IERG4230 / IEMS5721
Internet of Things
Mini-project
(Sensor connection and testing)

Prepared by:
Bun
Ver 2021.11.12

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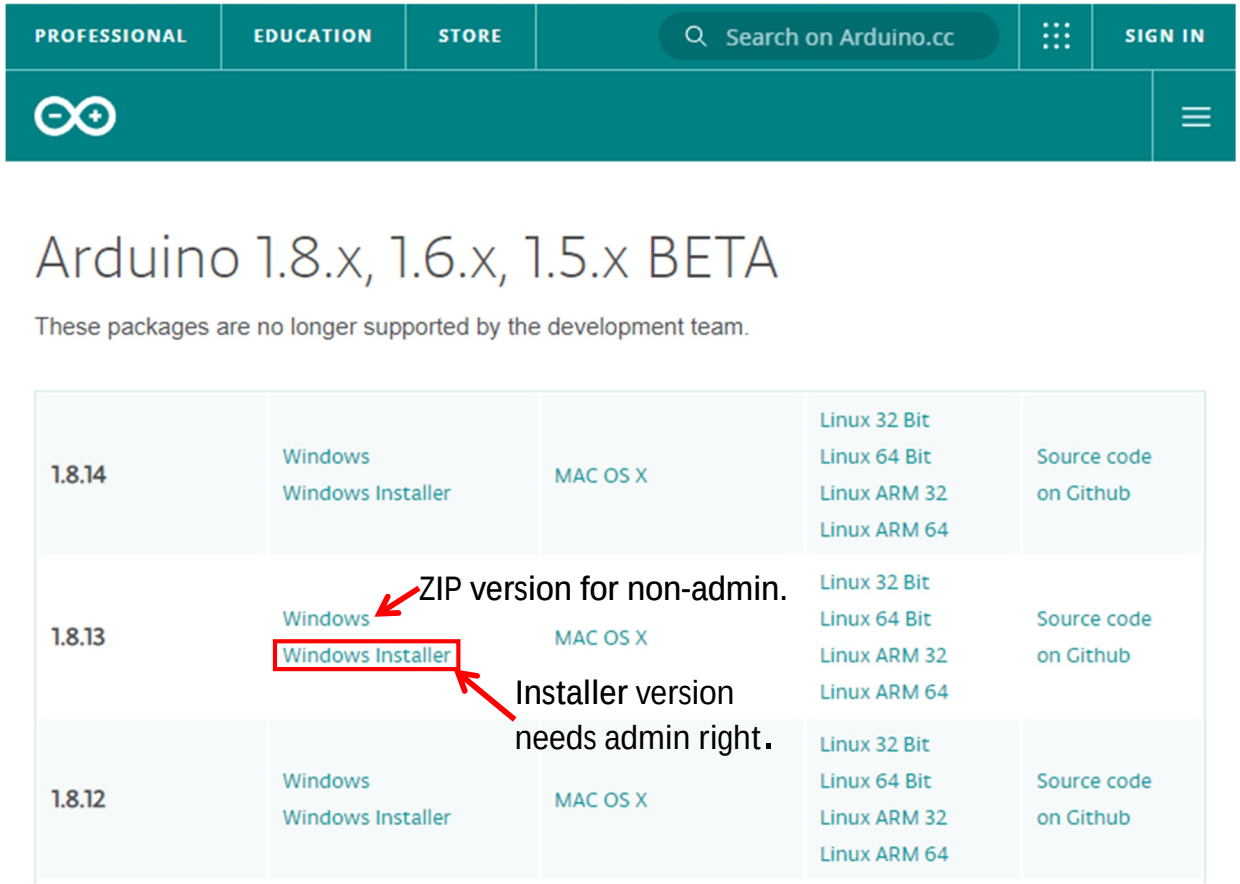
Install Arduino

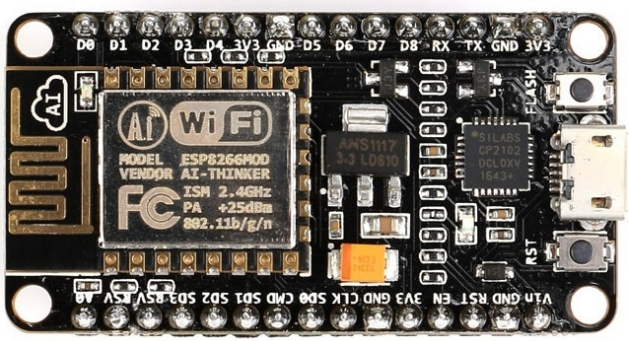
Install Arduino

- Go to Arduino official web page https://www.arduino.cc/en/Main/Software download the latest version.
- All sample codes are tested under version 1.8.13 (https://www.arduino.cc/en/Main/OldSoftwareReleases#previous)
- Run the downloaded installer or unzip the downloaded zip file.



Install ESP8266 to Arduino and basic test

The mark on ESP8266 is ESP8266MOD

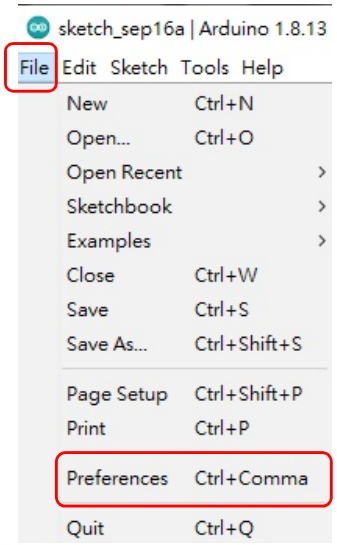


https://www.aliexpress.com/item/32799552941.html

Install ESP8266 to Arduino and basic test

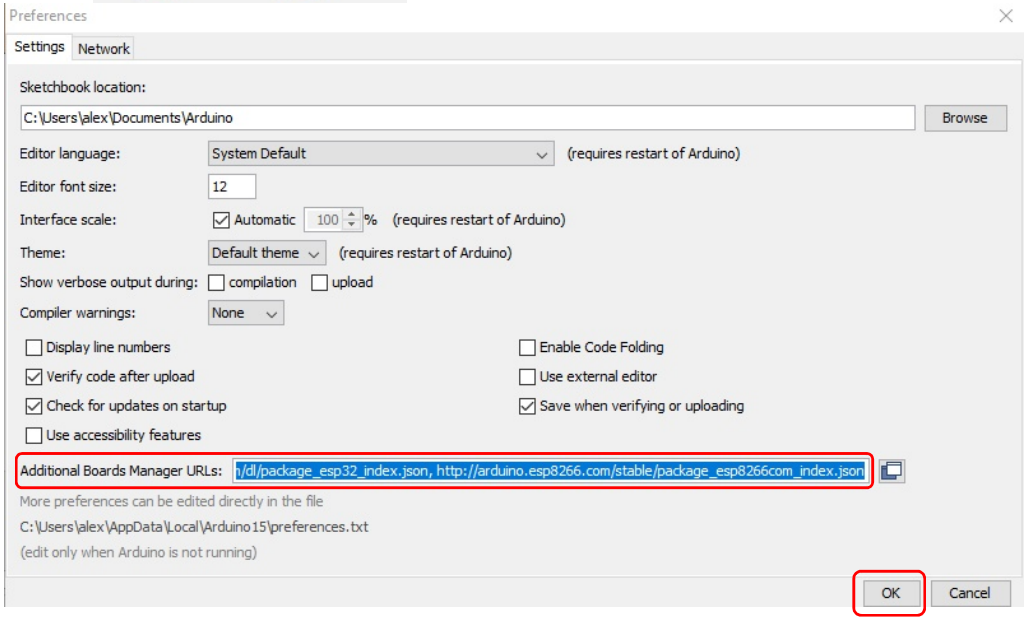
Reference video: https://randomnerdtutorials.com/how-to-install-esp8266-board-arduino-ide/

1. In Arduino IDE, go to File > Preference



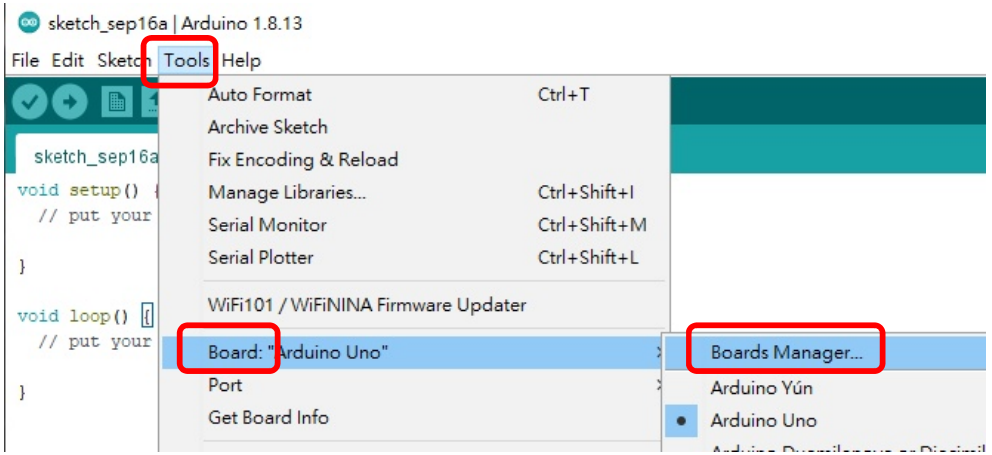
2. Fill Additional Boards Manger URLs:

- https://dl.espressif.com/dl/package_esp32_index.json, http://arduino.esp8266.com/stable/package_esp8266com_index.json
- Press OK.



Install ESP8266 to Arduino and basic test

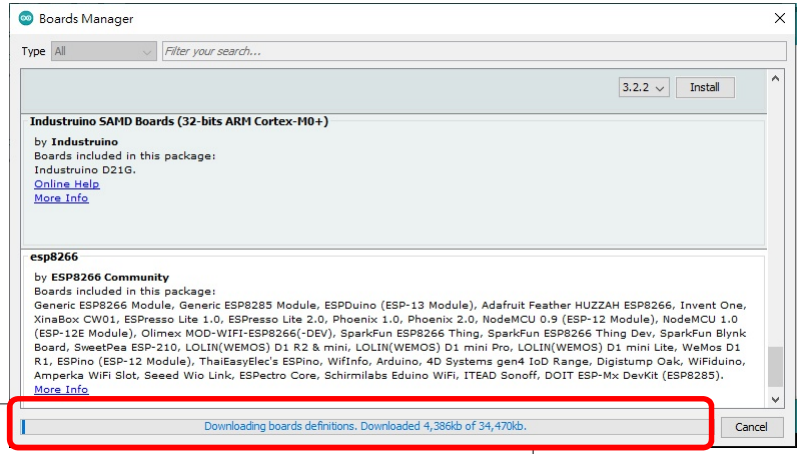
3. Go to Tools > Board: > Board Manger…



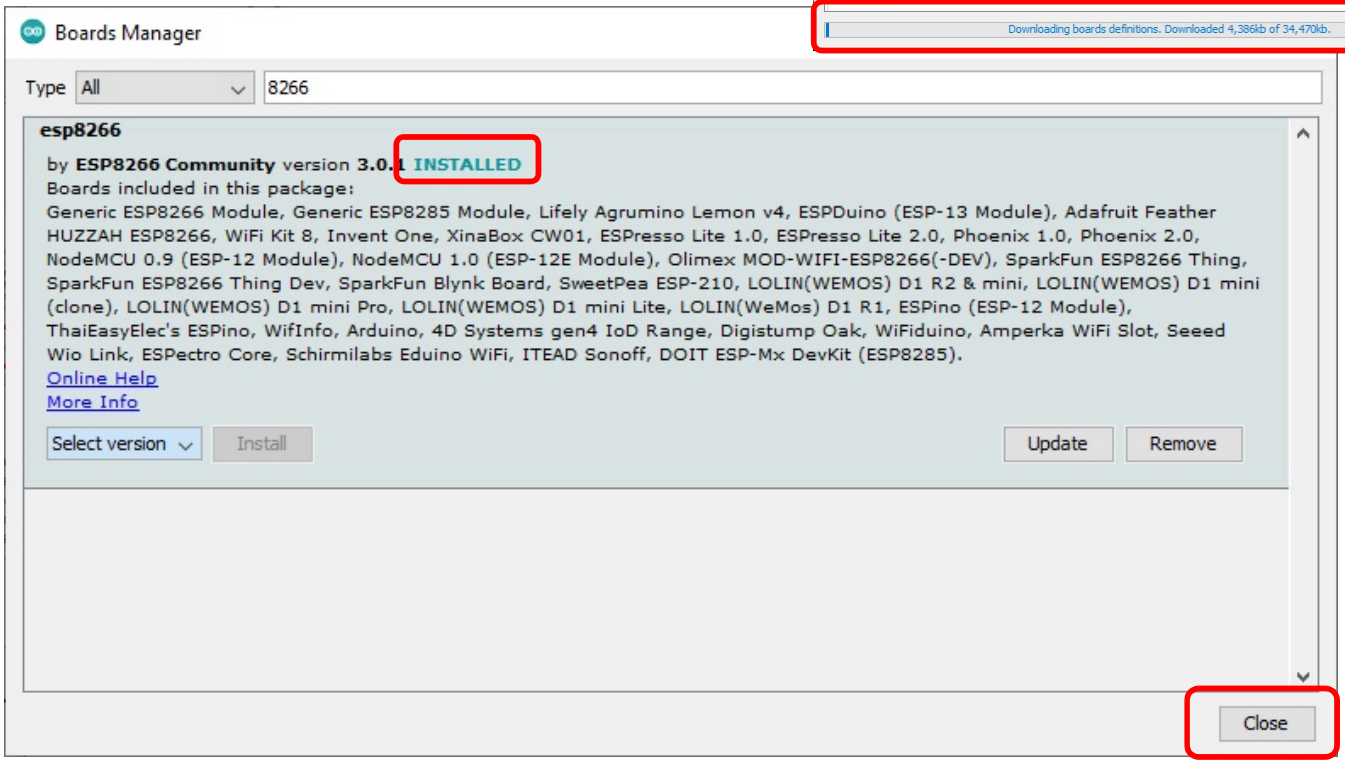
4. Key in ESP8266 to the Type field. The library for ESP8266 will be found from Internet due to step-2 setting.
5. Select version 3.0.1 and press Install.

Install ESP8266 to Arduino and basic test

7. Wait until installation complete.



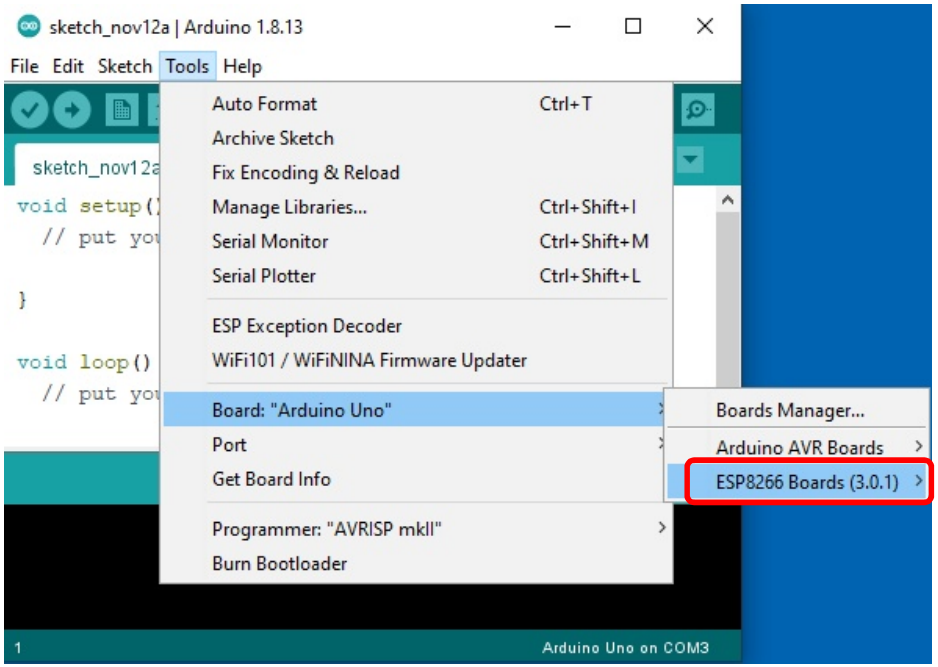
8. After installation, INSTALLED will be shown, and close the dialogue.



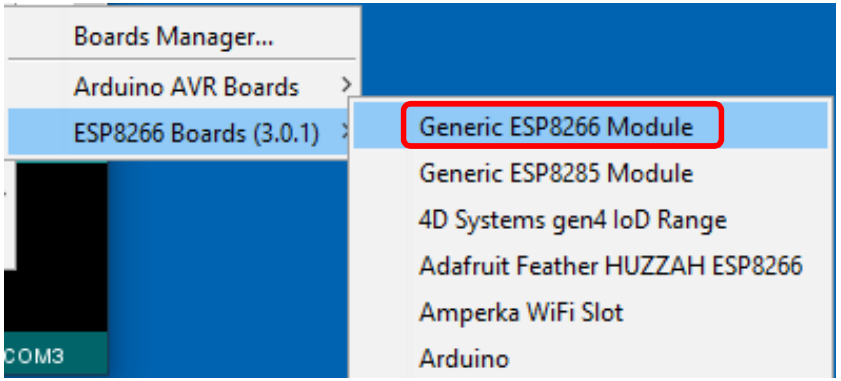
Install ESP8266 to Arduino and basic test

7. Change the target board to ESP8266.

   Go to Tools > Board > ESP8266.
   There are more than one model of ESP8266 in the selection list.

