temperature Sensing



Thermistor – What is it? How is it used?

A Thermistor is a resistor whose resistance is dependant on temperature

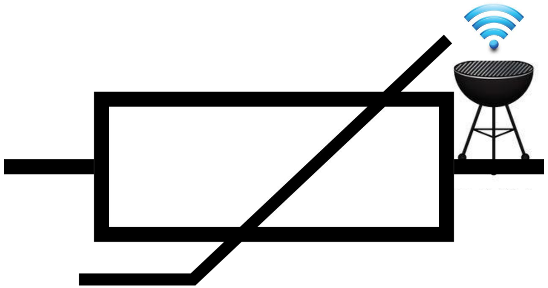
$$\Delta R = k \Delta T$$

ΔR = Change in Resistance

ΔT = Change in Temperature

k = First order Temperature Coefficient of Resistance

Temperature Sensing



Thermistor - What is it? How is it used?

$$\Delta R = k \Delta T$$

k = First order Temperature Coefficient of Resistance

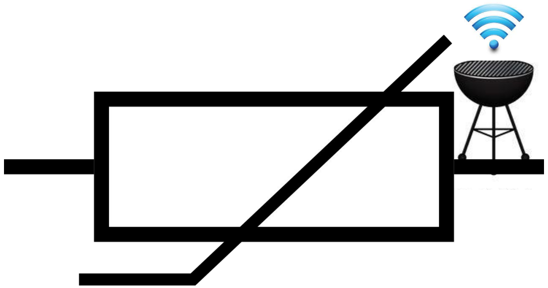
If **k** is positive **R⇧T⇧**

Positive Temperature Coefficent (PTC)

If **k** is negative **R⇩T⇧**

Negative Temperature Coefficent (NTC)

Temperature Sensing



Thermistor - What is it? How is it used?

$$\Delta R = k\Delta T$$

k = First order Temperature Coefficient of Resistance

- 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

Temperature Sensing

- We determined we needed;
    - A Larger Temperature Range
    - More Accurate Measurements

Used Steinhart-Hart equation instead as a 3rd order approximation instead of a 1st order approximation.

a, b and c are called the Steinhart–Hart parameters

$$\frac{1}{T} = a + b\ln(R) + c\,(\ln(R))^3$$

$$R = \exp\left[\left(x - \frac{1}{2}y\right)^{\frac{1}{3}} - \left(x + \frac{1}{2}y\right)^{\frac{1}{3}}\right]$$

Temperature Sensing

- **We used the Steinhart-Hart equation in our code for the Temperature sensors**

```
// get the Kelvin temperature    tempK = log(((10240000/temp) - 10000));
  tempK = 1 / (0.001129148 + (0.000234125 * tempK) + (0.0000000876741 *     tempK * tempK * tempK))
```

$$\frac{1}{T} = a + b\ln(R) + c\,(\ln(R))^3$$

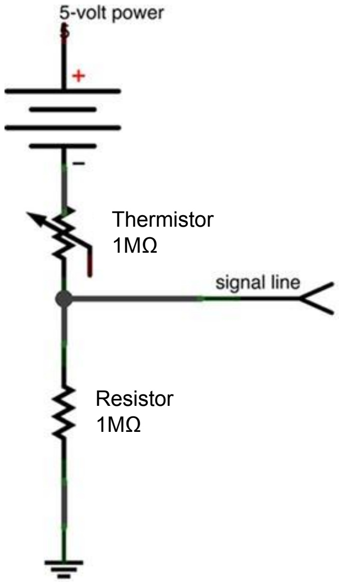
Temperature Sensing

- There is a change in voltage between the resistors where it is read on the analog pin at the signal line

