

## Lesson 3 Test the onboard WS2812 led

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# 1. Knowledge of ws2812 led

## 1.1 Overview:

WS2812B is an intelligently controlled LED that integrates the control circuit and RGB chip in a package of 5050 components. The interior includes intelligent digital ports, data latches and signal amplification drive circuits. It also includes a precise internal oscillator and a voltage programmable constant current control part to effectively ensure that the light color of the pixels is highly consistent.

The data transmission protocol adopts a single NZR communication mode. After the pixel is powered on and reset, the DIN port receives data from the controller, the first pixel collects the initial 24-bit data, and then sends it to the internal data latch, and other data processed by the internal signal amplification circuit are sent to the next one cascade pixels through the DO port. After each pixel is transmitted, the signal is reduced by 24 bits. The pixel adopts self-shaping transmission technology, so that the number of pixel cascading is not limited by signal transmission, but only depends on the speed of signal transmission.

Reset time >280us, no false reset when interrupted;

Support low frequency, with cheap MCU.

The refresh rate is updated to 2KHz, flicker-free, which improves the excellent display effect.

### Characteristic:

- \* The control circuit and LED share the only power supply.
- \* The control circuit and RGB chip are integrated in a package of 5050 components to form a complete addressable circuit
- \* The pixel has a built-in signal-shaping circuit. After the waveform is shaped to the next driver, it ensures that the waveform distortion does not accumulate.
- \* Built-in electronic reset circuit and power failure reset circuit.
- \* The three primary colors of each pixel can display 256 luminances, completing the display of 16777216 colors, and the scanning frequency is 2KHz.
- \* The cascade port transmits signals over a single wire.
- \* If the distance between any two points does not exceed 5m, no additional circuit is required to transmit the signal.
- \* When the refresh rate is 30fps, the number of cascades should not be less than 1024 pixels.
- \* Send data at 800Kbps.
- \* The color of the light is highly consistent and requires no external electronic components, not even capacitors.

## 1.2 Hardware Introduction:

WS2812B light strip: 30 beads per meter 9w, 60 beads per meter 18w, 144 beads per meter 43W, voltage: (DC) DC5V, the power consumption of each lamp bead is about 0.3W

Power supply: 5V

Power when each lamp bead is fully lit: 0.3W

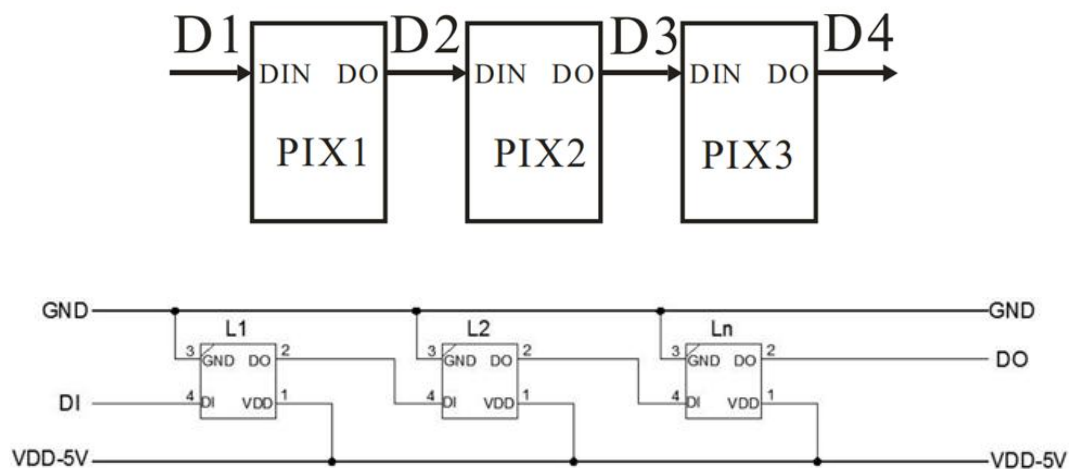
Current when each lamp bead is fully lit: 0.6mA

Each chip has four pins, and each pin is defined in the following table

NO.	Pin	Function
1	5V	Positive power supply
2	GND	Negative pole of power supply
3	DI	Data input pin, control data entry of MCU
4	DO	Data output pin, cascading multiple SW2812 outputs, connected to the DI of the next SW2812

### cascading wiring method

The DO of the previous chip is connected to the DI of the next chip



### 1.3 Control principle:

WS2812 is an RGB chip, so it has three colors of red, green and blue, and each color has corresponding 8 bits. Usually, a pixel is represented by three colors of RGB. For example, #FFFFFF means that the value of R (red) is 255, the value of G (green) is 255, the value of B (blue) is 255, #FFFFFFF is finally displayed as white. So

a SW2812 consists of 3 U8s, that is  $3 \times 8 = 24$  bits. To determine the color of a SW28122 chip, it is necessary to send 24 bits of data.

## Cascade data transmission

The cache of the first screen data

The first 24 bits are received and cached by the first module

The second 24 bits will be forwarded by the first module to the second module and cached

The third 24 bits will be forwarded to the third module by the first and second, and cached

The fourth 24 bits...

The Nth 24 bits...