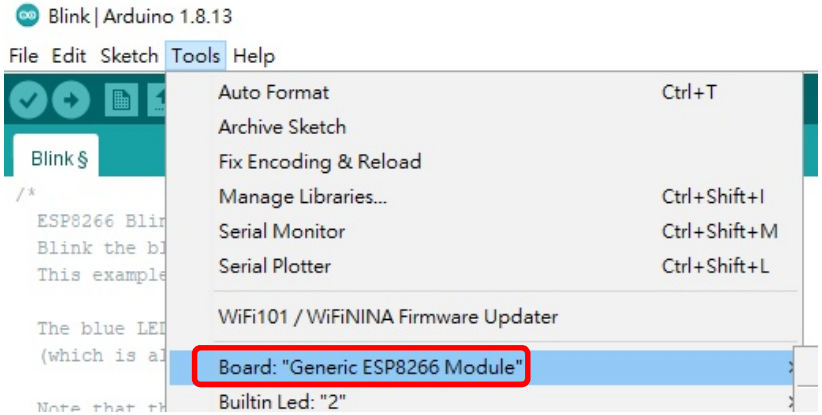


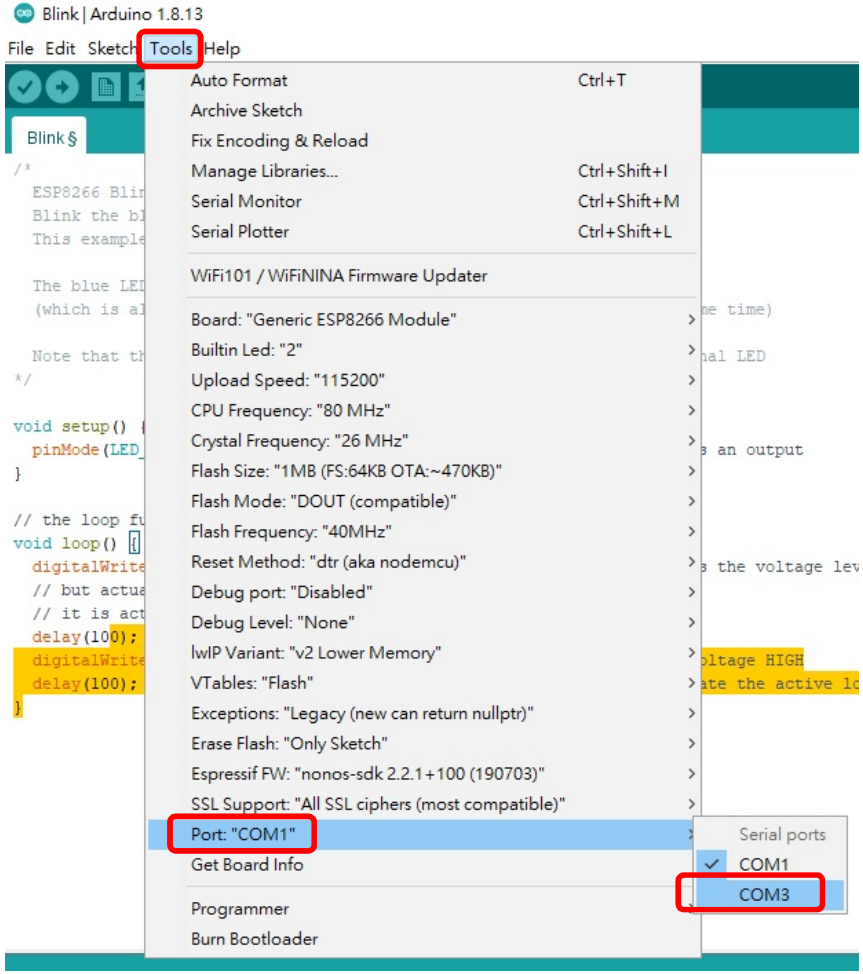
8. Select Generic ESP8266 Module



Install ESP8266 to Arduino and basic test

9. After change board, check it again.
   Go to Tools > Board > ESP8266. Make sure your target board is ESP8266.

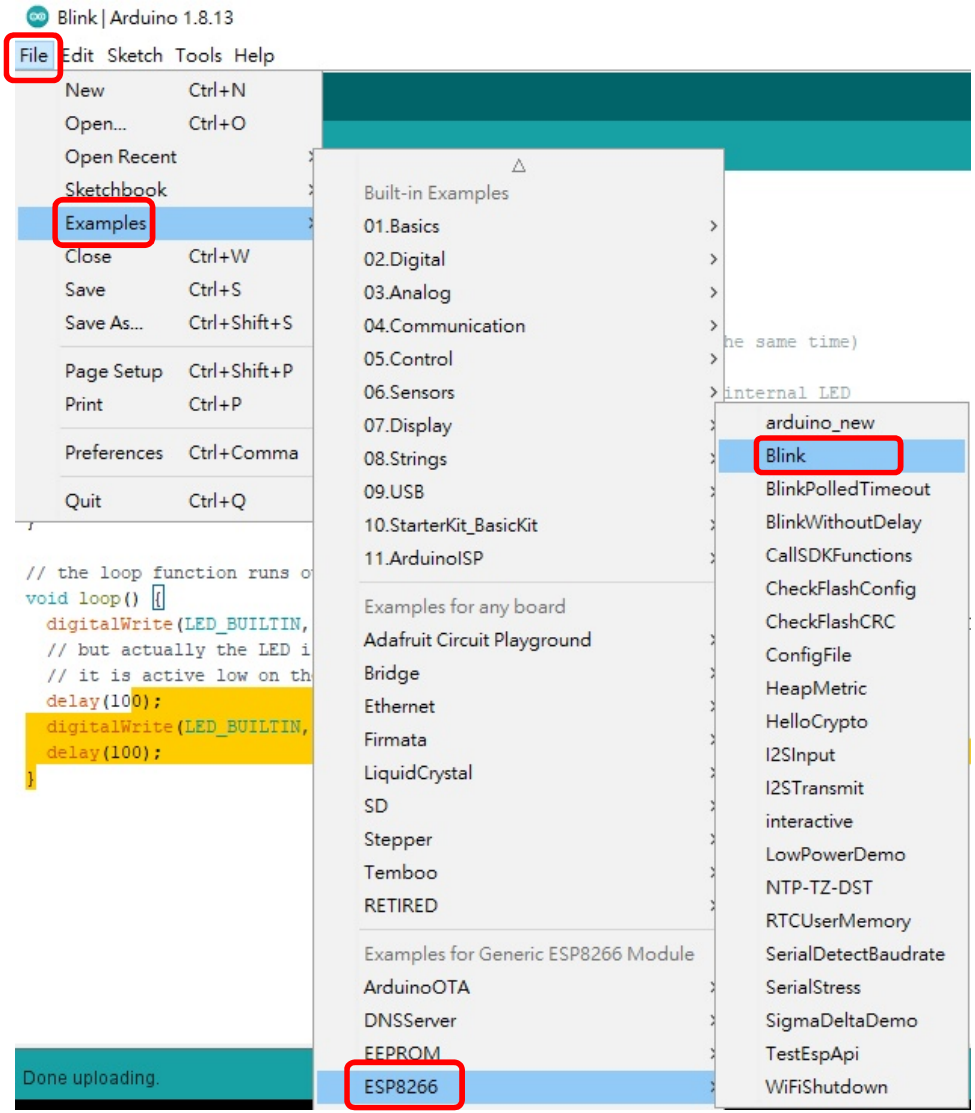




10. Connect the board to your PC with a USB cable (Micro-USB).
11. A new serial port (COM3 normally) will be found. It shows that your PC connects to the chip (USB to serial) on board correctly.
12. Go to Tools > Port , select the COM port according to your setting.

Install ESP8266 to Arduino and basic test

13. Open an example for test. Go to File > Example > ESP8266 > Blink.



Install ESP8266 to Arduino and basic test

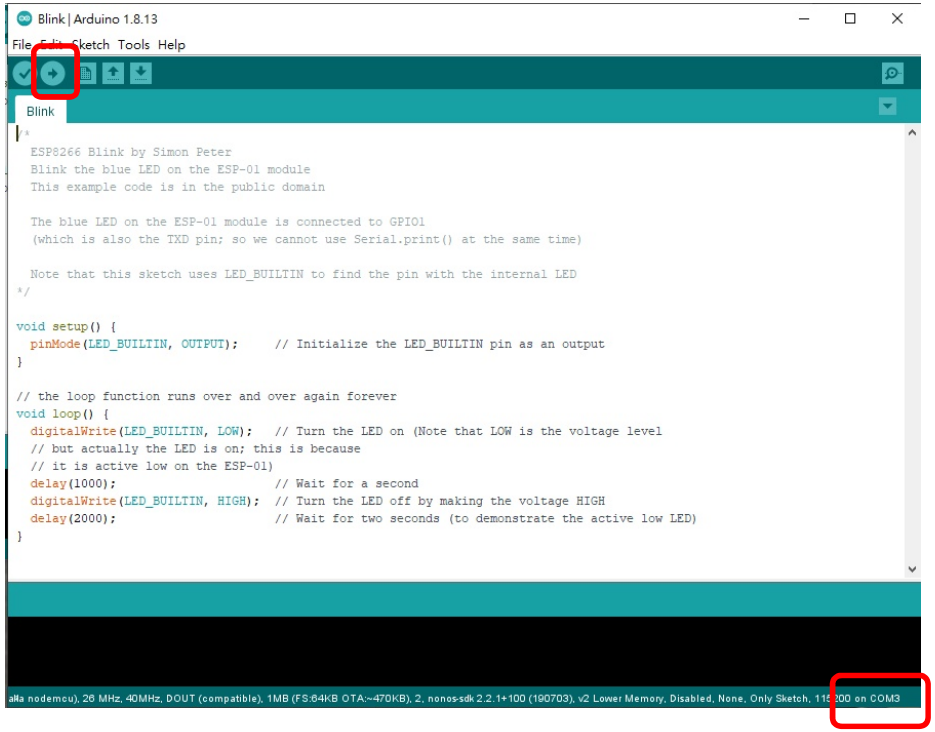
14. You can see the example program. Check the correct COM is selected (at the bottom right corner).

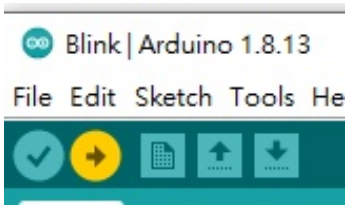
15. Press the arrow icon for compiling and download.

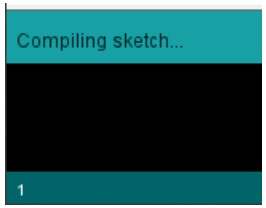
    The procedures are

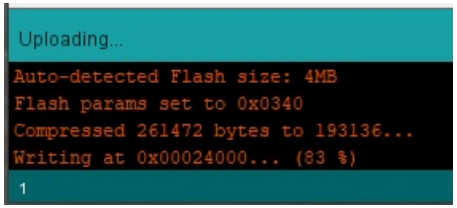
    - compiling sketch...
    - Uploading
    - Done uploading.

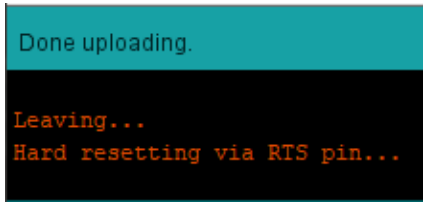
    The blue LED near the antenna will flash slowly. It means that Arduino IDE and ESP8266 library is installed correctly.











Install ESP8266 to Arduino and basic test

16. Modify the program, change two delay()s from 1000 and 2000 to 100 and 200. Press the arrow icon to recompile and download again. The blue LED must flash faster after Done downloading.

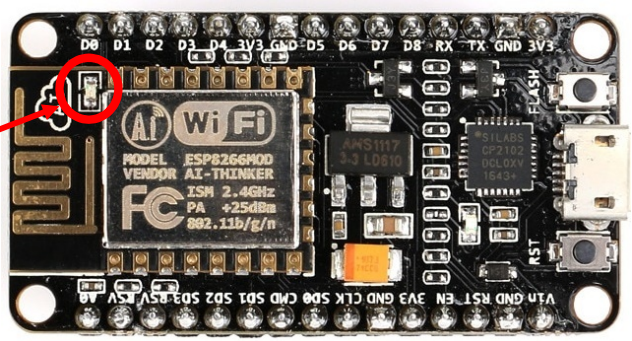
```
// the loop function runs over and over aga
void loop() {
  digitalWrite(LED_BUILTIN, LOW);   // Turn
  // but actually the LED is on; this is be
  // it is active low on the ESP-01)
  delay(1000);                      // Wait
  digitalWrite(LED_BUILTIN, HIGH);  // Turn
  delay(2000);                      // Wait
}
```

original

```
// the loop function runs over and over again f
void loop() {
  digitalWrite(LED_BUILTIN, LOW);   // Turn the
  // but actually the LED is on; this is becaus
  // it is active low on the ESP-01)
  delay(100);                       // Wait for
  digitalWrite(LED_BUILTIN, HIGH);  // Turn the
  delay(200);                       // Wait for
}
```

modified

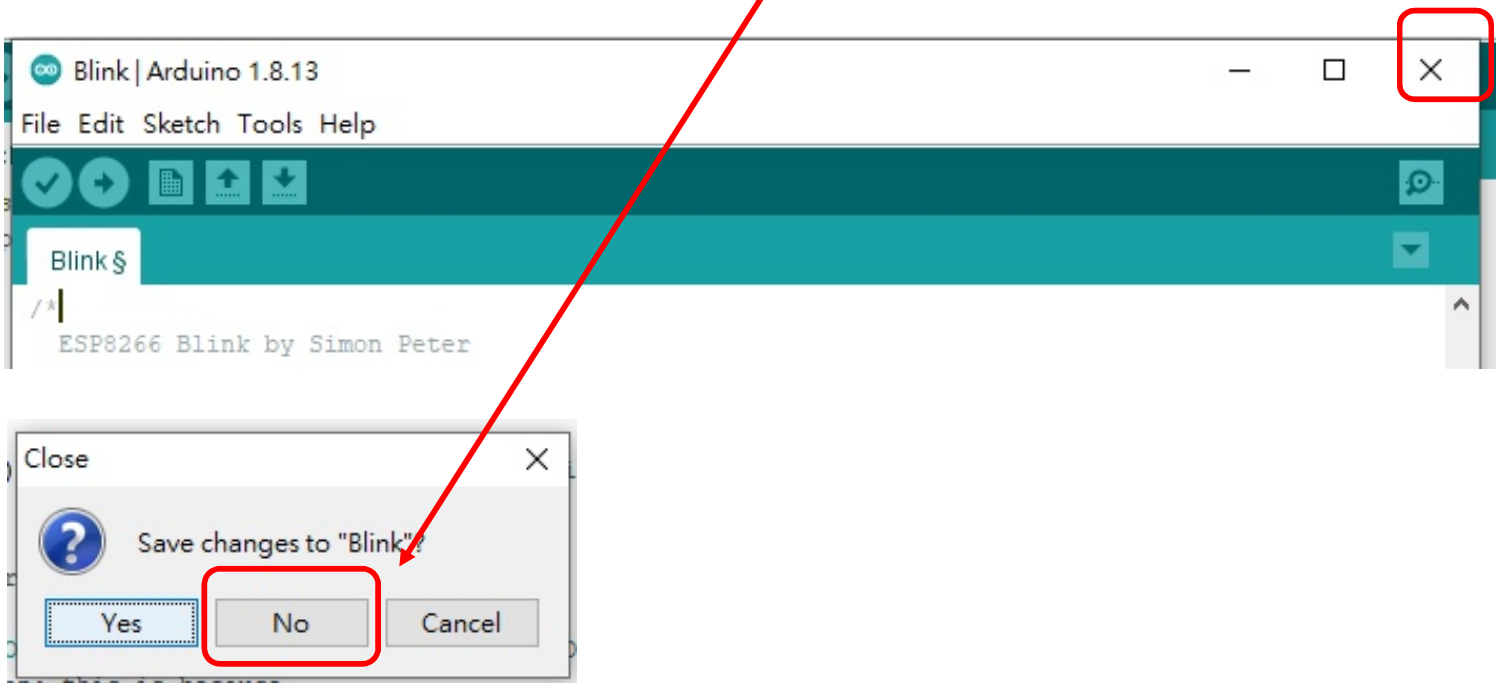
The blue LED



17. Modify the program, change two delay() from 1000 and 2000 to 100 and 200. Press the arrow icon to recompile and download again. The blue LED must flash faster after Done downloading.

Install ESP8266 to Arduino and basic test

18. Press the ‘X’ to close Arduino directly. And select ‘No’ for save changes to prevent modify the original example.



Important: Please keep all examples as the original, you can recall them again.

Install OLED Adafruit SSD 1306 to Arduino and basic test

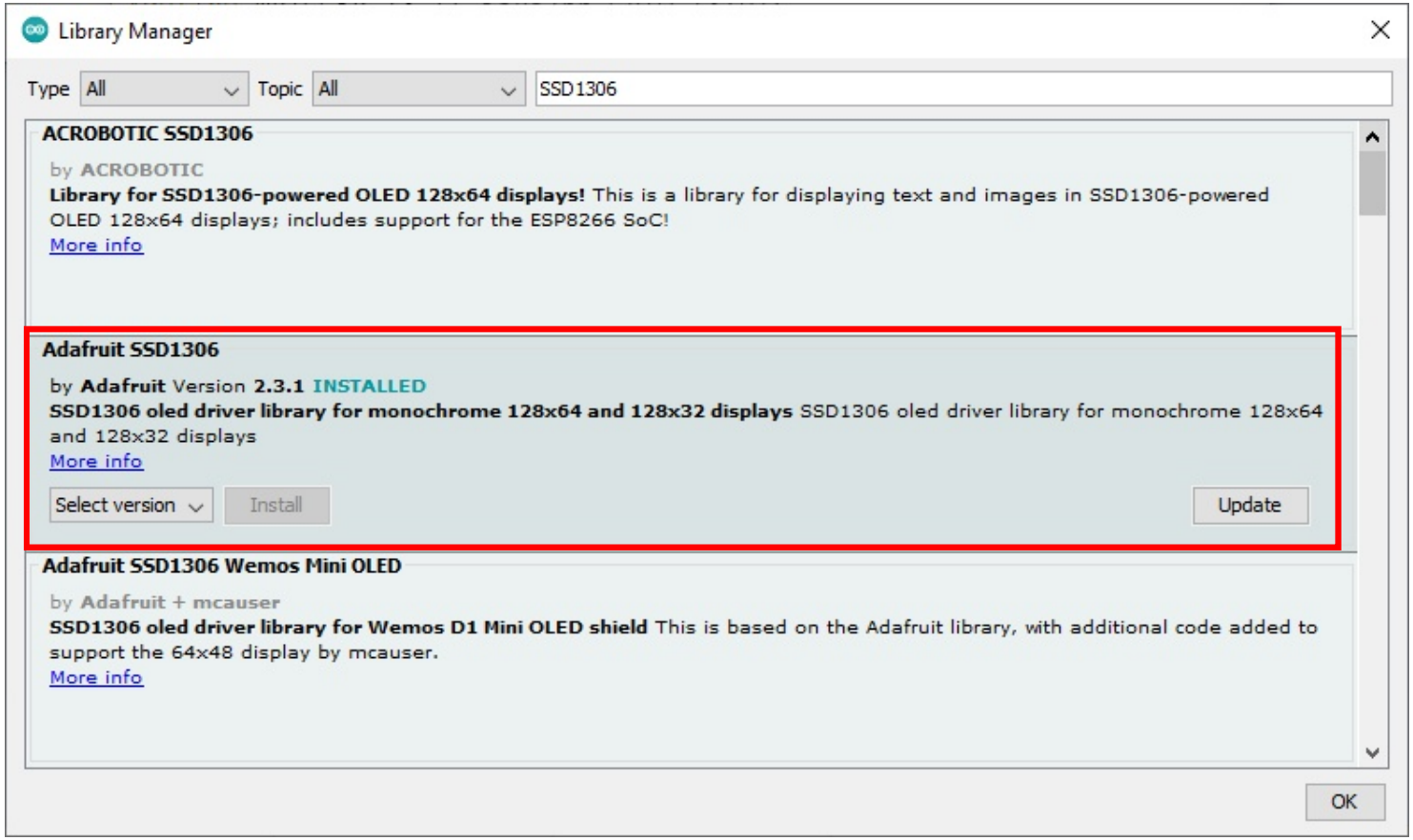
https://www.geekering.com/wp-content/uploads/2020/07/SSD1306-OLED-Display.png

Installing OLED Adafruit SSD 1306 Library to Arduino and basic test

Reference link: https://randomnerdtutorials.com/esp8266-0-96-inch-oled-display-with-arduino-ide/

There are several libraries available to control the OLED display with the ESP8266.
We'll use two Adafruit libraries: Adafruit_SSD1306 library and Adafruit_GFX library.