- At **75℉** the Thermistor Resistance measures **1MΩ**

- This is Baseline for most Thermistors to have a resistance at 75℉

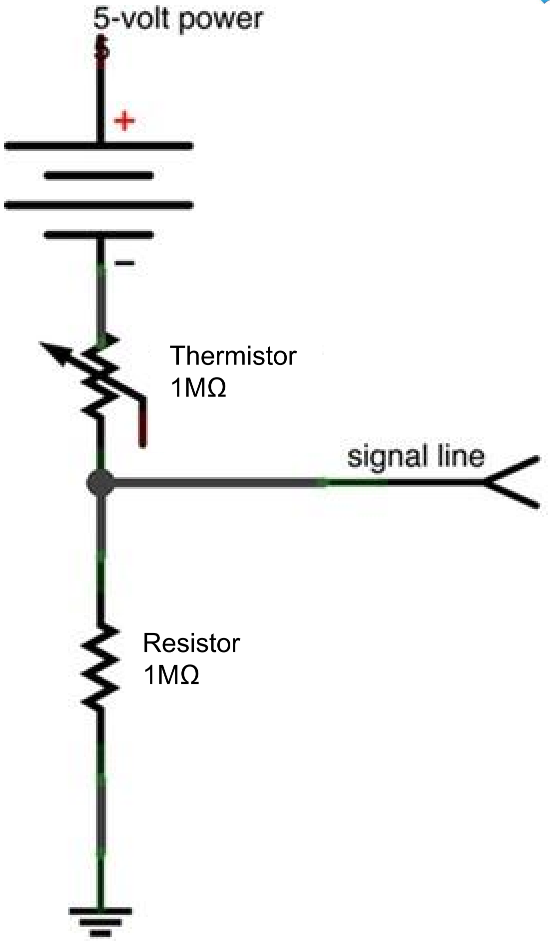
- 75℉ is room temperature



Temperature Sensing

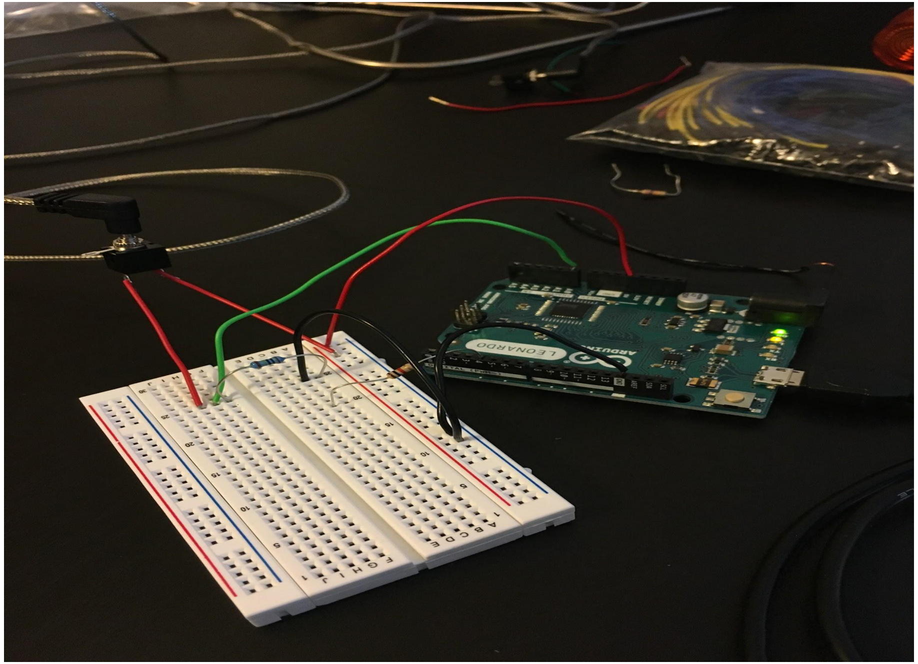
Temperature Sensor Circuit

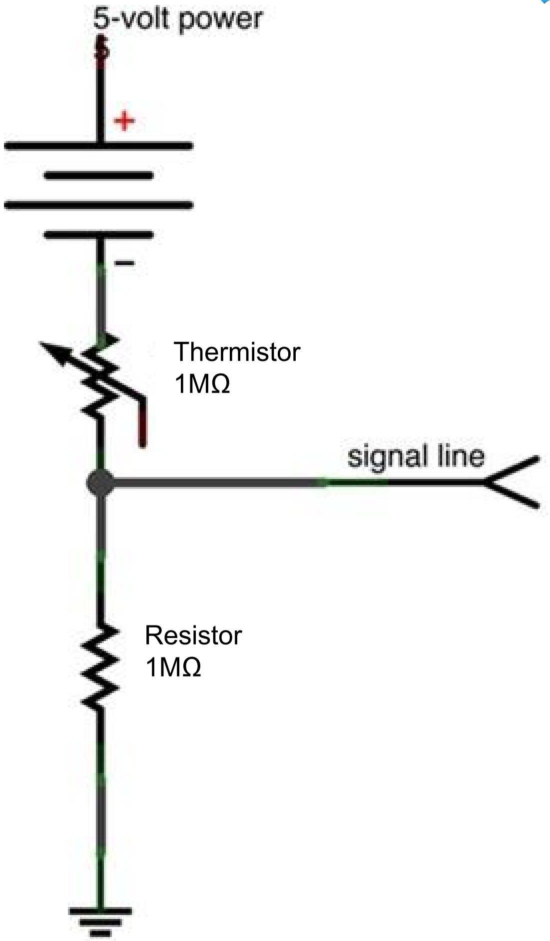
- 1M ohm resistor
- 1M ohm Thermistor @75F
- Funduino Uno (prototyping)
- ATmega328 Microcontroller



