Appendix A

Table 3. Requirements and Verification Table

REQUIREMENTS AND VERIFICATION TABLE	
Power Supply [3 Points]	
Requirements	**Verification**
1. The power supply should provide 120V AC with a RMS voltage in range 114V AC ~ 126V AC . [3]	1. Use a voltmeter to measure the voltage from the wall outlet.
AC/DC Converter [3 Points]	
Requirements	**Verification**
1. The converter must output a voltage value that is within 5±0.2V DC. [3]	1. a. Connect output to oscilloscope. b. Apply voltage. c. Check if the voltage has less than 4% of error.
Voltage Regulator [6 Points]	
Requirements	**Verification**
1. The regulator should output a voltage range from 3.27V to 3.33V [3]. 2. The regulator should output current of at least 500mA to supply the microcontroller. [3]	1. a. Connect output to multimeter. b. Apply voltage. c. Check if the voltage is within*3.3* ± *0.03*□. 2. a. Check if ESP32 works.
Microcontroller [16 Points]	
Requirements	**Verification**
1. It should be able to be programmed with the uploaded code via Arduino IDE. [4] 2. The GPIOs can input/output high/low signals. [4]	1. a. It is able to print “Hello World” onto the serial monitor. 2. a. Build a resistive circuit with a LED.

3. The microcontroller can connect to Wifi. [4] 4. The microcontroller should be able to read analog signals and convert into digital data. [4]	b. Output high/low signal with the delay on Arduino IDE. c. Check whether the LED lights on/off. 3. a. Upload the code that sets up a Wifi connection. b. Turn on the Hotspot on the smartphone. c. Check if the device is connected on the smartphone. 4. a. Build a simple resistive circuit. b. Supply voltage between 0-3.3V. c. Read both ends of the resistor as analogRead. d. Calculate the voltage between the resistor.
Relay [8 Points]	
Requirements	**Verification**
1. The relay switch should be able to control the current flow depending on the voltage. It should open when the supply voltage is higher than 3.75V and close when less than 2V. [8]	1. a. Build a resistive LED circuit attached with the relay. b. Supply the relay with voltage higher than 3.75V. c. Check if the LED lights off. d. Do the same thing with voltage lower than 2V and check if the LED lights on.
Current Sensor [10 Points]	
Requirements	**Verification**
1. The current sensor should be able to identify current with less than $\pm 3\%$ of error. [10]	1. a. Build a simple resistive circuit. b. Use resistors to adjust input current to be 20A. c. Connect microcontroller to computer and print input from the sensor to verify that measurement matches the actual current with less than ±3%.
BJT [4 Points]	

Requirements	Verification
1. BJT should be able to amplify the low signal voltage(0V) to the voltage that is higher than 3.75V. [2] 2. BJT should be able to reduce the high signal voltage(3.3V) to the voltage lower than 2V. [2]	1. a. Make a BJT circuit by connecting the base side with the GPIO from the microcontroller and 1kohm resistor. b. Connect collector side with a voltage supplier(5V). c. ground the emitter side. d. Check if high(3.3V) supply voltage will output voltage less than 2V when measured from the emitter side and the ground. 2. a. Do the same thing as in #1. b. Check if low(0V) suppply voltage will output voltage close to 5V.