Reset signal, that is, the real embodiment of the cached data on the display

Second screen data cache

The first 24 bits are received and cached by the first module

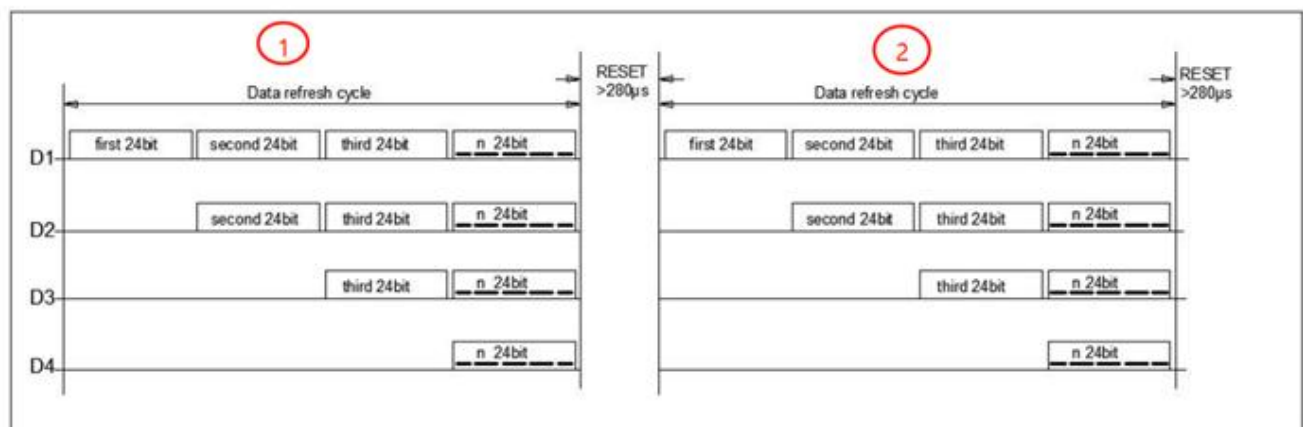
The second 24 bits will be forwarded by the first module to the second module and cached

The third 24 bits will be forwarded to the lower three modules by the first and second and cached

The fourth 24 bits...

Lower N 24 bits...

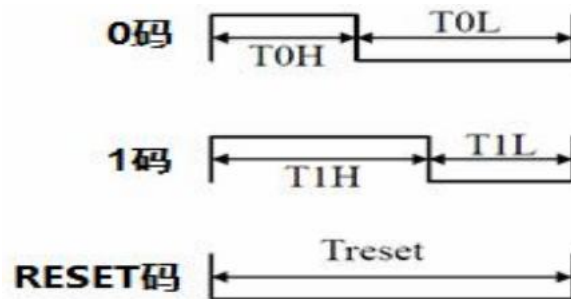
Reset signal, that is, the real embodiment of the cached data on the display



## The meaning of each 24-bit data

G7	G6	G5	G4	G3	G2	G1	G0	R7	R6	R5	R4	R3	R2	R1	R0	B7	B6	B5	B4	B3	B2	B1	B0
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

Data is transmitted in GRB order, the high-order data bits are transmitted first



T0H	0 code, high voltage time	220ns~380ns
T1H	1 code, high voltage time	580ns~1μs
T0L	0 code, low voltage time	580ns~1μs
T1L	1 code, low voltage time	580ns~1μs
RES	Frame unit, low voltage time	>280μs

## 1.4 About the HSV color model in Adafruit\_NeoPixel

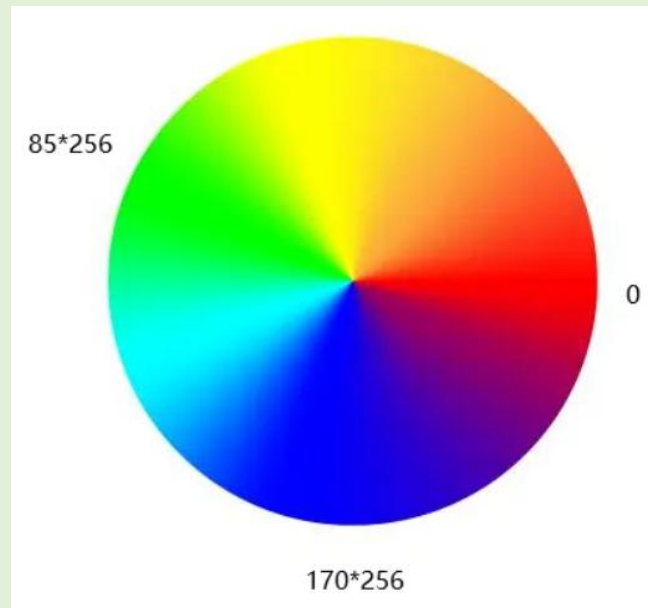
In Adafruit\_NeoPixel, the RGB color model can be used to control the red, green, and blue lights to synthesize various colors. The HSV color model can also be used to control the hue, saturation, and brightness of the lights to adjust the color.

The advantage of HSV control is that it is more convenient to control the brightness of the light and adjust the color to make it more in line with human intuition.