Temperature Sensing

Temperature Sensor Circuit



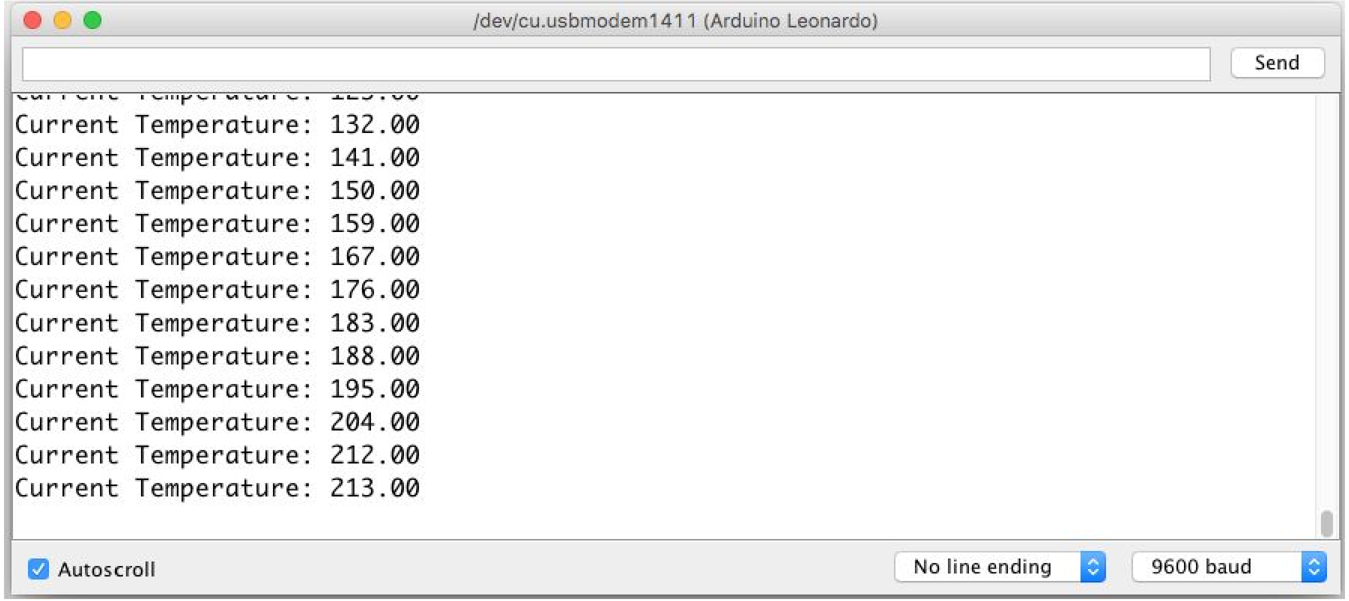


Temperature Sensing

```
#include <Math.h>
const int TestLT = 13; //Test LED const int sensorPin = A0; //Temp Sensor int temp; //Temp Variable double
tempK, tempC, tempF;
void setup() {
  // put your setup code here, to run once:   Serial.begin(9600);   delay(1000);
  digitalWrite(TestLT, HIGH);
}
void loop() {
  // put your main code here, to run repeatedly:
  temp = analogRead(sensorPin); //read sensor pin and save in temp variable
   // get the Kelvin temperature   tempK = log(((10240000/temp) - 10000));
  tempK = 1 / (0.001129148 + (0.000234125 * tempK) + (0.0000000876741 *       tempK * tempK * tempK));
  // convert to Celsius and round to 1 decimal place
  tempC = tempK - 273.15;
  tempC = round(tempC*10)/10;
  // get the Fahrenheit temperature, rounded   tempF = (tempC * 1.8) + 32;
  tempF = round(tempF*10)/10;
  Serial.print("Current Temperature: ");  //Print the temp text to screen
  Serial.println(tempF);  //Print the temp value to screen   delay(500); //wait 500ms
}
```

Temperature Sensing

- When test measurements were taken results very accurate



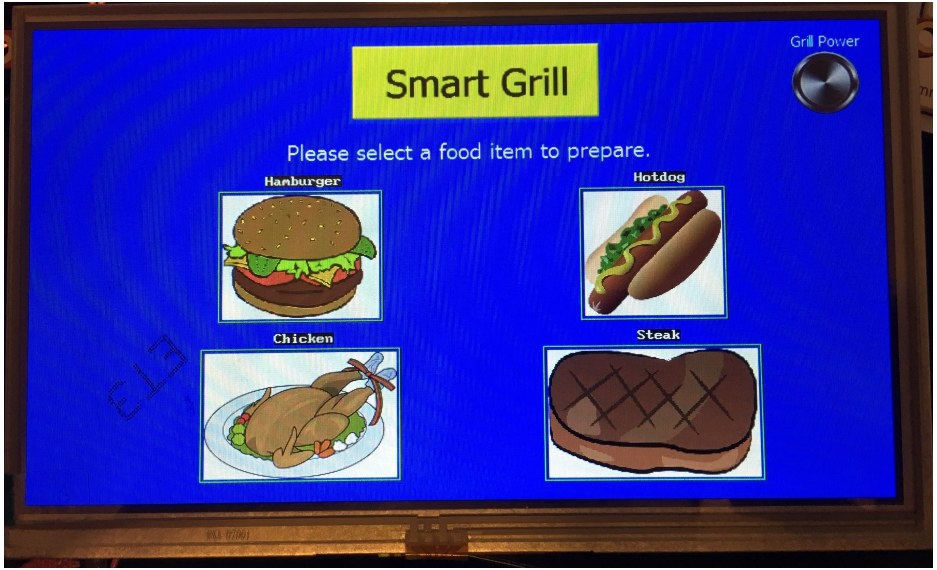
LCD Touchscreen

-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

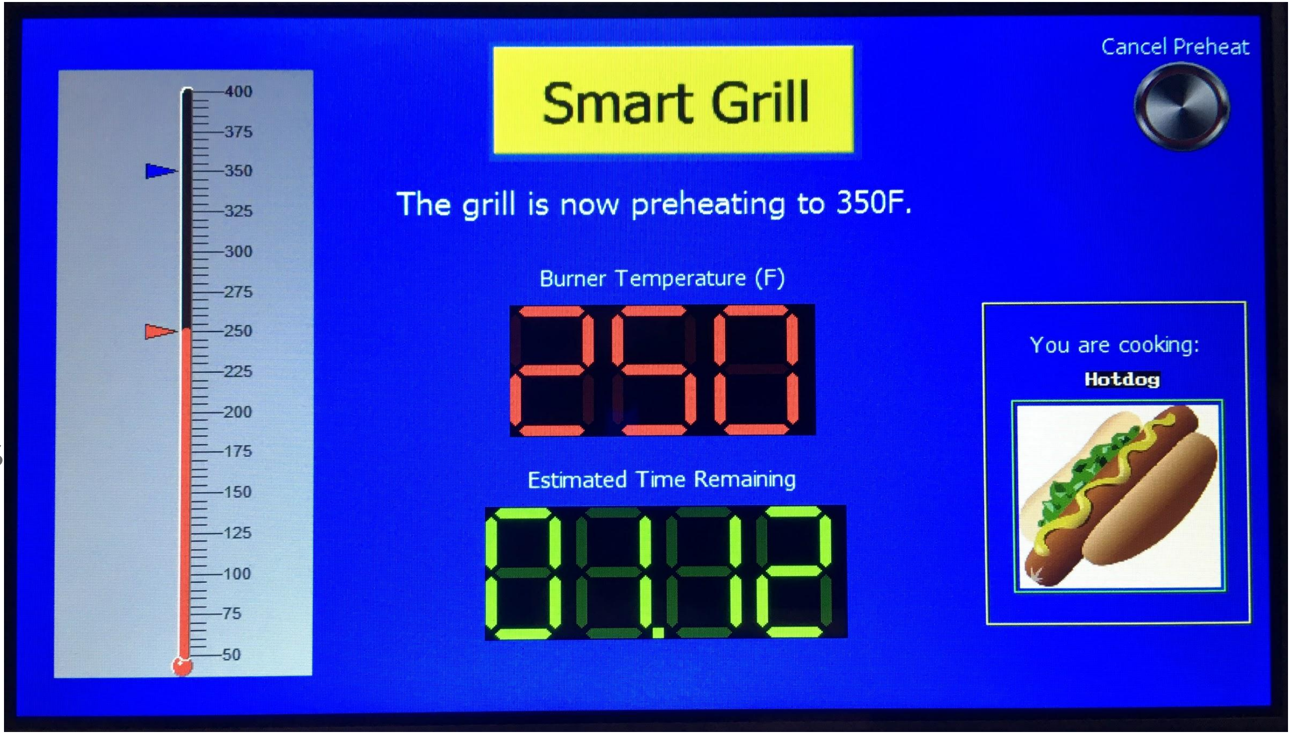
Part Number	uLCD-70DT
Price	$179.95
Supplier	www.sparkfun.com
Screen Size	7in



