

# Lesson 8 Intelligent Temperature and Humidity Meter

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## Background Knowledge

### Temperature and Humidity Sensor

Reading temperature and humidity values in a serial monitor

## Project Making

### Project description

### Write Program

Task 1: detect temperature and humidity and display on OLED display

Task 2: Add alarm function

### Appearance Design

Temperature and Humidity Meter can be seen everywhere in life. It can measure the temperature and humidity in the environment in real time. Just like the commonly used thermometer, when you feel unwell and confirm signs of fever, you will definitely use it. The invention of temperature and humidity meter brings great convenience to our life. In this lesson, we will make an intelligent temperature and humidity meter by using temperature and humidity sensors. Do you know what a temperature and humidity sensor is and what its function is?

## Background Knowledge

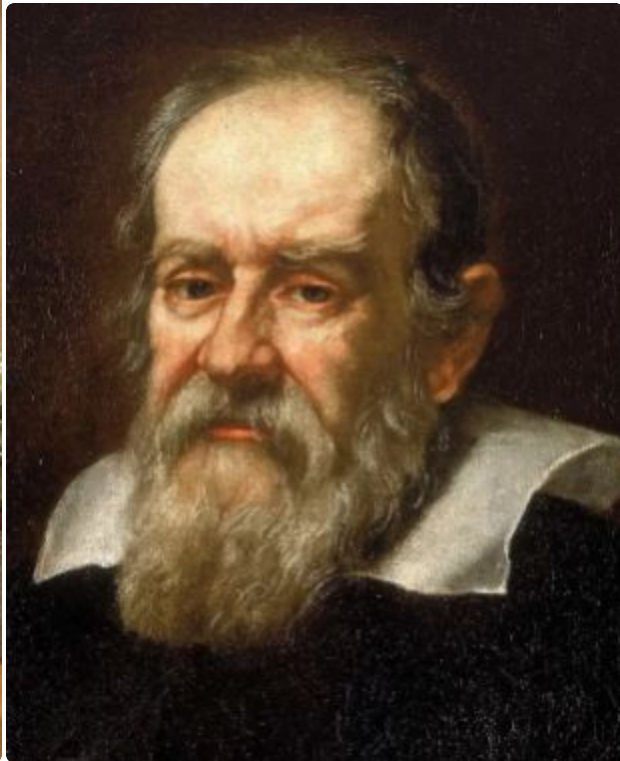
### Temperature and Humidity Sensor

The temperature and humidity sensor is used to detect the temperature and humidity in the environment. There are many types of temperature and humidity sensors. We choose DHT20 which has a clear advantage in supply voltage, measurement range of temperature and humidity, precision and quality of output signal. It is a product with low power consumption, high precision and high stability, equipped with a fully calibrated digital I2C interface.



### Knowledge window

As early as 1592, Galileo invented the thermometer, which **was** made of a glass cylinder with transparent liquid and heavy objects of different densities. The principle of temperature measurement is simply to expand with heat and contract with cold. When the temperature changes, the density of the liquid will also change, causing suspended solids with different densities to move up and down until the liquid and itself have the same density. After optimization and iteration by different people, the glass thermometer is more and more accurate and stable, and is applied to various fields. The traditional glass thermometer has a history of more than 300 years and is still in use today.



With the development and application of technology, there are more and more selections for types of thermometers, such as mercury glass thermometers, dial-type thermometers, thermistor thermometers, infrared thermometers, electronic thermometers, etc. Different thermometers have different use scenarios. Some thermometers will add the function of detecting humidity and become humidistats to monitor the temperature and humidity of the environment.

## Reading temperature and humidity values in a serial monitor

When using the sensor, we can use the DHT library to open the "DHTtester" example through the following path: **"File → Example → Temperature and humidity sensor → DHT tester."** After