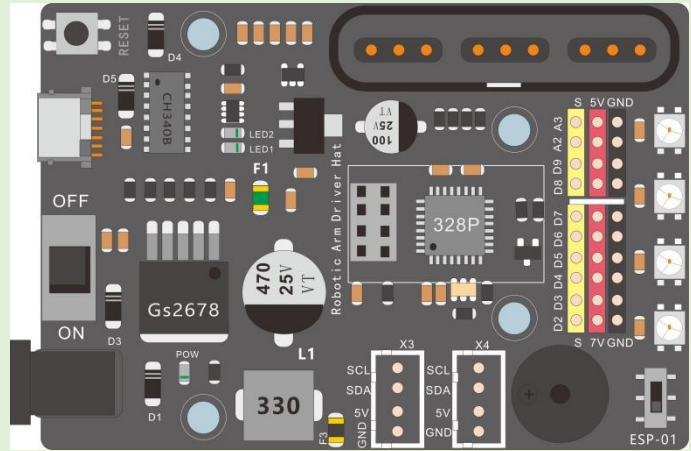
H in HSV: Hue parameter range 0--65535

S in HSV: Saturation parameter range 0--255

V in HSV: Brightness parameter range 0--255

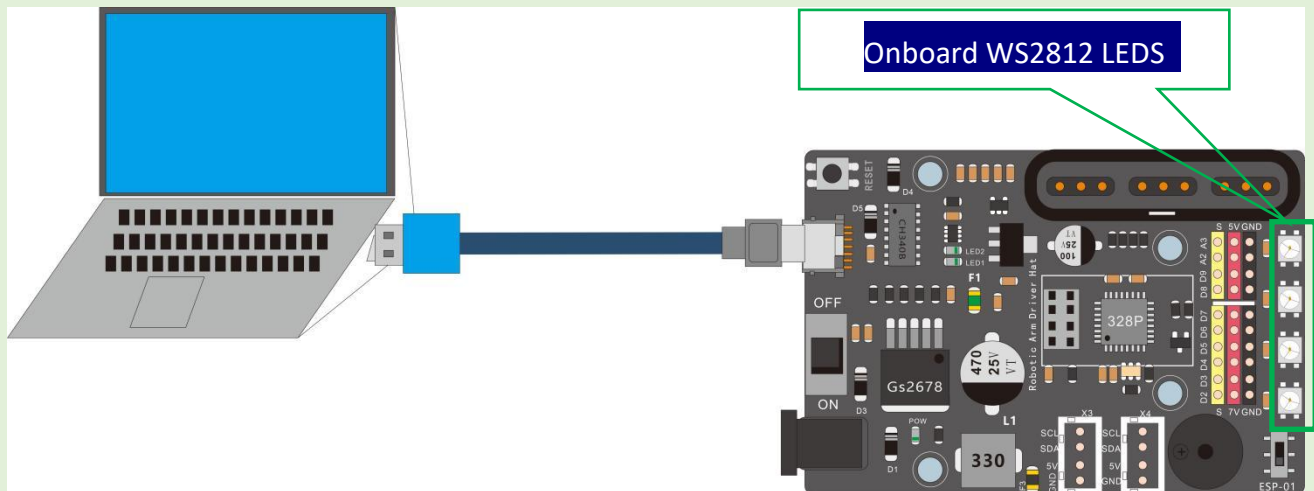


## 2. What do you need to prepare

Components	Quantity	Picture
USB cable	1	
Robotic Arm Driver board	1	

### 3. Hardware Connection Circuit

Referring to the figure below, connect the control board to the computer with a USB cable. Since the power of the onboard WS2812 LEDs are very small, it can be powered by a USB cable and does not require an external power supply.



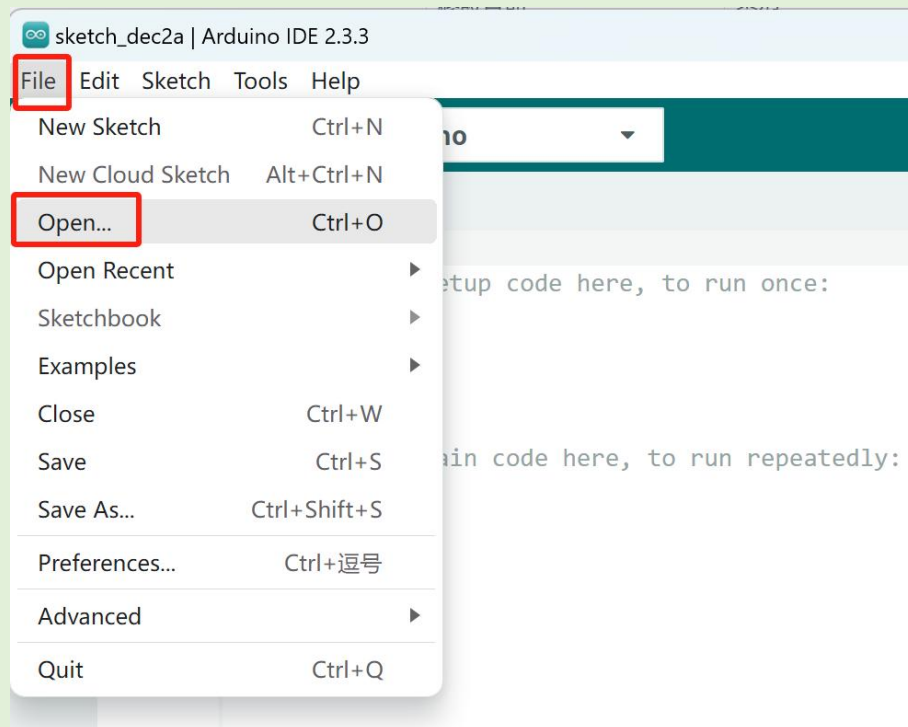
### 4. Upload the code and test

The code used in this lesson is placed in this folder: “E:\CKK0017-main\Tutorial\sketches”