LCD Touchscreen

Grill Preheating

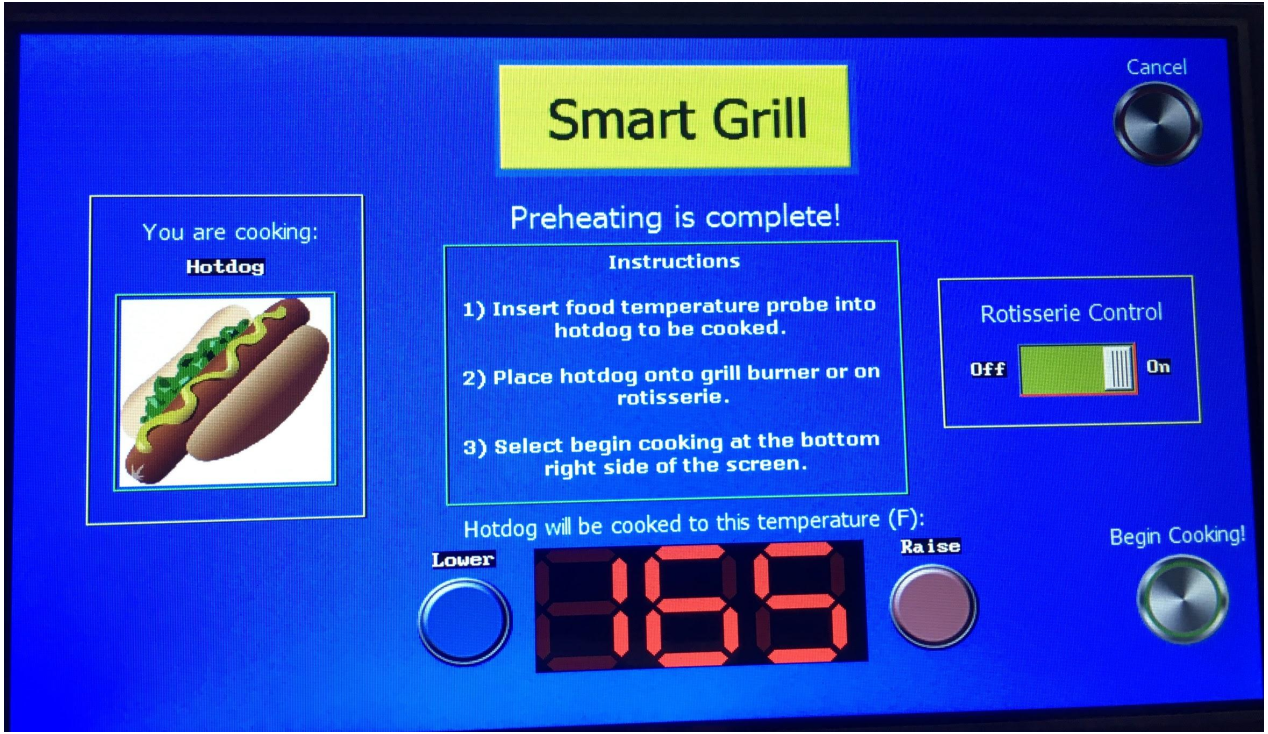
- Thermometer and red LED digits display burner temperature
- Green LED digits display time remaining for preheating