Appendix B

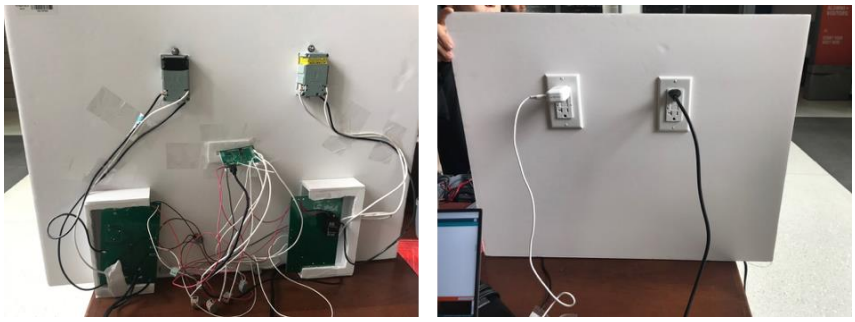

Figure 8. Final Design: Whole System

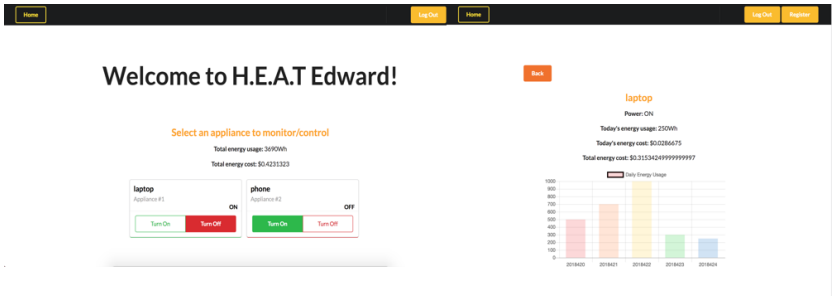

Figure 9. Final Design: Web Application

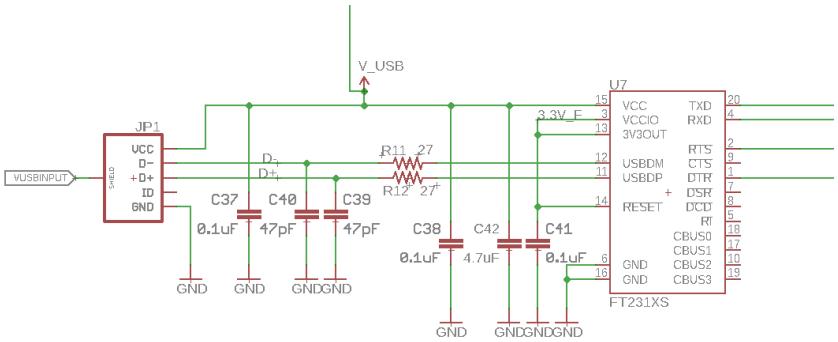

Figure 10. Control Module Schematic: USB to Serial Converter

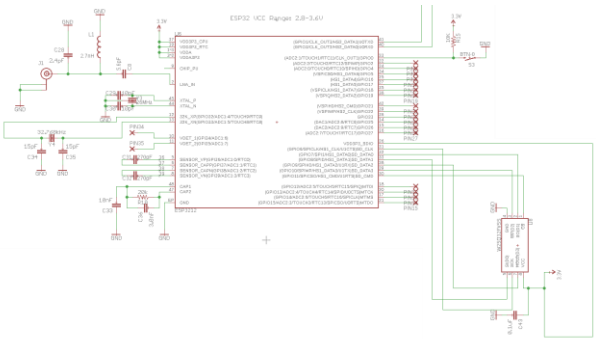