4.1 Double-click the Arduino IDE shortcut on the desktop to open it



4.2 On the Arduino IDE interface, click "File" --- "open"

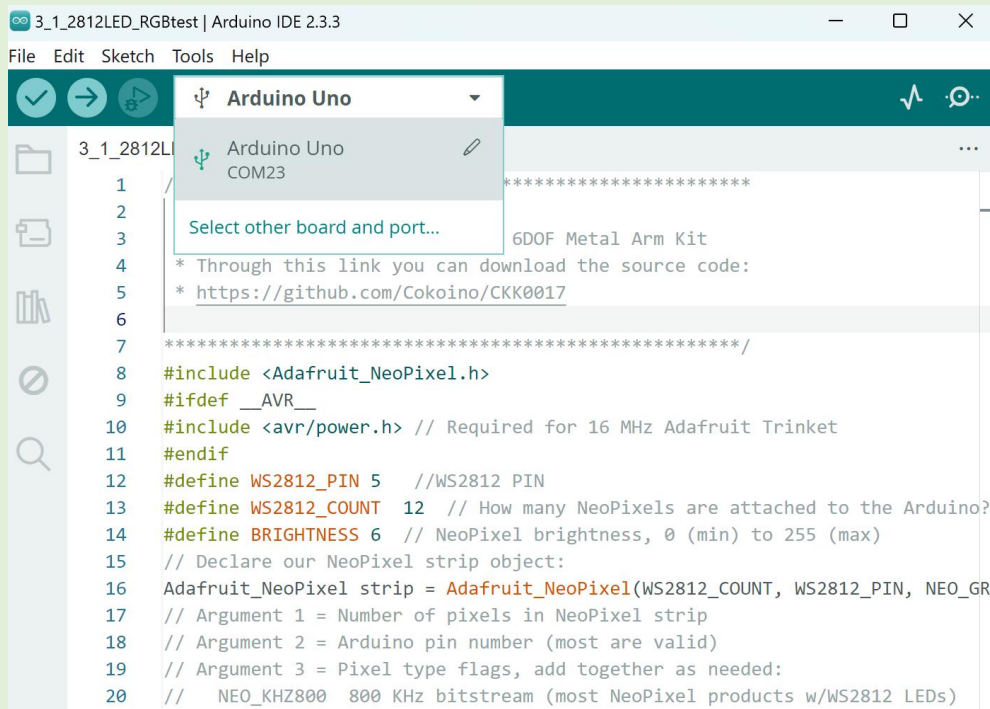


4.3 Select the code in the folder named **3\_1\_2812LED\_RGBtest**:

[E:\CKK0017-main\Tutorial\sketches\3\\_1\\_2812LED\\_RGBtest](#). Click "open"

4.4 Select the board "**Arduino UNO**" and Port "**COM23**" (COM port is commonly known as an input output port for a device normally PC which enables communication between Arduino and PC. You can check your arduino com number in device manager, the com port of our arduino board is recognized as COM23 in this tutorial)





#### 4.5 Install library Adafruit\_NeoPixel.h

##### Why use Libraries?

Libraries are incredibly useful when creating a project of any type. They make our development experience much smoother, and there almost an infinite amount out there. They are used to interface with many different sensors, RTCs, Wi-Fi modules, RGB matrices and of course with other components on your board.

##### Including a Library in the sketch

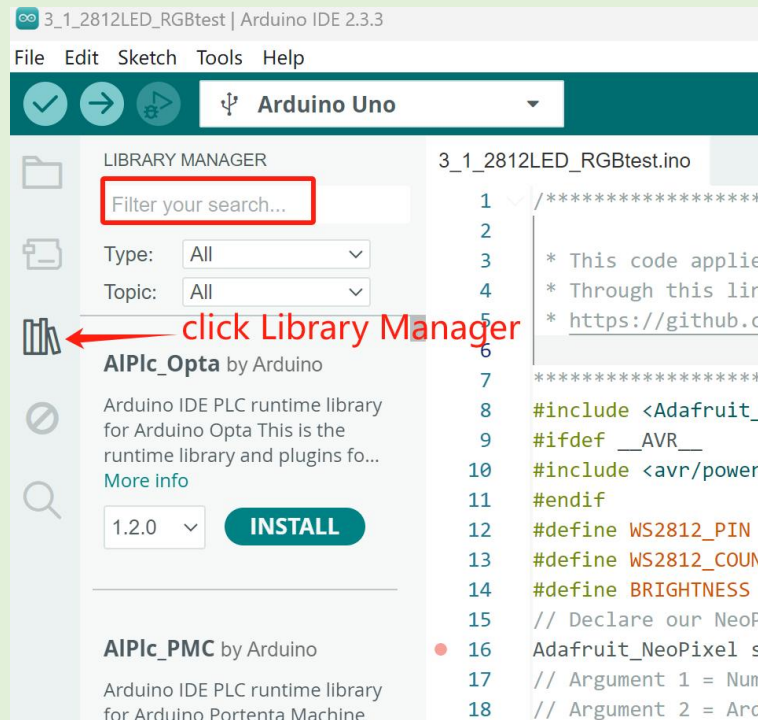
To use a library, you first need to include the library at the top of the sketch.

If you find a line of code in the format of `#include <library name.h>` at the beginning of the code when using our code, it means that you need to add this library file to Arduino IDE first before you can successfully upload this code.

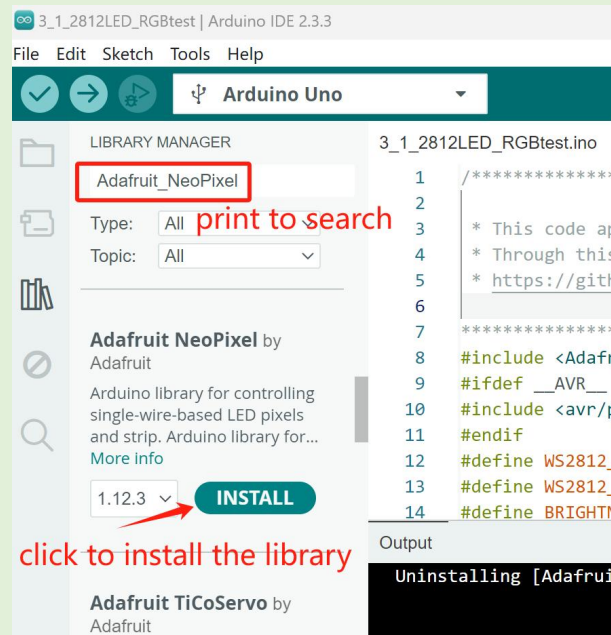
##### How to install Libraries to Arduino IDE?

There are two methods to install libraries to Arduino IDE

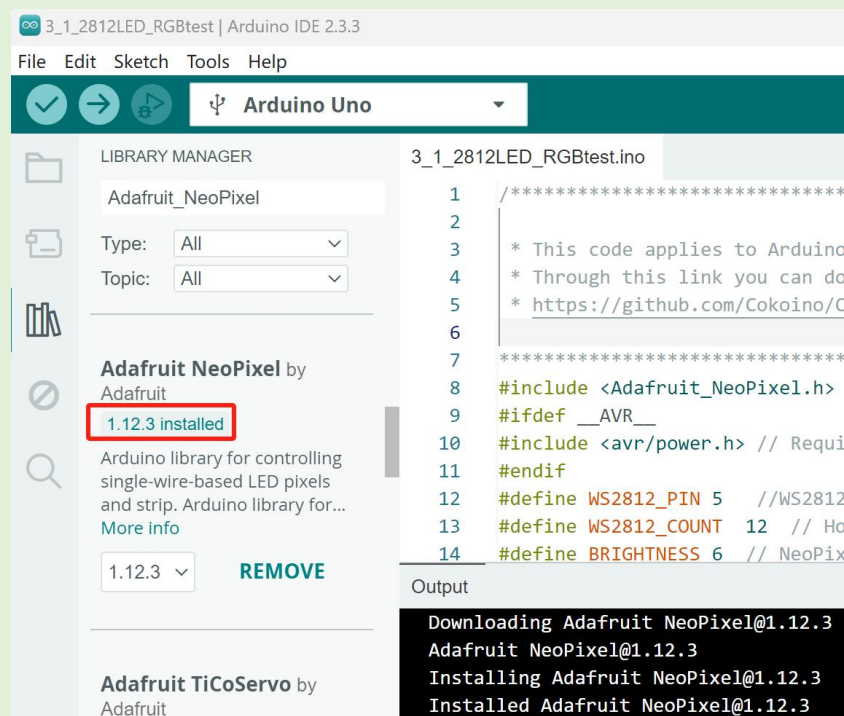
**Method 1:** Directly click "Library Manager" on the left side of the Arduino IDE interface, the interface is as follows



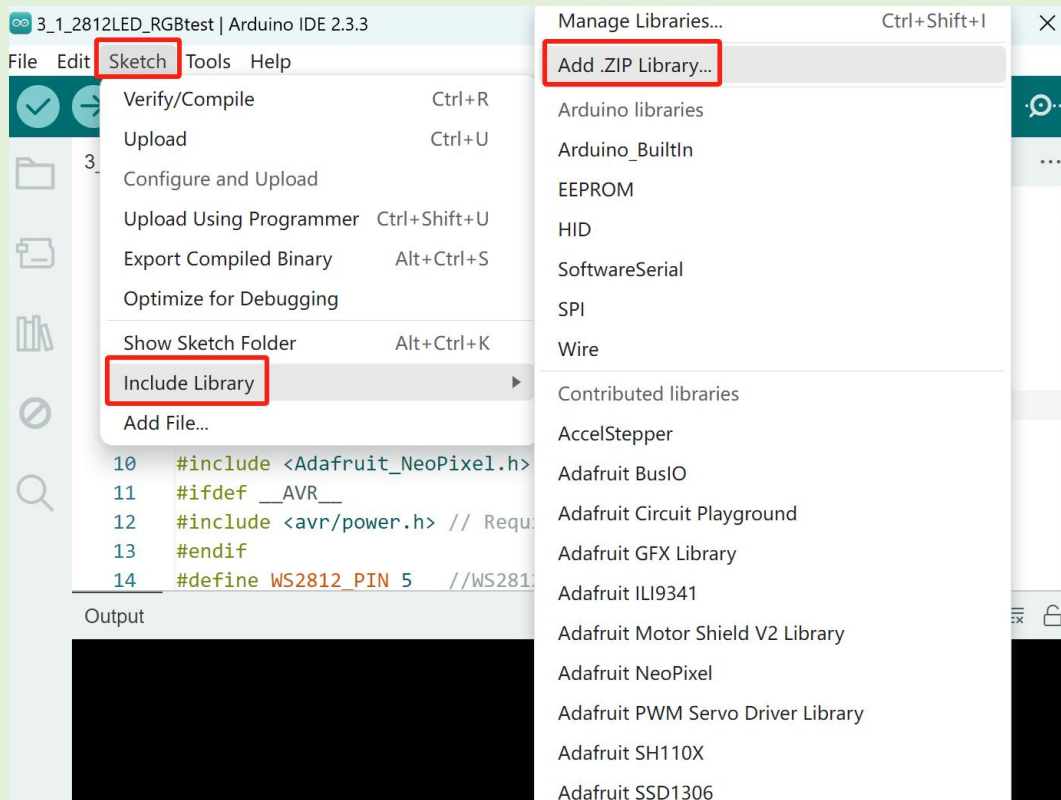
Search for “[Adafruit\\_NeoPixel](#)” in the red search box, Library Manager will quickly match related library files



Click "INSTALL" to install the library file of Adafruit\_NeoPixel. After the installation is complete, it will display "installed"

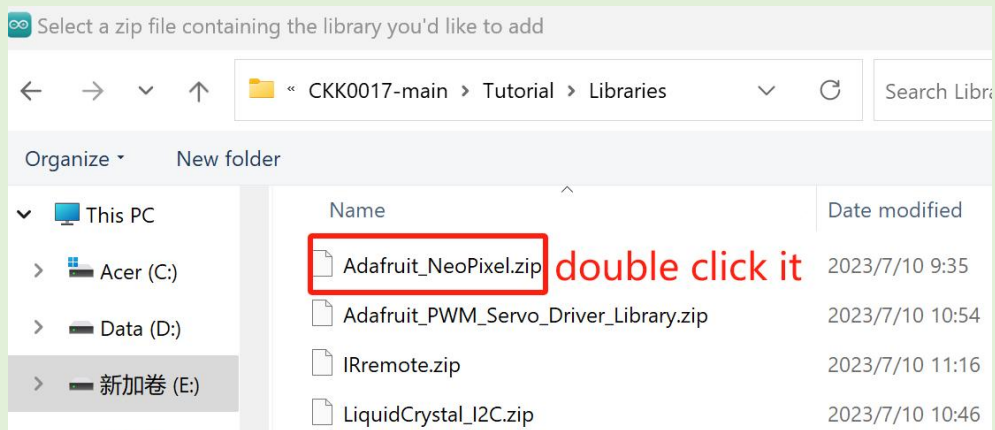



**Method 2:** After opening the `3_1_2812LED_RGBtest` code, click "Sketch" --- "Include Library" --- "Add .ZIP Library..." to open the library management interface.