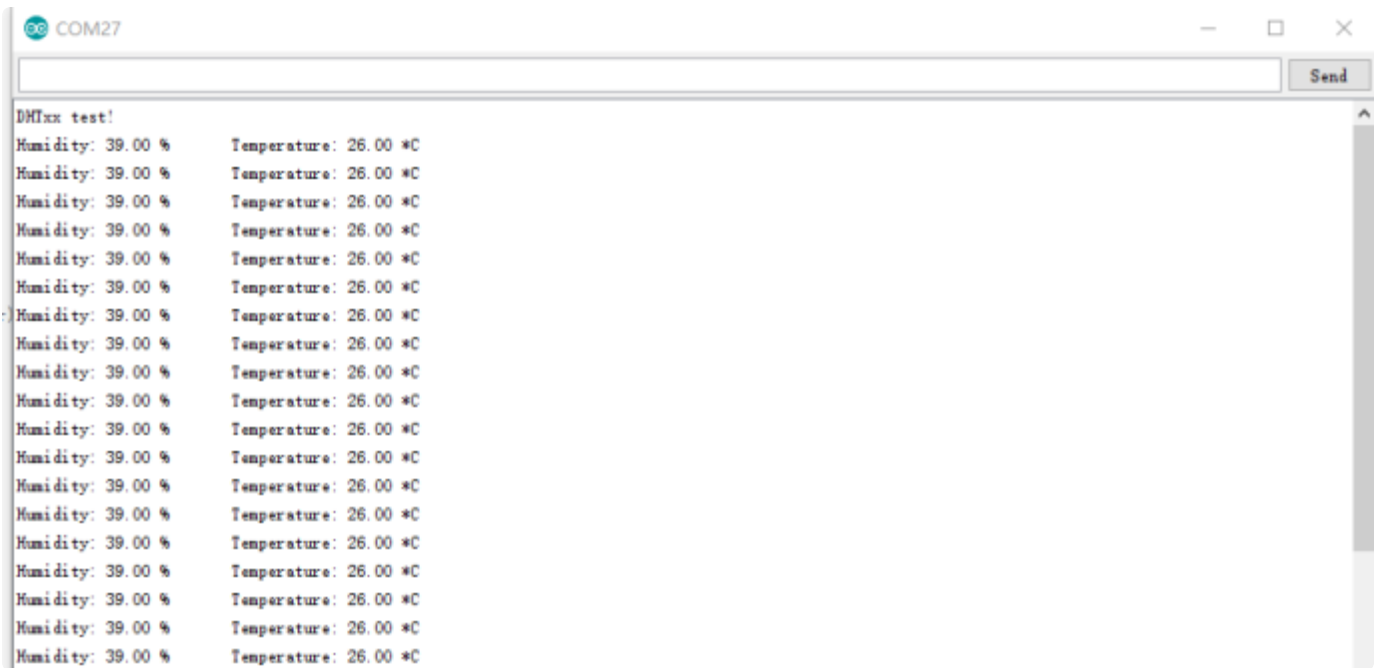
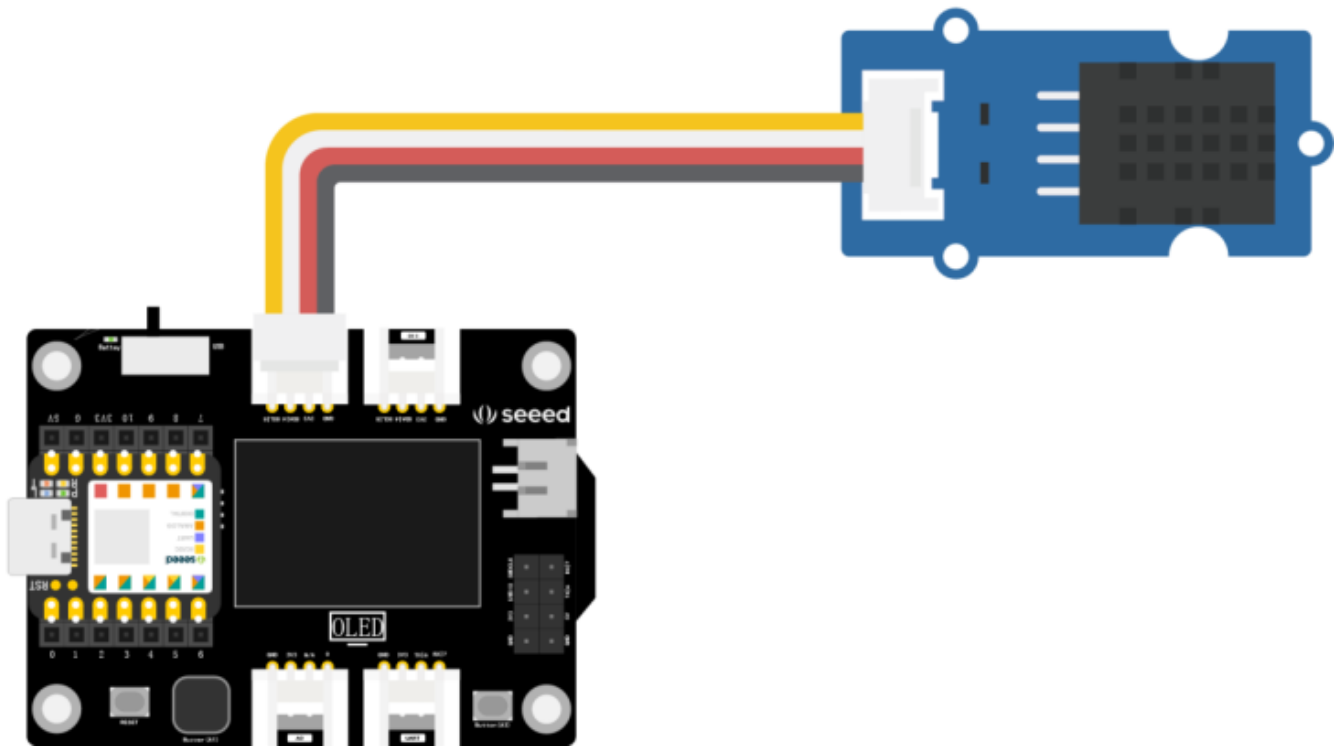
opening the example program, we can see the following program. The program can read the temperature and relative humidity information in the environment and display real-time data on the serial monitor. Some code for the sample program needs to be modified:

**#define DHTTYPE DHT 20 , we need to modify the parameters according to the pin number of the actual connection of the temperature and humidity sensor.**

**DHT dht(DHTTYPE) , The DHT20 is different from other DHT\* sensor ,it uses I2C interface rather than one wire, So it doesn't require a pin.**

```
1  #include "DHT.h"
2  #define DHTTYPE DHT20    // DHT 20
3  DHT dht(DHTTYPE);
4
5  #if defined(ARDUINO_ARCH_AVR)
6      #define debug Serial
7
8  #elif defined(ARDUINO_ARCH_SAMD) || defined(ARDUINO_ARCH_SAM)
9      #define debug SerialUSB
10 #else
11     #define debug Serial
12 #endif
13
14 void setup() {
15
16     debug.begin(115200);
17     debug.println("DHTxx test!");
18     Wire.begin();
19     dht.begin();
20 }
21
22 void loop() {
23     float temp_hum_val[2] = {0};
24     if (!dht.readTempAndHumidity(temp_hum_val)) {
25         debug.print("Humidity: ");
26         debug.print(temp_hum_val[0]);
27         debug.print(" %\t");
28         debug.print("Temperature: ");
29         debug.print(temp_hum_val[1]);
30         debug.println(" *C");
31     } else {
32         debug.println("Failed to get temprature and humidity value.");
33     }
34
35     delay(1500);
36 }
```

After modifying the code, connect the temperature and humidity sensor to **I2C** interface, upload the sample program to XIAO, and open the serial monitor, you can see the values of temperature and humidity. You can put the temperature and humidity sensors in different environments to observe whether the temperature and humidity values will change.



# Project Making

## Project description

We will make a portable small-scale temperature and humidity detector to detect the temperature and humidity value through the temperature and humidity sensor and display the value on the OLED display screen of XIAO expansion board. We can further add the buzzer alarm function

when the detected temperature and humidity exceed a certain value range, an alarm will be sounded to remind. The numerical range can be adjusted according to different application scenarios, such as home life scenarios, and the comfortable temperature and humidity numerical range can be set based on human body sensation; For example, in places where plants are planted, the numerical range of temperature and humidity is set on the basis of suitable plant growth, and once it exceeds the numerical range, an alarm can be generated to remind people to make adjustments.

## Write Program

With reference to the above example program, one of the effects we want to achieve is to display the temperature and humidity values on the OLED display screen, but with a different display medium. The code for reading the temperature and humidity sensor detection values can be reused. Combined with lesson 6, we learned how to display characters with an OLED, so we only need to add an "if.....else" conditional judgment statement to judge the temperature and humidity values. The programming ideas are as follows:

- Declare the DHT library, U8x8 library, etc. to be called, and connect the buzzer pin as a sounding device
- Initialize the library, define the buzzer pin state
- Define the temperature and humidity variables as readings, and display them on the OLED screen, add logical judgment, and realize buzzer alarm

Program implementation is divided into two tasks:

### Task 1: detect temperature and humidity and display on OLED display

Step 1: Header file, declaring the library file to be called.