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

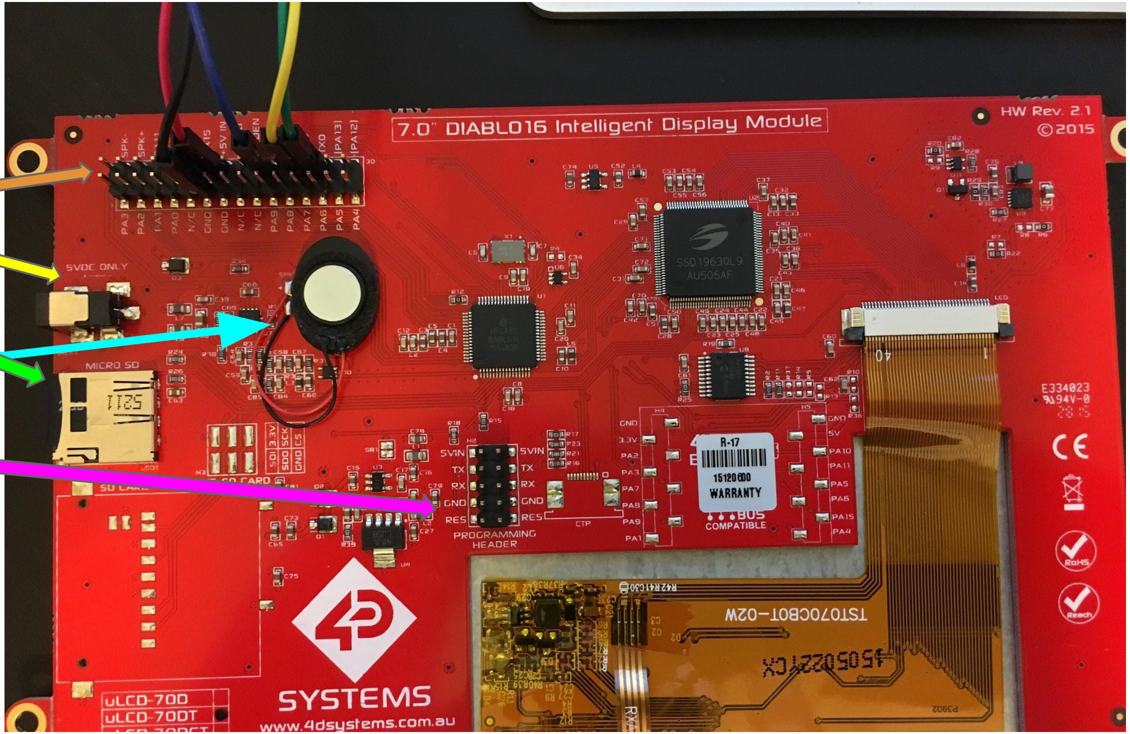
<u>Grill Cooking</u>

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

LCD Touchscreen

<u>Back of LCD Overview</u>

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



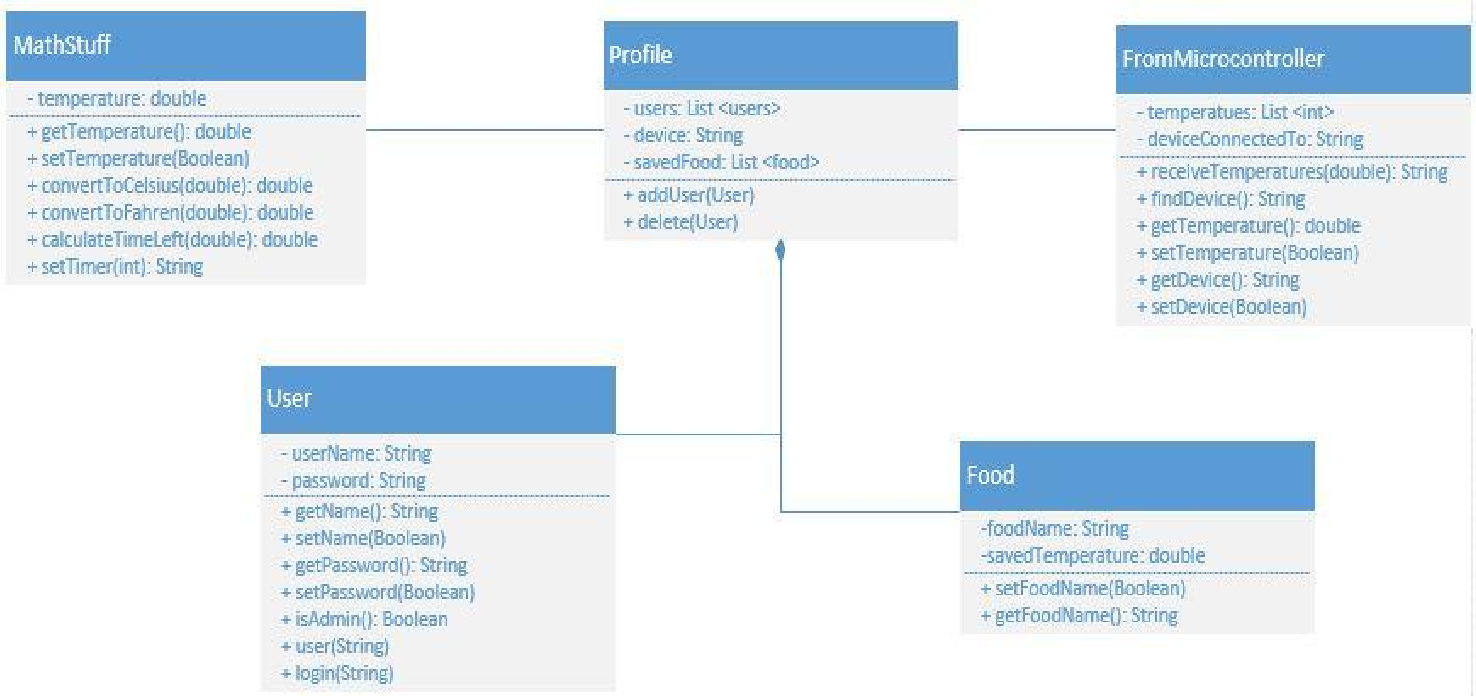
Mobile Application

- 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

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



Parse

- Database
- Email Verification
- Current User
- Anonymous User
- Secured Information
- Password Reset
- Twitter Login
- Facebook Login
- Google Login
- Push Notification
- Documentation
- Automatically Scaling
- Works Offline