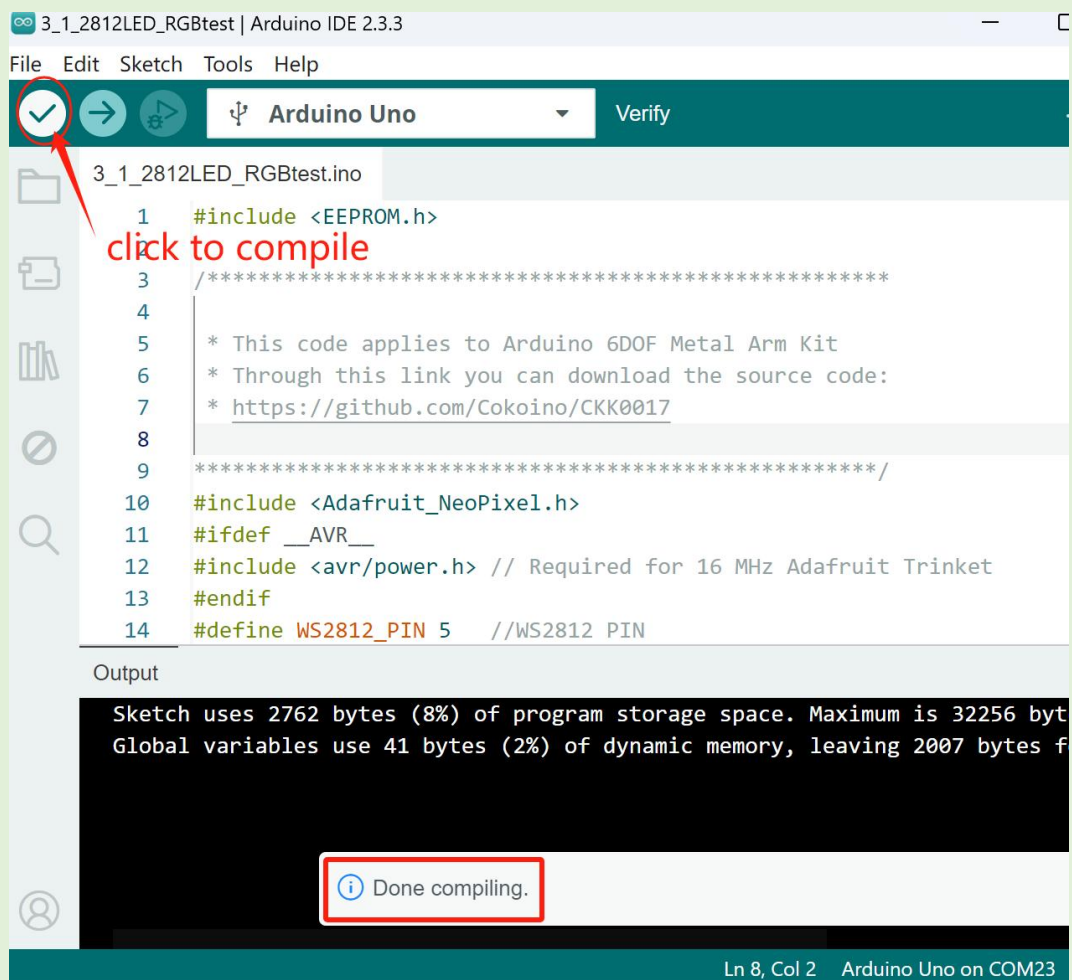


Find the `Adafruit_NeoPixel.ZIP` file in `E:CKK0017-main\Tutorial\Libraries\Adafruit_NeoPixel.zip`


Double click the `Adafruit_NeoPixel.ZIP` file, then it will be installed into Arduino IDE