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```
1  #include "DHT.h"
2  #include <Arduino.h>
3  #include <U8x8lib.h> // here we use the U8x8lib.h library.
4  #define DHTTYPE DHT20
5  DHT dht(DHTTYPE);
6
7  U8X8_SSD1306_128X64_NONAME_HW_I2C u8x8(/* reset= */ U8X8_PIN_NONE); // Set
the constructor to connect the OLED display
```

Step 2: Initialize the library file of DHT and u8x8.

```
1 void setup() {  
2   Wire.begin();  
3   dht.begin();//DHT begins  
4   u8x8.begin();//u8x8 begins  
5   u8x8.setPowerSave(0); //power-saving mode is turned off, 1 is turned  
   on, and nothing will be seen on the screen after power-saving mode is  
   turned on.  
6   u8x8.setFlipMode(1);//Flip the display 180 degrees, 0 is disabled, 1 is  
   enabled  
7 }
```

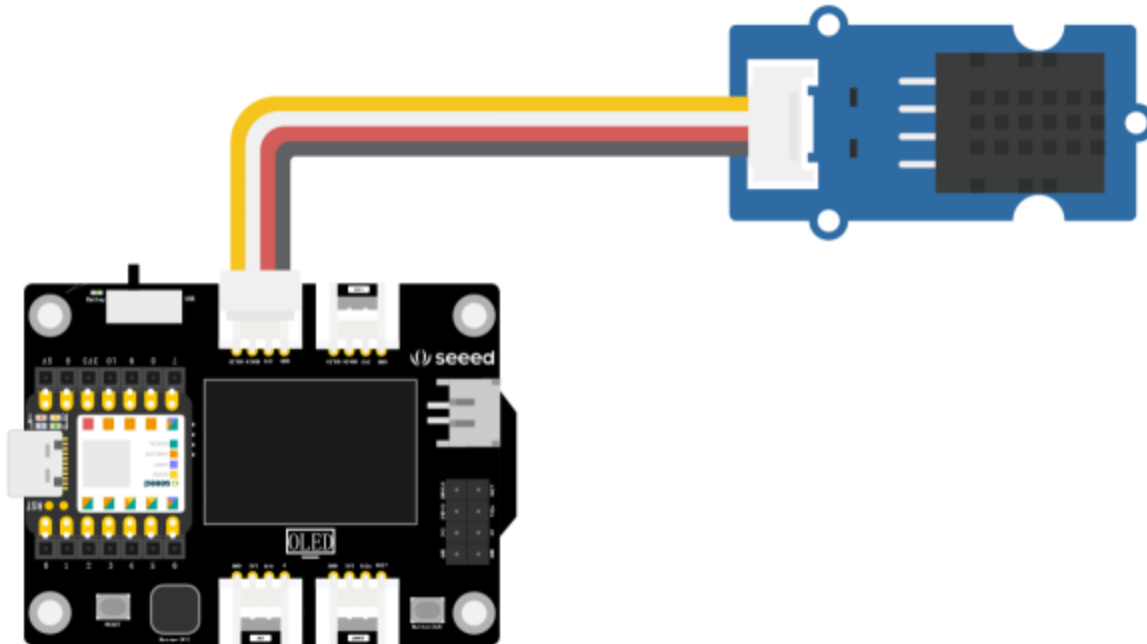
Step 3: Define the temperature and humidity variables as readings, and display them on the OLED screen, pay attention to the coordinate position for the display of temperature and humidity.

