

Laboratory 5: DHT Sensor

Objective:

1. Students be able to use simple sensors in their IoT project.
2. Students be able to write sketches displaying appropriate sensor data on M5Stack screen.
3. Students be able to create thermometer and hygrometer.

Background Theory

The DHT11/DHT22 Temperature & Humidity Sensor features a temperature and humidity sensor module with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and sensing technologies for temperature and humidity, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. DHT11/DHT22 pins and connection to M5Stack are shown in illustration 5.1.

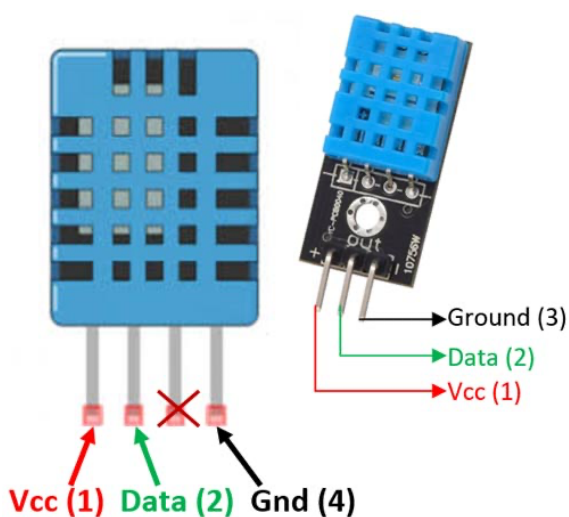


Illustration 5.1 DHT11/DHT22 Pins and M5Stack

Lab Exercises

Task 1: Setup DHT

- 1.1 Open Arduino IDE application
- 1.2 Install “DHT Sensor Library by Adafruit” by select menu Tools->Manage Libraries as show in Illustration 5.2

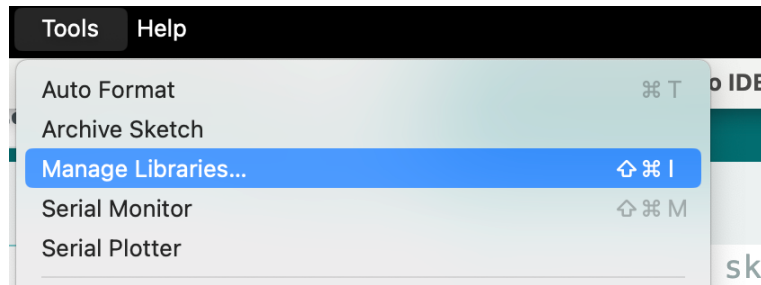


Illustration 5.2

- 1.3 Search for the “DHT Sensor Library by Adafruit” library and install the latest version (Illustration 5.3).

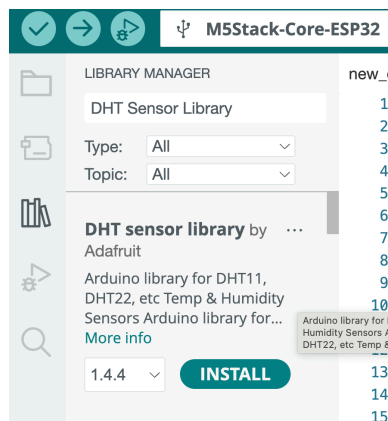


Illustration 5.3

- 1.4 Select “INSTALL ALL” to install all dependencies (Illustration 5.4).

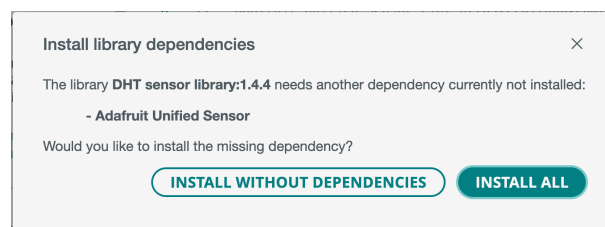


Illustration 5.4

1.5 Copy the following sketch (Illustration 5.5).

```
#include <M5Stack.h>
#include <DHT.h>

// Initialize DHT sensor connected to pin 21. use DHT11 for old sensor
DHT dht(21, DHT22);
int cnt = 0;
float old_t = -100.0, old_h = -100.0;
int LCD_state = 0;

void setup() {
  M5.begin();
  M5.Lcd.setTextSize(10);
  M5.Lcd.setTextColor(YELLOW);
  M5.Lcd.println("Lab 5");
  Serial.begin(115200);
  Serial.println("Lab 5");
  dht.begin();
}

void loop() {
  // Wait a few seconds between measurements.
  delay(2000);
  // Reading temperature or humidity takes about 250 milliseconds!
  // Sensor readings may also be up to 2 seconds 'old' (its a very slow sensor)
  float h = dht.readHumidity();
  // Read temperature as Celsius (the default)
  float t = dht.readTemperature();
  // Read temperature as Fahrenheit (isFahrenheit = true)
  float f = dht.readTemperature(true);
  // Check if any reads failed and exit early (to try again).
  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  ++cnt; // number of reading
  // show all info to serial monitor
  Serial.printf("%03d -> ", cnt);
  Serial.printf(" Humidity: %.2f%% Temperature: %.2f°C %.2f°F\n", h, t, f);
  update_LCD(cnt, h, t, f);
}

void update_LCD(int count, float humidity, float celsius, float fahrenheit) {
  M5.Lcd.setCursor(0, 0);
  M5.Lcd.fillScreen(BLACK); // clear LCD screen
  M5.Lcd.println(count);
  M5.Lcd.print(humidity);
  M5.Lcd.println("%");
  M5.Lcd.print(celsius);
  M5.Lcd.println("C");
}
```

Illustration 5.5

- 1.6 Prepare the (temperature and humidity) DHT11/DHT22 sensor connection to M5Stack (Illustration 5.6). **Connect, the negative pin to GND, the data pin (middle) to port 21 of M5Stack and the positive pin to 5V in order.** Upload and run the sketch.

Note that both LCD and serial monitor will continuously show reading #, humidity and temperature.

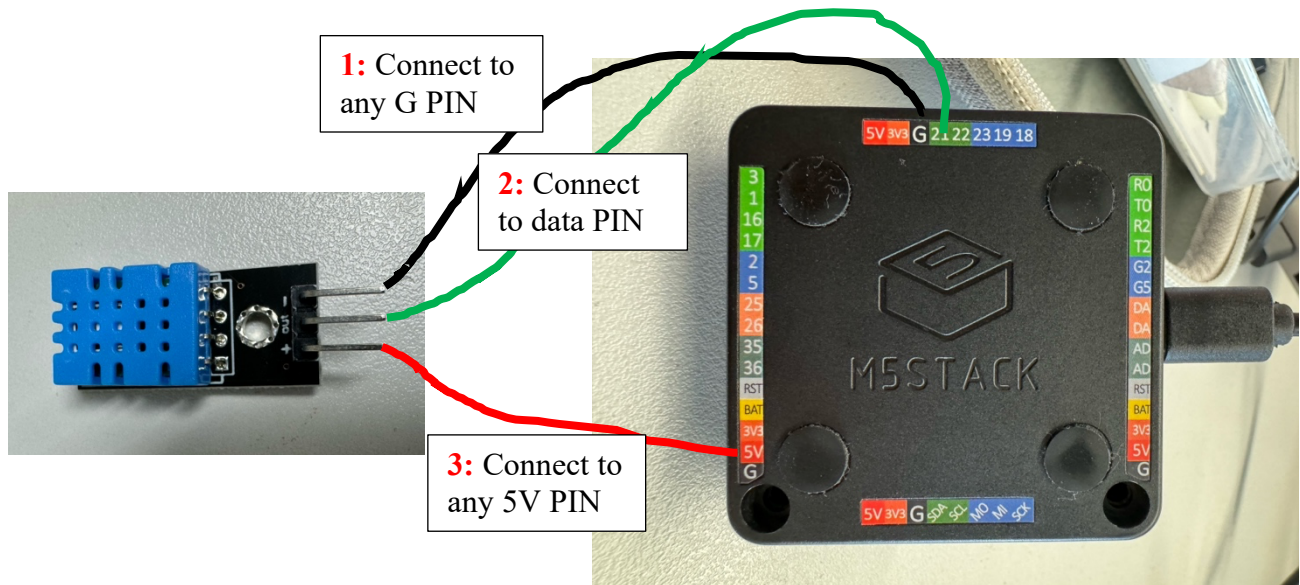


Illustration 5.6. Connecting DHT11/DHT22 sensor to M5Stack

Task 2. LCD Display only data changed.

