2inch LCD Module

This is a general LCD display Module, IPS screen, 2inch diagonal, 240×320 resolution, with embedded controller, communicating via SPI interface

Feature

- SPI interface requires minimum GPIO for controlling
- Comes with development resources and manual
- The basic functions have been encapsulated on the demo, which can realize picture rotation, draw dots, lines, circles, rectangles, display English characters and Chinese characters, and display pictures.

Specifications

- Operating voltage: 3.3V/5V
- Interface: SPI
- LCD type: IPS
- Controller: ST7789V
- Resolution: 240(V) x 320(H)RGB
- Display size: 23.4（H）x 23.4（V）mm
- Pixel size: 0.0975（H）x 0.0975（V）mm
- Dimension: 58 x 35(mm)

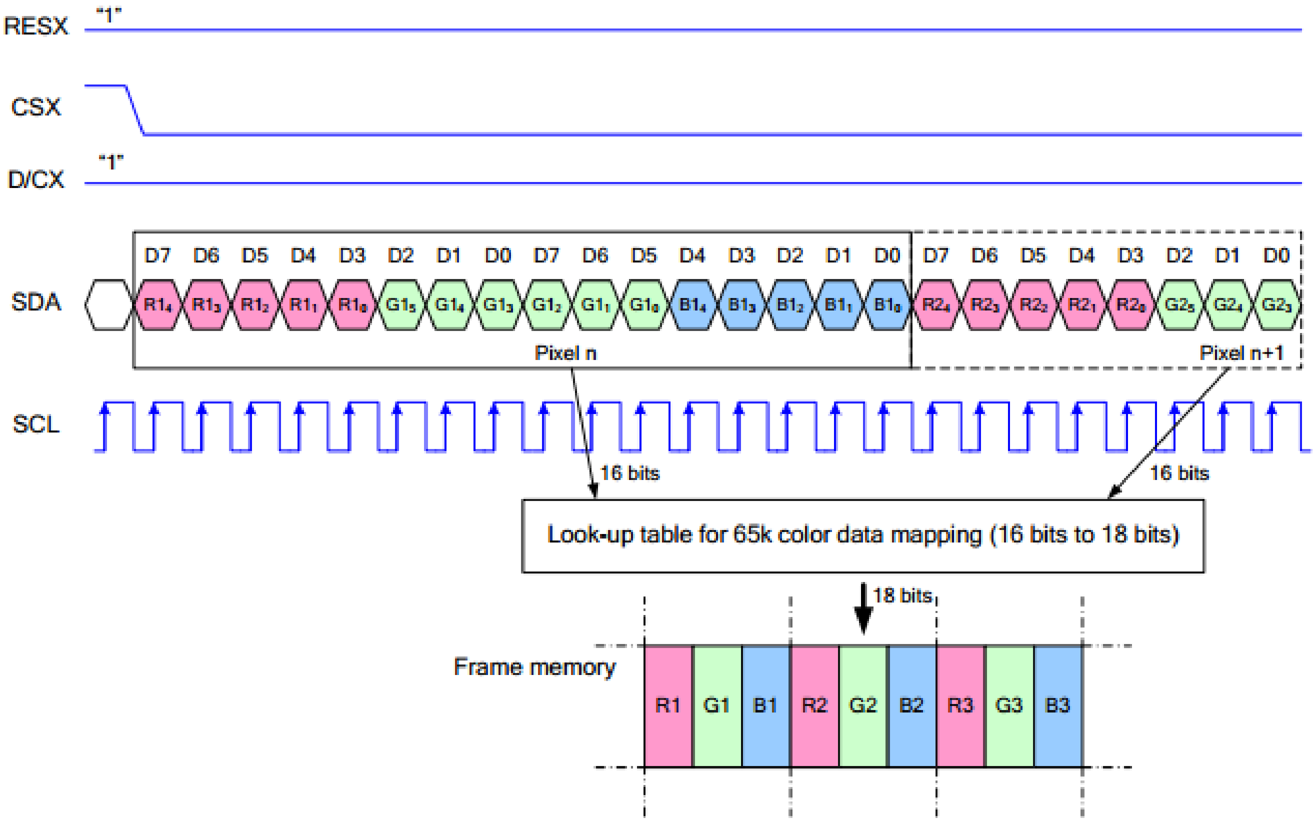
Interface

SYMBOL	Description
VCC	Power (3.3V input)
GND	Ground
DIN	SPI data input
CLK	SPI clock input
CS	Chip selection, low active
DC	Data/Command selection (high for data, low for command)
RST	Reset, low active
BL	Backlight

Hardware description

ST7789V supports RGB444, RGB565 and RGB666 three formats. This LCD uses RGB565.
For most LCD controllers, the communication method of the controller can be configured, they are usually using 8080 parallel interface, 3-line SPI, 4-line SPI, and other communication methods. This LCD uses a 4-line SPI interface for reducing GPIO and fast speed.LCD

Communication protocol


RESX
"1"
CSX
D/CX
"1"
SDA
D7 D6 D5 D4 D3 D2 D1 D0 D7 D6 D5 D4 D3 D2 D1 D0 D7 D6 D5 D4 D3 D2 D1 D0
$R1_4$ $R1_3$ $R1_2$ $R1_1$ $R1_0$ $G1_5$ $G1_4$ $G1_3$ $G1_2$ $G1_1$ $G1_0$ $B1_4$ $B1_3$ $B1_2$ $B1_1$ $B1_0$ $R2_4$ $R2_3$ $R2_2$ $R2_1$ $R2_0$ $G2_5$ $G2_4$ $G2_3$
Pixel n
Pixel n+1
SCL
16 bits
16 bits
Look-up table for 65k color data mapping (16 bits to 18 bits)
18 bits
Frame memory
R1 G1 B1 R2 G2 B2 R3 G3 B3

Note: It is not like the tradition SPI protocol, it only uses MOSI to send data from master to slave for LCD display. For details please refer to Datasheet Page 105.