PARSE: January 28, 2017

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

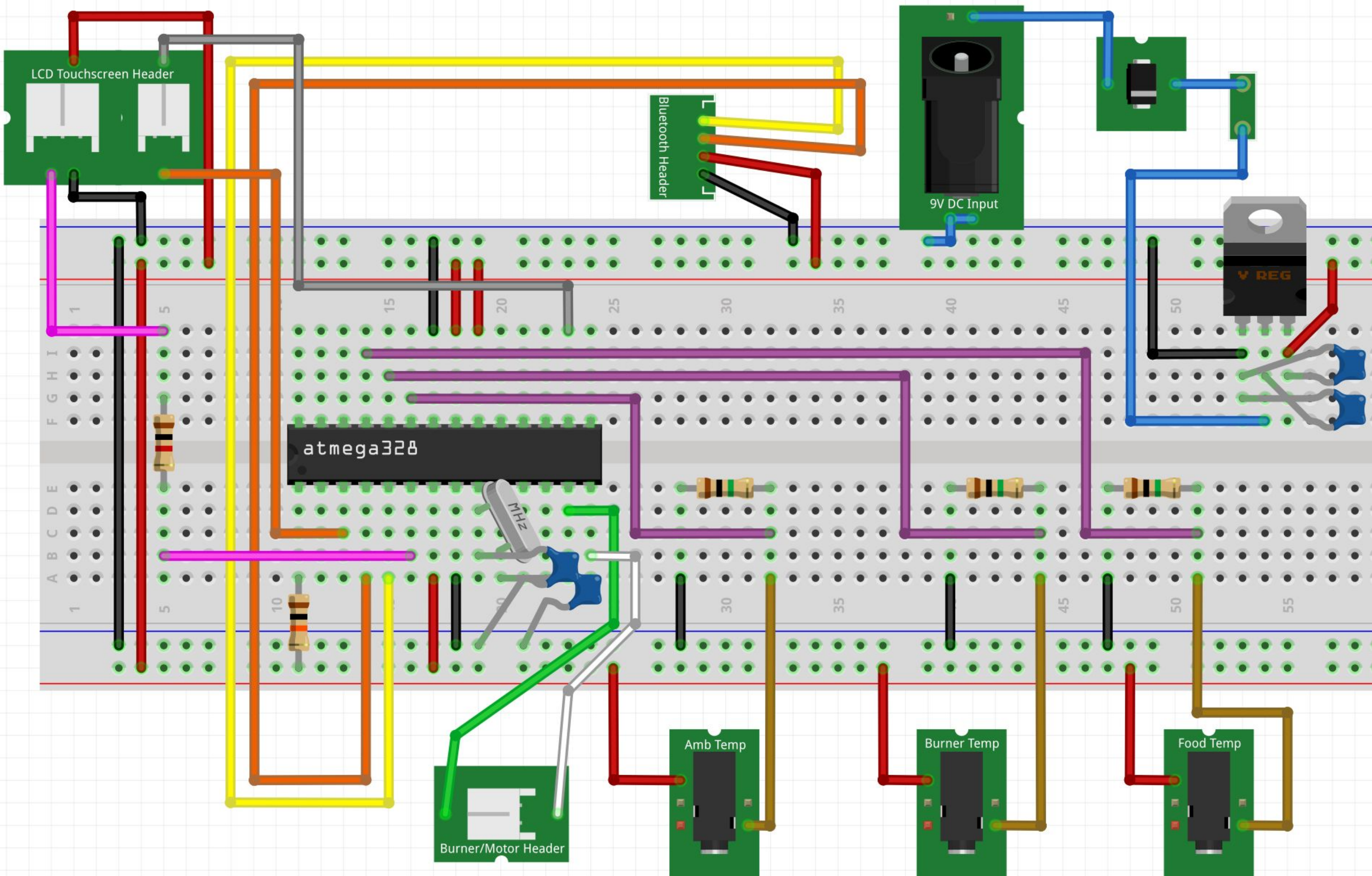
Dimensions: 45x16.6x3.9mm

Alternative Module

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

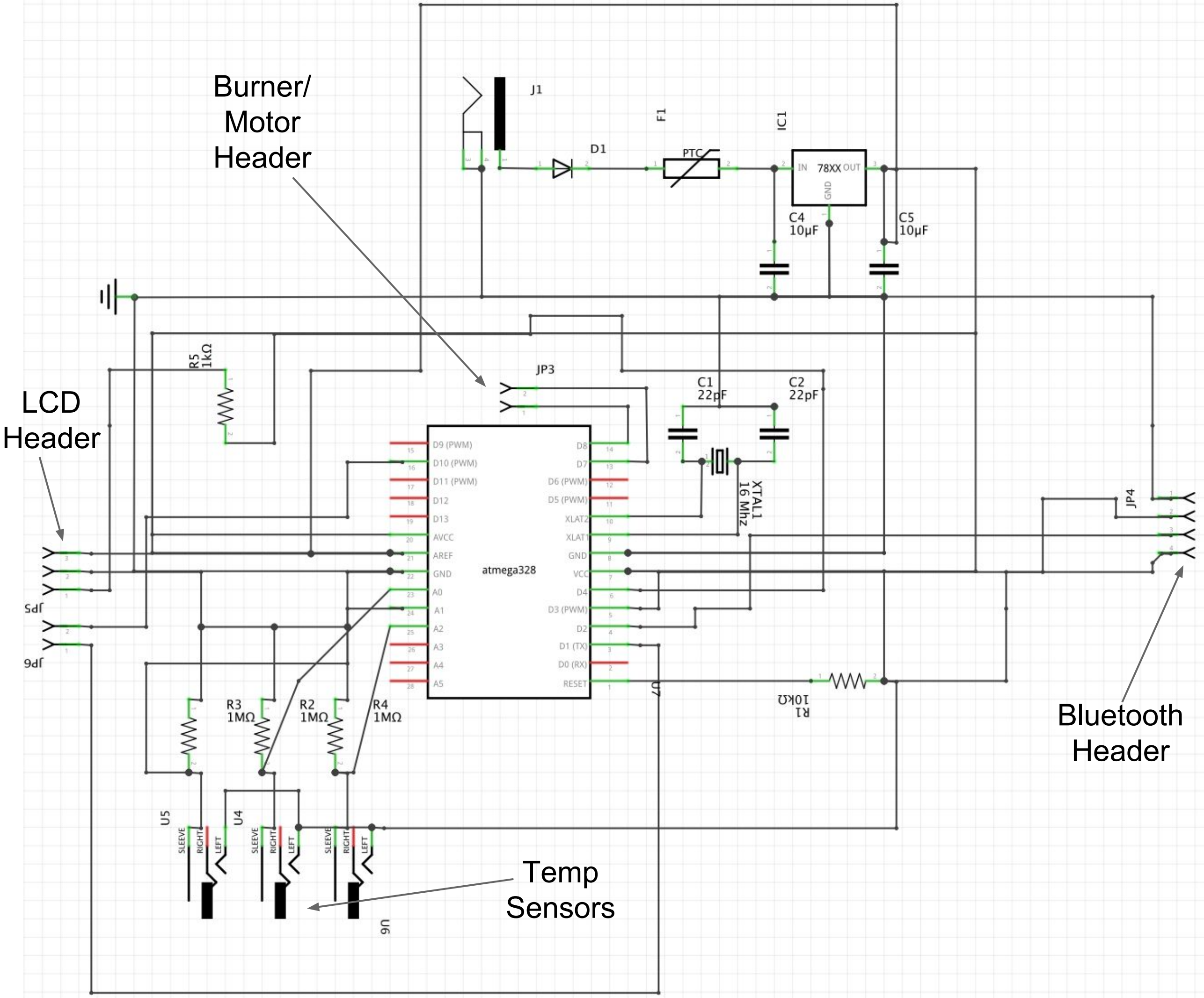
PCB Layout

Breadboard Prototype View



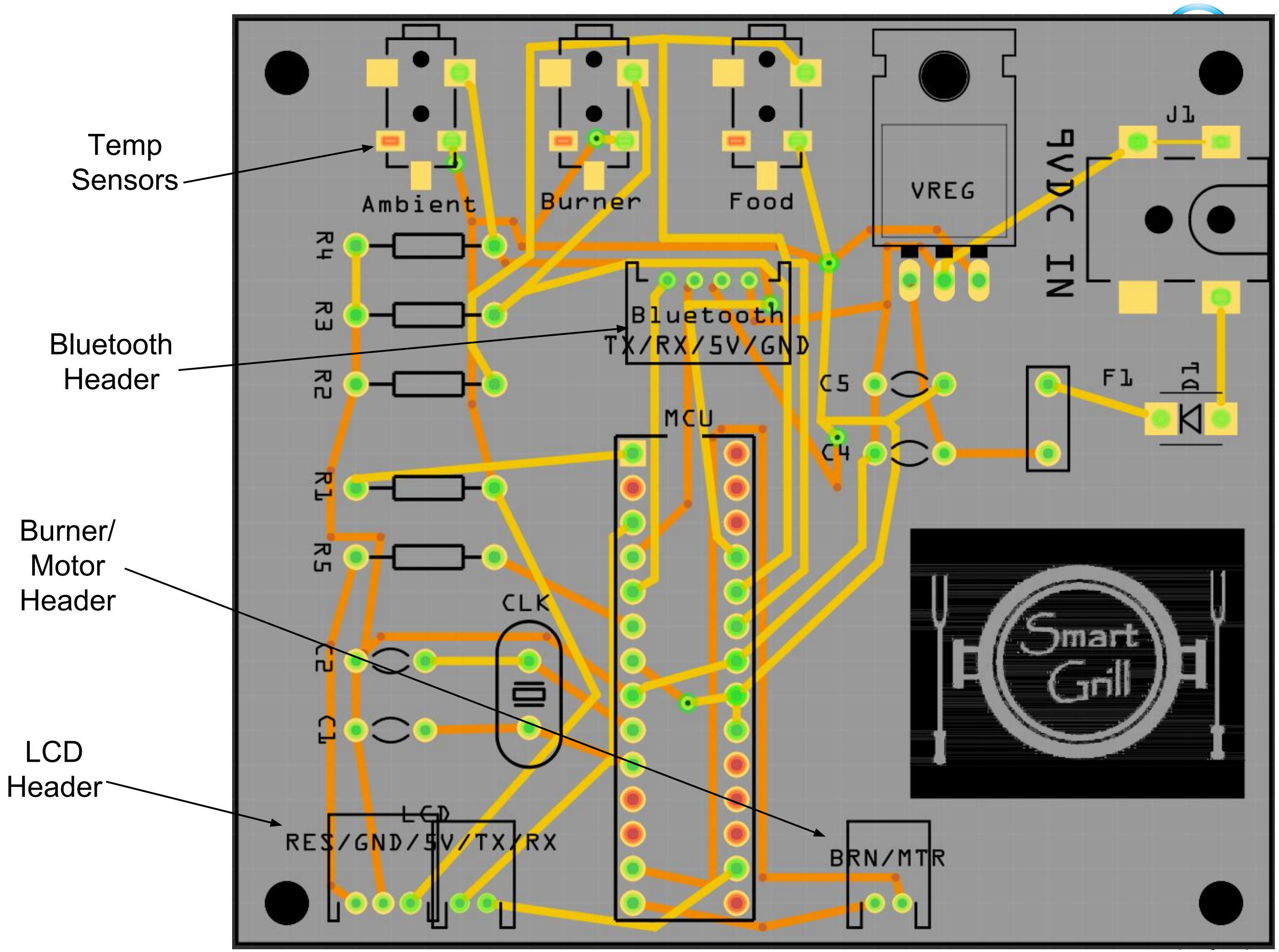
PCB Layout

Schematic View

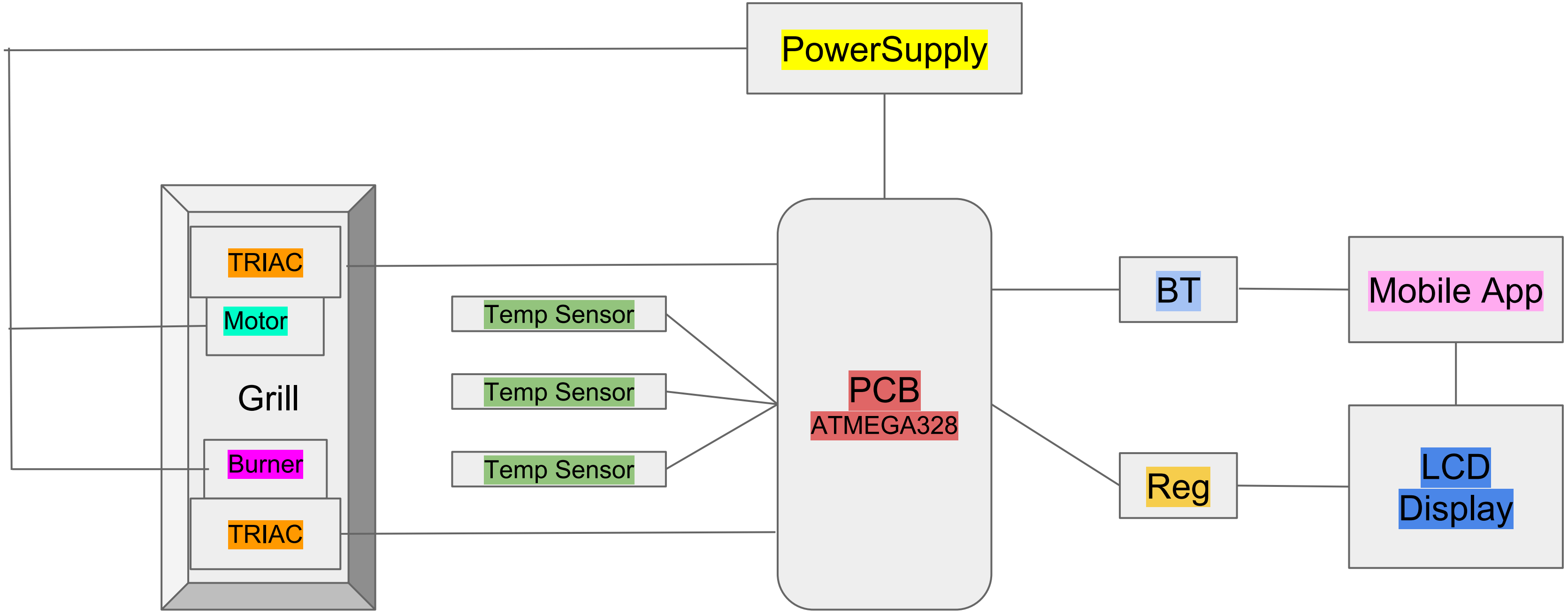


PCB LAYOUT

PCB View



Block Diagram



Work Distribution

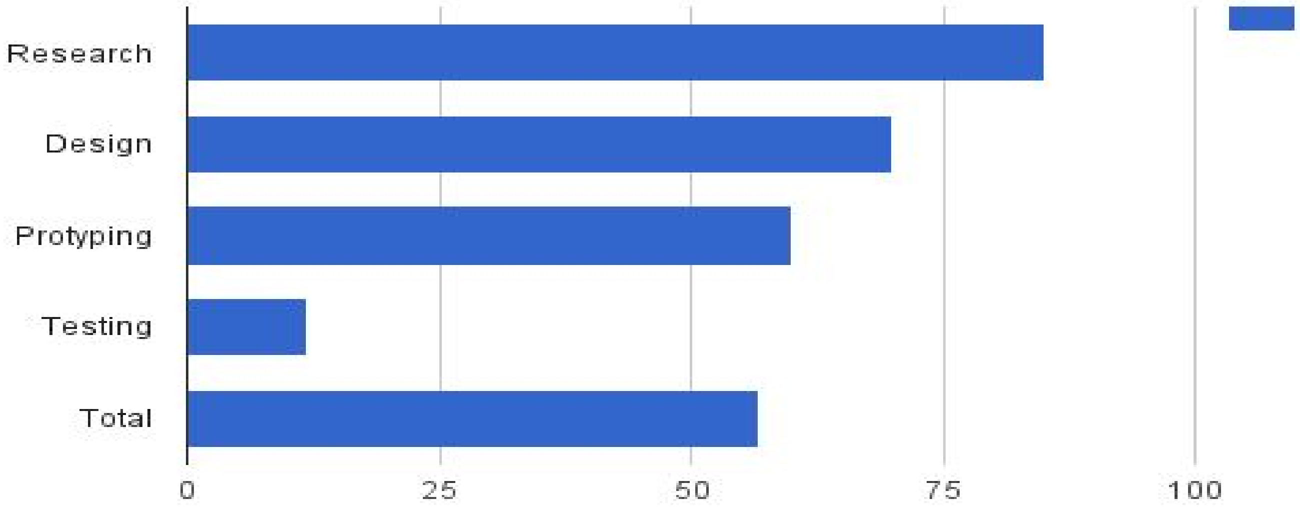
Group Member	Primary Focus	Secondary Focus
Jeff Mueller	Power Management	PCB
Jon Graff	Temperature Sensing	Bluetooth
Thierry Alerte	Mobile App/Bluetooth	LCD User Interface
Jonathan Schooley	LCD User Interface/PCB	Temperature Sensing

Budget

Part	Quantity	Price/Unit	Total Cost
Grill Housing	1	$174.99	$174.99
Funduino UNO	1	$9.99	$9.99
7" Touchscreen LCD	1	$179.95	$179.95
Wifi/Bluetooth Shield	1	$24.95	$24.95
Thermistor	3	$10.00	$30.00
Power System		$1.69	$16.40
PCB	1	$60.00	$60.00
10K Resistor	3	$0.12	$0.36
Android Phone	1	n/a	n/a
Food for Testing	10	$5.00	$50.00
Breadboard/Wire	1	$20.00	$20.00

Part	Quantity	Price/Unit	Total Cost
3/32" Connector	3	$1.26	$3.78
DC Barrel Power	1	$1.96	$1.96
22 pF Capacitor	2	$0.17	$0.34
16MHz Crystal	1	$0.96	$0.96
USB to Serial Bridge	1	$24.95	$24.95
0.1 mF Capacitor	1	$0.17	$0.17
10 uF Capacitor	1	$0.10	$0.10
Diode	1	$0.44	$0.44
		Total Planned Expenses	$601.49

Progress



Issues

-Food temperature sensing without cable getting tangled around rotisserie

-Providing accurate estimated cooking times to user

Questions