Welcome

Thank you for choosing Freenove products!

How to Start

When reading this, you should have downloaded the ZIP file for this product.
Unzip it and you will get a folder containing tutorials and related files. Please start with this PDF tutorial.

! Unzip the ZIP file instead of opening the file in the ZIP file directly.
! Do not move, delete or rename files in the folder just unzipped.

Get Support

Encounter problems? Don't worry! Refer to "TroubleShooting.pdf" or contact us.

When there are packaging damage, quality problems, questions encountering in use, etc., just send us an email. We will reply to you within one working day and provide a solution.

support@freenove.com

Attention

Pay attention to safety when using and storing this product:

- This product is not suitable for children under 12 years of age because of small parts and sharp parts.
- Minors should use this product under the supervision and guidance of adults.
- This product contains small and sharp parts. Do not swallow, prick and scratch to avoid injury.
- This product contains conductive parts. Do not hold them to touch power supply and other circuits.
- To avoid personal injury, do not touch parts rotating or moving while working.
- The wrong operation may cause overheat. Do not touch and disconnect the power supply immediately.
- Operate in accordance with the requirements of the tutorial. Fail to do so may damage the parts.
- Store this product in a dry and dark environment. Keep away from children.
- Turn off the power of the circuit before leaving.

About

Freenove provides open source electronic products and services.

Freenove is committed to helping customers learn programming and electronic knowledge, quickly implement product prototypes, realize their creativity and launch innovative products. Our services include:

- Kits for learning programming and electronics
- Kits compatible with Arduino®, Raspberry Pi®, micro:bit®, etc.
- Kits for robots, smart cars, drones, etc.
- Components, modules and tools
- Design and customization

To learn more about us or get our latest information, please visit our website:

http://www.freenove.com

Copyright

Contents

Preface

If you want to make some interesting projects or want to learn electronics and programming, this document will greatly help you.

Projects in this document usually contains two parts: the circuit and the code. No experience at all? Don't worry, this document will show you how to start from scratch.

If you encounter any problems, please feel free to send us an email, we will try our best to help you.

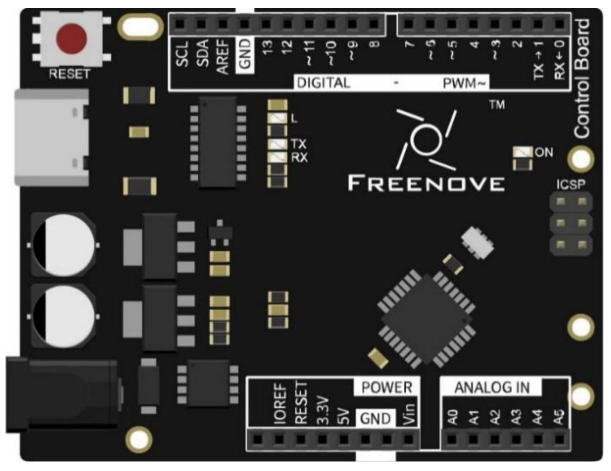
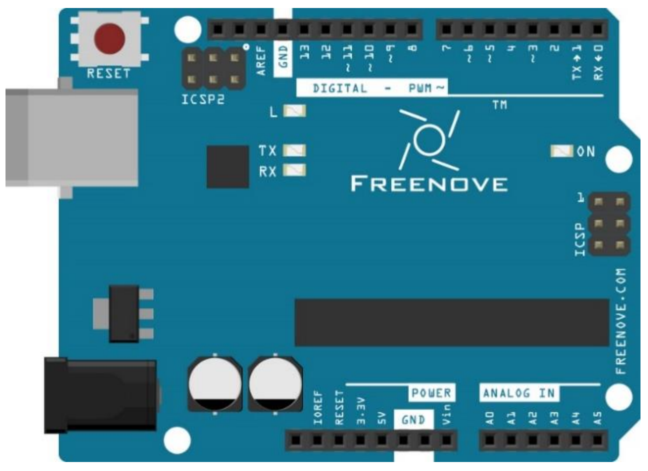
Support email: support@freenove.com

To complete these projects, you need to use a control board and software to program it, as well as some commonly used components.

Control Board

The control board is the core of a circuit. After programming, it can be used to control other components in the circuit to achieve intended functions.

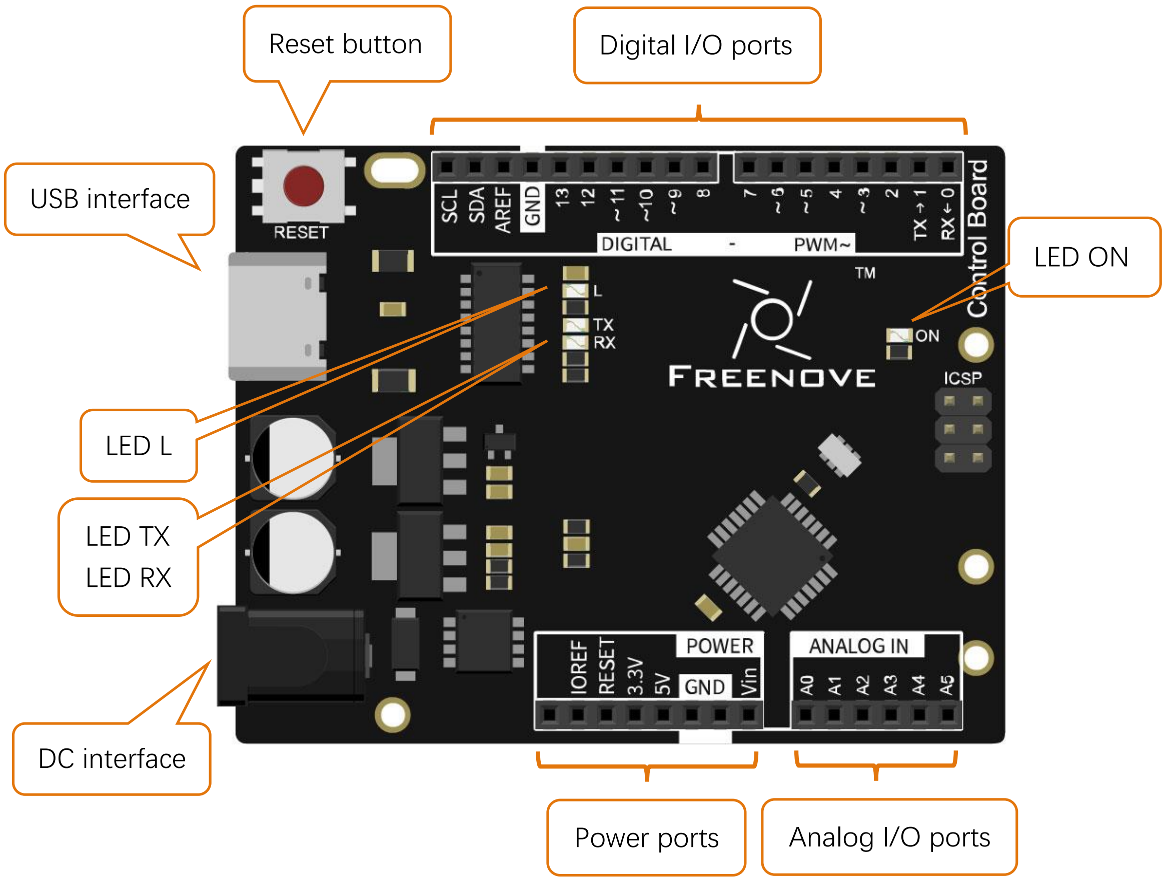
There are multiple versions of Freenove control board. Your purchase may be one of the following:

Freenove Control Board (Black)	Freenove Control Board (Blue)
	

Note: Although the colors and shapes of these control boards are somewhat different, their ports and functions are the same. They can be replaced with each other, and there is no difference in their usages.

Note: Only the black control board is used to display the hardware connection in this document.
The hardware connection of the blue control board is the same.

Diagram of the Freenove control board is shown below:



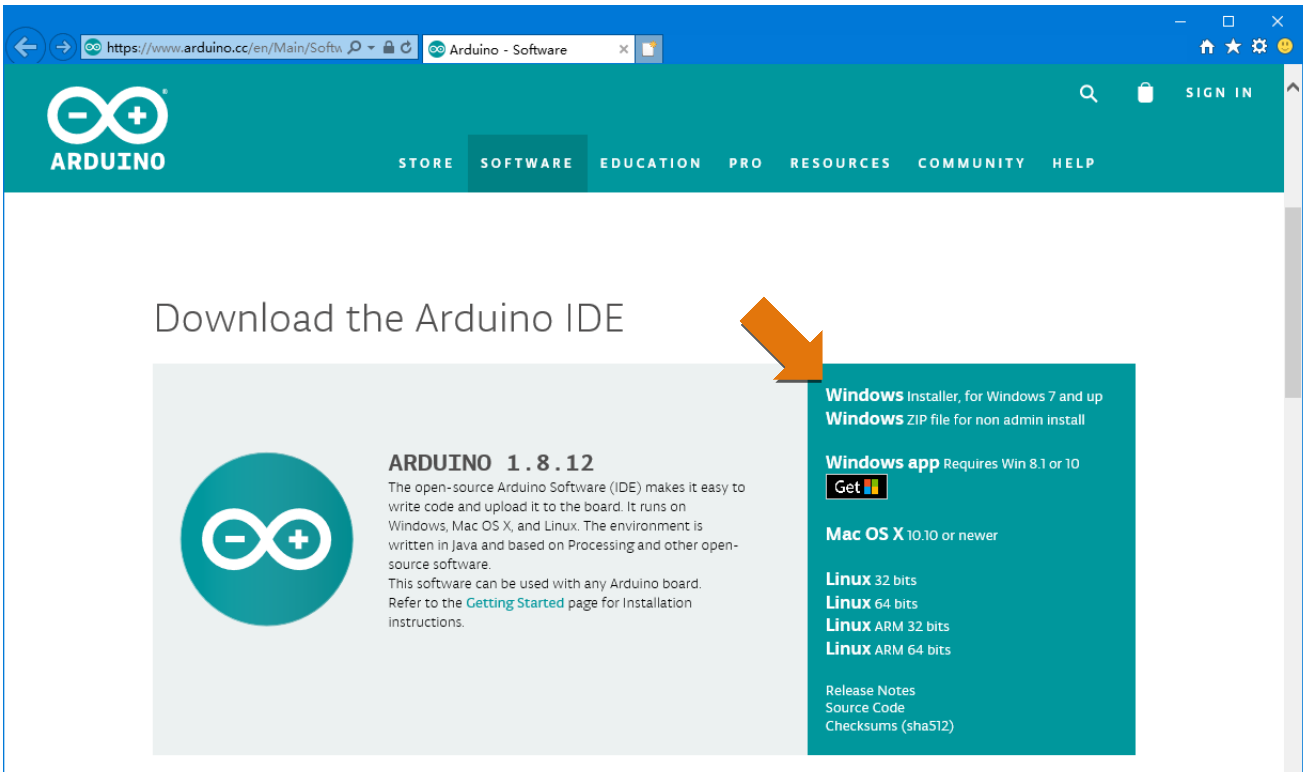
- Digital I/O ports is used to connect to other components or modules, to receive an input signal, or to send a control signal. Usually, we name it by adding a "D" in front of the number, such as D13 (pin 13).
- USB interface is used to provide power, upload code or communicate with PC.
- LED L is connected to digital I/O port 13 (pin 13).
- LED TX, RX is used to indicate the state of the serial communication.
- DC interface is connected DC power to provide power for the board.
- Power ports can provide power for electronic components and modules.
- Analog I/O ports can be used to measure analog signals.
- LED ON is used to indicate the power state.

Programming Software

We use Arduino® IDE to write and upload code for the control board, which is a free and open source. (Arduino® is a trademark of Arduino LLC.)

Arduino IDE uses C/C++ programming language. Don't worry if you have never used it, because this document contains programming knowledge and detailed explanation of the code.