Figure 11. Control Module Schematic: ESP32 with spi Flash and Antenna

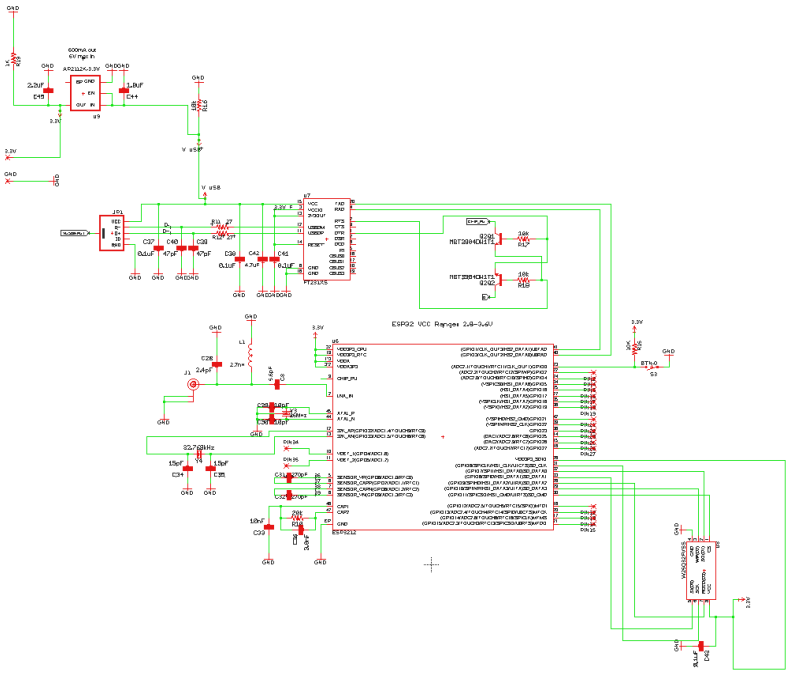

Figure 12. Control Module Schematic

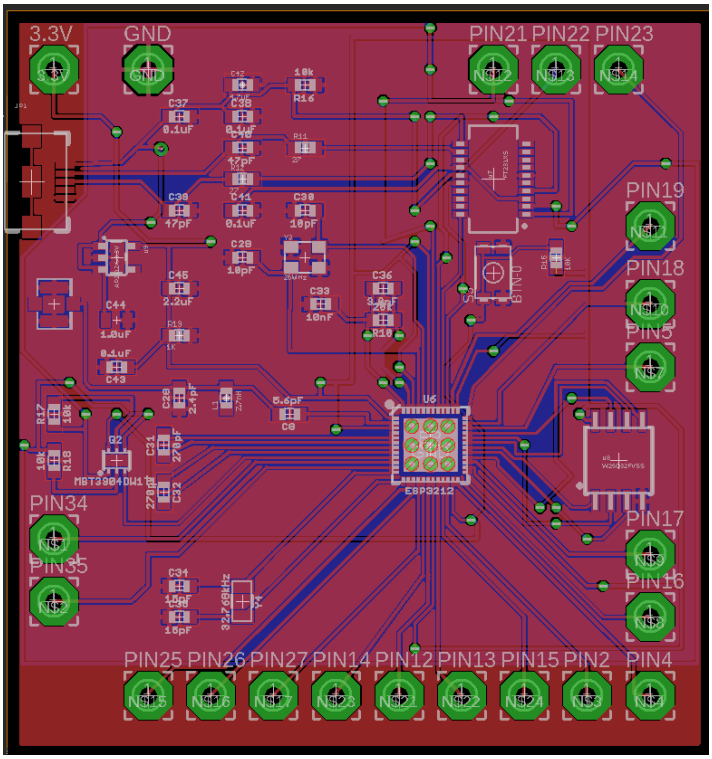

Figure 13. Control Module PCB Board

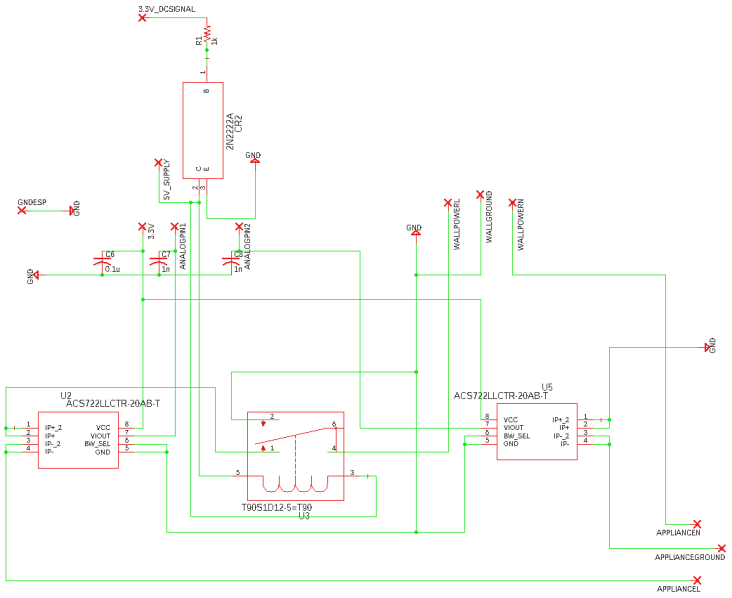

Figure 14. Sensor Module Schematic

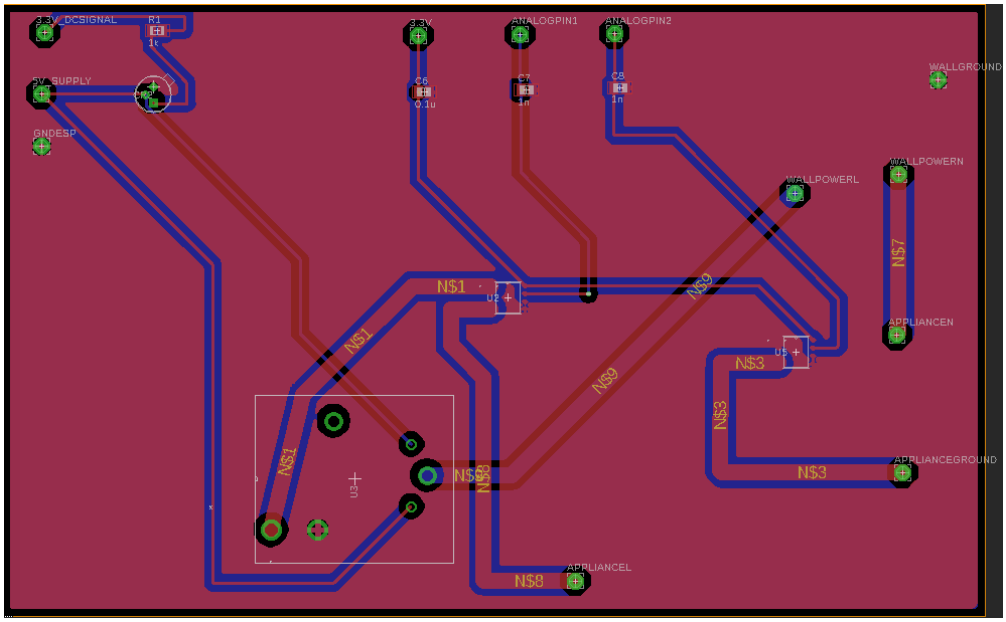

Figure 15. Sensor Module PCB Board