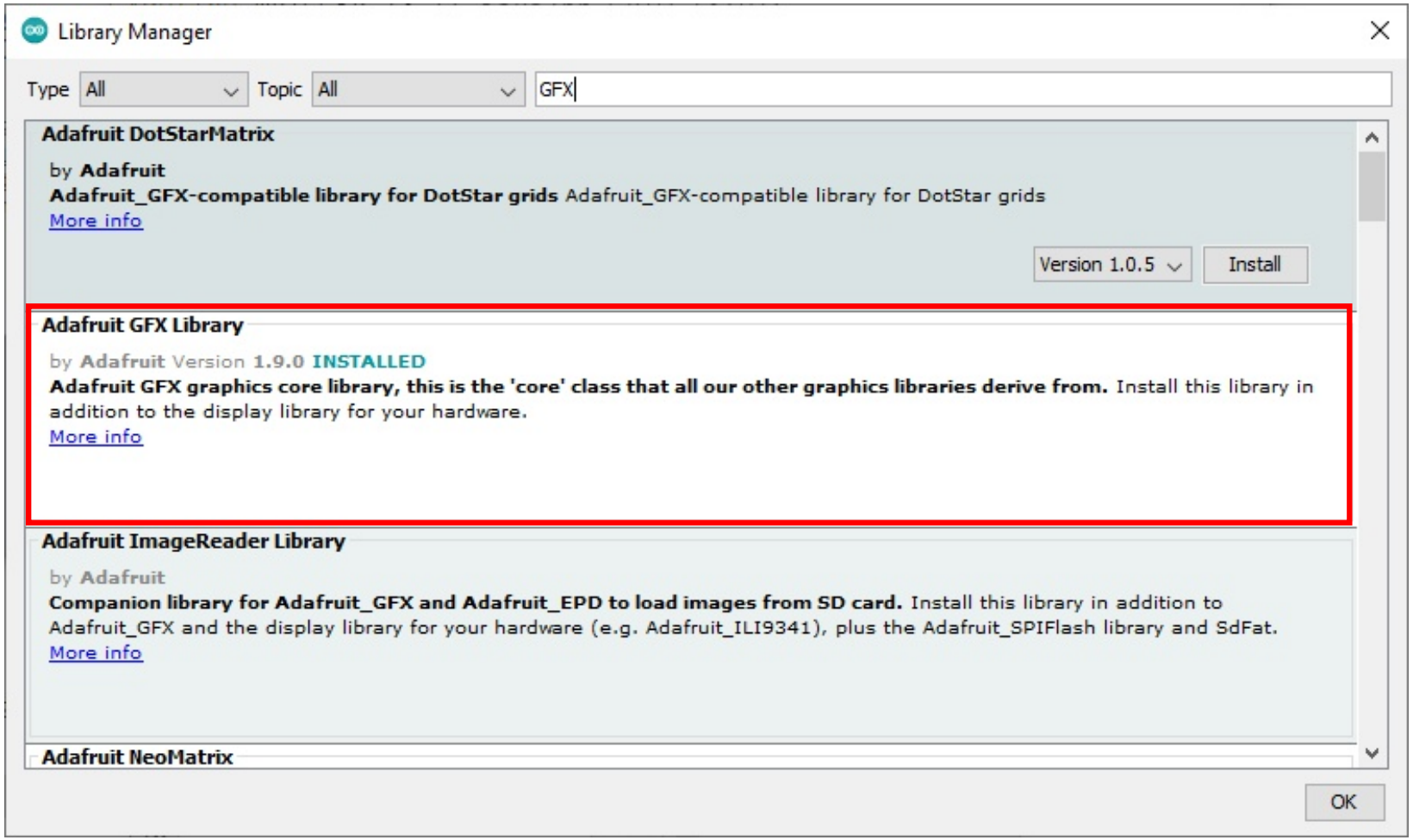
1. Open your Arduino IDE and go to Sketch > Include Library > Manage Libraries. The Library Manager should open.
2. Type "SSD1306" in the search box and install the SSD1306 library from Adafruit.



Installing OLED Adafruit SSD 1306 Library to Arduino and basic test

Reference link: https://randomnerdtutorials.com/esp8266-0-96-inch-oled-display-with-arduino-ide/

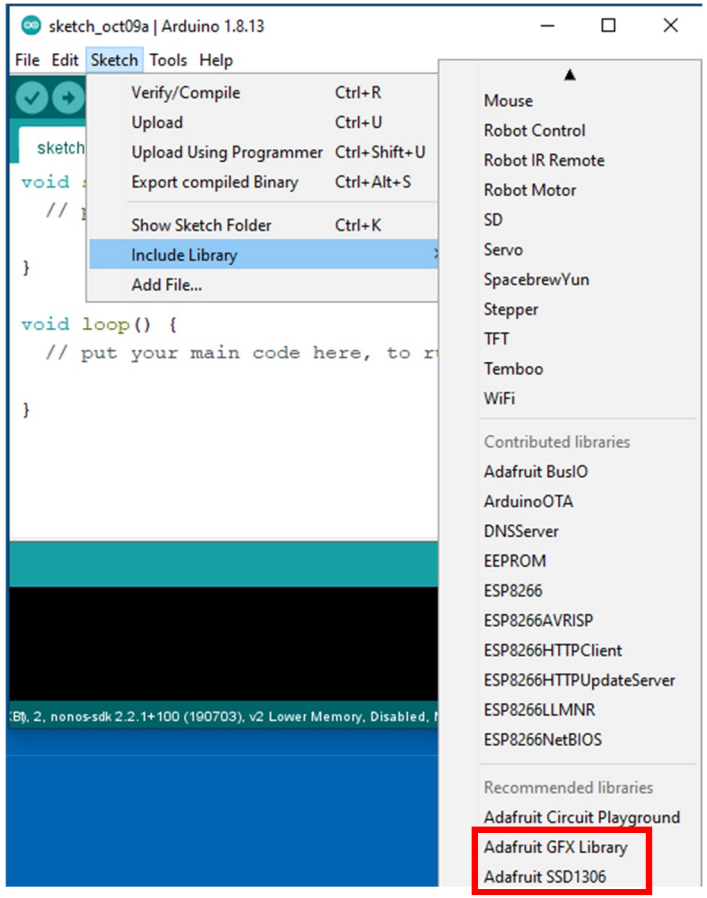
3. After installing the SSD1306 library from Adafruit, type “GFX” in the search box and install the library.
4. After installing the libraries, restart your Arduino IDE.



Installing OLED Adafruit SSD 1306 Library to Arduino and basic test

Reference link: https://randomnerdtutorials.com/esp8266-0-96-inch-oled-display-with-arduino-ide/

5. In your Arduino IDE, go to **Sketch > Include Library** you should see two libraries Adafruit SSD1306 and Adafruit_GFX library



Installing OLED Adafruit SSD 1306 Library to Arduino and basic test

Reference link: https://randomnerdtutorials.com/esp8266-0-96-inch-oled-display-with-arduino-ide/

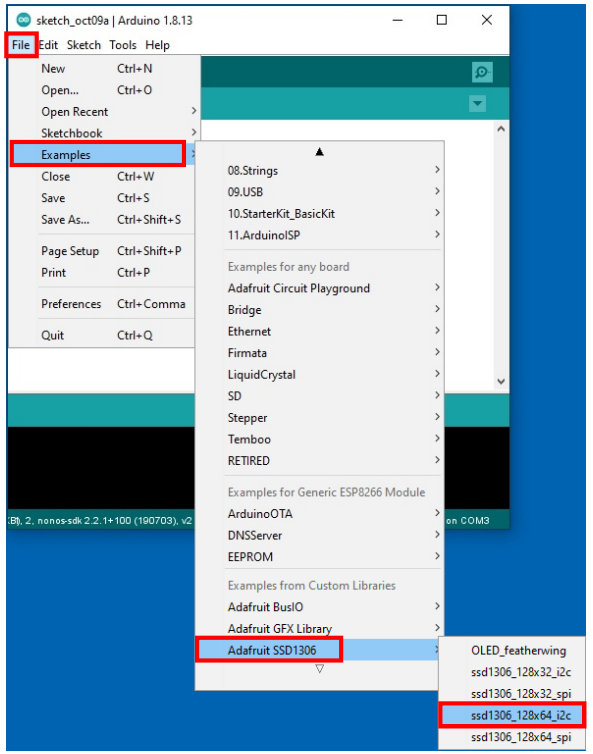
6. After wiring (I2C) the OLED display to the ESP8266 you can use one example from the library to see if everything is working properly.
7. In your Arduino IDE, go to File > Examples > Adafruit SSD1306 and open the example ssd1306_128x64_i2c
8. Change OLED_RESET variable to -1 as shown below

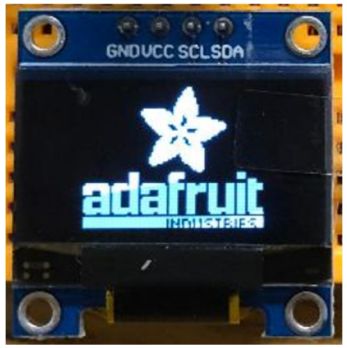
```
#define SCREEN_WIDTH 128 // OLED display width, in pixels
#define SCREEN_HEIGHT 64 // OLED display height, in pixels

// Declaration for an SSD1306 display connected to I2C (SDA, SCL pins)
#define OLED_RESET     -1 // Reset pin # (or -1 if sharing Arduino reset pin)
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, OLED_RESET);
```

9. Change OLED address to 0x3C as shown below

```
// SSD1306_SWITCHCAPVCC = generate display voltage from 3.3V internally
if(!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) { // Address 0x3D for 128x64
  Serial.println(F("SSD1306 allocation failed"));
  for(;;); // Don't proceed, loop forever
```

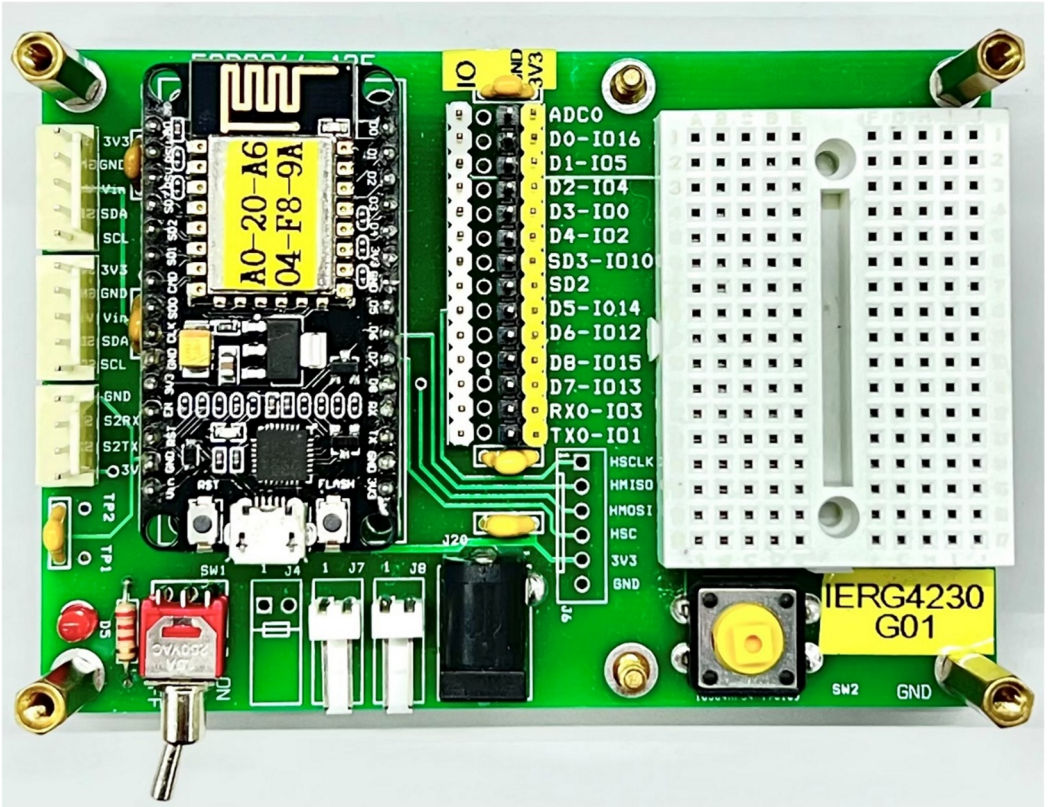
10. Upload the code to your ESP8266 board. Don't forget to select the right board and COM port in the Tools menu.





The result of the example ssd1306_128x64_i2c

ESP8266 with I/O extended board



Advantages of ESP8266:

- Support I^2C interface, suggest using I^2C modules.
- Support two UARTs.
- Support 802.11 b/g/n WLAN MAC protocol.
- Support sleep mode for power saving.
- Max. 17 digital I/Os (reduce number of I/O when special functions are used.).
- Support SPI interface.
- Support four PWM outputs.

Important notes (limitations) of ESP8266:

- The max. power supply of ESP8266 is 3.3V.
- Only one analogue input (10-bit A to D) A0.
- The output of on board regulator is 700mA only.
- For Digital I/Os, suggest using pin D5, D6, D7 and D8.
- No 5V supply. You need a voltage converter for interfacing to 5V I/O modules.

Matter needing attention:

On Boot/Reset/wakeup,

- D8(GPIO15) MUST keep LOW AND D4(GPIO2) MUST keep HIGH
- D3(GPIO0) MUST keep HIGH (Run mode) running downloaded program
- D3(GPIO0) MUST keep LOW (Flash mode) for downloading program

On Board LEDs (active LOW):

- D0(GPIO16)
- D4(GPIO2)

Important notes of our design.

- The provided ESP8266 board powered by computer USB port (normal 500mA). Do not powered by external power source (e.g. Mobile phone charger).

- For safety reason, the ESP8266 boards are powered by USB battery pack. **Do not use AC-to-USB converter.** Nobody know your AC converter that fulfils safety regulation or not.

- The current limit of ESP8266 on board regulator (5V to 3V3) is 700mA. Do not take too much current from it. It will be damaged by over current. Consult our technicians if your project needs to drive high current (e.g. motor, servo).

- ESP8266 does not support 5V I/O default. Need a voltage converter (simple resistor potential divider) for interface 5V modules. The provided 5V modules are tested. Consult our technicians if other 5V modules are connected to the CPU boards.

- For multiplex/protocol device, use I^2C.

- Release SPI pins for general I/Os .

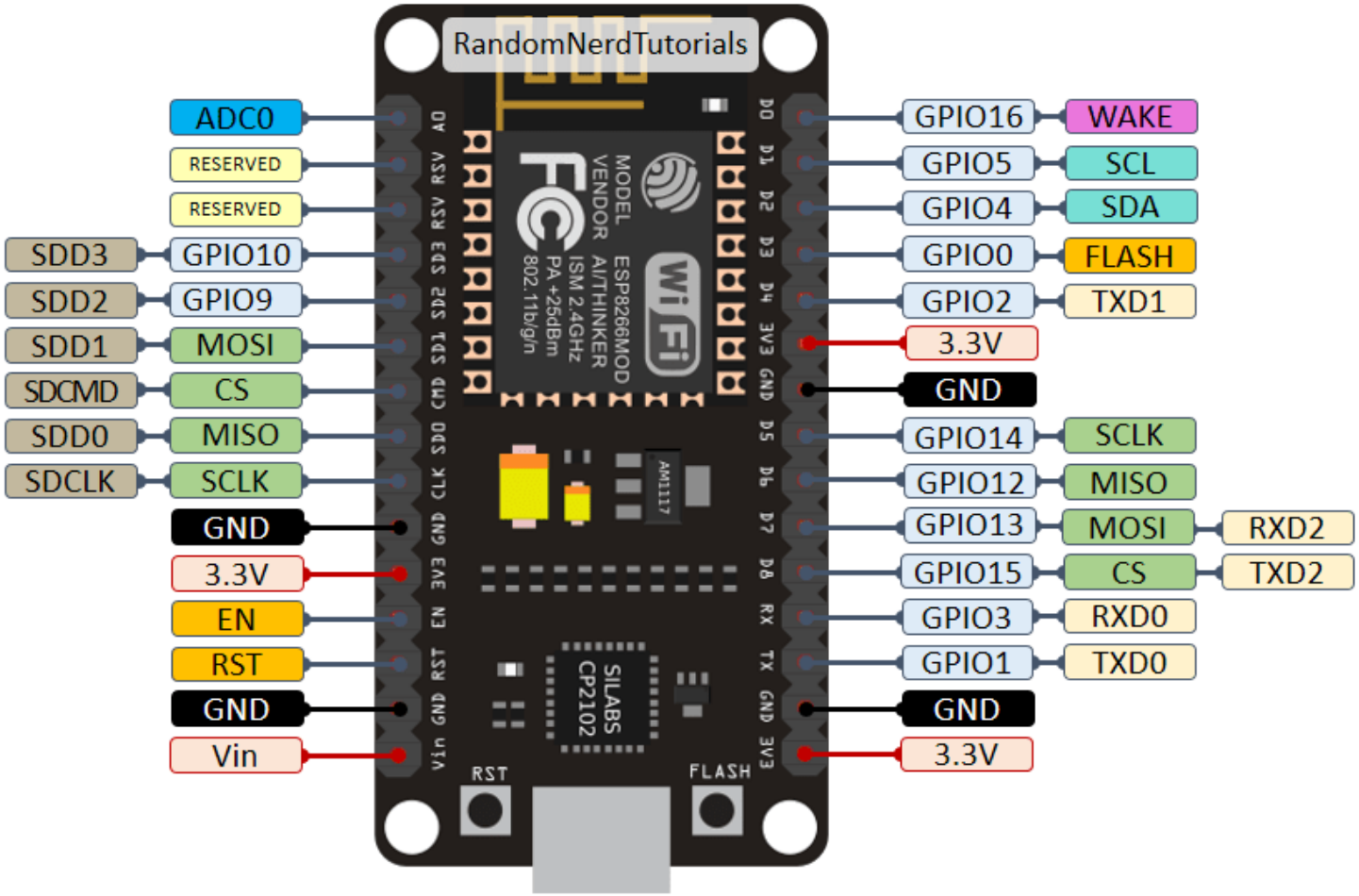
- Use UART monitor in Arduino for programme debugging.