```
1 void loop() {  
2   float temp, humi;//defines variables to store readings.  
3   temp = dht.readTemperature();//read the temperature value and store it  
   in temp  
4   humi = dht.readHumidity();//read the humidity value and store it in the  
   humi  
5  
6   u8x8.setFont(u8x8_font_chroma48medium8_r);//set display font  
7   u8x8.setCursor(0, 33);//sets the position of the draw cursor (0, 33)  
8   u8x8.print("Temp:");//show temp at (0, 33)  
9   u8x8.print(temp);//display real-time temperature values  
10  u8x8.print("C");//displays the unit "c" of temperature  
11  u8x8.setCursor(0,50);  
12  u8x8.print("Humidity:");  
13  u8x8.print(humi);  
14  u8x8.print("%");  
15  u8x8.refreshDisplay();  
16  delay(200);  
17 }
```

Please see details on entire program:



Step 4: Connect the temperature and humidity sensor to I2C interface of XIAO expansion board, as shown in the figure:



Connect XIAO to the computer with a data cable, click the "Upload" button to upload the program to the hardware. When "Done uploading" is displayed in the debugging area, observe whether the temperature and humidity values and numerical changes are displayed on the OLED screen, and hold the blue resistance part of the sensor with the palm of your hand.

## Task 2: Add alarm function

Step 1: Add code, the function of the alarm can be realized by connecting a buzzer to the circuit. The XIAO expansion board has an onboard buzzer, which we can use directly. In the program, the pin mode of buzzer pin needs to be set, and the conditional statement is added. When the temperature is greater than a certain value or the humidity is less than a certain value, the buzzer will sound, which needs to form a logic expression by "& &" logic.

Knowledge window:Logical operator

&&:stands for "and ", if (expression 1 && expression 2 ), and the statement in if ( ) is executed only when all expressions in parentheses are true

||: stands for or, if (expression 1 || expression 2), satisfies one of the expressions, evaluates to true, and executes the statement in if {}.

#### Usage:

When the temperature is greater than 30 or the humidity is less than 40, the buzzer shall sound an alarm.

```
if (temp > 30 || humi < 40) {  
    tone(buzzerPin, 200, 200);  
}
```

The mainly for setting the buzzer and judging the temperature and humidity, which controls the buzzer to sound:



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```
1  //Port programs do not run  
2  int buzzerPin = A3;//the number of buzzer pin  
3  
4  void setup() {  
5      pinMode(buzzerPin , OUTPUT);//initialize the buzzer pin as an output  
6  }  
7  
8  void loop() {  
9      float temp, humi;//defines variables to store readings  
10     temp = dht.readTemperature();  
11     humi = dht.readHumidity();  
12     if (temp > 30 || humi < 40) { //when the temperature is greater than 30  
        or the humidity is less than 40, the buzzer shall sound an alarm if one  
        of the conditions is met  
13         tone(buzzerPin, 200, 200);  
14     }
```

Add the above code to the corresponding position of task one program to realize all functions.

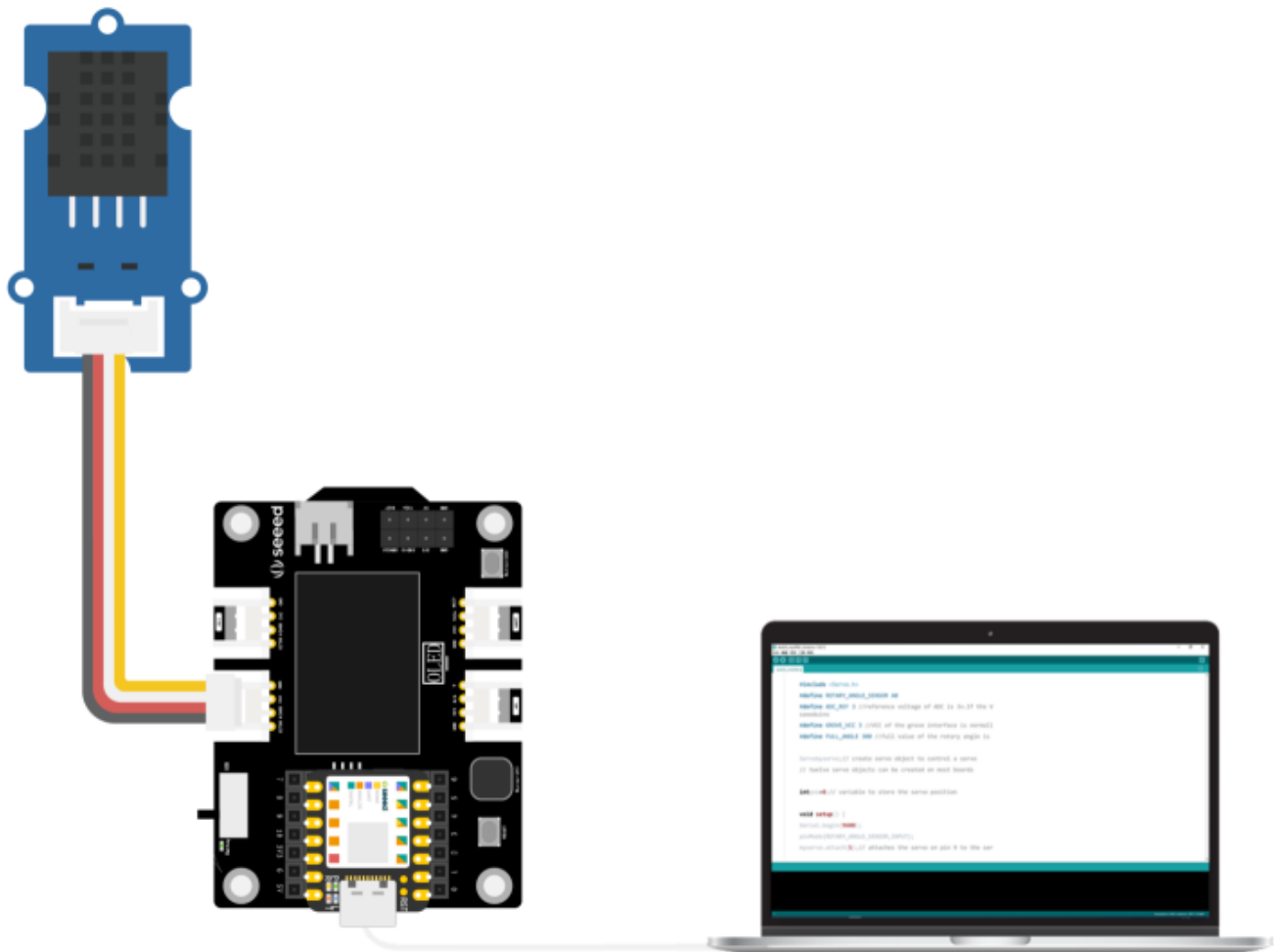
Please see details on entire program:



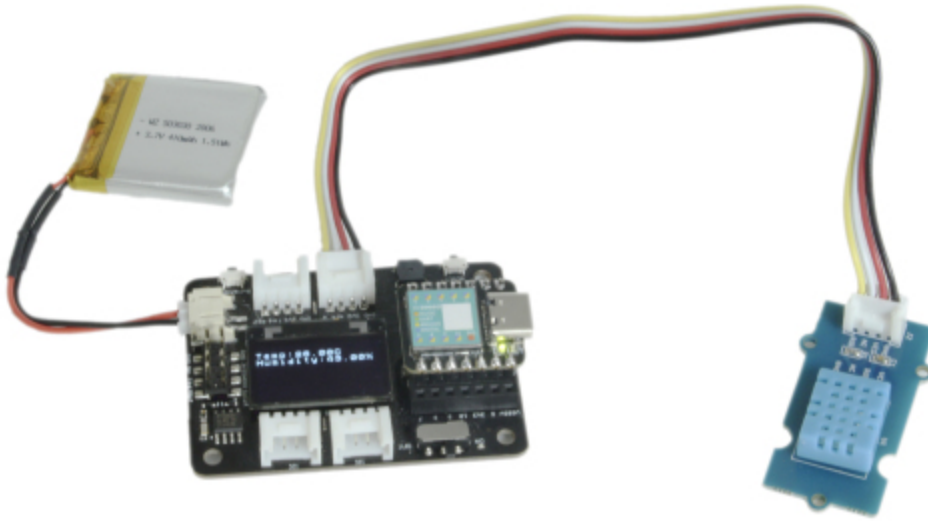
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e\_Humidity2.ino

## Step 2: Upload program

After the program is written, we will XIAO main control board with data cable connected to the computer, as shown in the figure below:



After connection, click "Verify" to verify the program. If verification is correct, click "Upload" button to upload the program to hardware. When "Done uploading" is displayed in debugging area. In order to verify whether the alarm function runs smoothly, we can hold the temperature and humidity sensor tightly with our palms, and observe the numerical change of the OLED display. Listen for the buzzer when the temperature goes over 30 degrees!



Note: We can see the characters on the OLED display screen constantly beating in the video, because the OLED display screen and the camera have different refresh rates. This has no effect on naked eye observation.

## Appearance Design

From this class, we will try to explore the appearance and make a complete prototype product. First, try to draw the design drawings and make a simple transformation with the existing materials. Then with reference to the intelligent temperature and humidity meter, please design the appearance of the prototype according to the product features and functions.

Product name	Intelligent temperature and humidity meter
Product characteristics	Small, portable, highly sensitive
Product characteristics	Temperature and humidity values are displayed in real time and an alarm sounds when the temperature and humidity values are outside the comfort range
Product function	(For example: make it into a pendant to carry on the backpack, stick on the paper towel storage box in the bedroom, etc.)

#### References:

