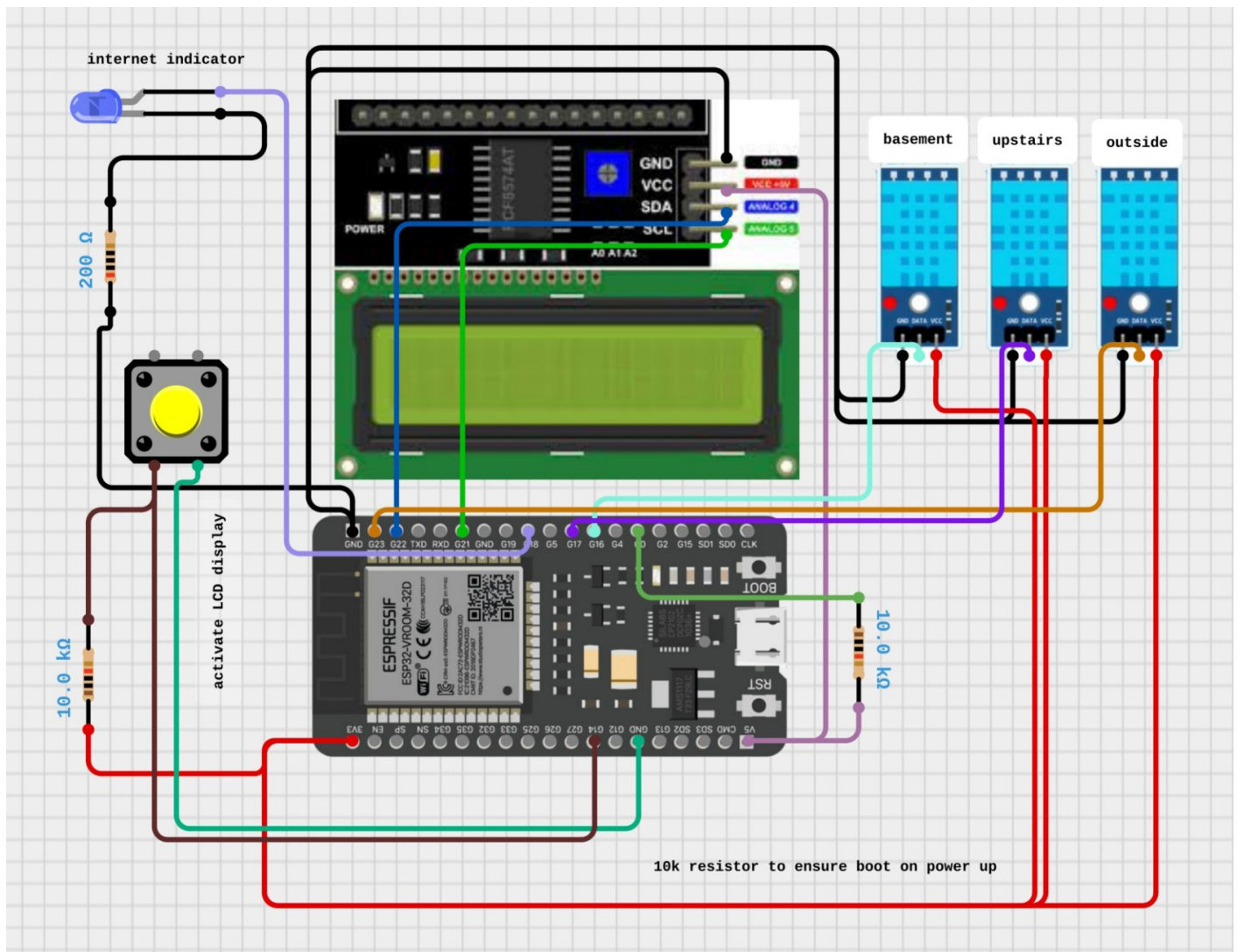


Temperature Monitoring (indoor and outdoor)

This project aims to relay indoor and outdoor temperature (and optionally humidity) to a server log. This project is fairly simple because we can use off-the-shelf DHT11 and DHT22 sensors (DHT22 is for below 0c).

Note to self: avoid non-oem DHT22 modules. You only save a couple of dollars and they are in my experience completely unreliable. The cheap clones either don't work or die after a few hours. I pay about \$6 per unit for OEM (original) AM2302 chips, which have been running without issue for months.