Best Pins to Use

https://randomnerdtutorials.com/esp8266-pinout-reference-gpios/

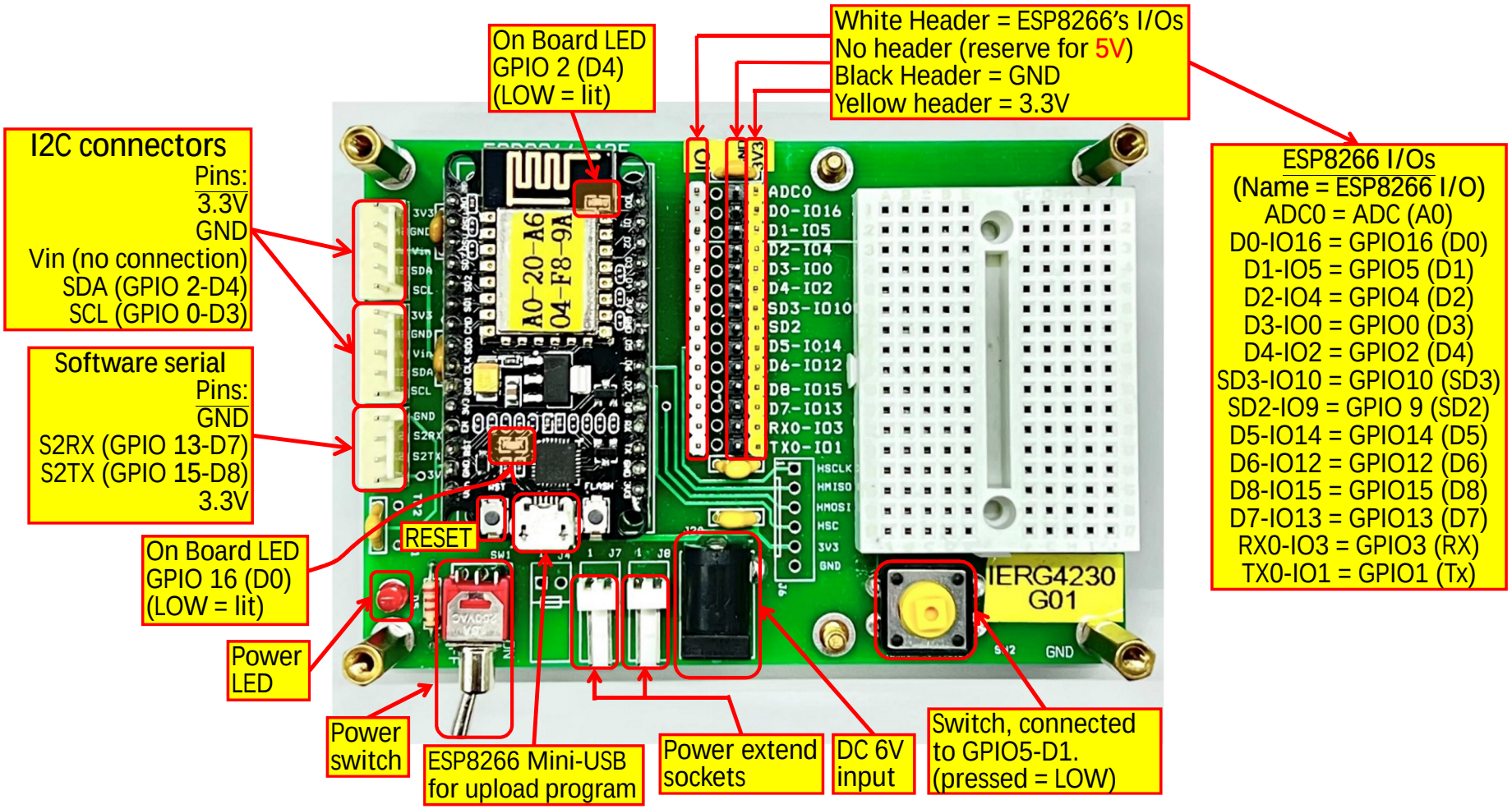
Label	GPIO	Input	Output	Notes
D0	GPIO16	no interrupt	no PWM or I2C support	HIGH at boot used to wake up from deep sleep
D1	GPIO5	OK	OK	often used as SCL (I2C)
D2	GPIO4	OK	OK	often used as SDA (I2C)
D3	GPIO0	pulled up	OK	connected to FLASH button, boot fails if pulled LOW
D4	GPIO2	pulled up	OK	HIGH at boot connected to on-board LED, boot fails if pulled LOW
D5	GPIO14	OK	OK	SPI (SCLK)
D6	GPIO12	OK	OK	SPI (MISO)
D7	GPIO13	OK	OK	SPI (MOSI)
D8	GPIO15	pulled to GND	OK	SPI (CS) Boot fails if pulled HIGH
RX	GPIO3	OK	RX pin	HIGH at boot
TX	GPIO1	TX pin	OK	HIGH at boot debug output at boot, boot fails if pulled LOW
A0	ADC0	Analog Input	X	

Pin assignment of ESP8266-12-E



https://i2.wp.com/randomnerdtutorials.com/wp-content/uploads/2019/05/ESP8266-NodeMCU-kit-12-E-pinout-gpio-pin.png?ssl=1

Provided ESP8266 with I/O extended board



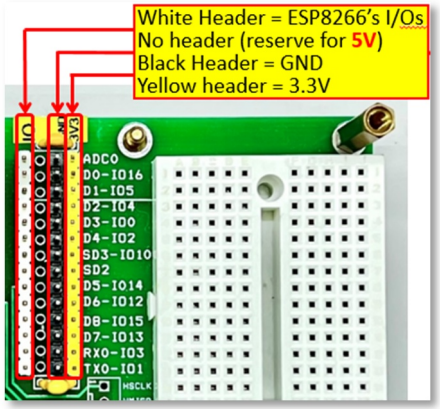
Sample Codes

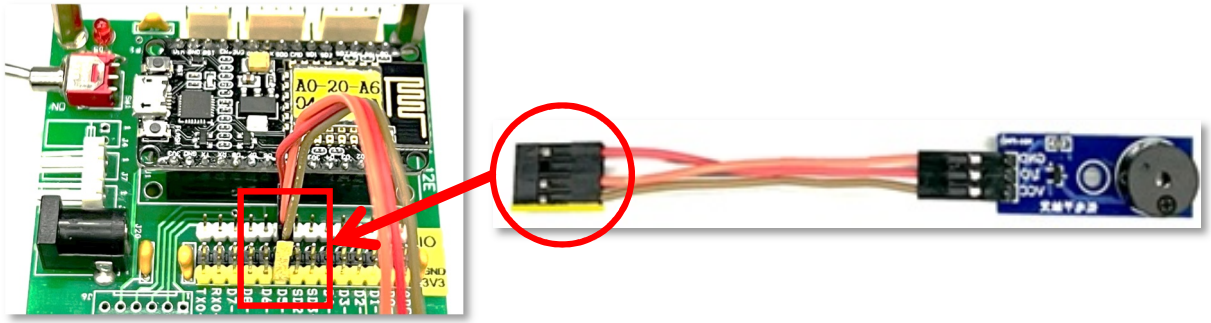
Notes to the sample codes:

- Download "All-in-one.rar" or individual rar file from the Blackboard.
- Only group C devices are provided sample codes.
- All sample codes are tested with ESP8266 board.
- If you are using the given programs in Experiments 1 and 2 to develop your prototype, you need to migrate the sample codes to the above given programs.
- The I/Os used in the sample codes are just reference. You may change its according to your design with compliance to the project boards (Nano/ESP8266) specification.
- If you use the sensors with Nano, you need modify the connections (I/O) and sample code with Nano board specification.
- The sample codes are just for functionality test.
- Please read the comments in the sample code for more information.

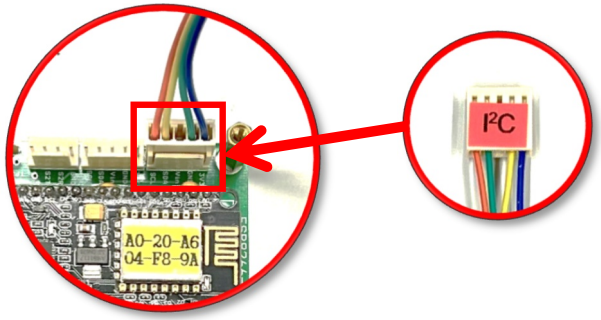
Provided ESP8266 with I/O extended board

- 3 rows of pins are ESP8266's I/O (White), GND (Black) and 3.3V (Yellow).
- The socket of provided modules are multiple pins for these pins. Connect the colour marks (Yellow) to the Yellow header.



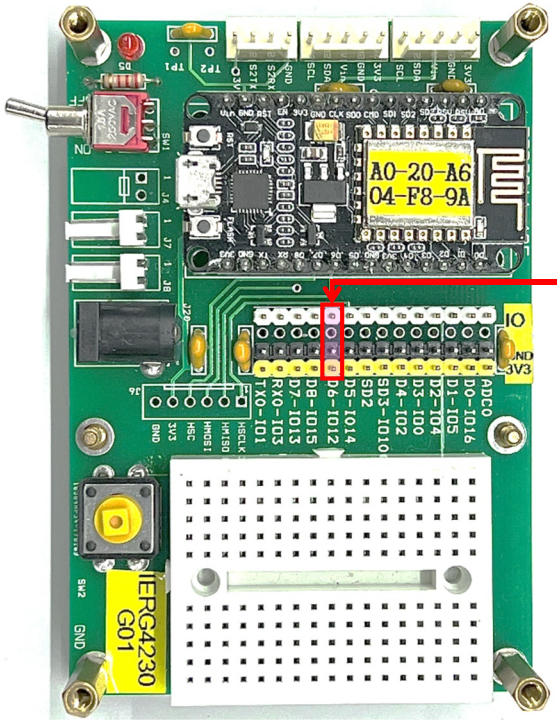


- The socket for I^2C modules is standardize, directly connect it to the *I²C* connectors.

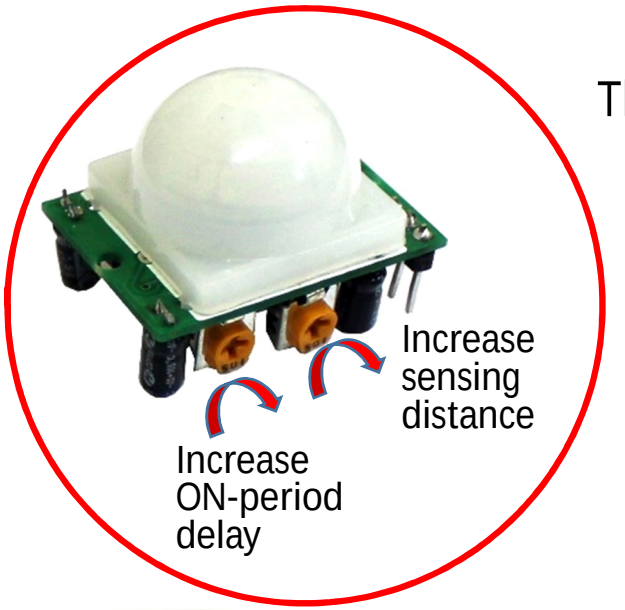


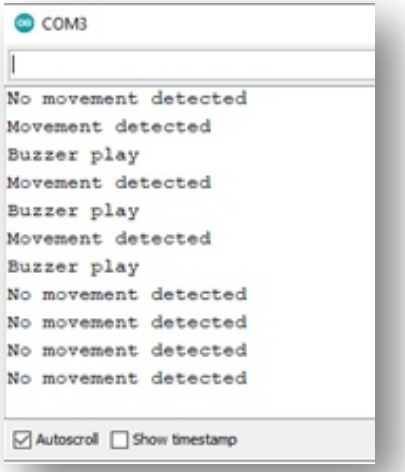
- A0 is 10-bit A/D input.
- The board did not provide 5V supply. Consult technician for 5V sensors.

C1. Human movement sensor (HC-SR501, Digital, 5V)

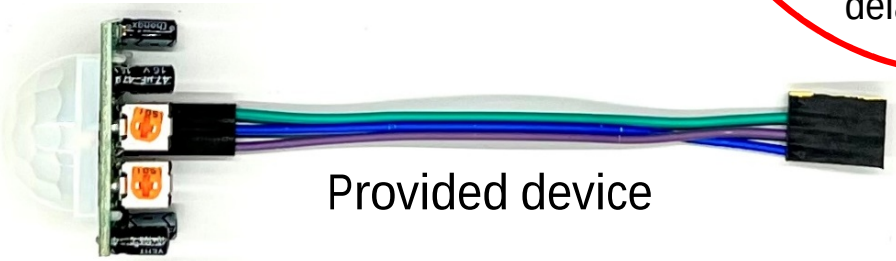


GPIO12 – D6 (Digital input)
5V
GND
X



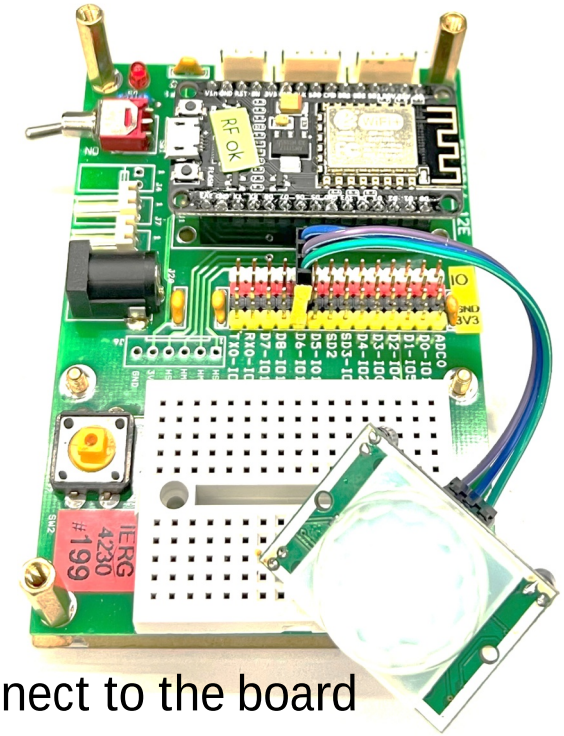


The result of the demo program



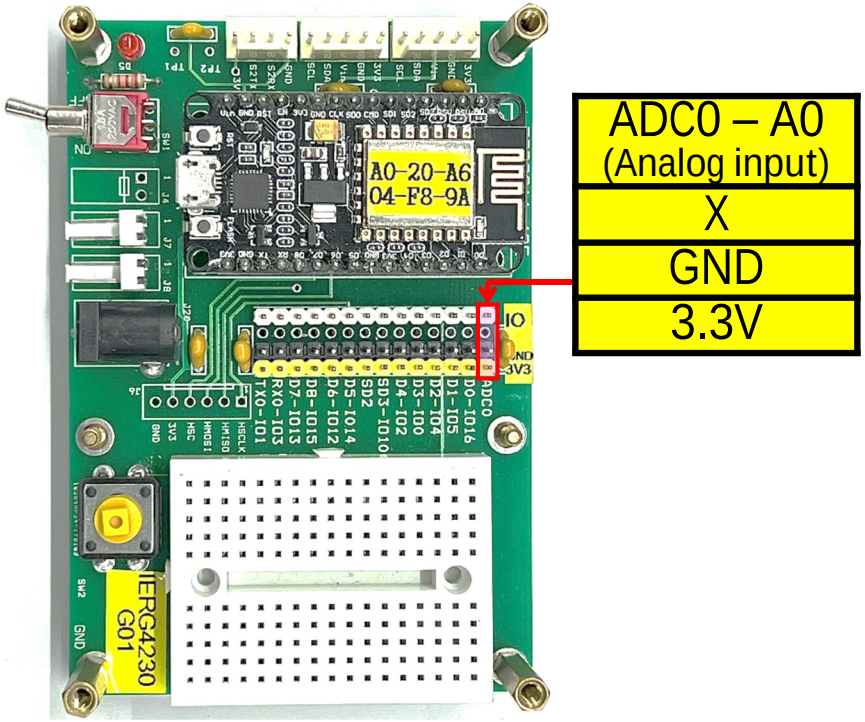
Provided device

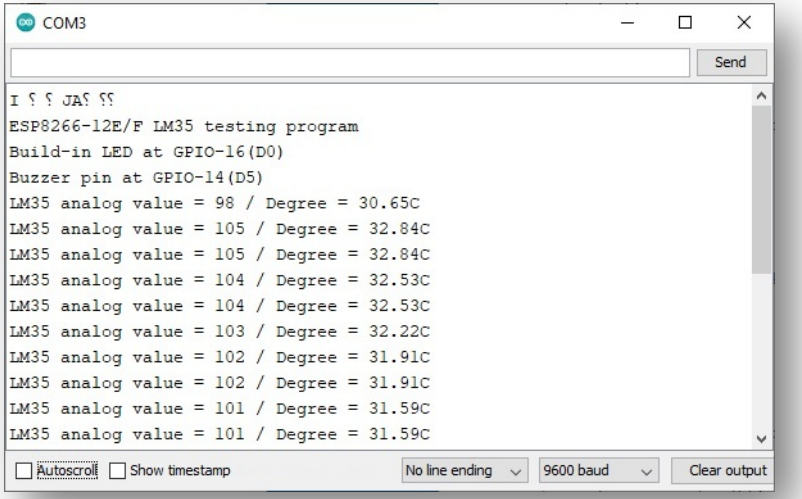
This is 5V device



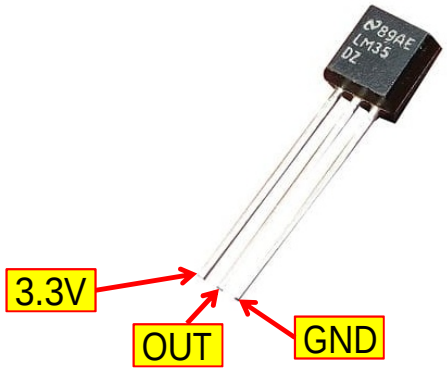
Connect to the board

C2. Temperature Sensor (LM35, analogue)

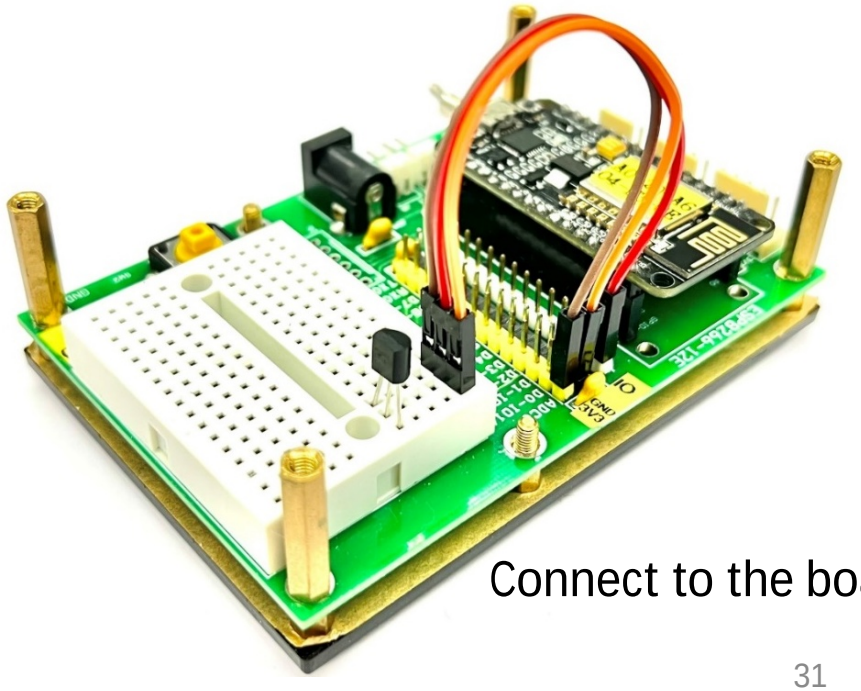




The result of the demo program

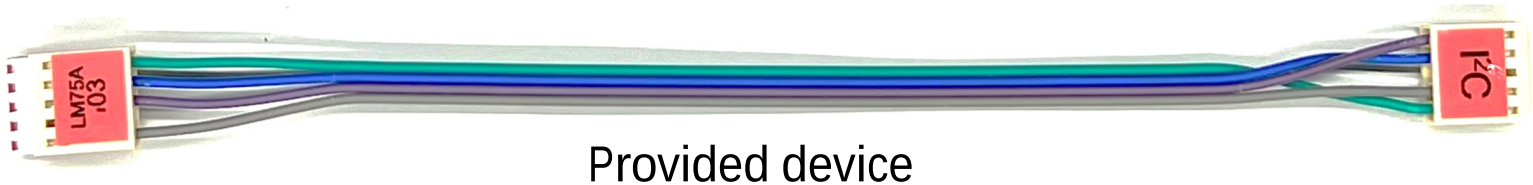


Provided device

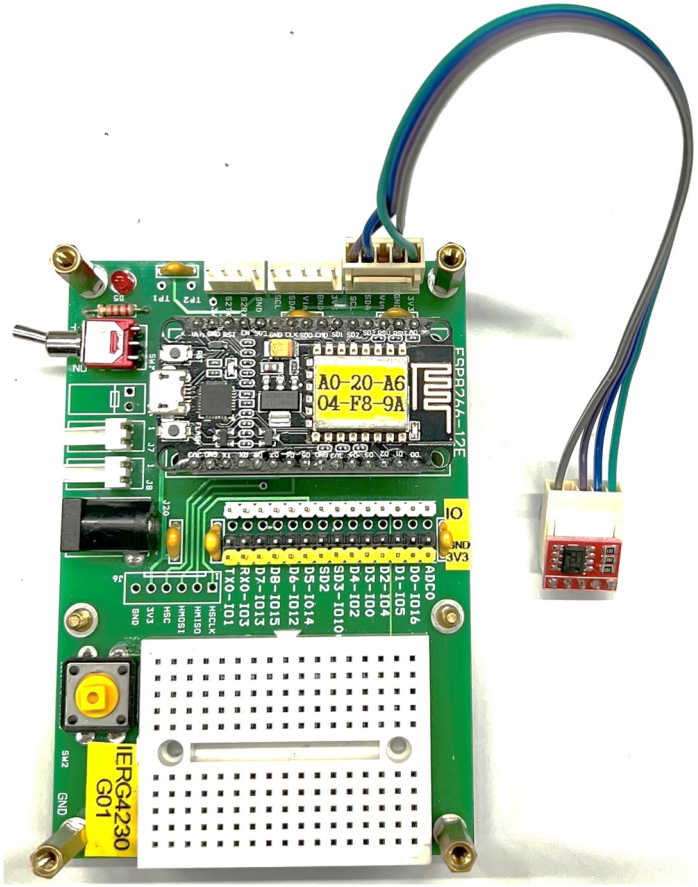


Connect to the board

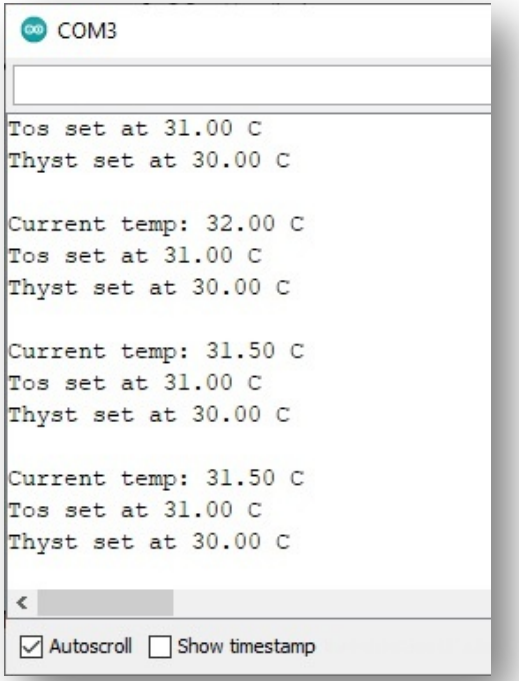
C3. Temperature Sensor (LM75 , I^2C)



Provided device

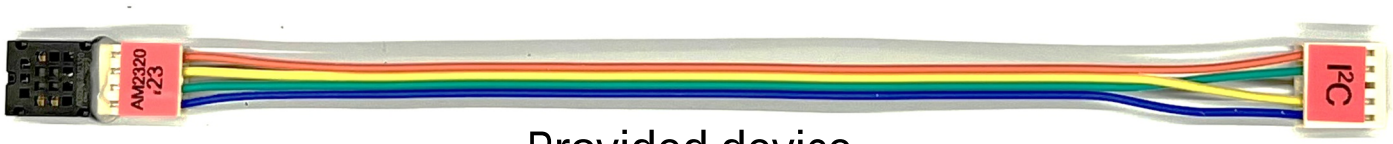


Connect to the board

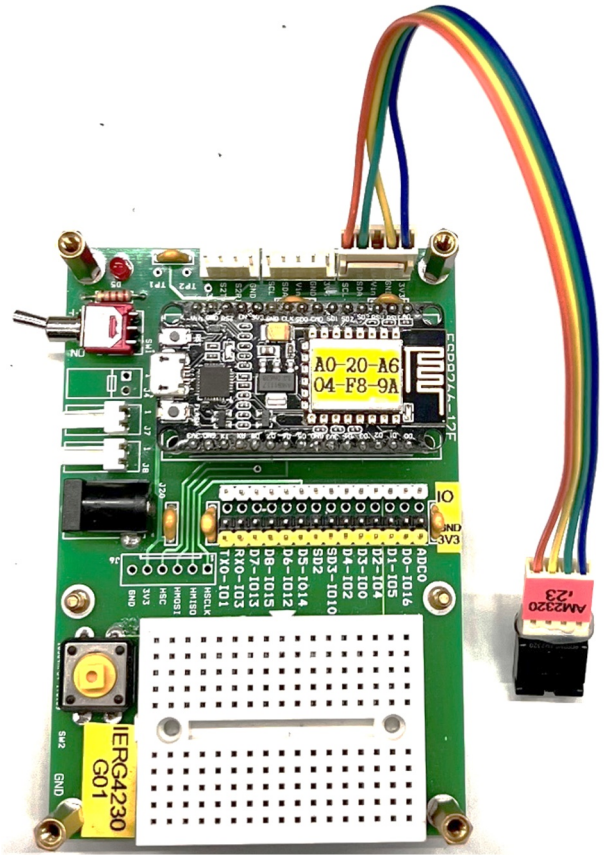


The result of the demo program

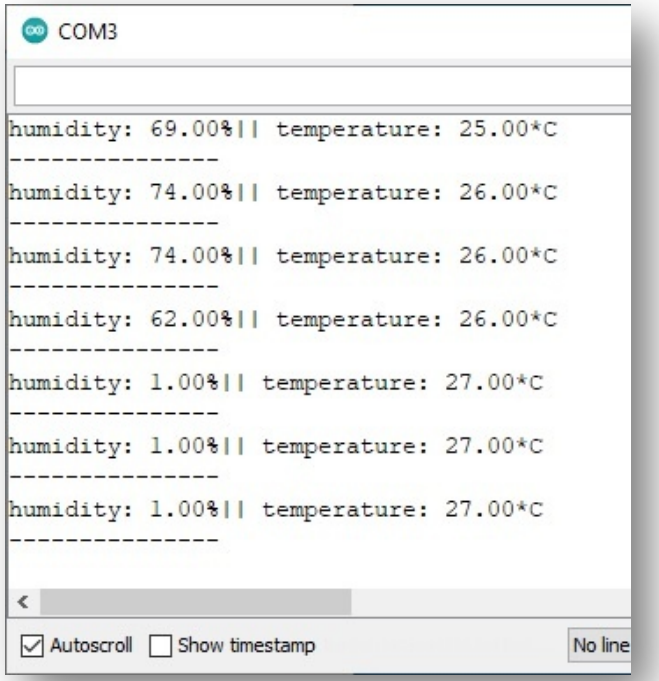
C4. Temperature and Humidity Sensor (AM2320, I^2C)



Provided device



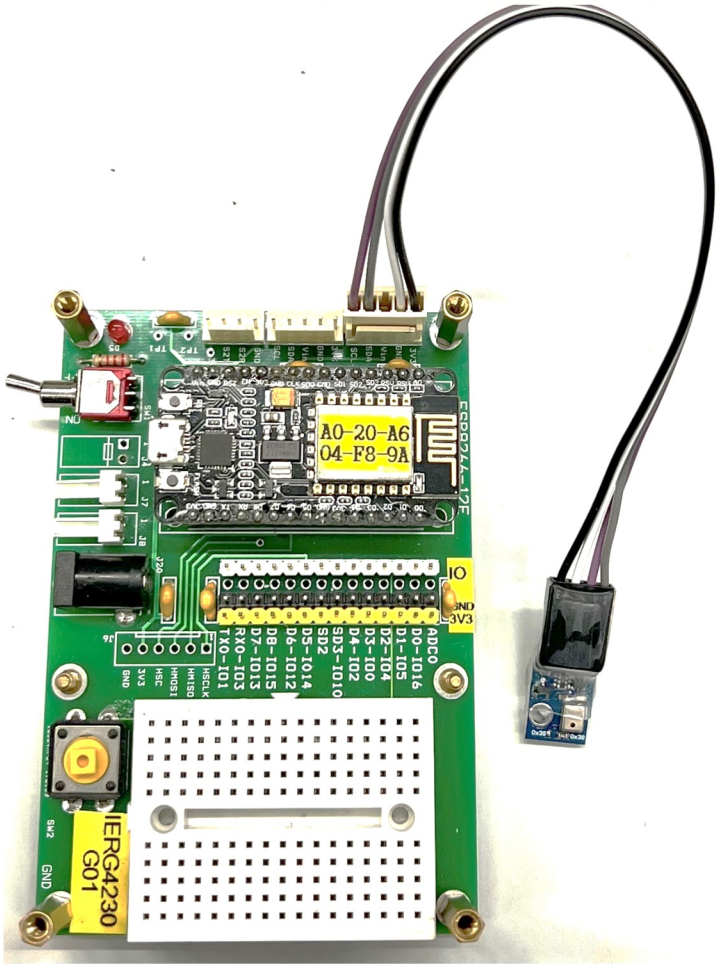
Connect to the board



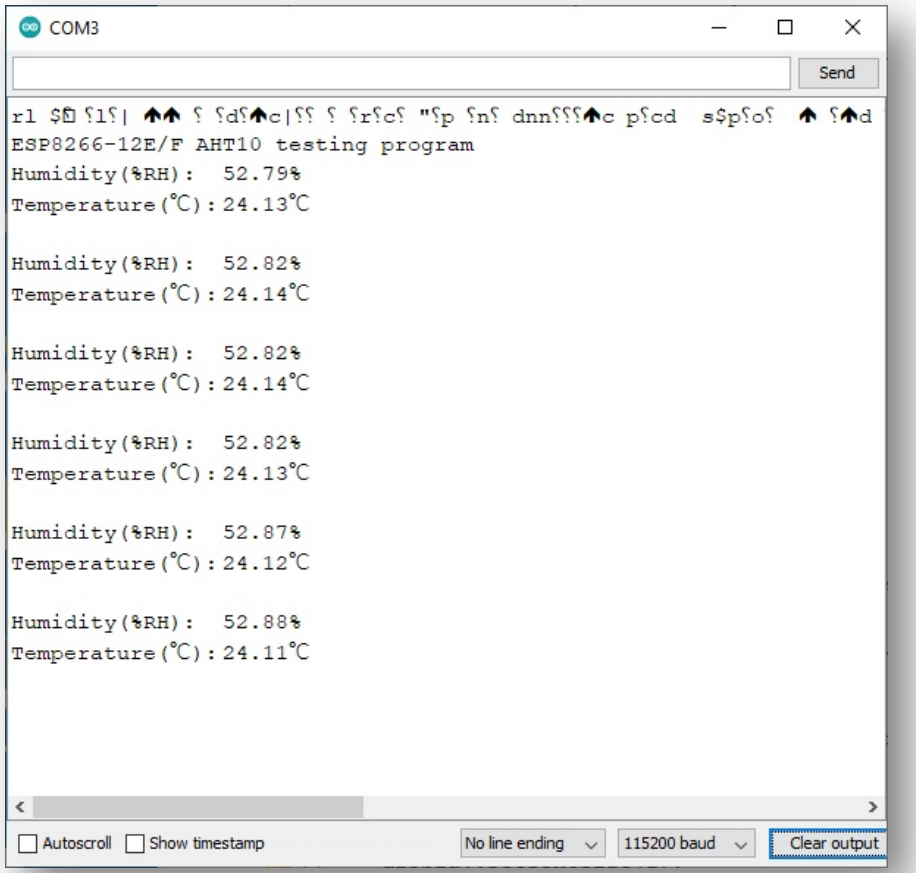
The result of the demo program

C5. Temperature and Humidity Sensor (AHT10, I^2C)

Provided device

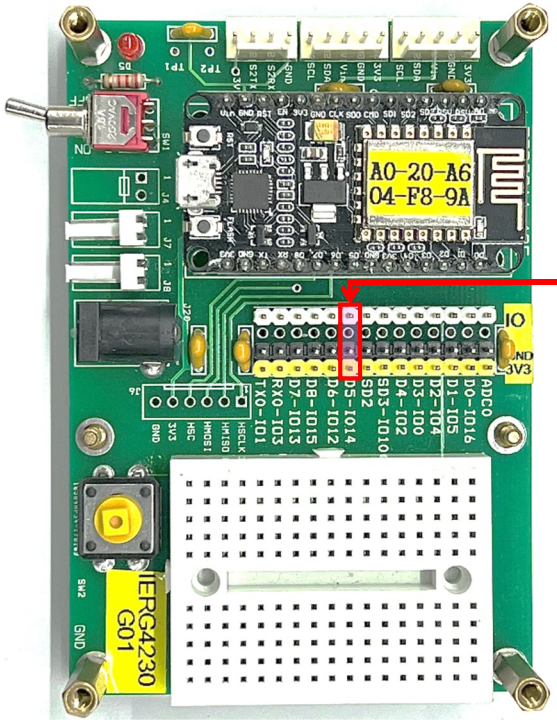


Connect to the board

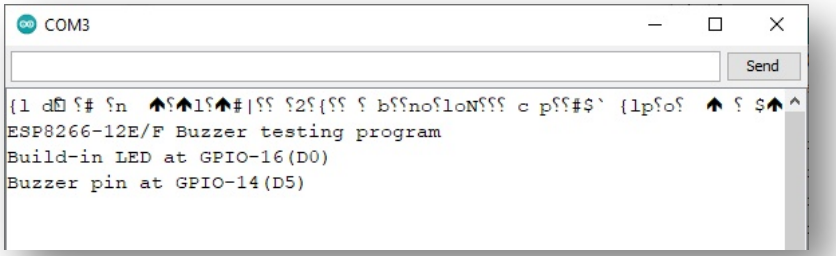


The result of the demo program

C6. Buzzer (Digital)

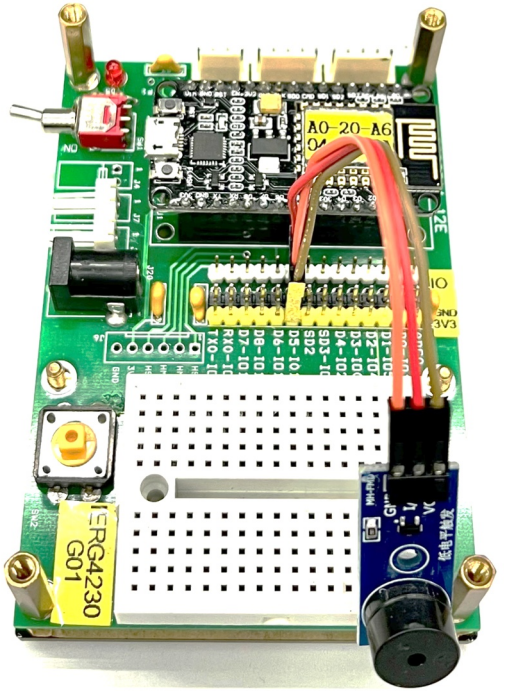


GPIO14 – D5 (Digital output)
X
GND
3.3V



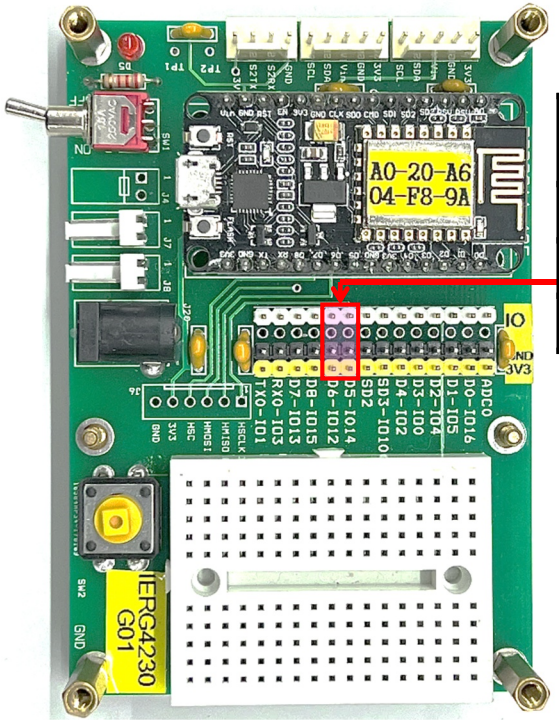
The demo songs of Starwar and SuperMario are in demo programs.