First, install Arduino IDE. Visit https://www.arduino.cc/en/Main/Software. Select and download a corresponding installer according to your operating system. If you are a windows user, please select the "Windows Installer".



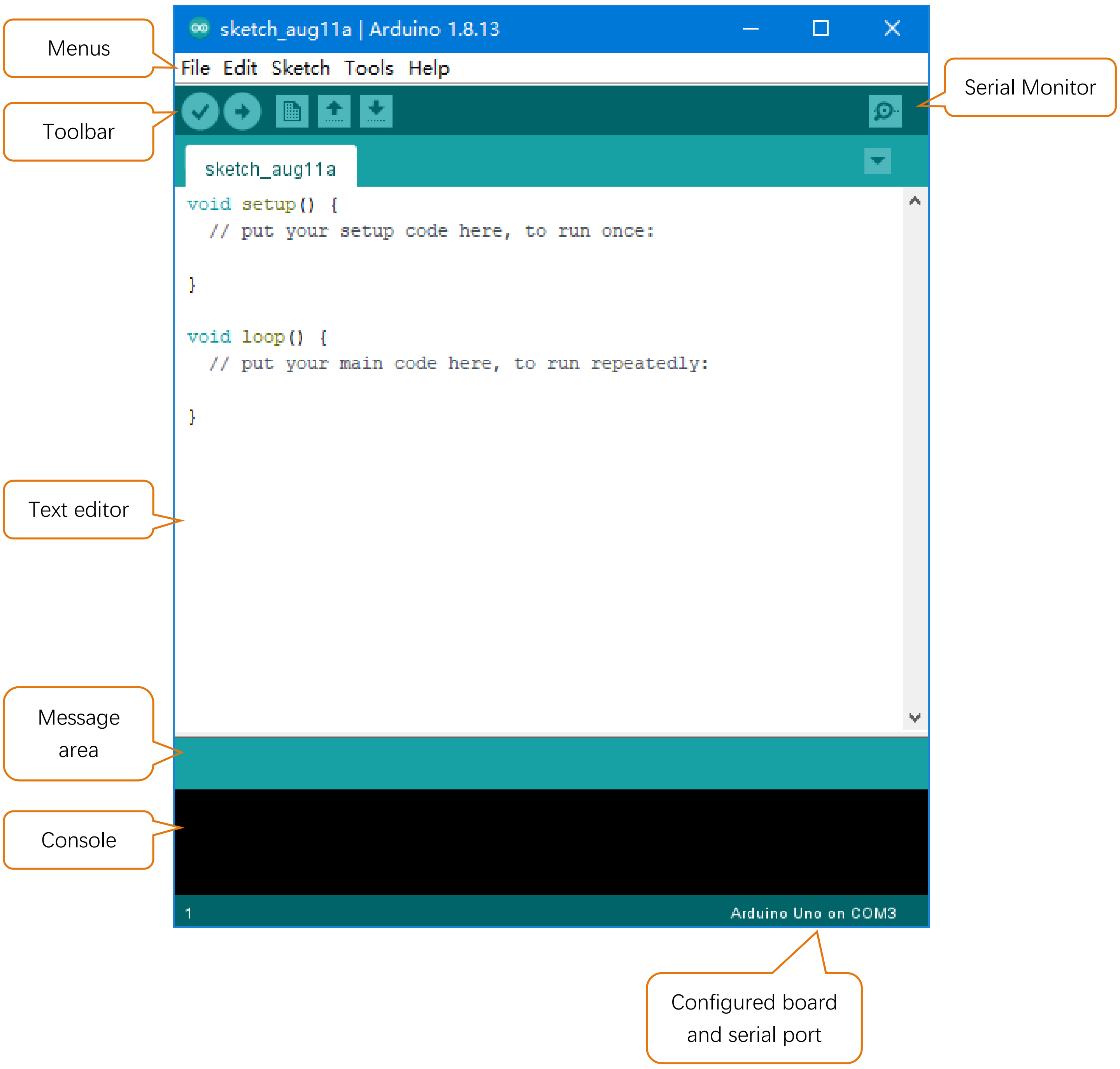
Download the Arduino IDE

ARDUINO 1.8.12

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.
This software can be used with any Arduino board.
Refer to the Getting Started page for Installation instructions.

After the downloading completes, run the installer. For Windows users, there may pop up an installation dialog box of driver during the installation process. When it is popped up, please allow the installation.
After installation is completed, an shortcut will be generated in the desktop.

Run it. The interface of the software is as follows:


Menus
Toolbar
Text editor
Message area
Console
Serial Monitor
Configured board and serial port
sketch_aug11a | Arduino 1.8.13
File Edit Sketch Tools Help
sketch_aug11a
1
Arduino Uno on COM3

```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

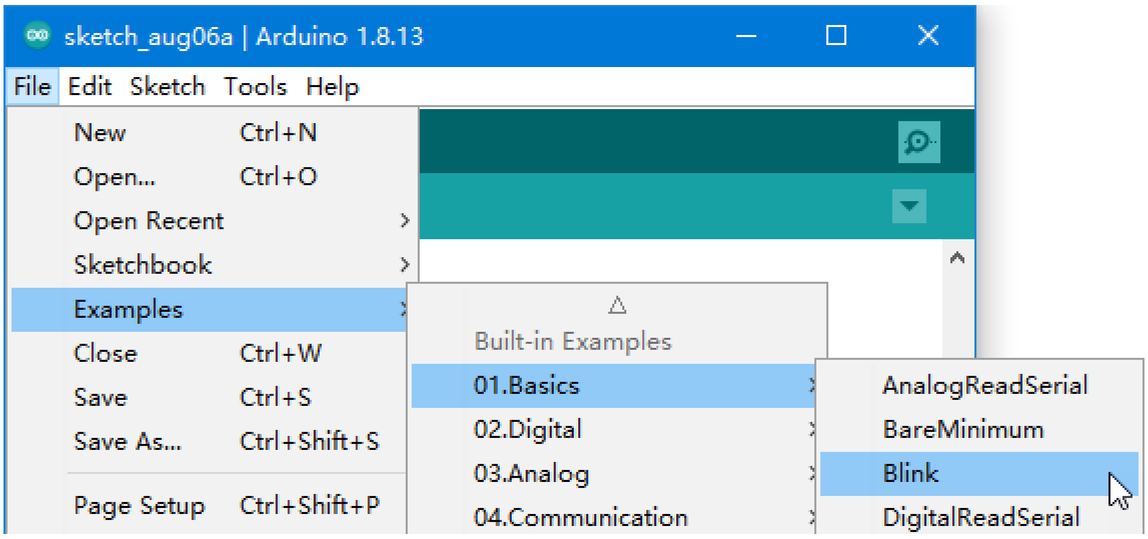
Programs written with Arduino IDE are called **sketches**. These sketches are written in a text editor and are saved with the file extension**.ino**. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino IDE, including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

✓	Verify Checks your code for errors compiling it.
➜	Upload Compiles your code and uploads it to the configured board.
🗎	New Creates a new sketch.
⬆	Open Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content.
⬇	Save Saves your sketch.
🔍	Serial Monitor Opens the serial monitor.

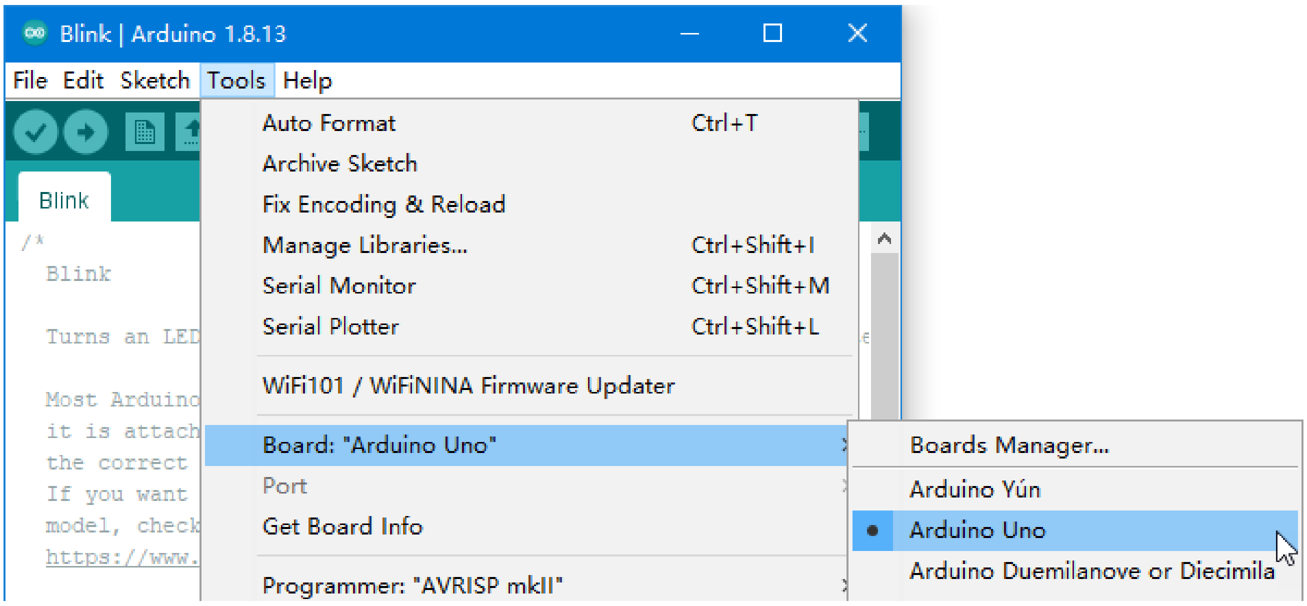
Additional commands are found within five menus: File, Edit, Sketch, Tools, Help. The menus are context sensitive, which means only those items relevant to the work currently being carried out are available.

First Use

Open the example sketch "Blink".

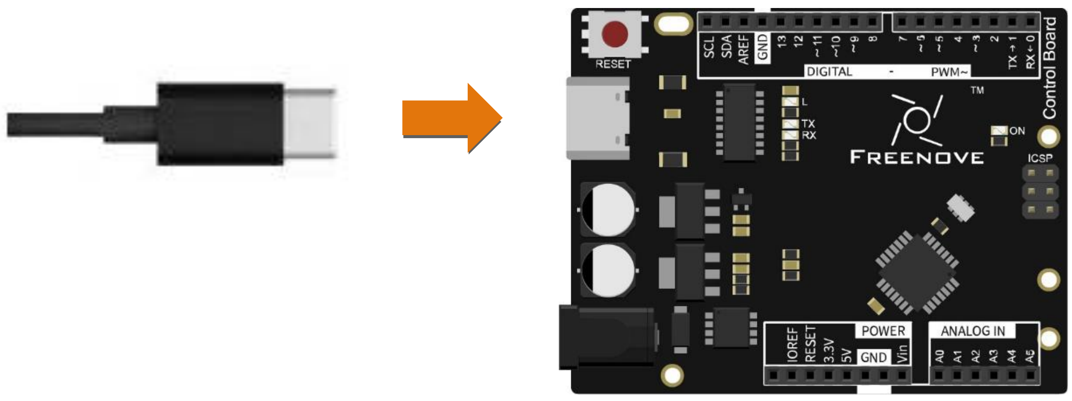


Select board "Arduino Uno". (Freenove control board is compatible with this board.)


Blink | Arduino 1.8.13
File Edit Sketch Tools Help
Blink
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
WiFi101 / WiFiNINA Firmware Updater
Board: "Arduino Uno"
Port
Get Board Info
Programmer: "AVRISP mkII"
Boards Manager...
Arduino Yún
● Arduino Uno
Arduino Duemilanove or Diecimila

```
/*
  Blink

  Turns an LED

  Most Arduino
  it is attach
  the correct
  If you want
  model, check
  https://www.
```

Connect control board to your computer with USB cable.



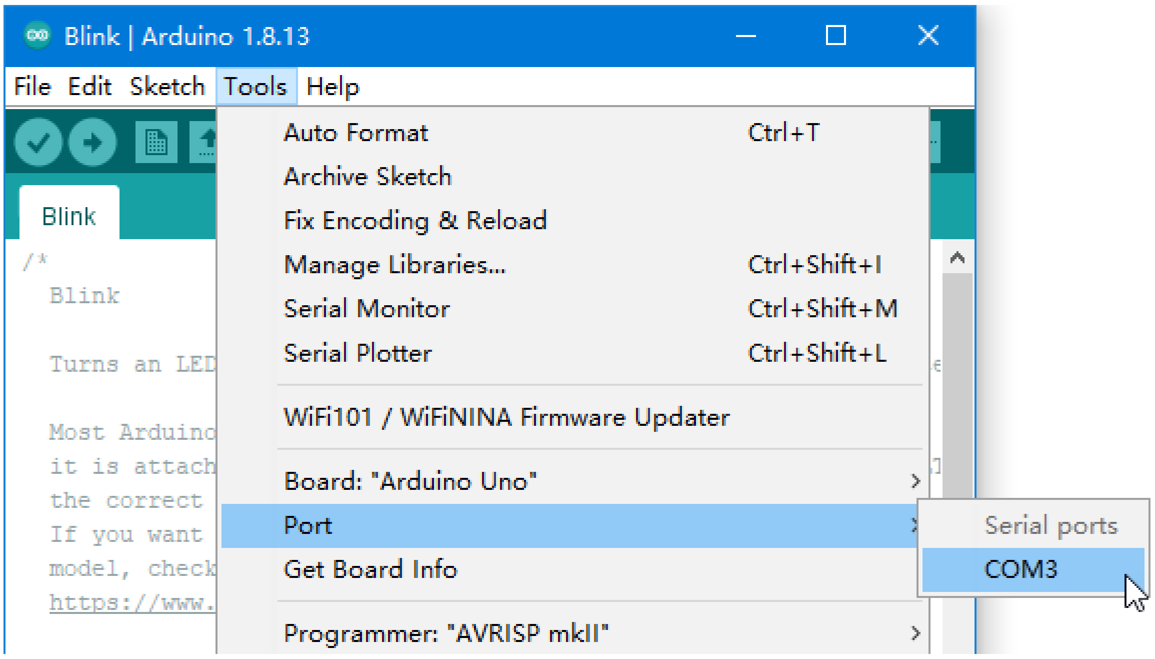
Select the port.

Note: Your port may be different from the following figure.

On Windows: It may be COM4, COM5 (Arduino Uno) or something like that.

On Mac: It may be /dev/cu.usbserial-710, /dev/cu.usemodem7101 (Arduino Uno) or something like that.

On Linux: It may be /dev/ttyUSB0, /dev/ttyACM0 or something like that.


Blink | Arduino 1.8.13
File Edit Sketch Tools Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
WiFi101 / WiFiNINA Firmware Updater
Board: "Arduino Uno"
Port
Get Board Info
Programmer: "AVRISP mkII"
Serial ports
COM3
Blink

```
/*
  Blink

  Turns an LED

  Most Arduino
  it is attach
  the correct
  If you want
  model, check
  https://www.
```

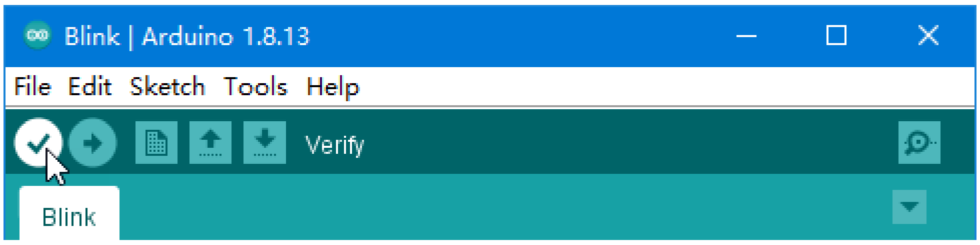
Note: If there is more than one port and you cannot decide which one to choose, disconnect the USB cable and check the port. Then connect the USB cable and check the port again. The new one is the correct port.

If there is no COM port for control board, you may need to install a driver to your conputer.

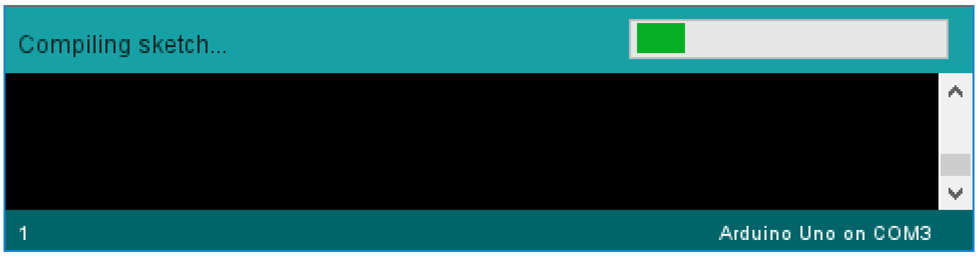
- For blue board, reinstall the latest version of Arduino IDE. During installation, agree to install the driver.
- For black board, see “InstallDriver.pdf” in “Drivers” folder (in the folder contains this Tutorial.pdf).

Having problems? Contact us for help! Send mail to: support@freenove.com

Click "Verify" button.

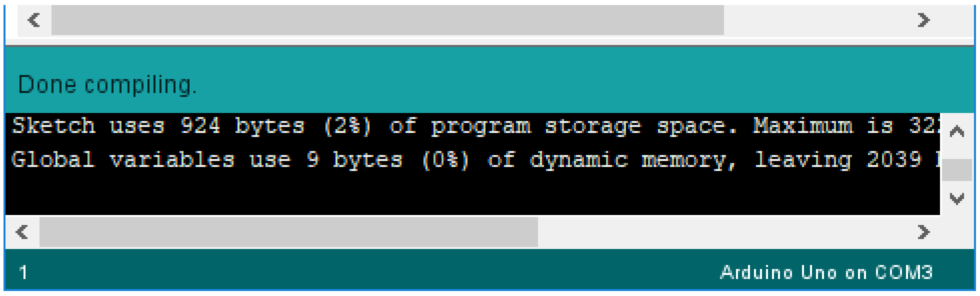


The following figure shows the code being compiled.



```
Compiling sketch...
```

Wait a moment for the compiling to be completed. Figure below shows the code size and percentage of space occupation. If there is an error in the code, the compilation will fail and the details are shown here.



```
Sketch uses 924 bytes (2%) of program storage space. Maximum is 32
Global variables use 9 bytes (0%) of dynamic memory, leaving 2039 
```

Click "Upload" button.

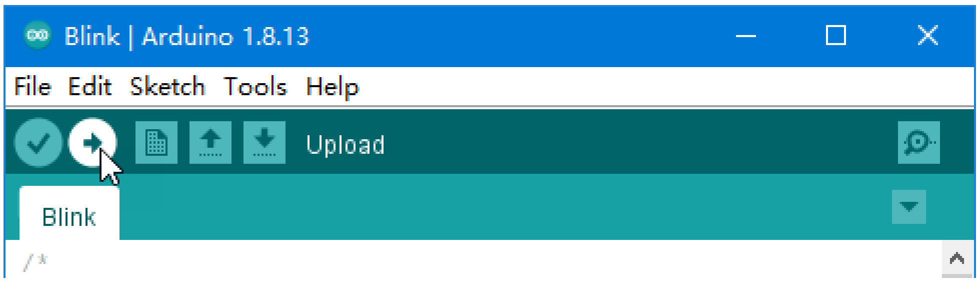
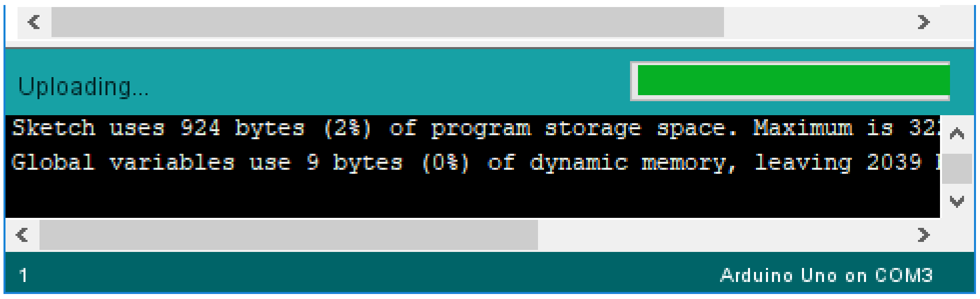
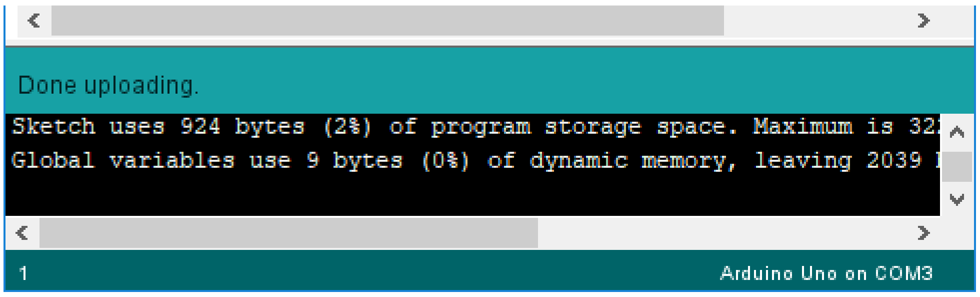


Figure below shows code are uploading.



```
Sketch uses 924 bytes (2%) of program storage space. Maximum is 32
Global variables use 9 bytes (0%) of dynamic memory, leaving 2039 
```

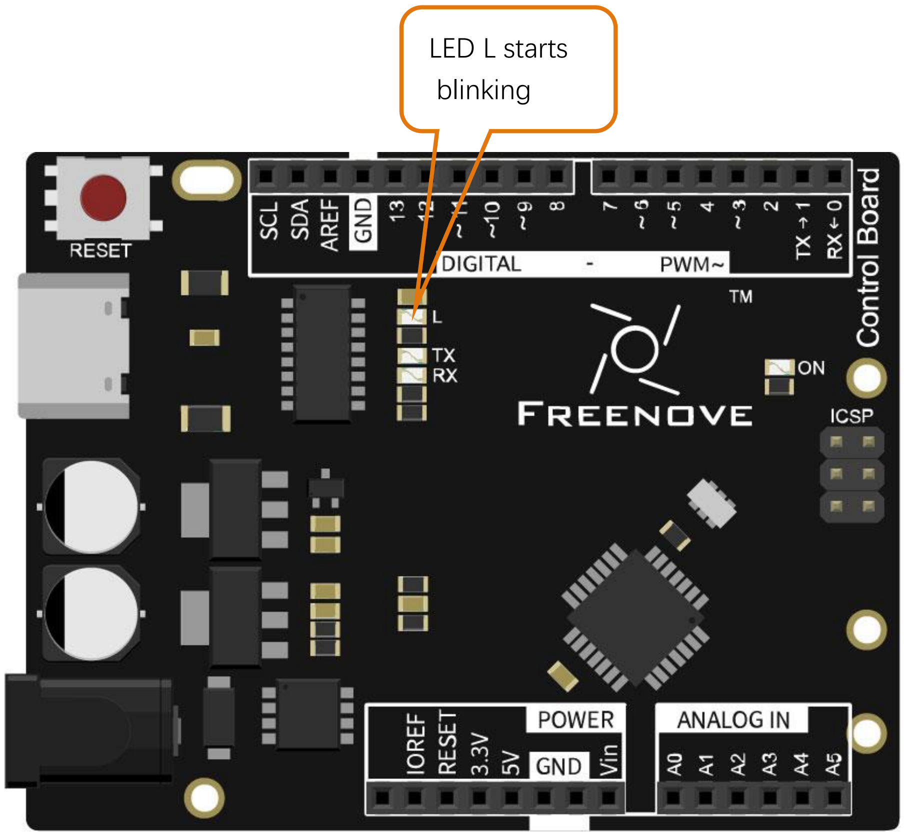
Wait a moment, and then the uploading is completed.



```
Sketch uses 924 bytes (2%) of program storage space. Maximum is 32
Global variables use 9 bytes (0%) of dynamic memory, leaving 2039 
```

Having problems? Contact us for help! Send mail to: support@freenove.com

After that, we will see the LED marked with "L" on the control board start blinking. It indicates that the code is running now!



So far, we have completed the first use. I believe you have felt the joy of it. Next, we will carry out a series of projects, from easy to difficult, taking you to learn programming and the building of electronic circuit.

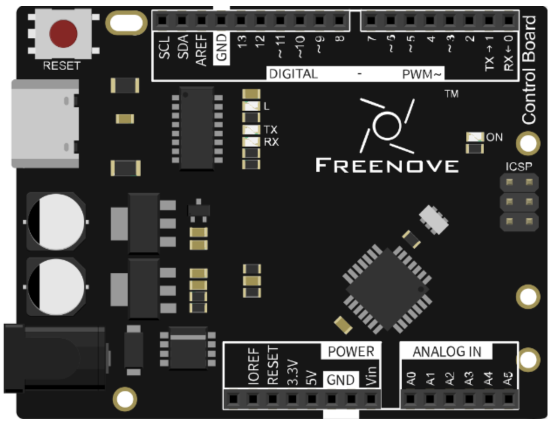
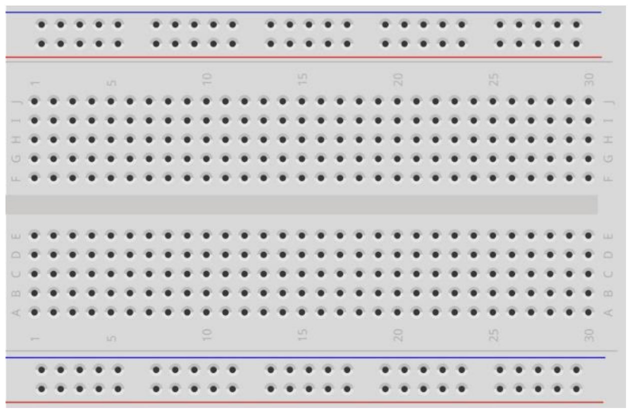
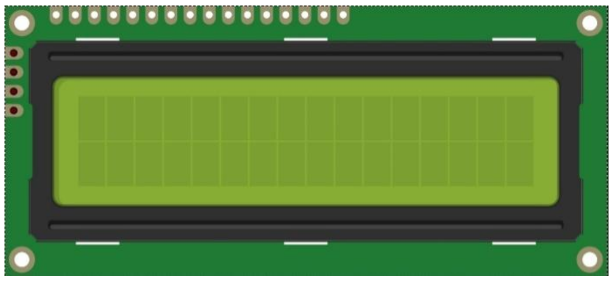
Chapter 1 I2C LCD1602

In this chapter, we will learn about the LCD1602 Display Screen.

Project 16.1 Display the String on I2C LCD1602

In this section we learn how to use lcd1602 to display something.

Component List

Control board x1 	Breadboard x1 
USB cable x1	I2C LCD1602 Module x1 
Jumper M/F x4	

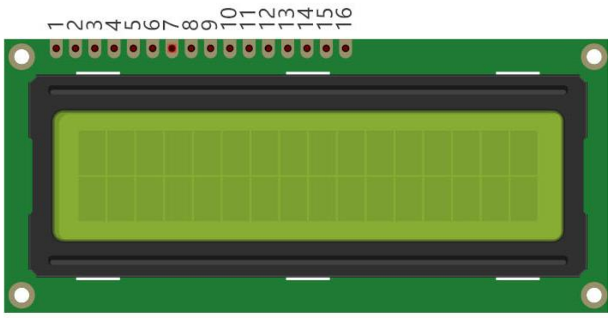
Component Knowledge

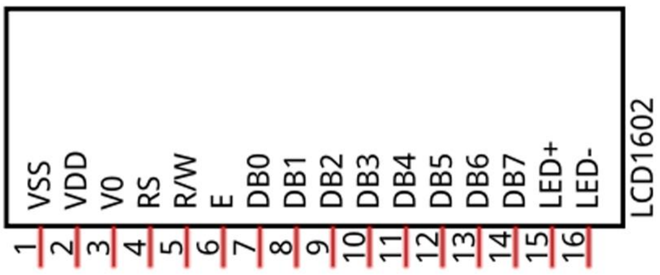
I2C communication

I2C (Inter-Integrated Circuit) is a two-wire serial communication mode, which can be used for the connection of micro controllers and their peripheral equipment. Devices using I2C communication must be connected to the serial data (SDA) line, and serial clock (SCL) line (called I2C bus). Each device has a unique address and can be used as a transmitter or receiver to communicate with devices connected to the bus.

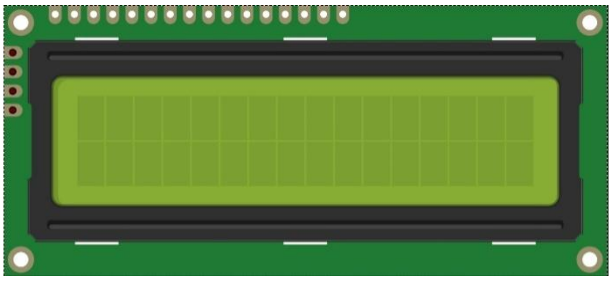
LCD1602 communication

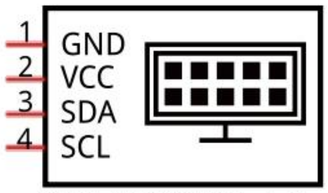
The LCD1602 Display Screen can display 2 lines of characters in 16 columns. It is capable of displaying numbers, letters, symbols, ASCII code and so on. As shown below is a monochrome LCD1602 Display Screen along with its circuit pin diagram.





I2C LCD1602 Display Screen integrates an I2C interface, which connects the serial-input & parallel-output module to the LCD1602 Display Screen. This allows us to use only 4 lines to the operate the LCD1602.

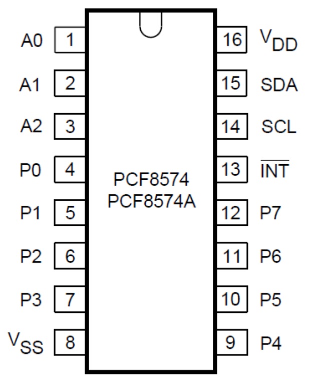
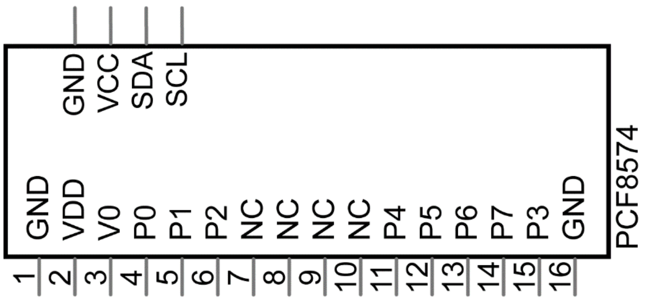




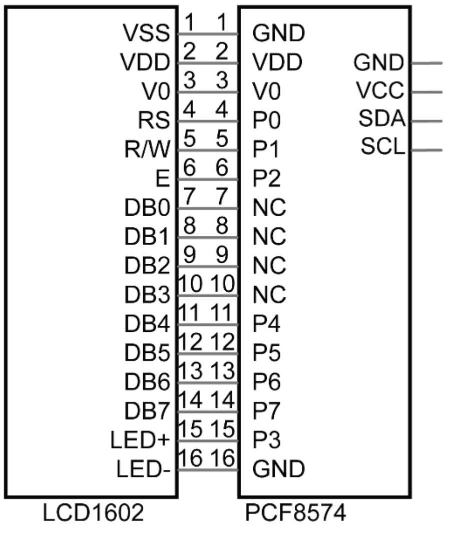
I2C LCD1602 Module

The serial-to-parallel IC chip used in this module is PCF8574T (PCF8574AT), and its default I2C address is 0x27(0x3F).

Below is the PCF8574 pin schematic diagram and the block pin diagram:

PCF8574 chip pin diagram	PCF8574 module pin diagram
 A0 1 A1 2 A2 3 P0 4 P1 5 P2 6 P3 7 V_{SS} 8 PCF8574 PCF8574A 16 V_{DD} 15 SDA 14 SCL 13 $\overline{INT}$ 12 P7 11 P6 10 P5 9 P4	 GND VCC SDA SCL 1 GND 2 VDD 3 V0 4 P0 5 P1 6 P2 7 NC 8 NC 9 NC 10 NC 11 P4 12 P5 13 P6 14 P7 15 P3 16 GND PCF8574

PCF8574 module pin and LCD1602 pin are corresponding to each other and connected with each other:

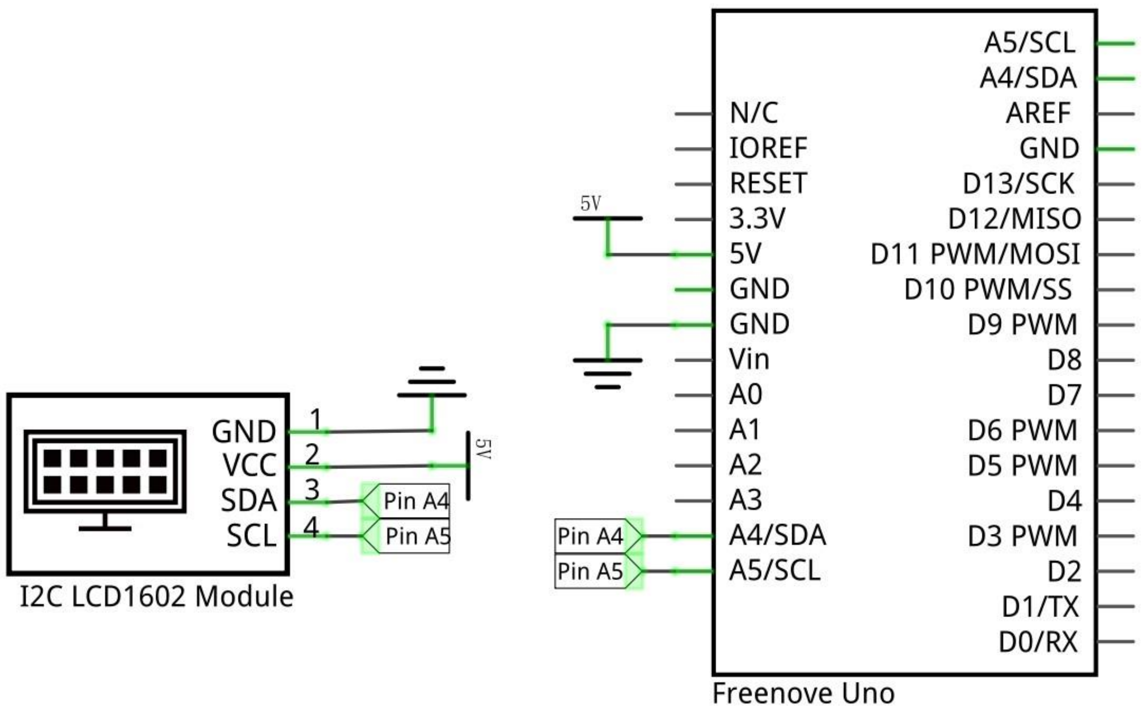


So we only need 4 pins to control the 16 pins of the LCD1602 Display Screen through the I2C interface. In this project, we will use the I2C LCD1602 to display some static characters and dynamic variables.

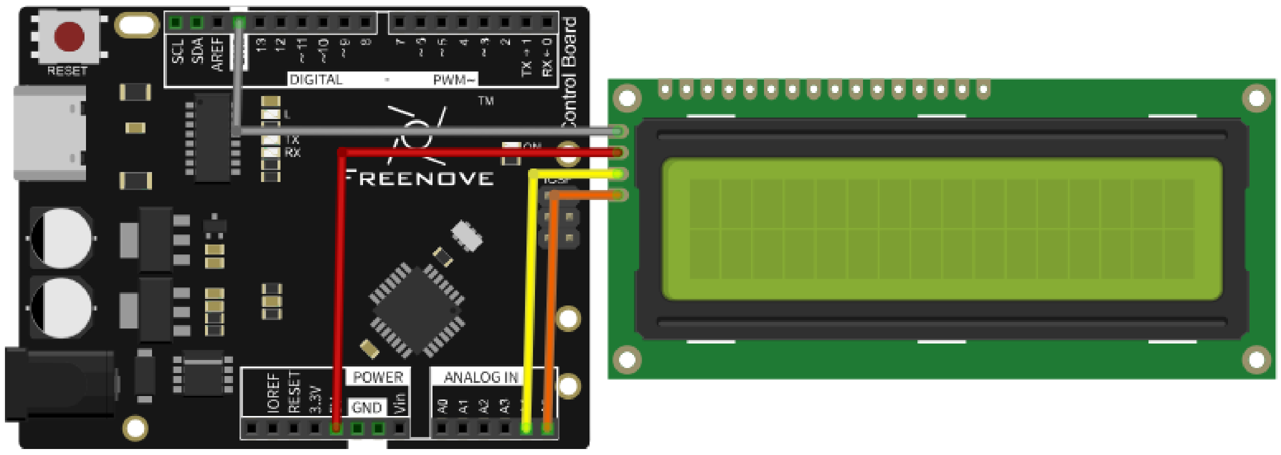
Circuit

The connection of control board and I2C LCD1602 is shown below.

Schematic diagram



Circuit connection

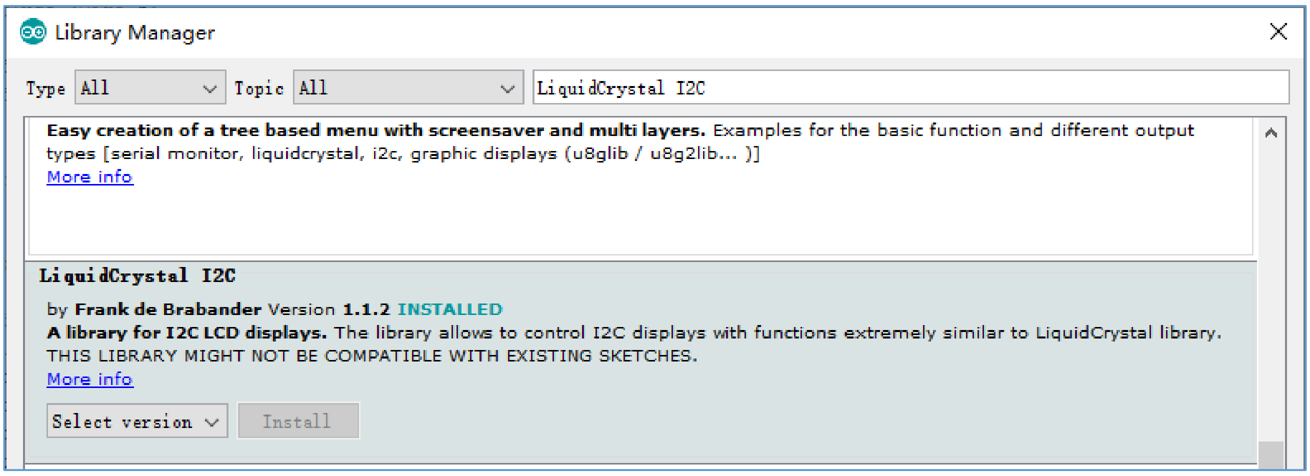


Sketch

Before writing code, we need to import the library needed.

How to install the library

We use the third party library **LiquidCrystal I2C**. If you haven't installed it yet, please do so before learning. The steps to add third-party Libraries are as follows: open arduino->Sketch->Include library-> Manage libraries. Enter " LiquidCrystal I2C" in the search bar and select " LiquidCrystal I2C " for installation.



Library Manager

Type All Topic All LiquidCrystal I2C

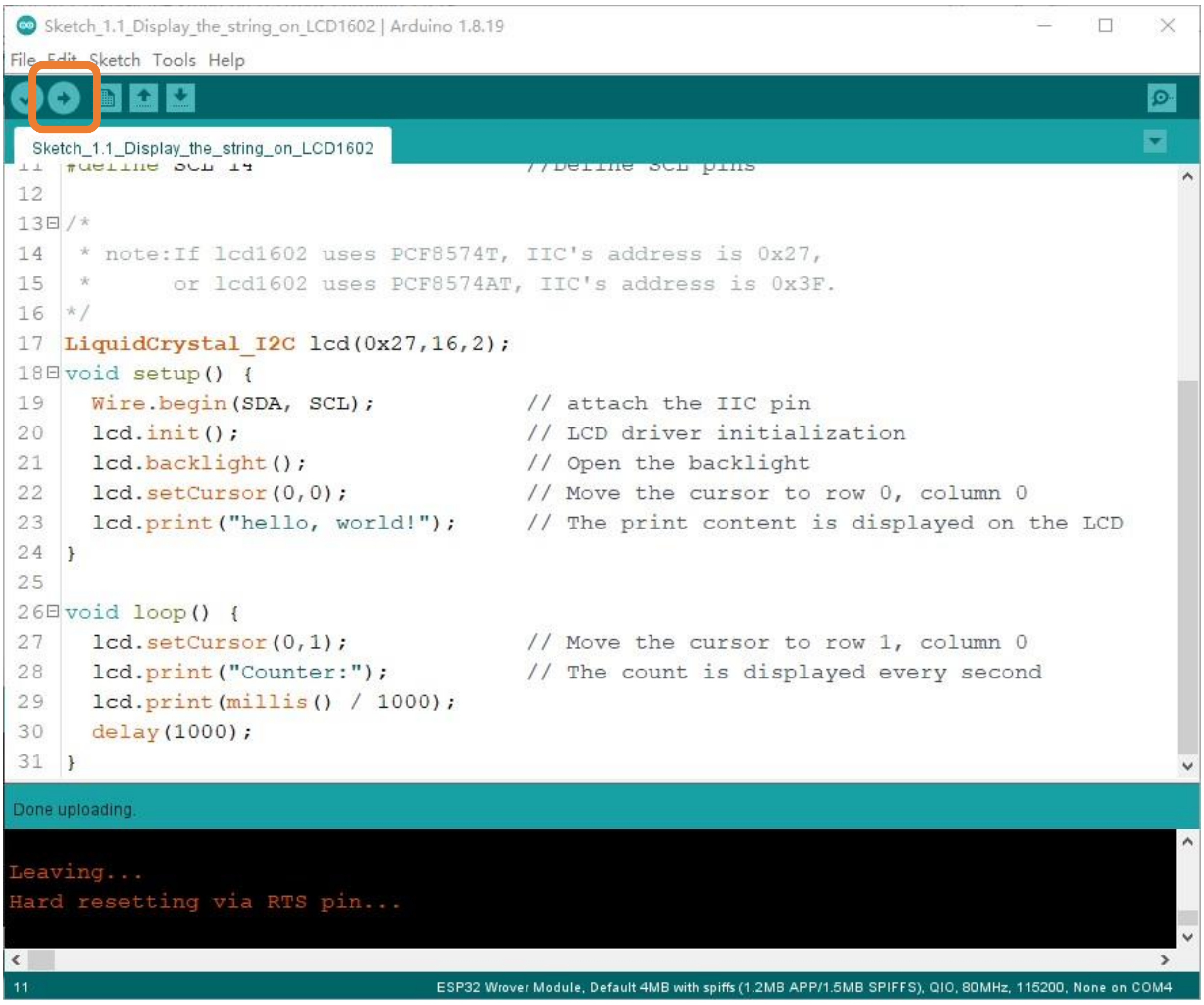
Easy creation of a tree based menu with screensaver and multi layers. Examples for the basic function and different output types [serial monitor, liquidcrystal, i2c, graphic displays (u8glib / u8g2lib...)]
More info

LiquidCrystal I2C
by **Frank de Brabander** Version **1.1.2** INSTALLED
A library for I2C LCD displays. The library allows to control I2C displays with functions extremely similar to LiquidCrystal library. THIS LIBRARY MIGHT NOT BE COMPATIBLE WITH EXISTING SKETCHES.
More info

There is another way you can install libraries.

Click “Add .ZIP Library...” and then find **LiquidCrystal_I2C.zip** in libraries folder (this folder is in the folder unzipped form the ZIP file we provided). This library can facilitate our operation of I2C LCD1602.

Sketch_1.1_Display_the_string_on_LCD1602

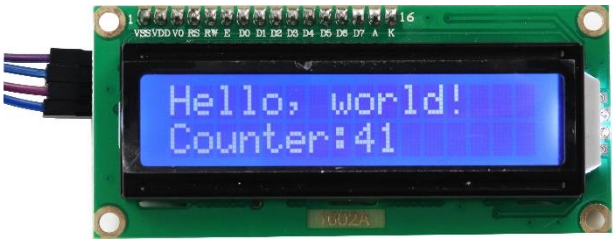

Sketch_1.1_Display_the_string_on_LCD1602 | Arduino 1.8.19
File Edit Sketch Tools Help
Sketch_1.1_Display_the_string_on_LCD1602

```
#define SCL 14                         //Define SCL pins

/*
 * note:If lcd1602 uses PCF8574T, IIC's address is 0x27,
 *      or lcd1602 uses PCF8574AT, IIC's address is 0x3F.
*/
LiquidCrystal_I2C lcd(0x27,16,2);
void setup() {
  Wire.begin(SDA, SCL);              // attach the IIC pin
  lcd.init();                        // LCD driver initialization
  lcd.backlight();                   // Open the backlight
  lcd.setCursor(0,0);                // Move the cursor to row 0, column 0
  lcd.print("hello, world!");        // The print content is displayed on the LCD
}

void loop() {
  lcd.setCursor(0,1);                // Move the cursor to row 1, column 0
  lcd.print("Counter:");             // The count is displayed every second
  lcd.print(millis() / 1000);
  delay(1000);
}
```

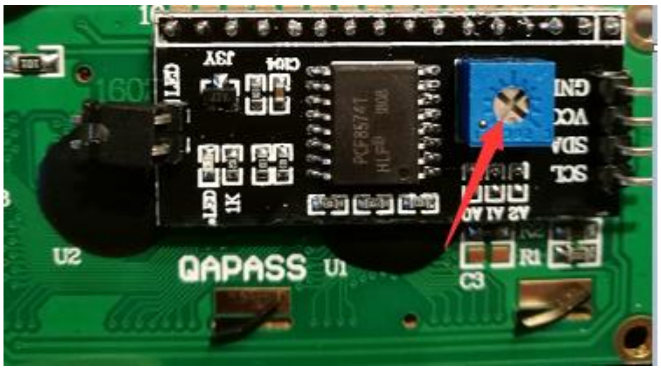
```
Done uploading.