The diagram below includes a 10k resistor between VIN (5v) and GPIO 0 because the esp32 unit I was using would not boot on power-up without having to hit the reset button. This is a common flaw with the esp32 units but so far for me only happened with one of the dozens I've used so far.

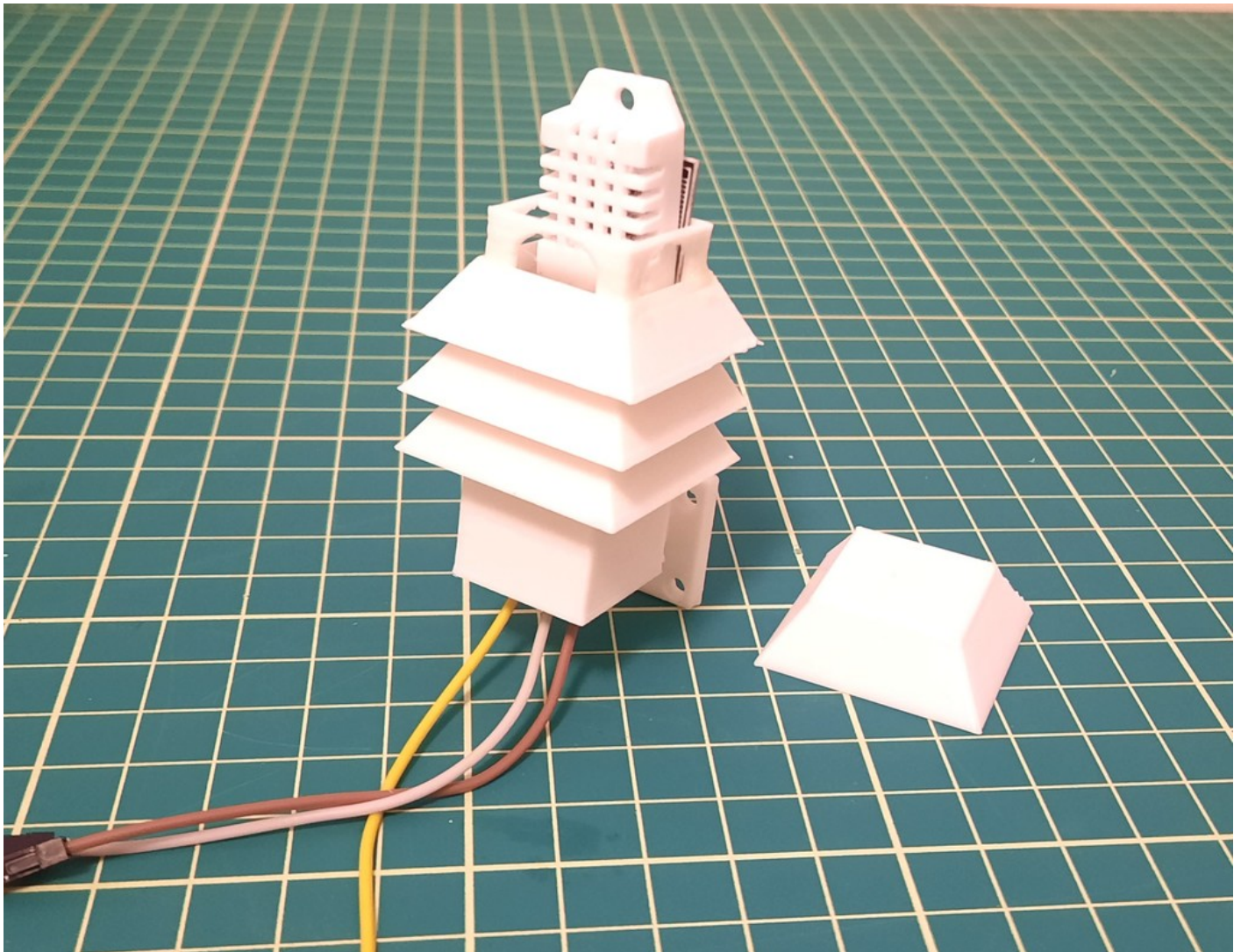


For the indoor sensor I used this case:

<https://www.thingiverse.com/thing:2497711>

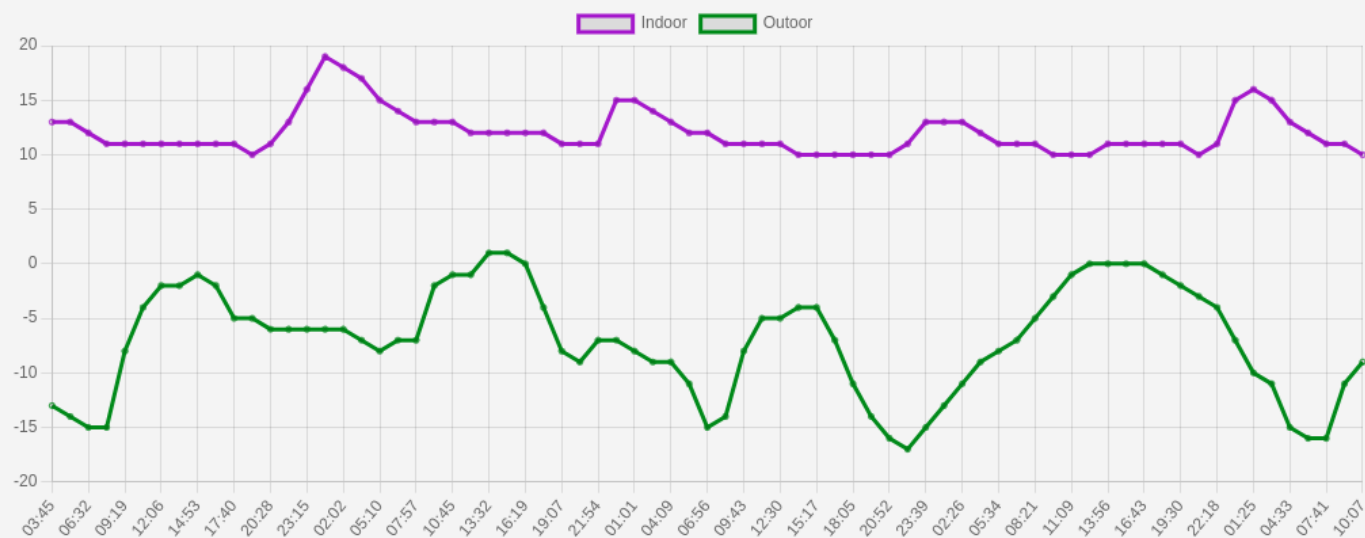
And for the outdoor sensor I used this case:

<https://www.thingiverse.com/thing:6400888>



The end result in my case is a chart showing the temperature over a couple of days. If I see the temperature drop significantly (like pipes freezing zone) I at least can get out there to remedy the situation before it becomes an issue.

Temperature - Thu 03:45 to Mon 10:07



Humidity - Thu 03:45 to Mon 10:07



And the code. It ain't pretty but it works. For the server-side code I am just using free web hosting since the load is almost nothing. For the ESP32 module, the code below is about as minimal as I dare go. I do record the server success/fail rates but if everything seems stable after a few weeks I will remove that too.

```
#include <WiFi.h>
#include <HTTPClient.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <DHT.h>
#include <DHT_U.h>
#include <EEPROM.h>
#include "soc/soc.h"
#include "soc/rtc_cntl_reg.h"
```

```
//////////
```

```
// EDIT THIS SECTION
```

```
// last updated June 23, 2024
```

```
int activeConnection = 1;

// lab
const String ssid1 = "asiuy2G";
const String password1 = "654765";

// other place
const String ssid2 = "cheytr";
const String password2 = "87654";

const String temperatureUrl = "https://homelab.htd.org/set_temp_humidity.php?data=";

// end edit section
//////////

#define EEPROM_SIZE 48
int eepromPingsAddress = 0;
float totalServerPings = 0;
int eepromFailedPingsAddress = 1;
float totalServerPingFails = 0;
int eepromActiveConnectionAddress = 1;

String prevTemperatureText = "";
String prevHumidifyText = "";
String prevConnectivityText1 = "";
String prevConnectivityText2 = "";

const int basementTemperaturePin = 16;
const int upstairsTemperaturePin = 17;
const int outdoorTemperaturePin = 23;

const int buttonPin = 14;
int buttonState = 0;
int displayMode = 1; // 1: temp, humidiy 2: internet

const int pulseRate = 2; // 2 seconds

const int temperatureServerSendInterval = 1; // 10 minutes between sending a
```

temperature update to the server

const int temperatureSamplesPerReading = (60 * temperatureServerSendInterval) / pulseRate; // every x minutes send a sample to the server

int temperatureLoopCount = 0;

int lcdBacklightOnCounter = 0;