Provided device

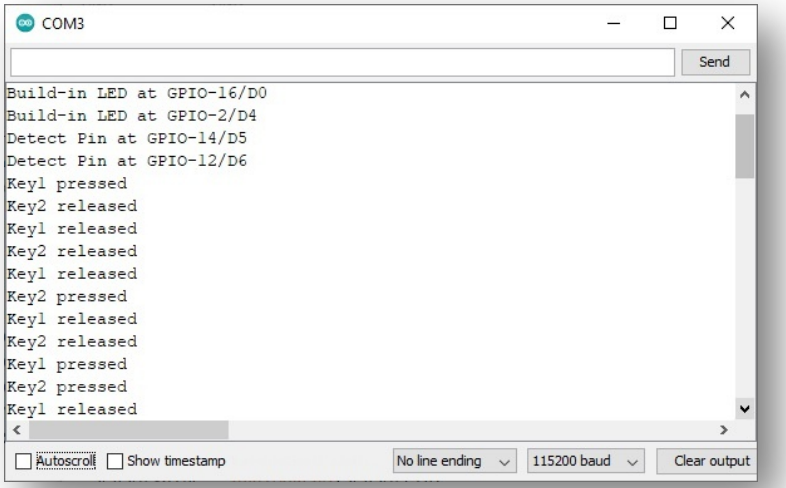


Connect to the board

C7. Dual tact switches (Digital)

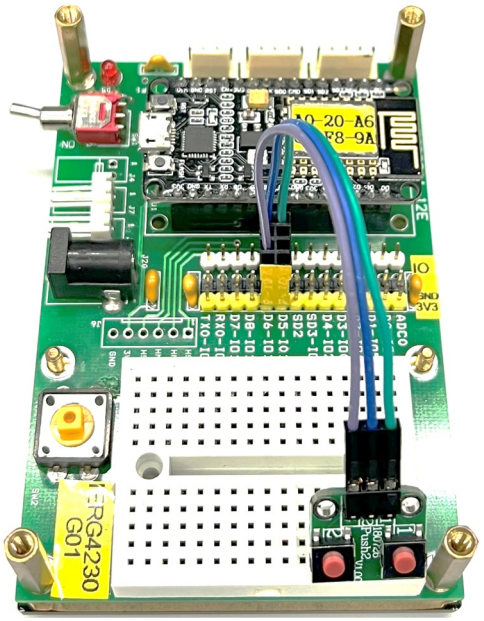


GPIO12 – D6 (Digital input)	GPIO14 – D5 (Digital input)
X	X
GND	X
3.3V	X



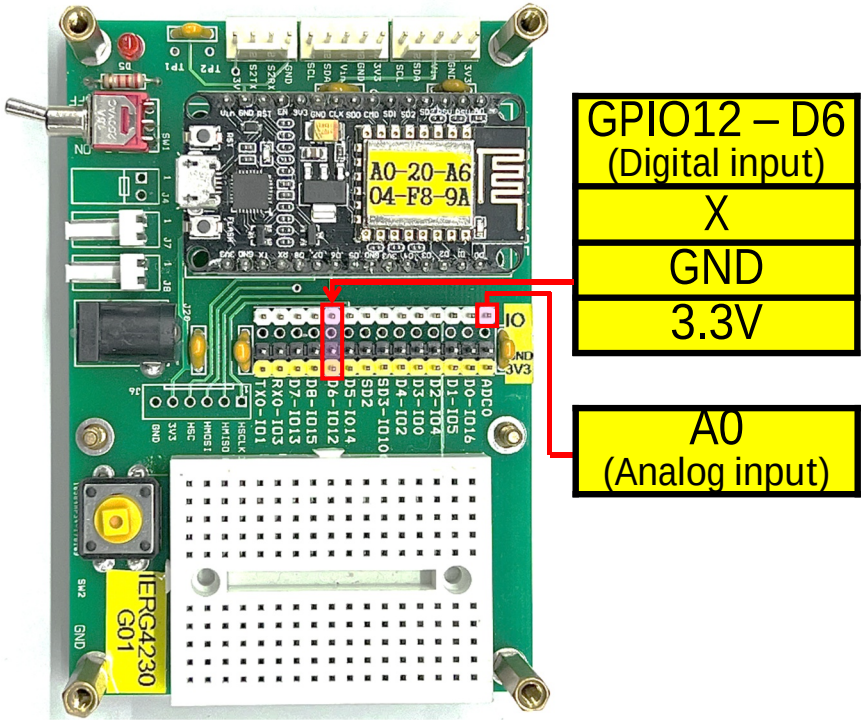
The result of the demo program

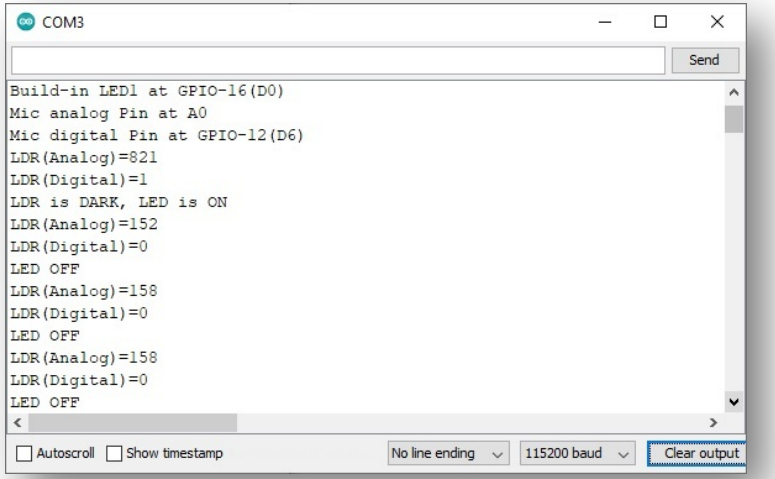
Provided device



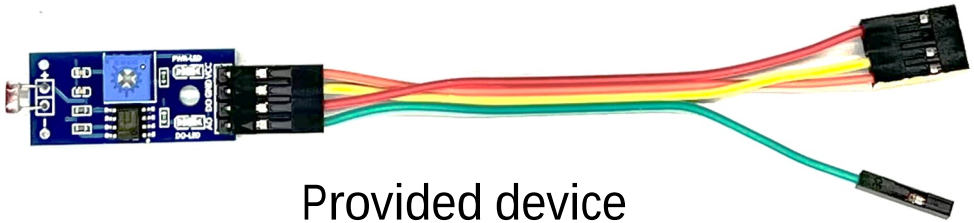
Connect to the board

C8. Light sensor module (Digital & Analogue)

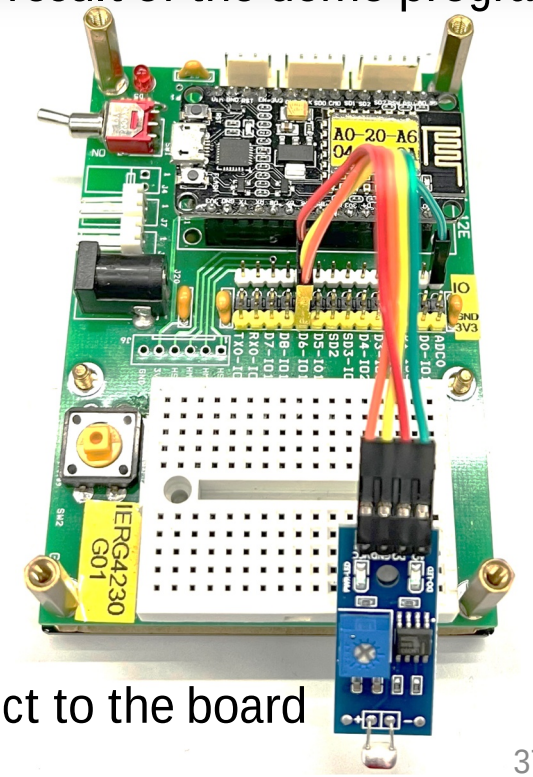




The result of the demo program



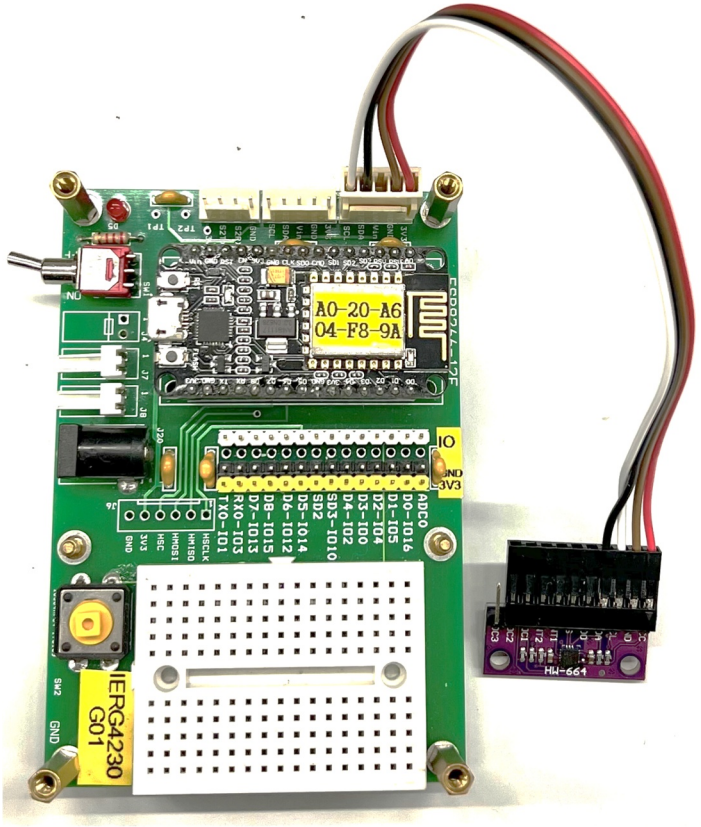
Provided device



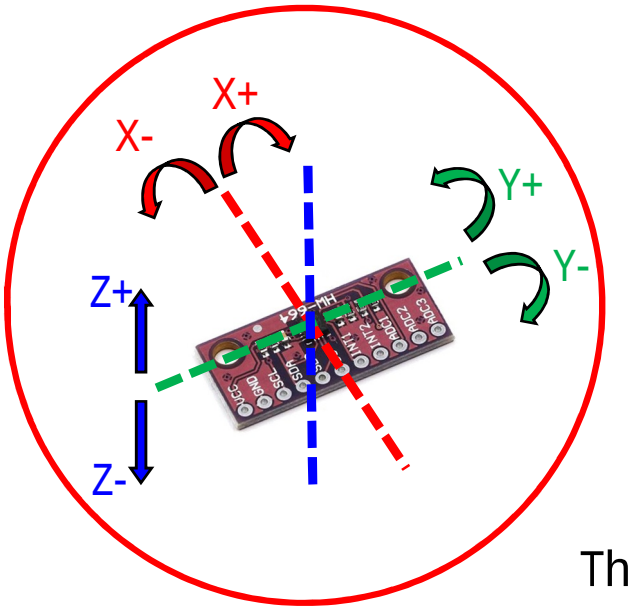
Connect to the board

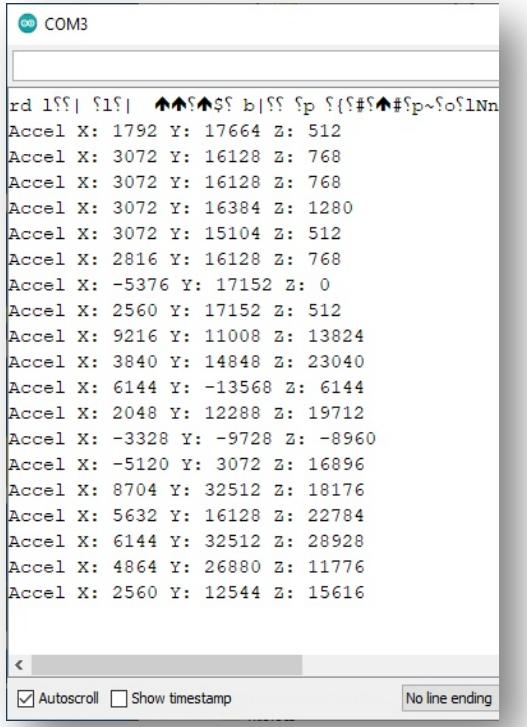
C9. MEMS Motion sensor (LIS3DSH , I^2C)

Provided device



Connect to the board

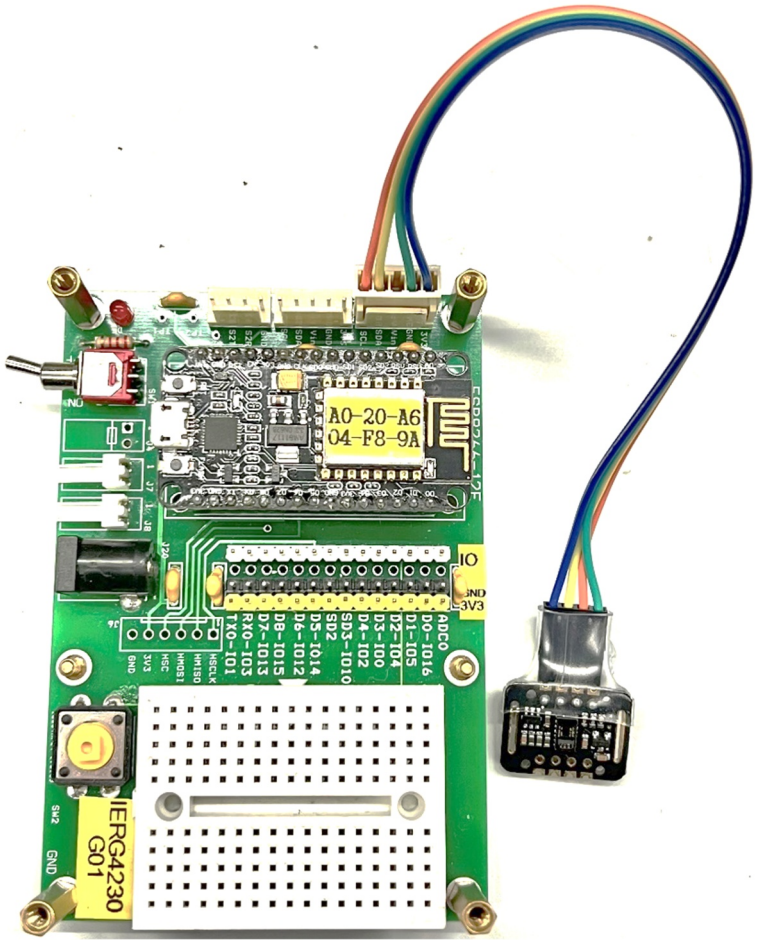




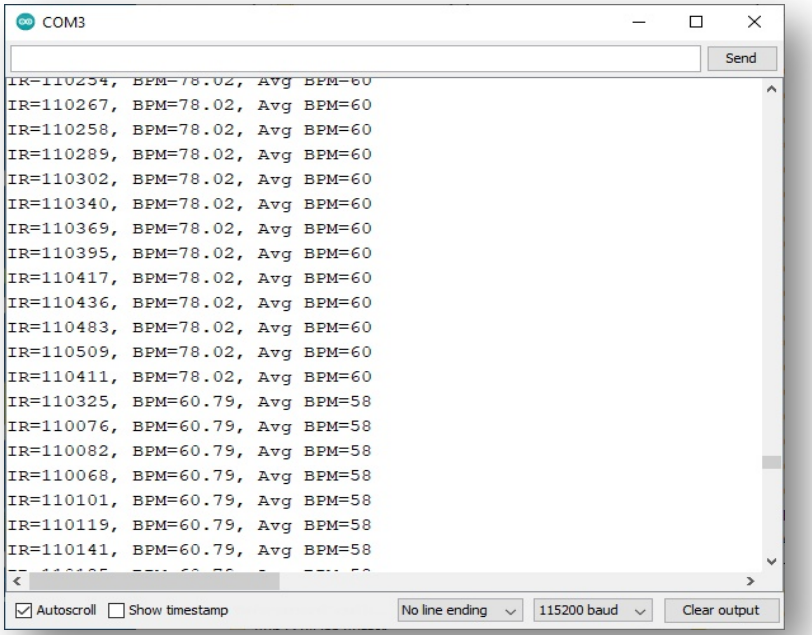
The result of the demo program

C10. Heart Rate Sensor (MAX30102 , I^2C)

Provided device

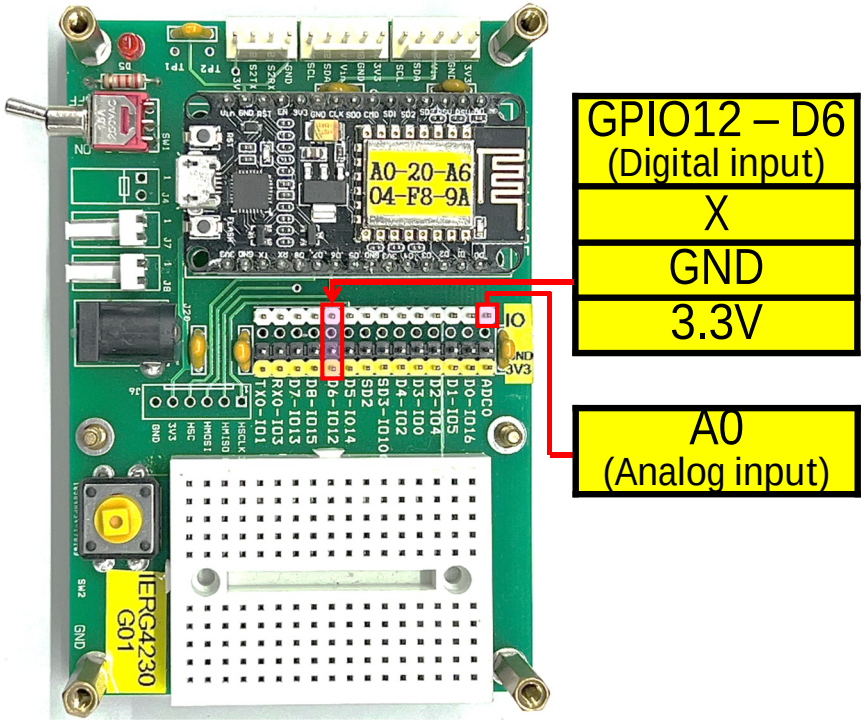


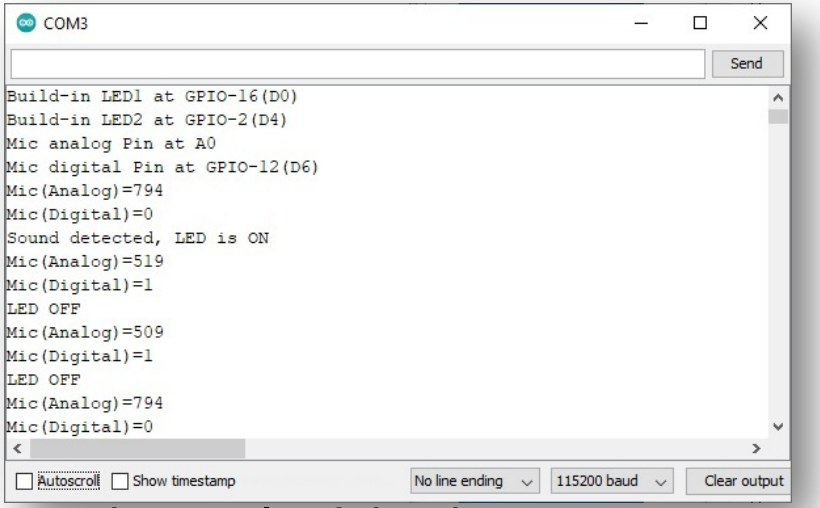
Connect to the board



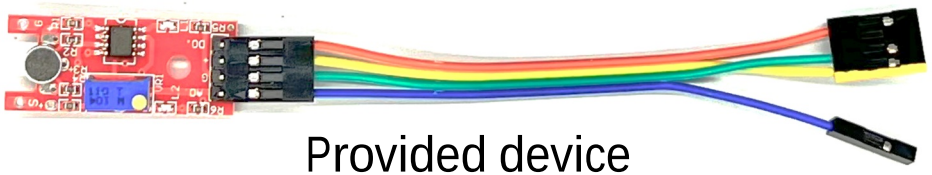
The result of the demo program

C11. Microphone (MIC, Digital & Analogue)