Leaving...
Hard resetting via RTS pin...
```

```
11        ESP32 Wrover Module, Default 4MB with spiffs (1.2MB APP/1.5MB SPIFFS), QIO, 80MHz, 115200, None on COM4
```

Compile and upload the code to Arduino and the LCD1602 displays characters.



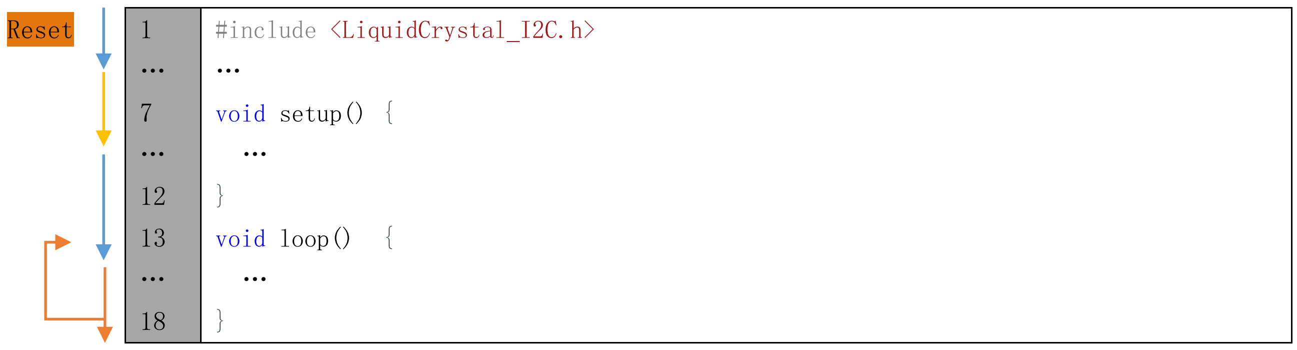
If you cannot see anything on the display or the display is not clear, try rotating the white knob on back of LCD1602 slowly, which adjusts the contrast, until the screen can display clearly.



Now let's start to write code to use LCD1602 to display static characters and dynamic variables.

```
#include <LiquidCrystal_I2C.h>
/*
* note:If lcd1602 uses PCF8574T, IIC's address is 0x27,
* or lcd1602 uses PCF8574AT, IIC's address is 0x3F.
*/
LiquidCrystal_I2C lcd(0x27,16,2);
void setup() {
  lcd.init(); // LCD driver initialization
  lcd.backlight(); // Open the backlight
  lcd.setCursor(0,0); // Move the cursor to row 0, column 0
  lcd.print("hello world"); // The print content is displayed on the LCD
}
void loop() {
  lcd.setCursor(0,1); // Move the cursor to row 1, column 0
  lcd.print("Counter:"); // The count is displayed every second
  lcd.print(millis() / 1000);
  delay(1000);
}
```

The code usually contains two basic functions: void setup() and void loop().
After control board is reset, the setup() function will be executed first, and then the loop() function will be executed.
setup() function is generally used to write code to initialize the hardware. And loop() function is used to write code to achieve certain functions. loop() function is executed repeatedly. When the execution reaches the end of loop(), it will jump to the beginning of loop() to run again.



```
1    #include <LiquidCrystal_I2C.h>
…    …
7    void setup() {
…      …
12   }
13   void loop()  {
…      …
18   }
```

Following are the LiquidCrystal_I2C library used for controlling LCD:

```
#include <LiquidCrystal_I2C.h>
```

LiquidCrystal_I2C library provides LiquidCrystal_I2C class that controls LCD1602. When we instantiate a LiquidCrystal_I2C object, we can input some parameters. Instantiate the I2C LCD1602 screen. It should be noted here that if your LCD driver chip uses PCF8574T, set the I2C address to 0x27, and if uses PCF8574AT, set the I2C address to 0x3F. And these parameters are the row/column numbers of the I2C addresses and screen that connect to LCD1602:

```
LiquidCrystal_I2C lcd(0x27,16,2);// set the LCD address to 0x27 for a 16 chars and 2 line display
```

First, initialize the LCD and turn on LCD backlight.

```
  lcd.init(); // LCD driver initialization
  lcd.backlight(); // Open the backlight
```

And then print a string:

```
  lcd.print("hello world"); // The print content is displayed on the LCD
```

Print a changing number in the loop () function:

```
void loop() {
  lcd.setCursor(0,1); // Move the cursor to row 1, column 0
  lcd.print("Counter:"); // The count is displayed every second
  lcd.print(millis() / 1000);
  delay(1000);
}
```

Before printing characters, we need to set the coordinate of the printed character, that is, in which line and which column:

```
  lcd.setCursor(0,1); // Move the cursor to row 1, column 0
```

LiquidCrystal_I2C Class

LiquidCrystal_I2C class can control common LCD screen. First, we need instantiate an object of LiquidCrystal_I2C type, for example:

LiquidCrystal_I2C lcd(0x27, 16, 2);

When an object is instantiated, a constructed function of the class is called a constructor. In the constructor function, we need to fill in the I2C address of the LCD module, as well as the number of columns and rows of the LCD module. The number of columns and rows can also be set in the lcd.begin ().

The functions used in the LiquidCrystal_I2C class are as follows:

lcd.setCursor (col, row): set the coordinates of the to-be-printed character. The parameters are the numbers of columns and rows of the characters (start from 0, the number 0 represents first row or first line).

lcd.print (data): print characters. Characters will be printed on the coordinates set before. If you do not set the coordinates, the string will be printed behind the last printed character.

Verify and upload the code, then observe the LCD screen. If the display is not clear or there is no display, adjust the potentiometer on the back of I2C module to adjust the screen contrast until the character is clearly displayed on the LCD.

hello, world!
Counter:1

You can use the I2C LCD1602 to replace the serial port as a mobile screen when you print the data latter.

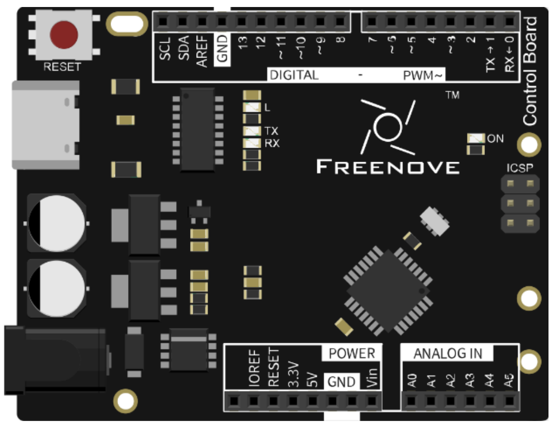
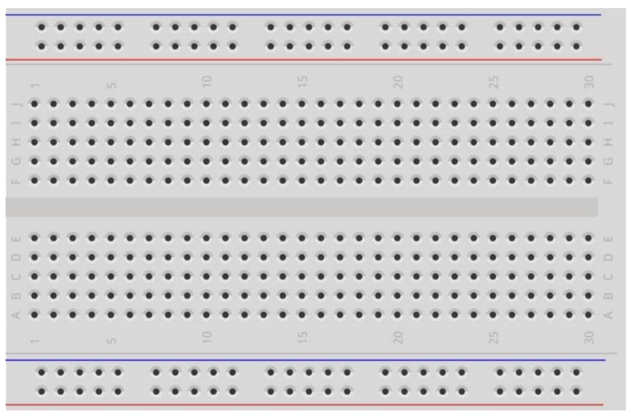
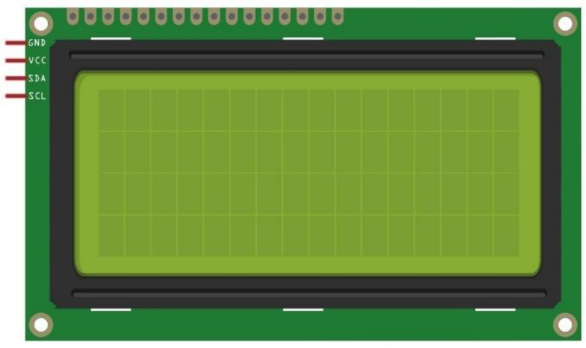
Chapter 2 I2C LCD2004

In the previous chapter, we studied the LCD2004 display. In order to display more content,In this chapter, we will learn about the LCD2004 Display Screen.

Project 2.1 Display the String on I2C LCD2004

In this section we learn how to use LCD2004 to display something.

Component List

Control board x1  RESET SCL SDA AREF GND DIGITAL PWM~ FREENOVE Control Board ON ICSP TX RX POWER IOREF RESET 3.3V 5V GND Vin ANALOG IN A0 A1 A2 A3 A4 A5	Breadboard x1 
USB cable x1	I2C LCD2004 Module x1 
Jumper M/F x4	

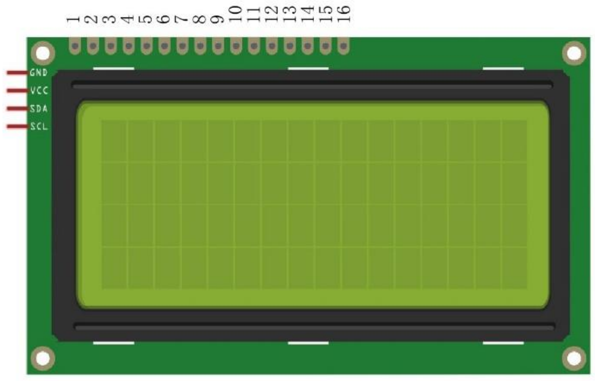
Component Knowledge

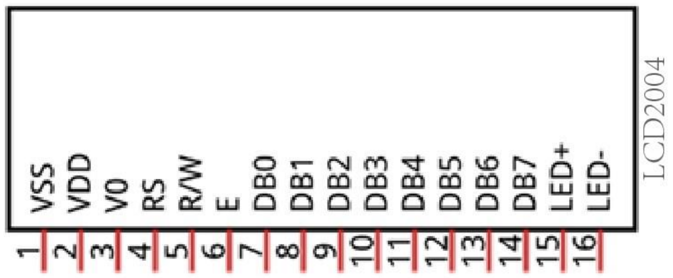
I2C communication

I2C (Inter-Integrated Circuit) is a two-wire serial communication mode, which can be used for the connection of micro controllers and their peripheral equipment. Devices using I2C communication must be connected to the serial data (SDA) line, and serial clock (SCL) line (called I2C bus). Each device has a unique address and can be used as a transmitter or receiver to communicate with devices connected to the bus.

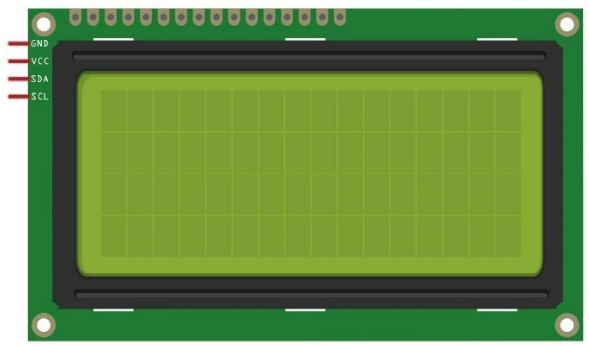
LCD2004 communication

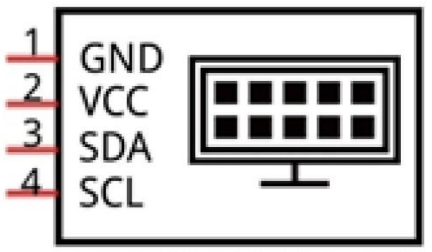
The LCD2004 display screen can display 4 lines of characters in 20 columns. It is capable of displaying numbers, letters, symbols, ASCII code and so on. As shown below is a monochrome LCD2004 display screen along with its circuit pin diagram.





I2C LCD2004 display screen integrates a I2C interface, which connects the serial-input & parallel-output module to the LCD2004 display screen. This allows us to only use 4 lines to the operate the LCD2004.

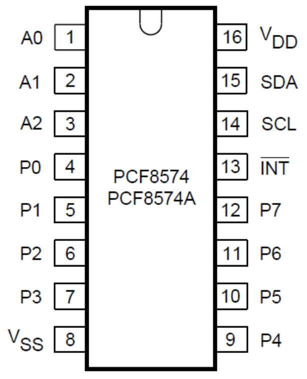
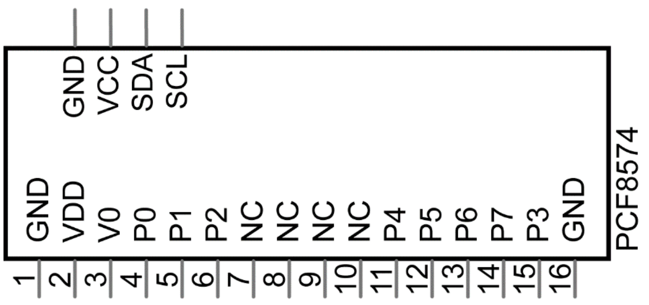




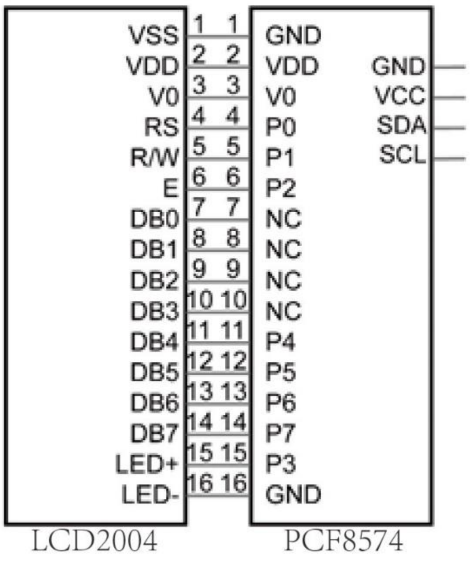
I2C LCD2004 Module

The serial-to-parallel IC chip used in this module is PCF8574T (PCF8574AT), and its default I2C address is 0x27(0x3F).

Below is the PCF8574 pin schematic diagram and the block pin diagram:

PCF8574 chip pin diagram	PCF8574 module pin diagram
 A0 1 A1 2 A2 3 P0 4 P1 5 P2 6 P3 7 VSS 8 16 VDD 15 SDA 14 SCL 13 INT 12 P7 11 P6 10 P5 9 P4 PCF8574 PCF8574A	 GND VCC SDA SCL 1 GND 2 VDD 3 V0 4 P0 5 P1 6 P2 7 NC 8 NC 9 NC 10 NC 11 P4 12 P5 13 P6 14 P7 15 P3 16 GND PCF8574

PCF8574 module pin and LCD2004 pin are corresponding to each other and connected with each other:

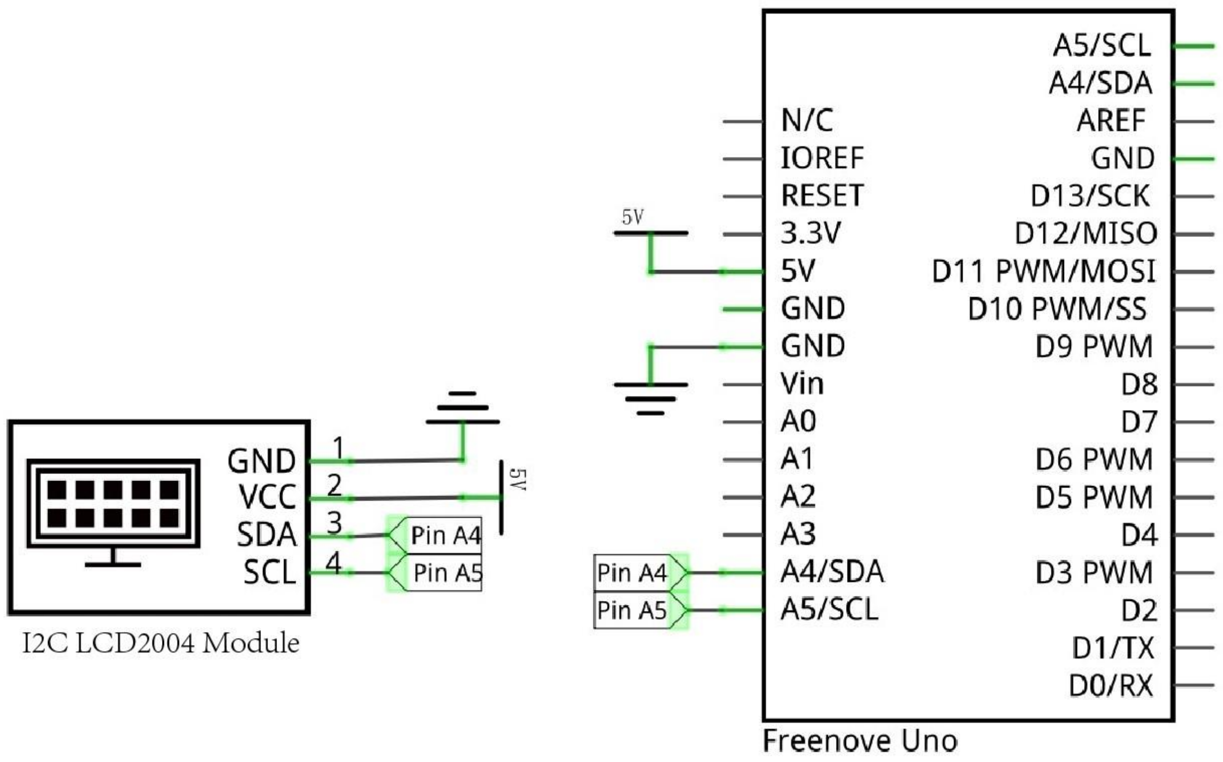


So we only need 4 pins to control the 16 pins of the LCD2004 Display Screen through the I2C interface.
In this project, we will use the I2C LCD2004 to display some static characters and dynamic variables.

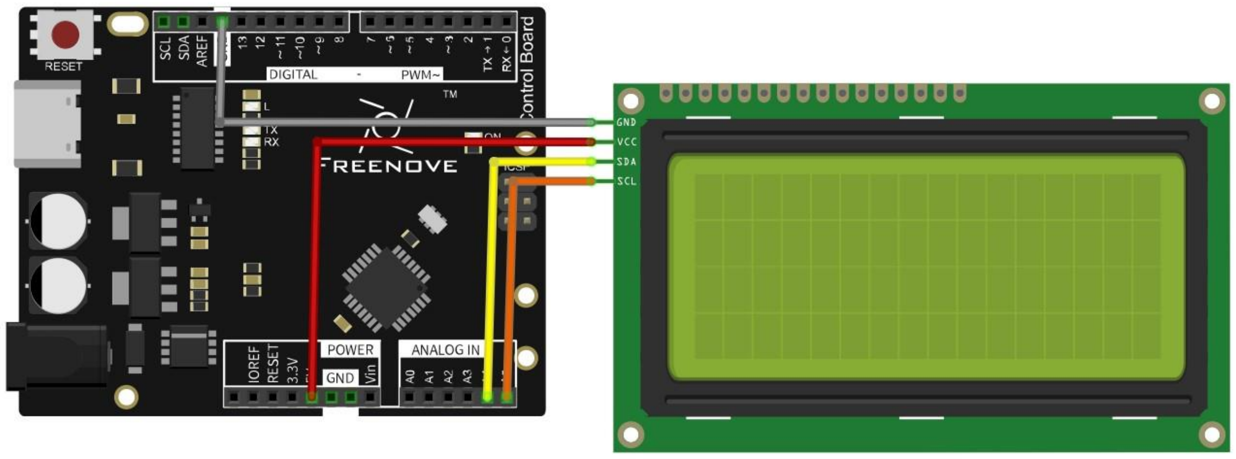
Circuit

The connection of control board and I2C LCD2004 is shown below.

Schematic diagram



Circuit connection

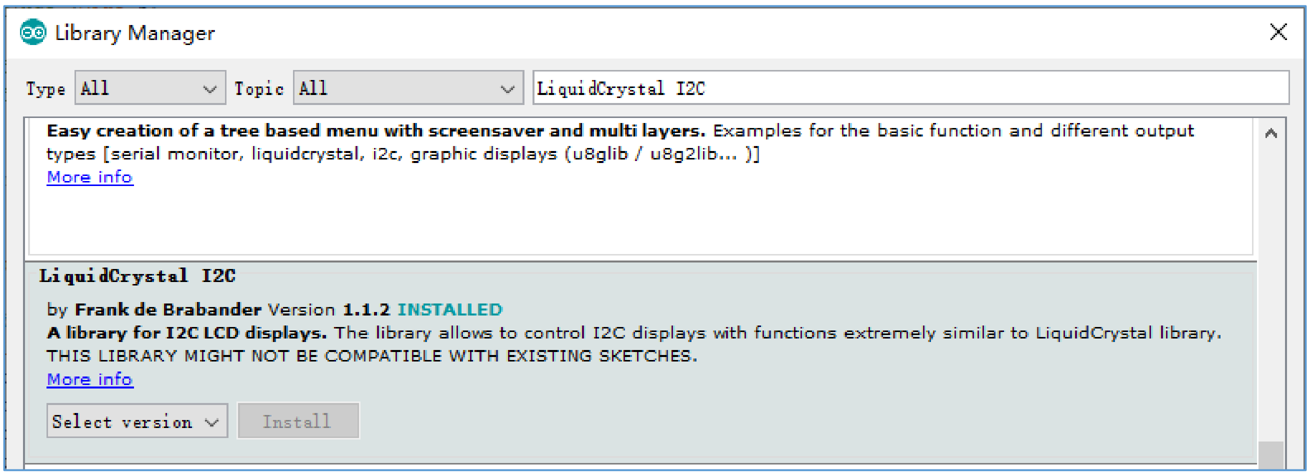


Sketch

Before writing code, we need to import the library needed. Skip this section if you have already installed it, or proceed if you haven't.

How to install the library

We use the third party library **LiquidCrystal I2C**. If you haven't installed it yet, please do so before learning. The steps to add third-party Libraries are as follows: open arduino->Sketch->Include library-> Manage libraries. Enter " LiquidCrystal I2C" in the search bar and select " LiquidCrystal I2C " for installation.



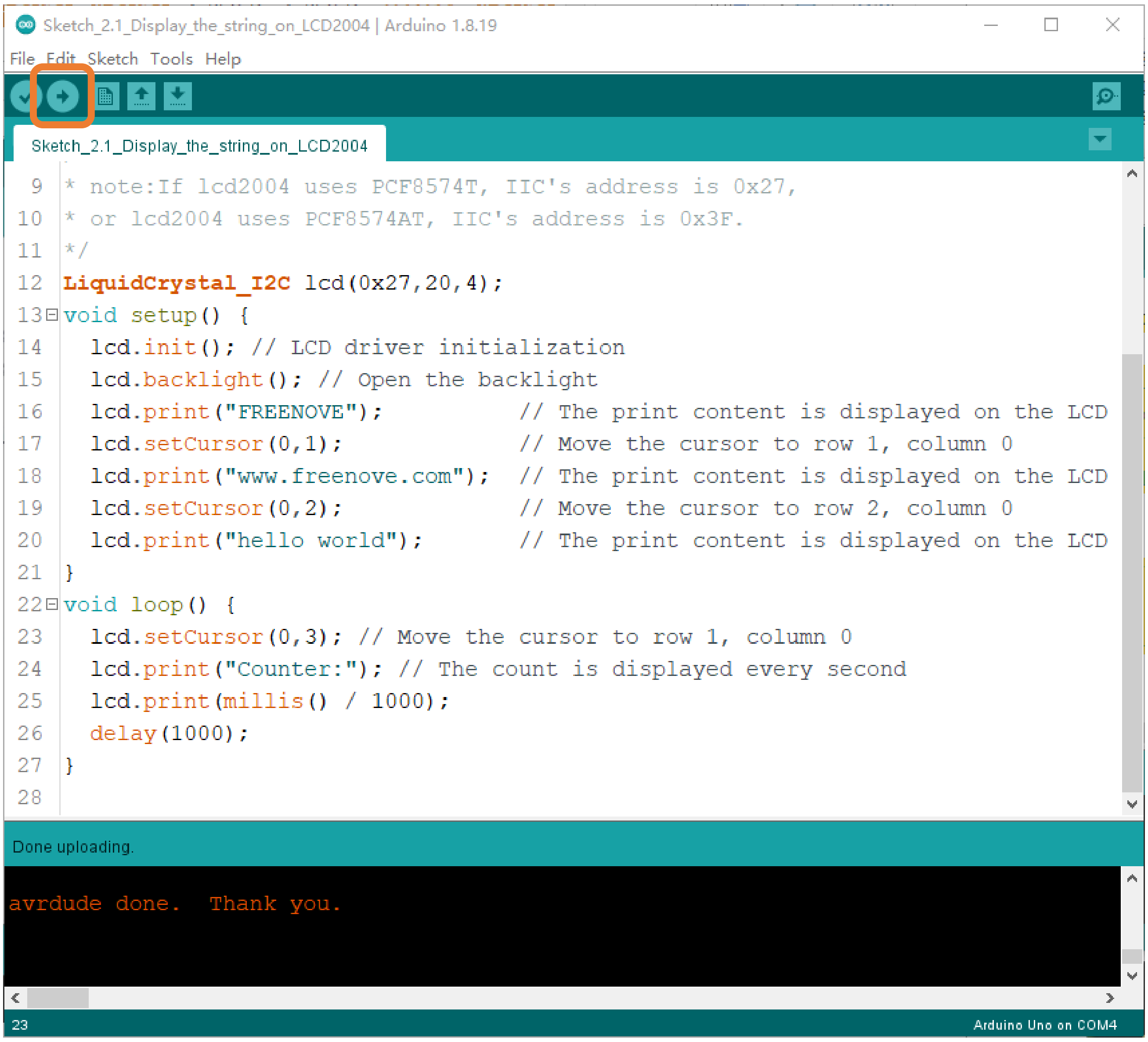
Easy creation of a tree based menu with screensaver and multi layers. Examples for the basic function and different output types [serial monitor, liquidcrystal, i2c, graphic displays (u8glib / u8g2lib...)]
More info

LiquidCrystal I2C
by **Frank de Brabander** Version **1.1.2** **INSTALLED**
A library for I2C LCD displays. The library allows to control I2C displays with functions extremely similar to LiquidCrystal library. THIS LIBRARY MIGHT NOT BE COMPATIBLE WITH EXISTING SKETCHES.
More info

There is another way you can install libraries.

Click “Add .ZIP Library...” and then find **LiquidCrystal_I2C.zip** in libraries folder (this folder is in the folder unzipped form the ZIP file we provided). This library can facilitate our operation of I2C LCD2004.

Sketch_2.1_Display_the_string_on_LCD2004

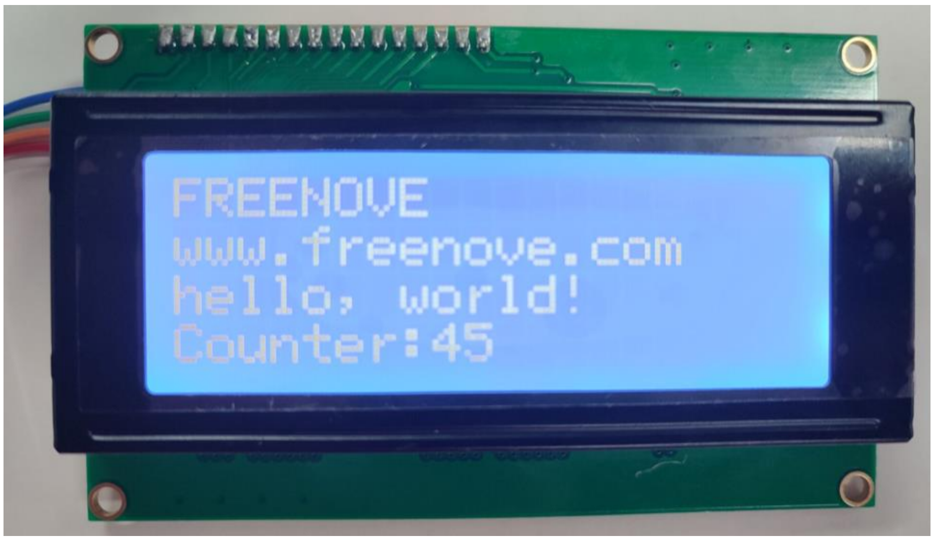

Sketch_2.1_Display_the_string_on_LCD2004 | Arduino 1.8.19
File Edit Sketch Tools Help
Sketch_2.1_Display_the_string_on_LCD2004

```
* note:If lcd2004 uses PCF8574T, IIC's address is 0x27,
* or lcd2004 uses PCF8574AT, IIC's address is 0x3F.
*/
LiquidCrystal_I2C lcd(0x27,20,4);
void setup() {
  lcd.init(); // LCD driver initialization
  lcd.backlight(); // Open the backlight
  lcd.print("FREENOVE");           // The print content is displayed on the LCD
  lcd.setCursor(0,1);              // Move the cursor to row 1, column 0
  lcd.print("www.freenove.com");   // The print content is displayed on the LCD
  lcd.setCursor(0,2);              // Move the cursor to row 2, column 0
  lcd.print("hello world");        // The print content is displayed on the LCD
}
void loop() {
  lcd.setCursor(0,3); // Move the cursor to row 1, column 0
  lcd.print("Counter:"); // The count is displayed every second
  lcd.print(millis() / 1000);
  delay(1000);
}
```

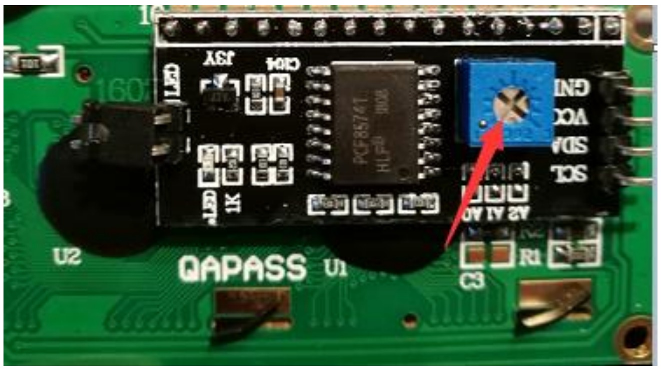
Done uploading.

```
avrdude done.  Thank you.
```

Compile and upload the code to Arduino and the LCD2004 displays characters.



If you cannot see anything on the display or the display is not clear, try rotating the white knob on back of LCD2004 slowly, which adjusts the contrast, until the screen can display clearly.



Now let’s start to write code to use LCD2004 to display static characters and dynamic variables.

```
#include <LiquidCrystal_I2C.h>
/*
* note:If lcd2004 uses PCF8574T, IIC’s address is 0x27,
* or lcd2004 uses PCF8574AT, IIC’s address is 0x3F.
*/
LiquidCrystal_I2C lcd(0x27,20,4);
void setup() {
  lcd.init(); // LCD driver initialization
  lcd.backlight(); // Open the backlight
  lcd.setCursor(0,0);             // Move the cursor to row 0, column 0
  lcd.print("FREENOVE");          // The print content is displayed on the LCD
  lcd.setCursor(0,1);             // Move the cursor to row 1, column 0
  lcd.print("www.freenove.com");  // The print content is displayed on the LCD
  lcd.setCursor(0,2);             // Move the cursor to row 2, column 0
  lcd.print("hello world");       // The print content is displayed on the LCD
}
void loop() {
  lcd.setCursor(0,3); // Move the cursor to row 1, column 0
  lcd.print("Counter:"); // The count is displayed every second
  lcd.print(millis() / 1000);
  delay(1000);
}
```

Following are the LiquidCrystal_I2C library used for controlling LCD:

```
#include <LiquidCrystal_I2C.h>
```

LiquidCrystal_I2C library provides LiquidCrystal_I2C class that controls LCD2004. When we instantiate a LiquidCrystal_I2C object, we can input some parameters. And these parameters are the row/column numbers of the I2C addresses and screen that connect to LCD2004:

```
LiquidCrystal_I2C lcd(0x27, 20 4);//set the LCD address to 0x27 for a 16 chars and 2 line display
```

First, initialize the LCD and turn on LCD backlight.

```
  lcd.init(); // LCD driver initialization
  lcd.backlight(); // Open the backlight
```

And then print a string:

```
  lcd.print("hello world");        // The print content is displayed on the LCD
```

Print a changing number in the loop () function:

```
void loop() {
  lcd.setCursor(0,3); // Move the cursor to row 1, column 0
  lcd.print("Counter:"); // The count is displayed every second
  lcd.print(millis() / 1000);
  delay(1000);
}
```

Before printing characters, we need to set the coordinate of the printed character, that is, in which line and which column:

```
  lcd.setCursor(0,1);              // Move the cursor to row 1, column 0
```

LiquidCrystal_I2C Class

LiquidCrystal_I2C class can control common LCD screen. First, we need instantiate an object of LiquidCrystal_I2C type, for example:

LiquidCrystal_I2C lcd(0x27, 20, 4);

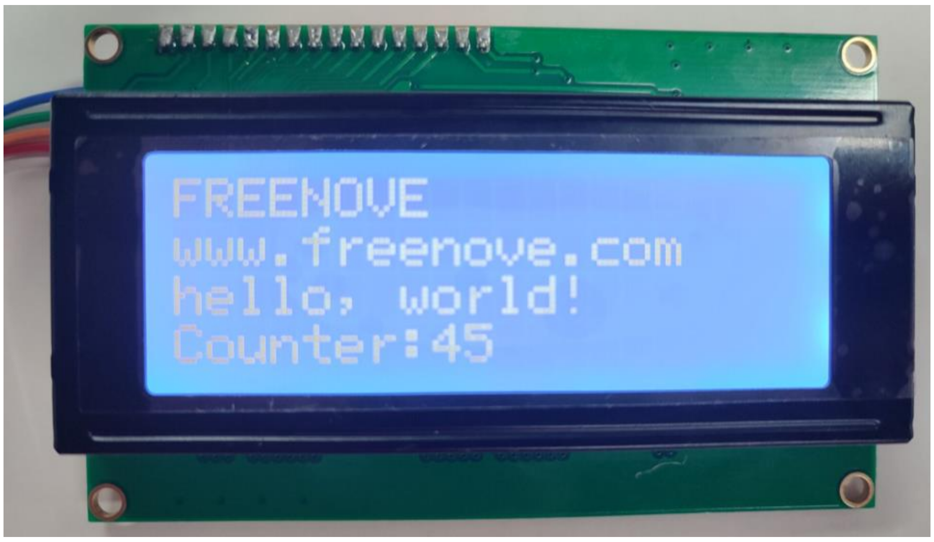
When an object is instantiated, a constructed function of the class is called a constructor. In the constructor function, we need to fill in the I2C address of the LCD module, as well as the number of columns and rows of the LCD module. The number of columns and rows can also be set in the lcd.begin ().

The functions used in the LiquidCrystal_I2C class are as follows:

lcd.setCursor (col, row): set the coordinates of the to-be-printed character. The parameters are the numbers of columns and rows of the characters (start from 0, the number 0 represents first row or first line).

lcd.print (data): print characters. Characters will be printed on the coordinates set before. If you do not set the coordinates, the string will be printed behind the last printed character.

Verify and upload the code, then observe the LCD screen. If the display is not clear or there is no display, adjust the potentiometer on the back of I2C module to adjust the screen contrast until the character is clearly displayed on the LCD.



```
FREENOVE
www.freenove.com
hello, world!
Counter:45
```

You can use the I2C LCD2004 to replace the serial port as a mobile screen when you print the data latter.

What's next?

Thanks for your reading. This tutorial is all over here. If you find any mistakes, omissions or you have other ideas and questions about contents of this tutorial or the kit and etc., please feel free to contact us:

support@freenove.com

We will check and correct it as soon as possible.

If you want to learn more about Arduino, Raspberry Pi, smart cars, robots and other interesting products in science and technology, please continue to focus on our website. We will continue to launch cost-effective, innovative and exciting products.

http://www.freenove.com/

What's next?(others)

Thanks for your reading. This tutorial is all over here. If you find any mistakes, omissions or you have other ideas and questions about contents of this tutorial or the kit and etc., please feel free to contact us:

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If you want to learn more about Arduino, Raspberry Pi, smart cars, robots and other interesting products in science and technology, please continue to focus on our website. We will continue to launch cost-effective, innovative and exciting products.

http://www.freenove.com/

End of the Tutorial

Thank you again for choosing Freenove products.