long secondsOfHour = 0;

const int secondsPerHour = 3600; // set to 60 for debugging

const int hoursPerDay = 24;

float currentBasementTemperature = 0;

float currentUpstairsTemperature = 0;

float currentOutdoorTemperature = 0;

float currentBasementHumidity = 0;

float currentUpstairsHumidity = 0;

float currentOutdoorHumidity = 0;

bool connectingToWifi = false;

bool wifiConnected = false;

bool wifiPaused = false;

int wifiPausedTick = 0;

bool wifiSleeping = false;

bool debug = false; // when true server does not update

bool serverFailed = false;

int wifiConnectionAttempts = 0;

HTTPClient http;

```
DHT_Unified dhtBasement(basementTemperaturePin, DHT11);
DHT_Unified dhtUpstairs(upstairsTemperaturePin, DHT11);
DHT_Unified dhtOutdoor(outdoorTemperaturePin, DHT11); //DHT22 is actually in ouse outside

LiquidCrystal_I2C lcd_i2c(0x27, 16, 2);

sensors_event_t basementSensorEvent;
sensor_t basementSensor;
sensors_event_t upstairsSensorEvent;
sensor_t upstairsSensor;
sensors_event_t outdoorSensorEvent;
sensor_t outdoorSensor;

#define LED_PIN 18 // ESP32 pin GPIO18 connected to LED

void setup() {

    // We sometimes run into brownouts due to main hydro line voltage drops. For this situation set BOD to 3 volts
    // WRITE_PERI_REG(RTC_CNTL_BROWN_OUT_REG, 0); //disable brownout detector
    WRITE_PERI_REG(RTC_CNTL_BROWN_OUT_REG, 0x03); // 3 volts
    //WRITE_PERI_REG(RTC_CNTL_BROWN_OUT_REG, 0x04); // set brownout detector to 3.2 volts
    // WRITE_PERI_REG(RTC_CNTL_BROWN_OUT_REG, 0x07); // Set 3.3V as BOD level

    Serial.begin(115200); // this needs to match the value in the serial monitor

    //Init EEPROM
    EEPROM.begin(EEPROM_SIZE);

    pinMode(buttonPin, INPUT); // button for displaying info on LCD
    pinMode(LED_PIN, OUTPUT); // led to indicate internet connectivity

    delay(2000);

    dhtBasement.begin();
    dhtUpstairs.begin();
    dhtOutdoor.begin();

    dhtBasement.temperature().getSensor(&basementSensor);
```

```
dhtBasement.humidity().getSensor(&basementSensor);

dhtUpstairs.temperature().getSensor(&upstairsSensor);
dhtUpstairs.humidity().getSensor(&upstairsSensor);

dhtOutdoor.temperature().getSensor(&outdoorSensor);
dhtOutdoor.humidity().getSensor(&outdoorSensor);

getSensorReadings();

EEPROM.begin(EEPROM_SIZE);

activeConnection = EEPROM.read(eepromActiveConnectionAddress);

Serial.print("eepromActiveConnection :");
Serial.println(activeConnection);

if (isnan(activeConnection)) {
    activeConnection = 1;
}

if (activeConnection == 0) {
    activeConnection = 1;
}

if (activeConnection > 2) {
    activeConnection = 2;
}

Serial.print("activeConnection: ");
Serial.println(activeConnection);

if (!connectToWiFi()) {
    delay(2000);
    WiFi.disconnect();
    delay(1000);
    if (activeConnection == 1) {
        activeConnection = 2;
    } else {
        activeConnection = 1;
    }
}
```

```

    connectToWiFi();
}

// in case we did a reboot allow remote server a moment
delay(5000);

// if wifi connect failed again just reboot
if (WiFi.status() != WL_CONNECTED) {
    ESP.restart();
}

lcd_i2c.init();
lcd_i2c.backlight();
}

void loop() {

    secondsOfHour += pulseRate;

    // after 24 hours reset this integer
    if (secondsOfHour > 86400) {
        secondsOfHour = 1;
        // Serial.println("restarting :");
        ESP.restart();
    }

    if (lcdBacklightOnCounter == 0) {
        lcd_i2c.noBacklight();
    } else {
        // if lcb backlight counter is over zero it is active so increment
        lcdBacklightOnCounter++;
        // turn off backlight after 300 5 mintes of inactivity
        if (lcdBacklightOnCounter % 300 == 0) {
            lcd_i2c.noBacklight();
            lcdBacklightOnCounter = 0;
        }
    }

    buttonState = digitalRead(buttonPin);