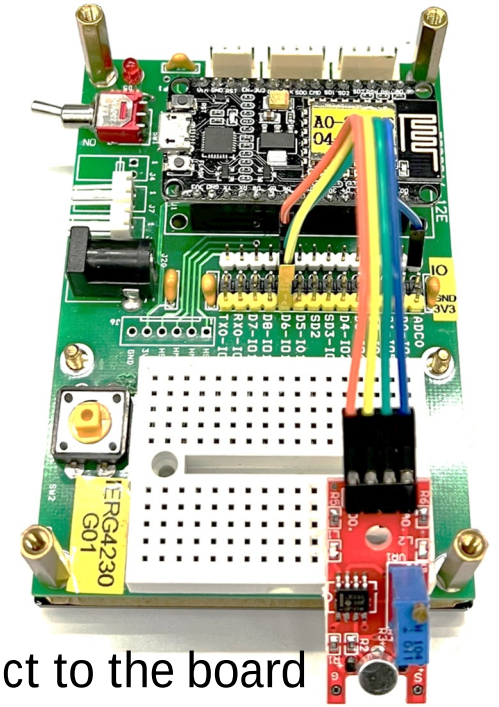




The result of the demo program

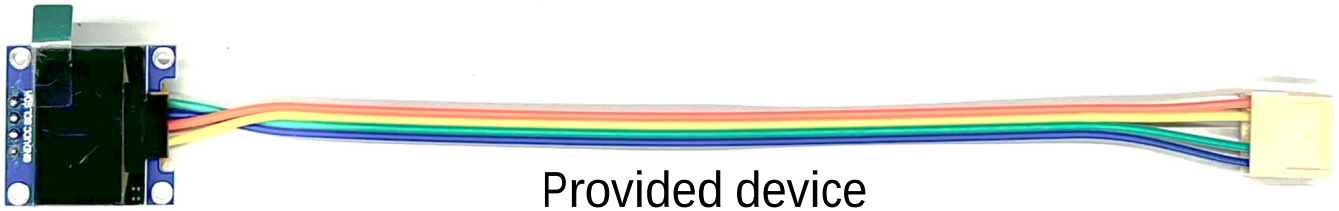


Provided device

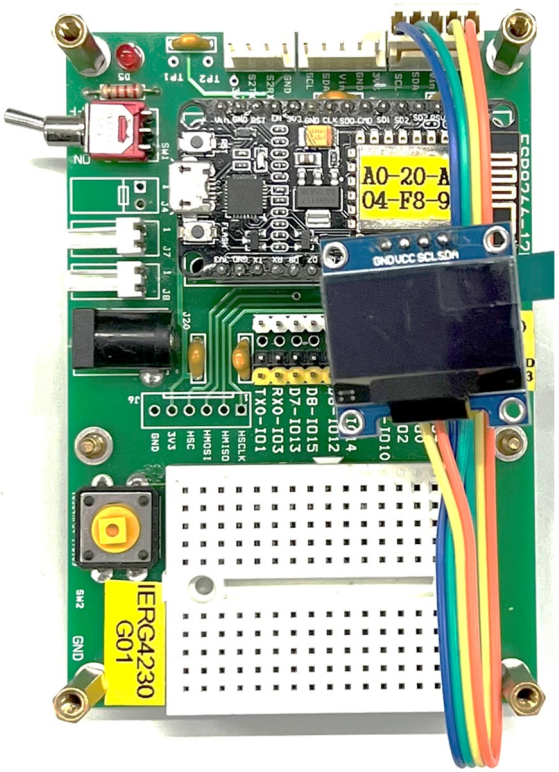


Connect to the board

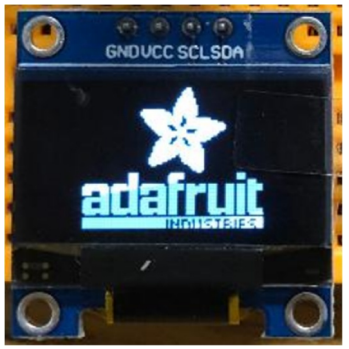
C12. OLE Display (SSD 1306 , I^2C)



Provided device

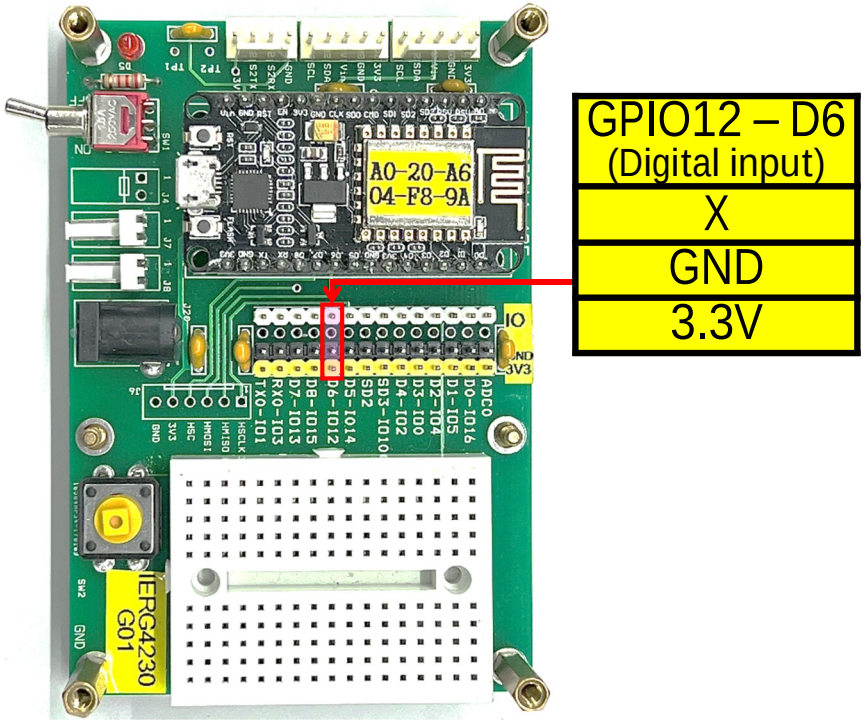


Connect to the board

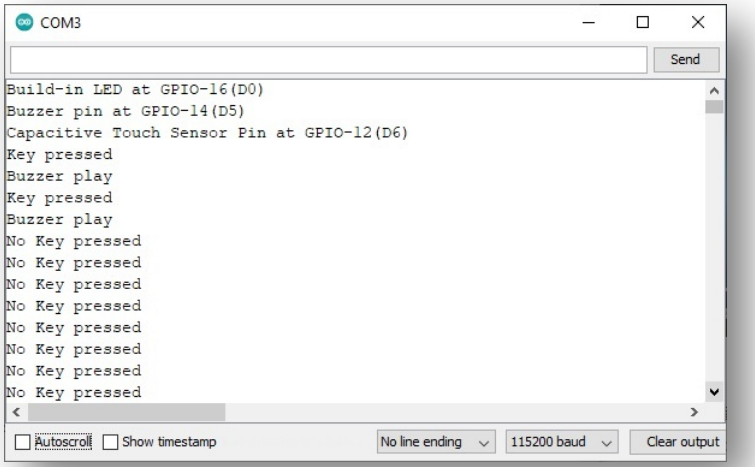


The result of the demo

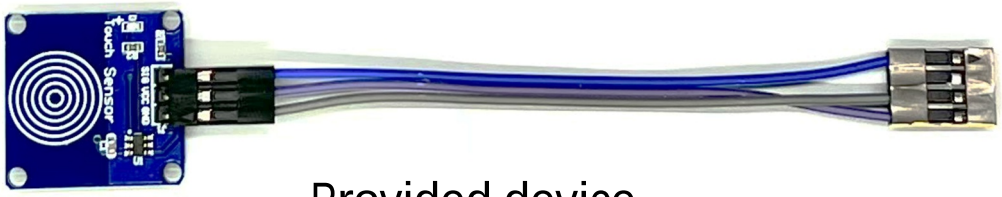
C13. Touch switch (TTP223, Digital)



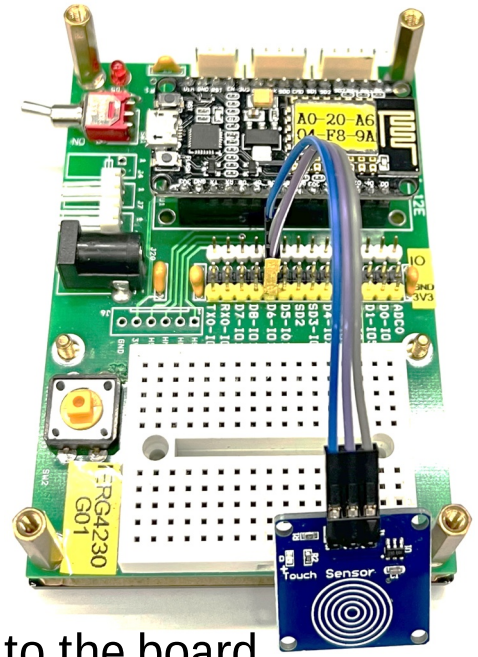
GPIO12 – D6 (Digital input)
X
GND
3.3V



The result of the demo program

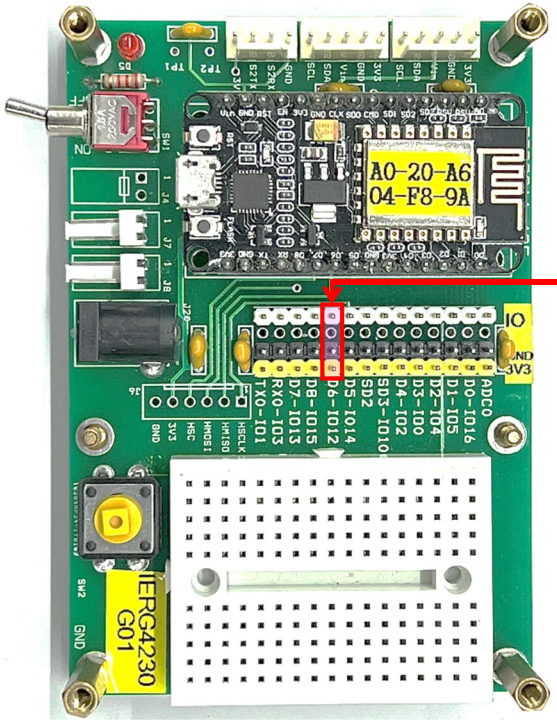


Provided device

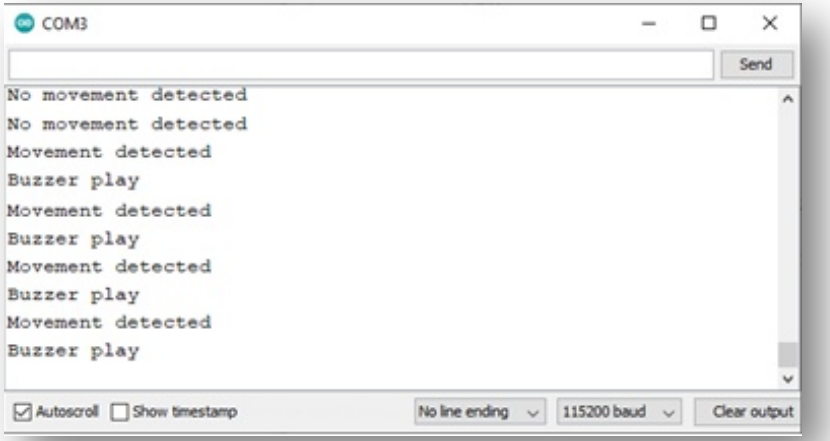


Connect to the board

C14. Microwave motion detector (RCWL-0516, Digital, 5V)



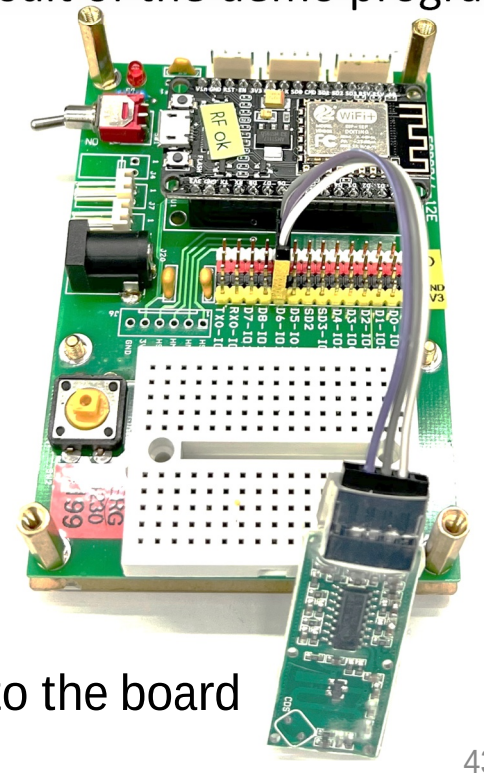
GPIO12 – D6 (Digital input)
5V
GND
X



The result of the demo program

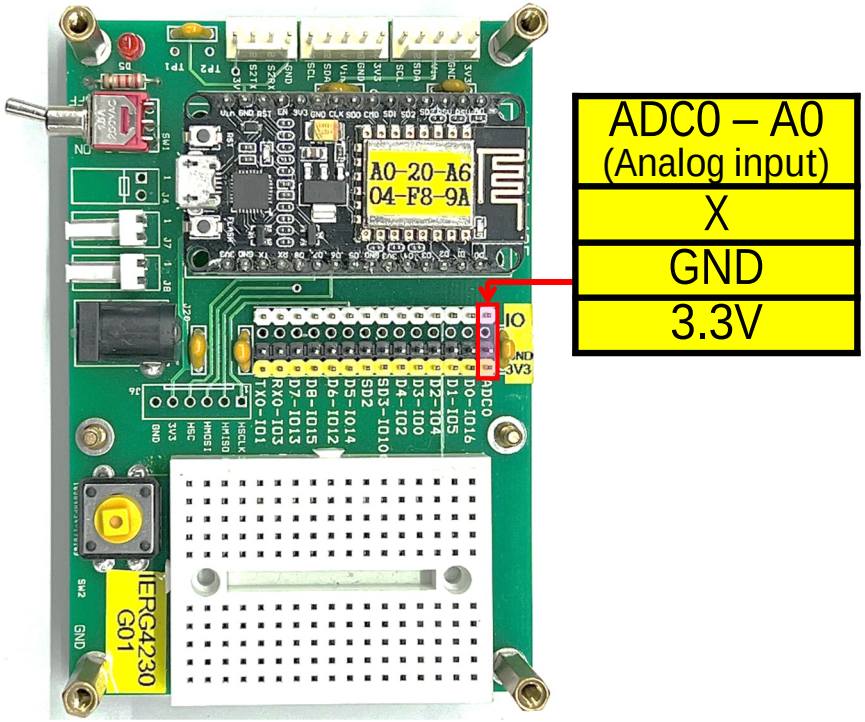
Provided device

This is 5V device
This sensor is very sensitive.

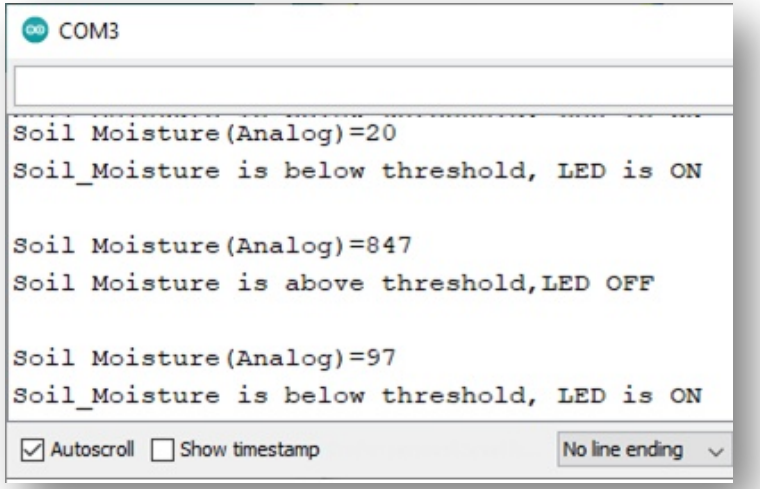


Connect to the board

C15. Soil Moisture Sensor (Analogue)