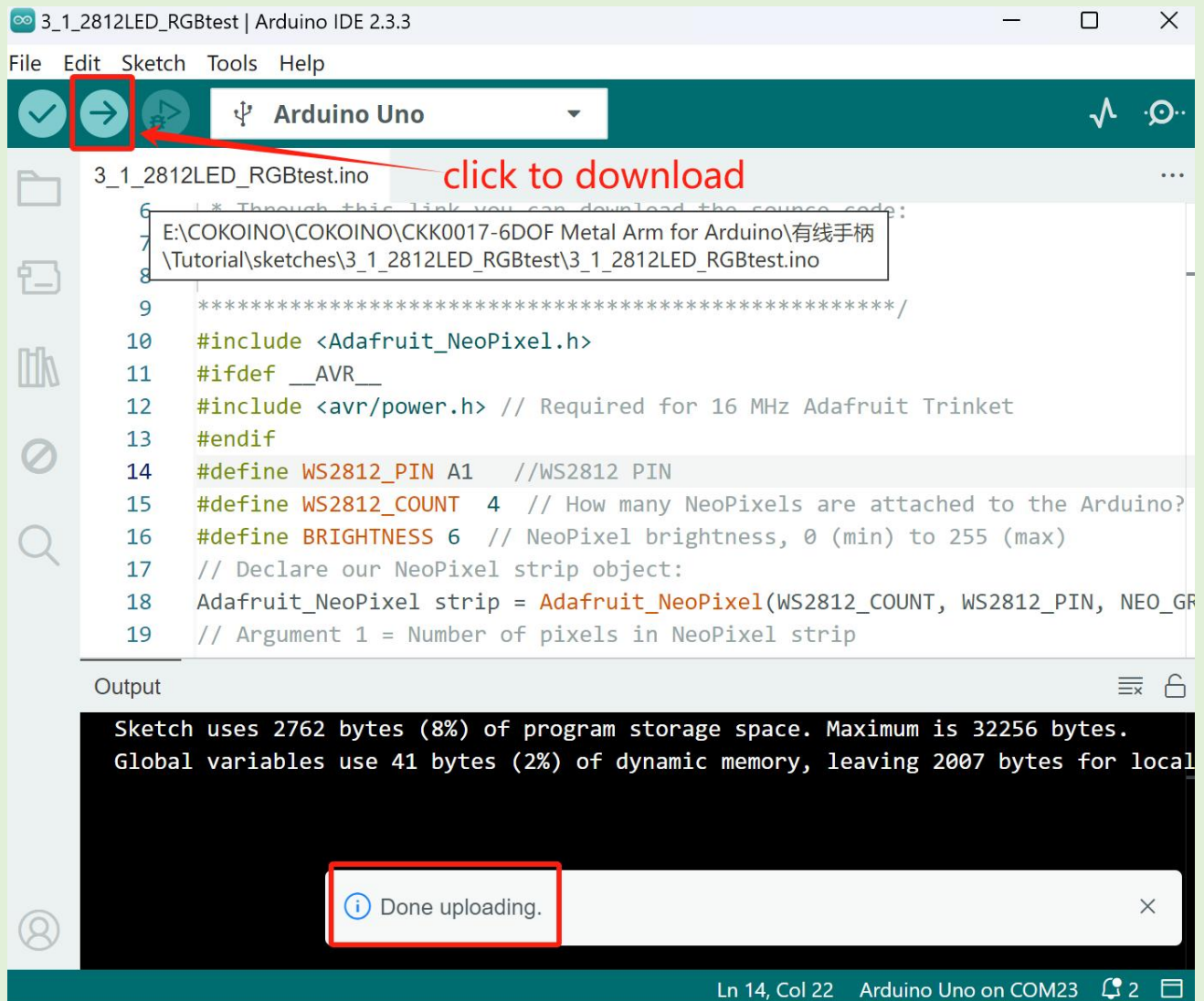


4.6 Click compile button , successfully compiled the code will display “Done compiling”





4.7 Click upload button , successfully uploading the code will display “Done uploading”.



When code is uploaded successfully, the program starts to run, you can see that the 4 LEDs on the board are cyclically changing colors from red to green to blue to white.

## 5. Code

### 3-1-2812LED-RGBtest.ino

```
#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
#include <avr/power.h> // Required for 16 MHz Adafruit Trinket
#endif

#define WS2812_PIN A1 //WS2812 PIN
#define WS2812_COUNT 4 // How many NeoPixels are attached to the Arduino?
#define BRIGHTNESS 6 // NeoPixel brightness, 0 (min) to 255 (max)
// Declare our NeoPixel strip object:
Adafruit_NeoPixel strip = Adafruit_NeoPixel(WS2812_COUNT, WS2812_PIN, NEO_GRB +
NEO_KHZ800);
// Argument 1 = Number of pixels in NeoPixel strip
// Argument 2 = Arduino pin number (most are valid)
// Argument 3 = Pixel type flags, add together as needed:
//   NEO_KHZ800 800 KHz bitstream (most NeoPixel products w/WS2812 LEDs)

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void setup()
{
  // These lines are specifically to support the Adafruit Trinket 5V 16 MHz.
  // Any other board, you can remove this part (but no harm leaving it):
  #if defined (__AVR_ATtiny85__)
    if (F_CPU == 16000000) clock_prescale_set(clock_div_1);
  #endif // END of Trinket-specific code.
  strip.begin();// INITIALIZE NeoPixel strip object (REQUIRED)
  strip.show(); // Turn OFF all pixels ASAP
  strip.setBrightness(BRIGHTNESS);
}

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void loop()
{
  // Fill along the length of the strip in various colors...
  colorWipe(strip.Color(255, 0, 0), 6); // Red
  delay(800);
  colorWipe(strip.Color(0, 255, 0), 6); // Green
  delay(800);
```

```
colorWipe(strip.Color(0, 0, 255), 6); // Blue
delay(800);
//colorWipe(strip.Color(180, 0, 255), 6); // purple
//delay(800);
colorWipe(strip.Color(127, 127, 127), 6); // White
delay(800);
//colorWipe(strip.Color(0, 0, 0), 0); // Clear
}

void colorWipe(uint32_t c, uint8_t wait)
{
  for(uint16_t i=0; i<strip.numPixels(); i++) { // For each pixel in strip...
    strip.setPixelColor(i, c);                // Set pixel's color (in RAM)
    strip.show();                             // Update strip to match
    delay(wait);                              // Pause for a moment
  }
}
```

```
//Theatre-style crawling lights.
void theaterChase(uint32_t c, uint8_t wait)
{
  for (int j=0; j<10; j++) { //do 10 cycles of chasing
    for (int q=0; q < 3; q++) {
      for (int i=0; i < strip.numPixels(); i=i+3) {
        strip.setPixelColor(i+q, c);    //turn every third pixel on
      }
      strip.show();
      delay(wait);
      for (int i=0; i < strip.numPixels(); i=i+3) {
        strip.setPixelColor(i+q, 0);    //turn every third pixel off
      }
    }
  }
}
```



## 6. Expansion exercises

This lesson also expanded on two code examples to demonstrate the diversity of WS2812 light display. One is a colored flowing light, and the other is a rainbow light. It should be noted that these two codes use the FastLED. h library, Please refer to Install library Adafruit\_NeoPixel.h above to install the FastLED. h library

The code path for the colored flowing light is:

[E:\CKK0017-main\Tutorial\sketches\3\\_2\\_color\\_flowng\\_light](#)

The code path for rainbow lights is:

[E:\CKK0017-main\Tutorial\sketches\3\\_3\\_Rainbow\\_light](#)

Please refer to the fourth point of this lesson for the method of uploading code, which will not be explained in detail here.

## 7. Any questions and suggestions are welcome

Thank you for reading this document!

If you find any errors and omissions in the tutorial, or if you have any suggestions and questions, please feel free to contact us:

**[cokoino@outlook.com](mailto:cokoino@outlook.com)**

We will do our best to make changes and publish revisions as soon as possible.

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