```



```

if (buttonState == LOW) {
    lcd_i2c.clear();
    lcd_i2c.backlight();

    if (lcdBacklightOnCounter == 0) {
        displayMode = 1;
    } else {
        displayMode++;
        if (displayMode > 2) {
            displayMode = 1;
        }
    }
    lcdBacklightOnCounter = 1;
}

sensors_event_t basementSensorEvent;

//////////
// TEMPERATURE AND HUMIDITY

// no need to read the temperature every second
if (temperatureLoopCount % 10 == 0) {
    getSensorReadings();
}

String temperatureText = "T U:" + String(currentUpstairsTemperature, 0) + " B:" +
String(currentBasementTemperature, 0) + " E:" + String(currentOutdoorTemperature, 0) + "c";
String humidifyText = "H U:" + String(currentUpstairsHumidity, 0) + " B:" + String(currentBasementHumidity,
0) + " E:" + String(currentOutdoorHumidity, 0) + "";

if (wifiPaused) {
    if (wifiPausedTick > 60 && wifiConnectionAttempts == 0) { // wait 1 minute before attempting to reconnect
        wifiPaused = false;
        wifiPausedTick = 0;
        connectToWiFi();
    } else {
        wifiPausedTick++;
    }
}

```

```

}

//////////

// SERVER RELAY

if (!debug && (temperatureLoopCount >= temperatureSamplesPerReading) || serverFailed) {
    String recordedUpstairsTemperature = String(currentUpstairsTemperature, 1);
    String recordedUpstairsHumidity = String(currentUpstairsHumidity, 1);
    String recordedBasementTemperature = String(currentBasementTemperature, 1);
    String recordedBasementHumidity = String(currentBasementHumidity, 1);
    String recordedOutdoorTemperature = String(currentOutdoorTemperature, 1);
    String recordedOutdoorHumidity = String(currentOutdoorHumidity, 1);

    recordedBasementTemperature.trim();
    recordedBasementHumidity.trim();
    recordedOutdoorTemperature.trim();
    recordedOutdoorHumidity.trim();

    temperatureLoopCount = 0;
    setWifiSleepMode(false);
    http.begin(temperatureUrl + recordedBasementTemperature + "," + recordedBasementHumidity + "," +
recordedUpstairsTemperature + "," + recordedUpstairsHumidity + "," + recordedOutdoorTemperature + "," +
recordedOutdoorHumidity);
    int httpCode = http.GET();
    if (httpCode > 0) {
        String payload = http.getString();
        Serial.println("HTTP Response: " + payload);
        recordPingSuccess();
    } else {
        recordPingFailure();
    }
    http.end();

    setWifiSleepMode(true);
}

temperatureLoopCount++;

```

```
////////////////////////////////
```

```
// LCD DISPLAY
```

```
switch (displayMode) {
```

```
case 1:
```

```
    temperatureText.trim();
```

```
    humidifyText.trim();
```

```
    if (prevTemperatureText != temperatureText || prevHumidifyText != humidifyText) {
```

```
        lcd_i2c.clear();
```

```
    }
```

```
    prevTemperatureText = temperatureText;
```

```
    prevHumidifyText = humidifyText;
```

```
    lcd_i2c.setCursor(0, 0);
```

```
    lcd_i2c.print(temperatureText);
```

```
    lcd_i2c.setCursor(0, 1);
```

```
    lcd_i2c.print(humidifyText);
```

```
    break;
```

```
case 2:
```

```
    String connectivityText1 = "";
```

```
    if (wifiConnected) {
```

```
        connectivityText1 += "WF ON";
```

```
    }
```

```
    if (wifiConnected && !serverFailed) {
```

```
        connectivityText1 += " SERVER ON";
```

```
    }
```

```
    String serverPings = String(totalServerPings, 0);
```

```
    serverPings.trim();
```

```
    String serverPingFails = String(totalServerPingFails, 0);
```

```
    serverPingFails.trim();
```

```
    String connectivityText2 = serverPings + "/" + serverPingFails + " PINGS";
```

```
    connectivityText1.trim();
```

```
    connectivityText2.trim();
```

```

    if (prevConnectivityText1 != connectivityText1 || prevConnectivityText2 != connectivityText2) {
        lcd_i2c.clear();
    }

    prevConnectivityText1 = connectivityText1;
    prevConnectivityText2 = connectivityText2;

    lcd_i2c.setCursor(0, 0);
    lcd_i2c.print(connectivityText1);
    lcd_i2c.setCursor(0, 1);
    lcd_i2c.print(connectivityText2);
    break;
}

//delay(pulseRate * 1000);
pulseLed(!wifiPaused);

// analogWrite(LED_PIN, 255);
}

/**
 * pulse the led in and out over a span of 2 seconds
 *
 */
void pulseLed(bool active) {

    // analogWrite(LED_PIN, 255);

    int dutyCycle = 166;
    int delayMs = pulseRate * 1000 / dutyCycle;

    // Fade in the LED
    for (int brightness = 0; brightness <= dutyCycle; brightness++) {
        if (active) {
            analogWrite(LED_PIN, brightness);
        }
    }
}