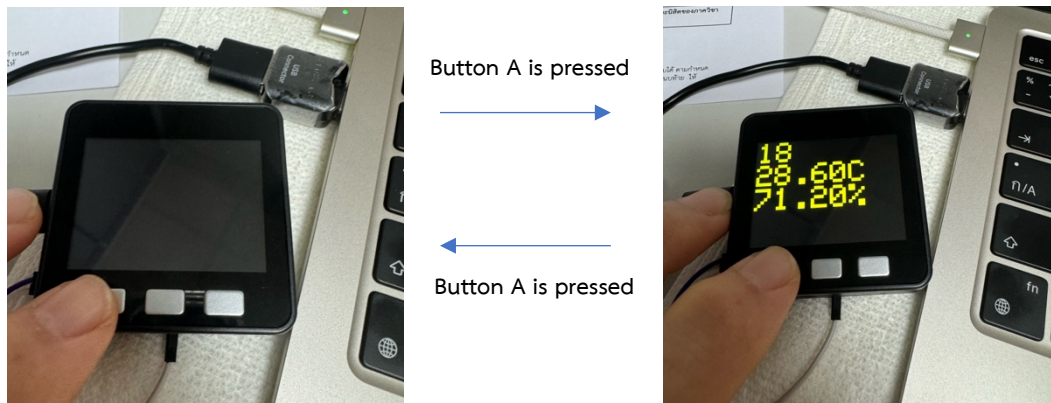
Update Task 1 sketch to do update the LCD only when temperature or humidity is changed. (Hint: use `old_t`, `old_h` to store current temperature, humidity and check for changed.)

Task 3. Turn LCD ON/OFF

Update Task 2 sketch to do the following:

- Initially, LCD shows nothing (state **OFF** or **0**). Serial monitor shows same information as in previous task.
- When button A is pressed, it should toggle the LCD state from **OFF** -> **ON**, **ON** -> **OFF**.
 - o Serial monitor shows message "**Button A is pressed!**" with LCD state as show in illustration 5.7.
 - o When LCD state is **ON**, show the temperature (in Celsius) and humidity on the LCD display.
 - o When LCD state is **OFF**, show nothing.

- **Hint:** You can turn LCD **OFF** or **ON** by set the brightness of the LCD using **M5.Lcd.setBrightness(0)** or **M5.Lcd.setBrightness(255)**.
- Note that you might need to press and hold the button longer than 2 seconds to make sure that the button state is updated.



```

Output  Serial Monitor  X
Message (Enter to send message to 'M5Stack-Core-ES
18 -> Humidity: 71.20% Temperature 28.60C
Button A was pressed! LCD state: 1
19 -> Humidity: 71.20% Temperature 28.60C
20 -> Humidity: 71.20% Temperature 28.60C
21 -> Humidity: 71.10% Temperature 28.60C
22 -> Humidity: 71.10% Temperature 28.60C
23 -> Humidity: 71.10% Temperature 28.60C
24 -> Humidity: 71.10% Temperature 28.60C
25 -> Humidity: 71.10% Temperature 28.60C

```

```

Output  Serial Monitor  X
Message (Enter to send message to 'M5Stack-Core-ES
40 -> Humidity: 70.70% Temperature 28.50C
41 -> Humidity: 70.40% Temperature 28.50C
42 -> Humidity: 70.40% Temperature 28.50C
43 -> Humidity: 70.30% Temperature 28.50C
Button A was pressed! LCD state: 0
44 -> Humidity: 70.20% Temperature 28.50C
45 -> Humidity: 70.20% Temperature 28.50C
46 -> Humidity: 70.10% Temperature 28.50C
47 -> Humidity: 70.00% Temperature 28.50C

```

Illustration 5.7

Task 4: Fahrenheit-Celsius Thermometer and Hygrometer

Update task 3 sketch to add the following response to button B and C.

- When button B is pressed, show temperature in Celsius when LCD is updated.
- When button C is pressed, show temperature in Fahrenheit when LCD is updated.
- Show message “**Button A was pressed**”, “**Button B was pressed**”, or “**Button C was pressed**” on serial monitor according to which button is pressed.

Hint: Define a new variable to store temperature type to display (Celsius or Fahrenheit), for example `bool show_celsius = true;`. When button B/C is pressed, update that variable. Modify function `update_LCD()` based on the value of the new variable.

Lab 5: DHT Sensor

Section: _____ Date: _____

Members

Name: _____ Student ID: _____

Name: _____ Student ID: _____

Name: _____ Student ID: _____

Task		Graded by
1	Setup DHT	
2	LCD display only when data changed	
3	Turn LCD ON/OFF	
4	Fahrenheit-Celcius Display	

5. Reflection about this lab. See assignment in **MycourseVille**