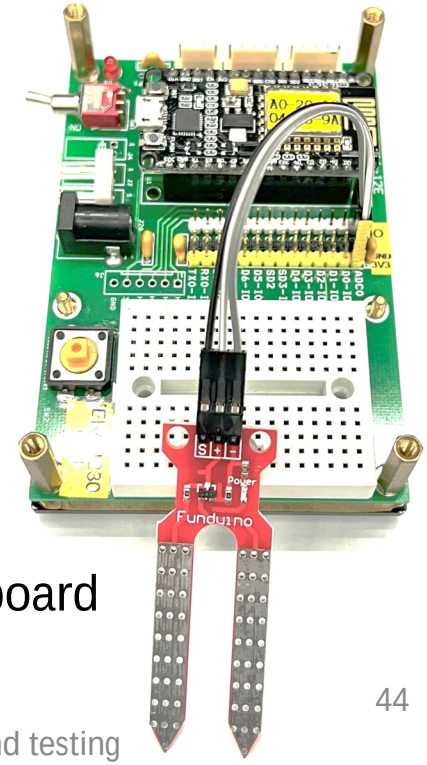


ADC0 – A0 (Analog input)
X
GND
3.3V



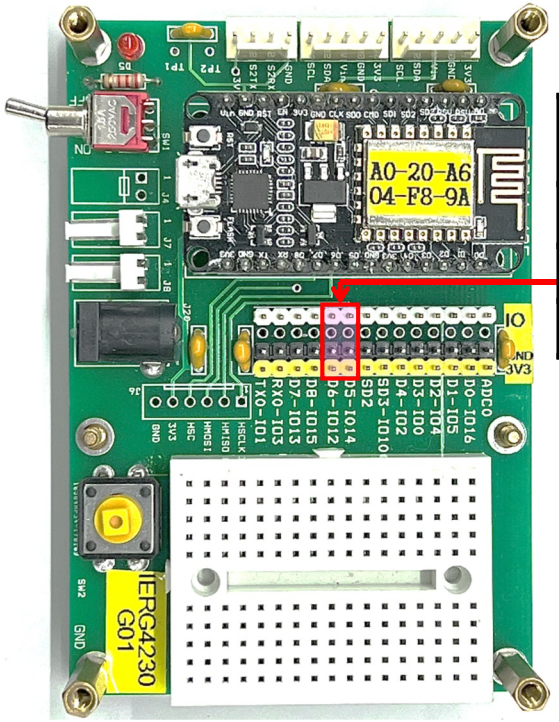
The result of the demo program

Provided device



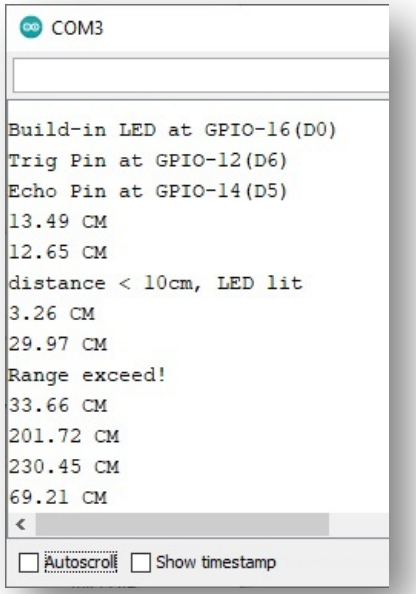
Connect to the board

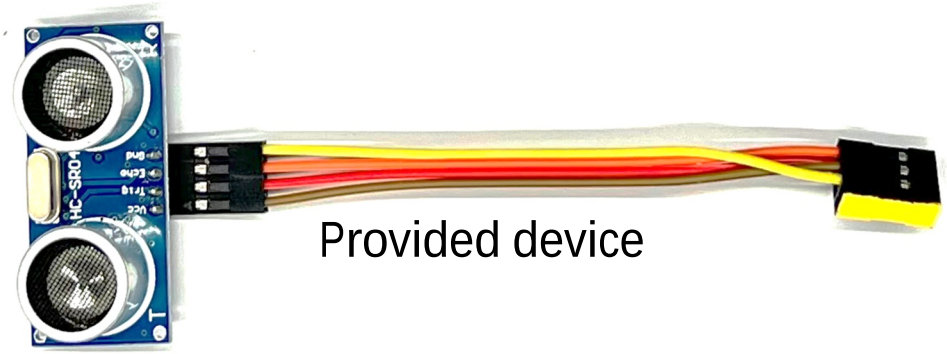
C16. Ultrasonic Sensor Distance Measure Module (HC-SR04, Digital, 5V)



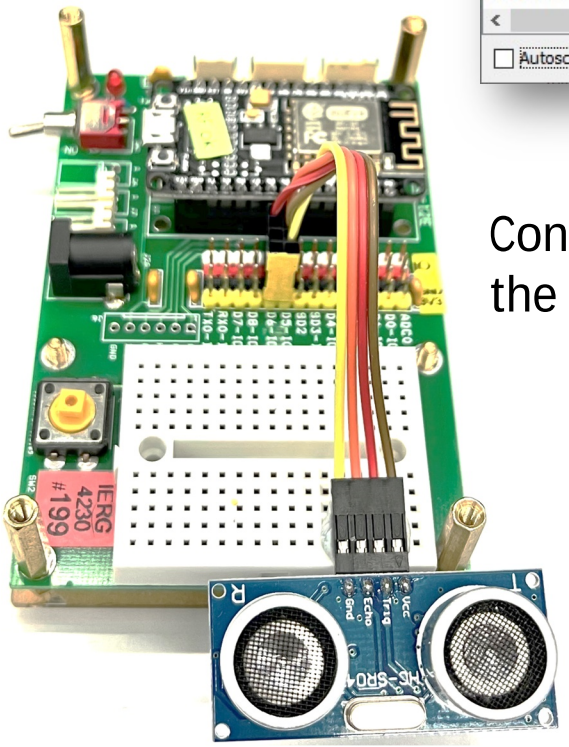
GPIO12 – D6 (Digital input)	GPIO14 – D5 (Digital input)
X	5V
X	GND
X	X

The result of the demo program





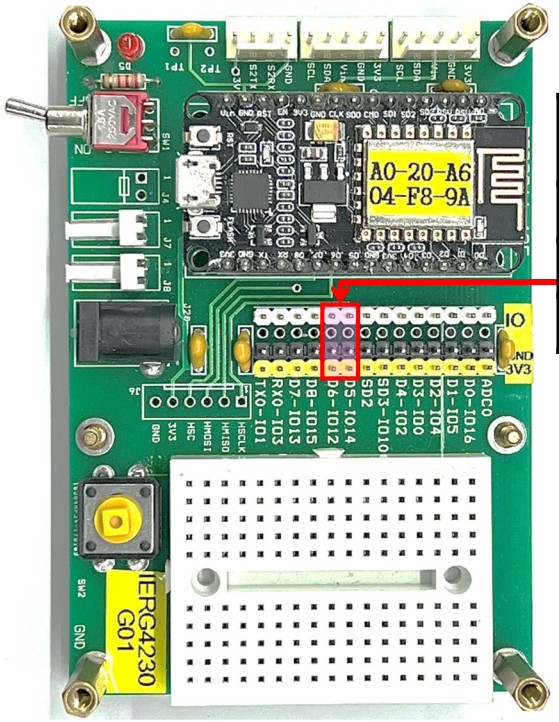
Provided device



Connect to the board

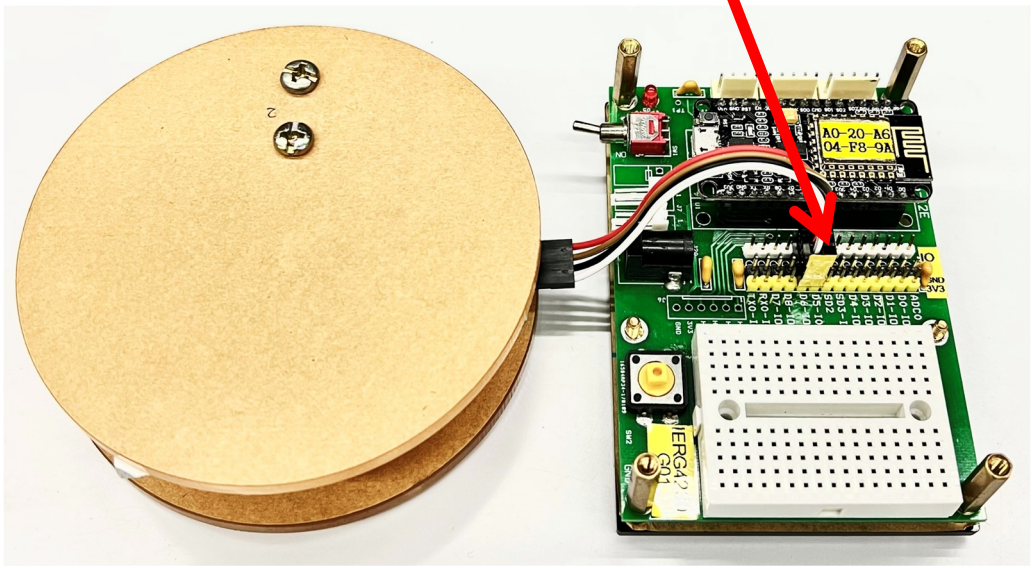
- Use two digital I/Os
  [Sample code use D6 (GPIO 12) & D5 (GPIO14)]
- Power: 5V

C17. Electronic scale, weight sensor (HX711AD, digital)



GPIO12 – D6 (Digital input)	GPIO14 – D5 (Digital input)
X	X
GND	X
3.3V	X

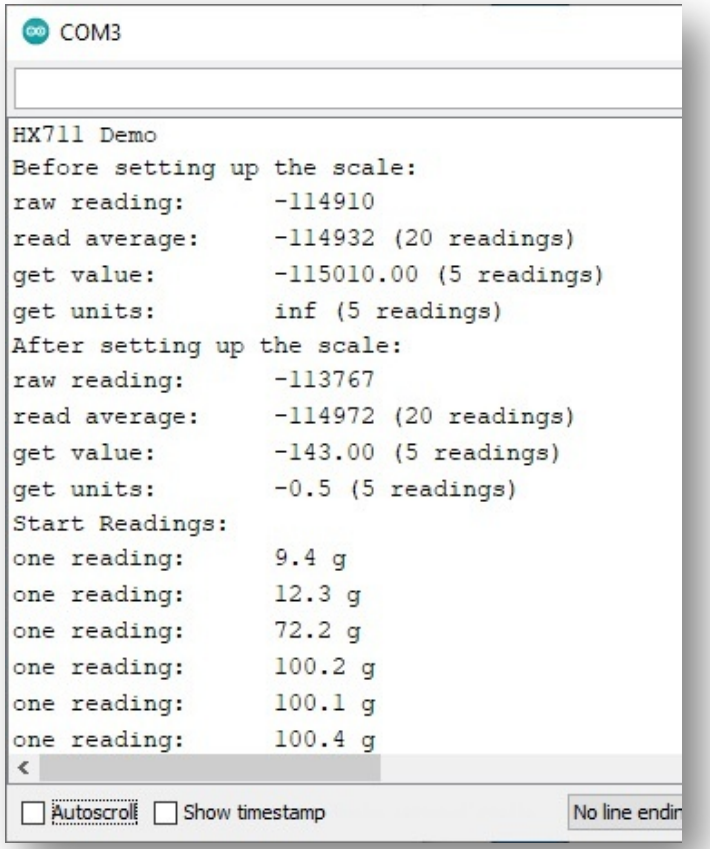
The coloured face connect to Yellow header



- Use two digital I/Os [Sample code use D6 (GPIO 12) & D5 (GPIO14)]
- Power: 3.3V

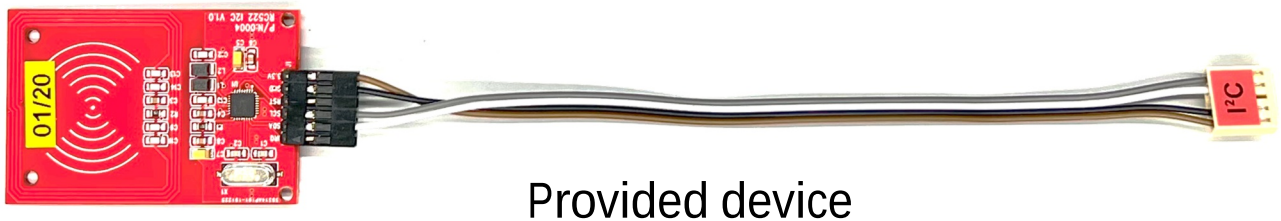
C17. Electronic scale, weight sensor (HX711AD, Digital)

- Decompress “HX711.rar” can get the test program for ESP8266 (Arduino platform) and datasheet.
- Folder “HX711” is the main program
- Before use the Electronic scale, you need to calibrate the scale first.
- Use folder “HX711-Calibrate” program to get the parameter “calibrate_parameter” for main program (Line 38).

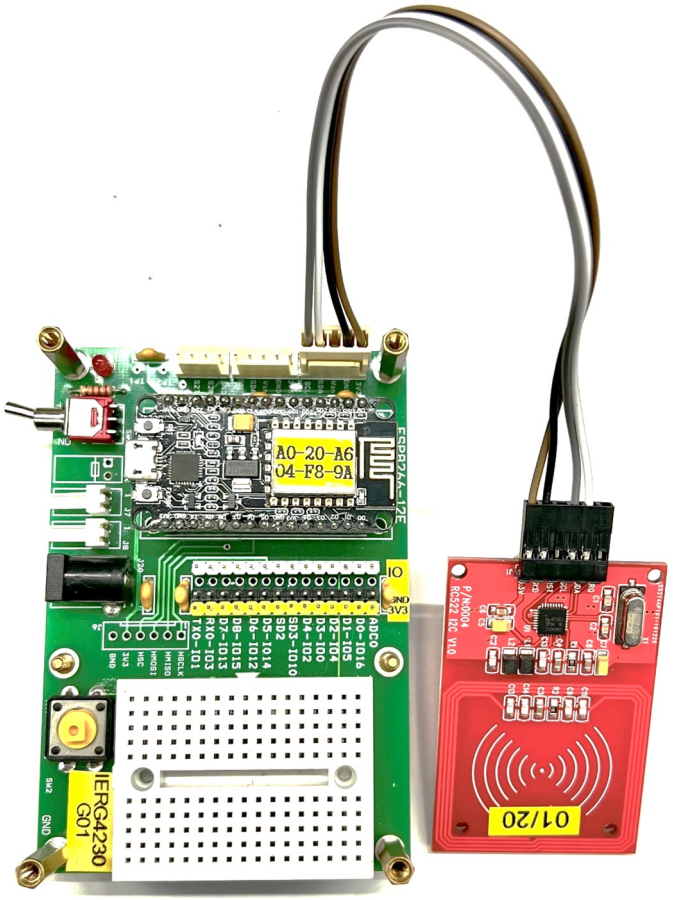


The result of the demo program

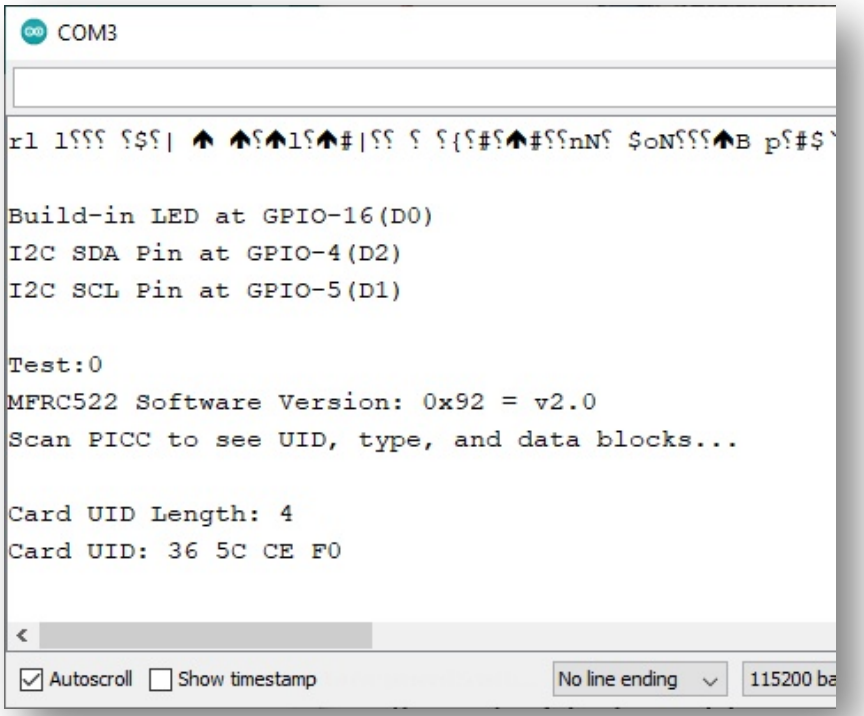
C18. RFID reader (MFRC522, I^2C)



Provided device



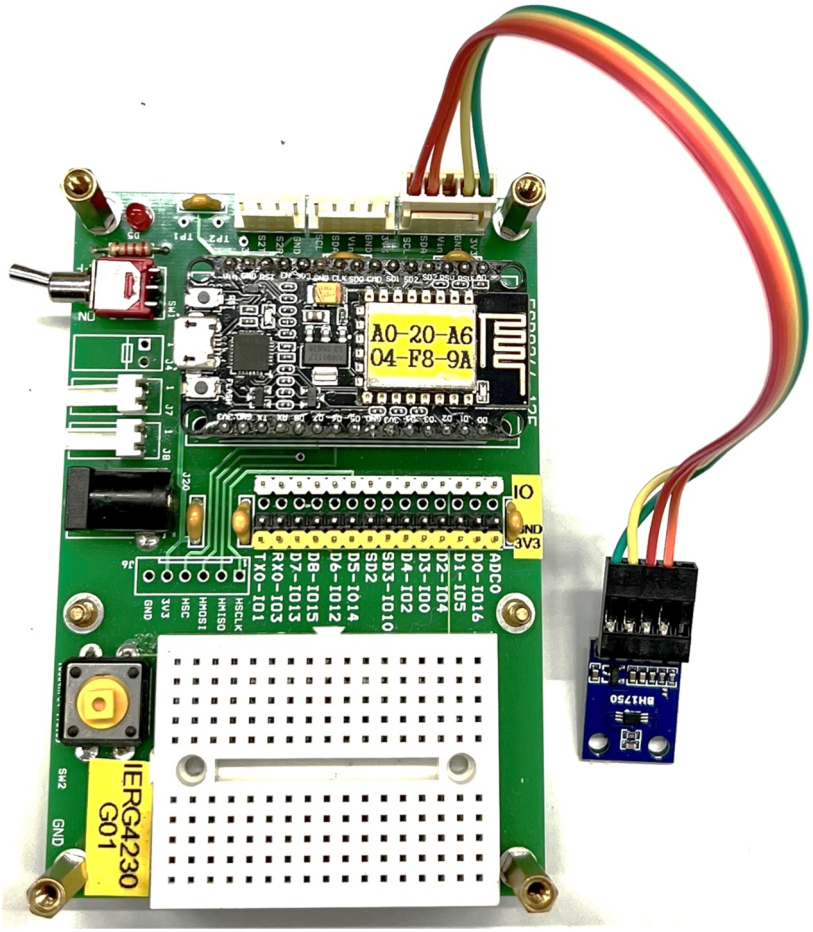
Connect to the board



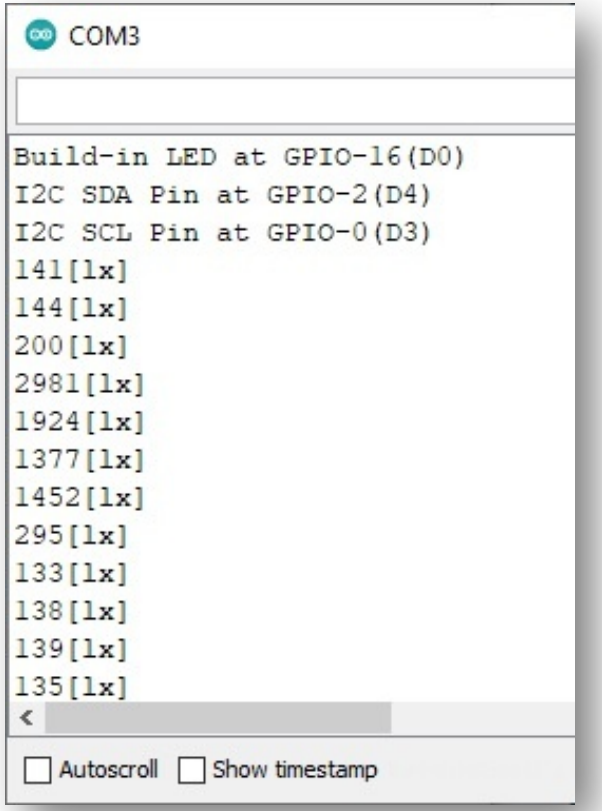
The result of the demo program

C19. Light density detector (BH1750, I^2C)

Provided device



Connect to the board



The result of the demo program