```

```

    delay(delayMs); // Adjust this value to change the fade duration
}

// Fade out the LED
for (int brightness = dutyCycle; brightness >= 0; brightness--) {
    if (active) {
        analogWrite(LED_PIN, brightness);
    }
    delay(delayMs); // Adjust this value to change the fade duration
}

// delay(1000);
}

bool connectToWiFi() {

    if (connectingToWifi || wifiConnected) {
        return true;
    }

    connectingToWifi = true;

    String activeSsid = "";
    String activePassword = "";

    if (activeConnection == 1) {
        activeSsid = ssid1;
        activePassword = password1;
    } else if (activeConnection == 2) {
        activeSsid = ssid2;
        activePassword = password2;
    }

    Serial.print("Connecting to WiFi: ");
    Serial.println(activeSsid);

    WiFi.begin(activeSsid, activePassword);

    while (WiFi.status() != WL_CONNECTED && wifiConnectionAttempts < 20) {
        delay(500);
    }
}

```

```
Serial.print(".");
wifiConnectionAttempts++;
}

wifiConnectionAttempts = 0;

if (WiFi.status() == WL_CONNECTED) {
  Serial.println("\nConnected to WiFi");
  Serial.print("IP Address: ");
  Serial.println(WiFi.localIP());

  EEPROM.write(eepromActiveConnectionAddress, activeConnection);
  EEPROM.commit();

  Serial.print("set activeConnection to : ");
  Serial.println(activeConnection);

  // 5 flashes means internet is connected
  for (int i = 0; i < 5; i++) {
    digitalWrite(LED_PIN, HIGH);
    delay(10);
    digitalWrite(LED_PIN, LOW);
    delay(200);
  }

  wifiConnected = true;
  connectingToWifi = false;
  return true;

} else {
  Serial.print("Connection to ");
  Serial.print(activeSsid);
  Serial.println(" failed. Trying alternative");

  wifiConnected = false;
  connectingToWifi = false;

  return false;
}
}
```

```

/**
 * set wifi sleep mode between data relays to conserve energy
 * @param sleepMode - if true set wifi card to sleep to conserve energy
 */
void setWifiSleepMode(bool sleepMode) {

    wifiSleeping = sleepMode;

    if (sleepMode) {
        WiFi.disconnect();
        WiFi.setSleep(true);
        wifiConnected = false;
        delay(1000);
        Serial.print("sleep wifi status: ");
        Serial.println(wl_status_to_string(WiFi.status()));
    } else {
        WiFi.setSleep(false);
        WiFi.reconnect();
        delay(2000);
        Serial.print("awaken wifi status: ");
        Serial.println(wl_status_to_string(WiFi.status()));
        // Check if the connection is still active. if not trigger wait for it to come back online
        if (WiFi.status() != WL_CONNECTED && !wifiPaused) {
            Serial.println("Connection lost. Attempting to reconnect in 1 minute ...");
            WiFi.disconnect();
            wifiPaused = true;
            wifiConnected = false;
            connectToWiFi();
        }
    }
}

/**
 * record server ping success in long term memory
 */
void recordPingSuccess() {
    totalServerPings++;
    EEPROM.begin(EEPROM_SIZE);

```

```

EEPROM.writeFloat(eepromPingsAddress, totalServerPings);
EEPROM.commit();
EEPROM.end();
wifiConnected = true;
serverFailed = false;
}

/**
 * record server ping fails in long term memory
 */
void recordPingFailure() {
    totalServerPingFails++;
    EEPROM.begin(EEPROM_SIZE);
    EEPROM.writeFloat(eepromFailedPingsAddress, totalServerPingFails);
    EEPROM.commit();
    EEPROM.end();
    wifiConnected = false;
    serverFailed = true;
}

/**
 * ESP32 wifi card statuses
 * @param status
 * @return string
 */
String wl_status_to_string(wl_status_t status) {

    String response = "";

    switch (status) {
        case WL_NO_SHIELD:
            response = "WL_NO_SHIELD";
            break;
        case WL_IDLE_STATUS:
            response = "WL_IDLE_STATUS";
            break;
        case WL_NO_SSID_AVAIL:
            response = "WL_NO_SSID_AVAIL";
            break;
        case WL_SCAN_COMPLETED:

```



```

    response = "WL_SCAN_COMPLETED";
    break;
case WL_CONNECTED:
    response = "WL_CONNECTED";
    break;
case WL_CONNECT_FAILED:
    response = "WL_CONNECT_FAILED";
    break;
case WL_CONNECTION_LOST:
    response = "WL_CONNECTION_LOST";
    break;
case WL_DISCONNECTED:
    response = "WL_DISCONNECTED";
    break;
}

return response;
}

void getSensorReadings() {

    float newTempReading;
    float newHumidityReading;

    // BASEMENT

    dhtBasement.temperature().getEvent(&basementSensorEvent);
    if (isnan(basementSensorEvent.temperature)) {
        Serial.println(F("Error reading basement temperature!"));
    } else {
        newTempReading = basementSensorEvent.temperature;
        if (newTempReading > -10 && newTempReading < 50) {
            currentBasementTemperature = basementSensorEvent.temperature;
        }
        Serial.print("basement temp: ");
        Serial.println(currentBasementTemperature);
    }
}

```

```

}

dhtBasement.humidity().getEvent(&basementSensorEvent);
if (isnan(basementSensorEvent.relative_humidity)) {
    Serial.println(F("Error reading basement humidity!"));
} else {

    newHumidityReading = basementSensorEvent.relative_humidity;
    if (newHumidityReading > -10 && newHumidityReading < 100) {
        currentBasementHumidity = basementSensorEvent.relative_humidity;
    }

    Serial.print("basement humidity: ");
    Serial.println(currentBasementHumidity);
}

// UPSTAIRS
dhtUpstairs.temperature().getEvent(&upstairsSensorEvent);
if (isnan(upstairsSensorEvent.temperature)) {
    Serial.println(F("Error reading upstairs temperature!"));
} else {
    newTempReading = upstairsSensorEvent.temperature;
    if (newTempReading > -10 && newTempReading < 50) {
        currentUpstairsTemperature = upstairsSensorEvent.temperature;
    }
    Serial.print("upstairs temp: ");
    Serial.println(currentUpstairsTemperature);
}

dhtUpstairs.humidity().getEvent(&upstairsSensorEvent);
if (isnan(upstairsSensorEvent.relative_humidity)) {
    Serial.println(F("Error reading upstairs humidity!"));
} else {

    newHumidityReading = upstairsSensorEvent.relative_humidity;
    if (newHumidityReading > -10 && newHumidityReading < 100) {
        currentUpstairsHumidity = upstairsSensorEvent.relative_humidity;
    }
}

```

```

}

Serial.print("upstairs humidity: ");
Serial.println(currentUpstairsHumidity);
}

// OUTDOOR

dhtOutdoor.temperature().getEvent(&outdoorSensorEvent);
if (isnan(outdoorSensorEvent.temperature)) {
    Serial.println(F("Error reading outdoor temperature!"));
} else {
    newTempReading = outdoorSensorEvent.temperature;
    if (newTempReading > -10 && newTempReading < 50) {
        currentOutdoorTemperature = outdoorSensorEvent.temperature;
    }
    Serial.print("outdoor temp: ");
    Serial.println(currentOutdoorTemperature);
}

dhtOutdoor.humidity().getEvent(&outdoorSensorEvent);
if (isnan(outdoorSensorEvent.relative_humidity)) {
    Serial.println(F("Error reading outdoor humidity!"));
} else {

    newHumidityReading = outdoorSensorEvent.relative_humidity;
    if (newHumidityReading > -10 && newHumidityReading < 100) {
        currentOutdoorHumidity = outdoorSensorEvent.relative_humidity;
    }

    Serial.print("outdoor humidity: ");
    Serial.println(currentOutdoorHumidity);
}
}

```