RESX: Reset, should be pull-down when power on, set to 1 other time.

CSX: Slave chip select. The chip is enabled only CS is set Low

D/CX: Data/Command selection; DC=0, write command; DC=1, write data

SDA: Data transmitted. (RGB data)

SCL: SPI clock

The SPI communication protocol of the data transmission uses control bits: clock phase (CPHA) and clock polarity (CPOL):

CPOL defines the level while the synchronization clock is idle. If CPOL=0, then it is LOW.

CPHA defines at whish clock's tick the data transmission starts. CPHL=0 – at the first one, otherwise at the second one

This combination of two bits provides 4 modes of SPI data transmission. The commonly used is SPI0 mode, i.e. GPHL=0 and CPOL=0.

According to the figure above, data transmitting begins at the first falling edge, 8bit data are transmitted at one clock cycle. It is SPI0. MSB.

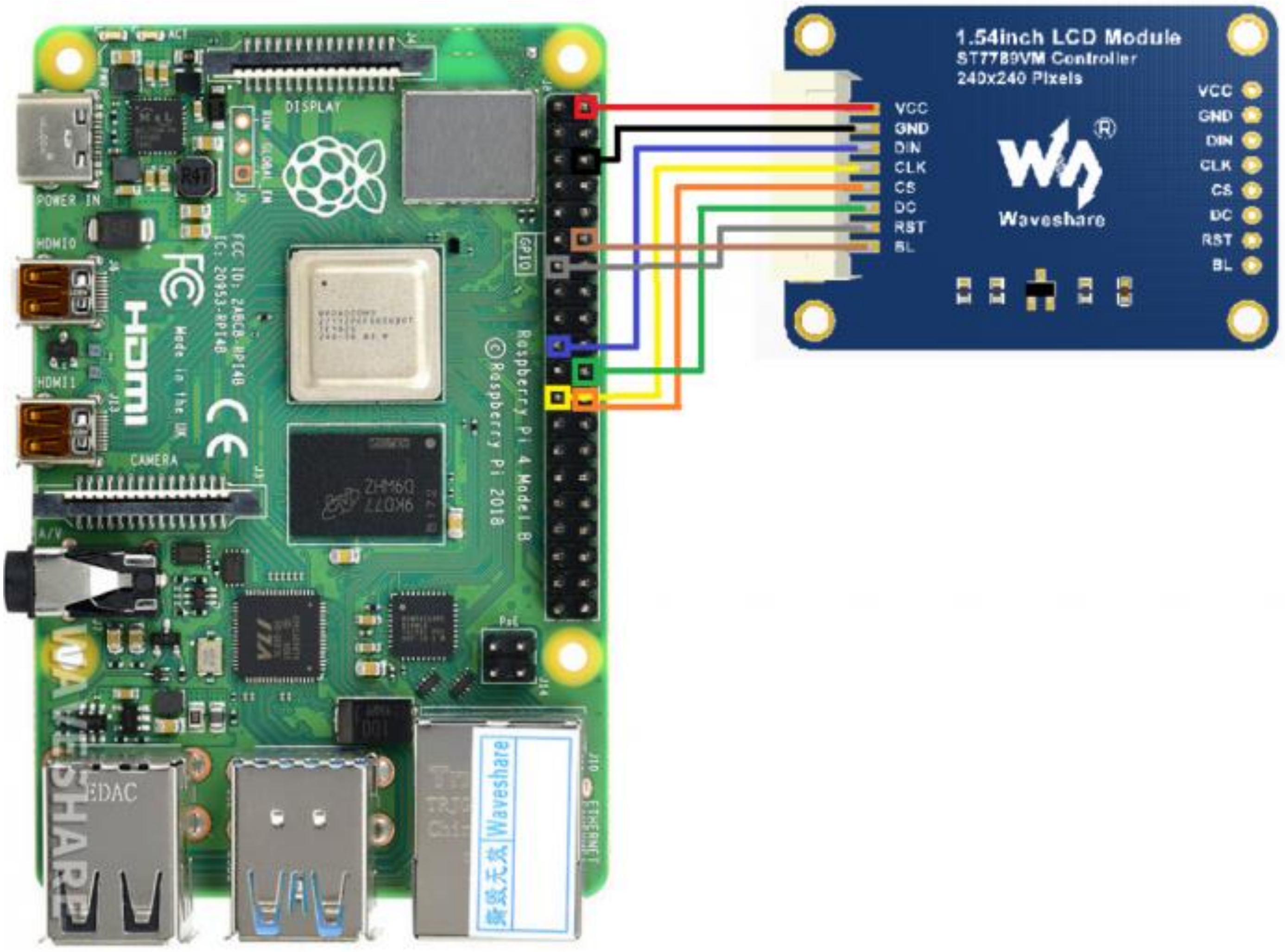
Hardware connection

Please connect the LCD to your Raspberry Pi by the 8PIn cable according to the table below

Connect to Raspberry Pi	
LCD	Raspberry Pi

	BCM2835	Board
VCC	5V	5V
GND	GND	GND
DIN	MOSI	19
CLK	SCLK	23
CS	CE0	24
DC	25	22
RST	27	13
BL	18	12

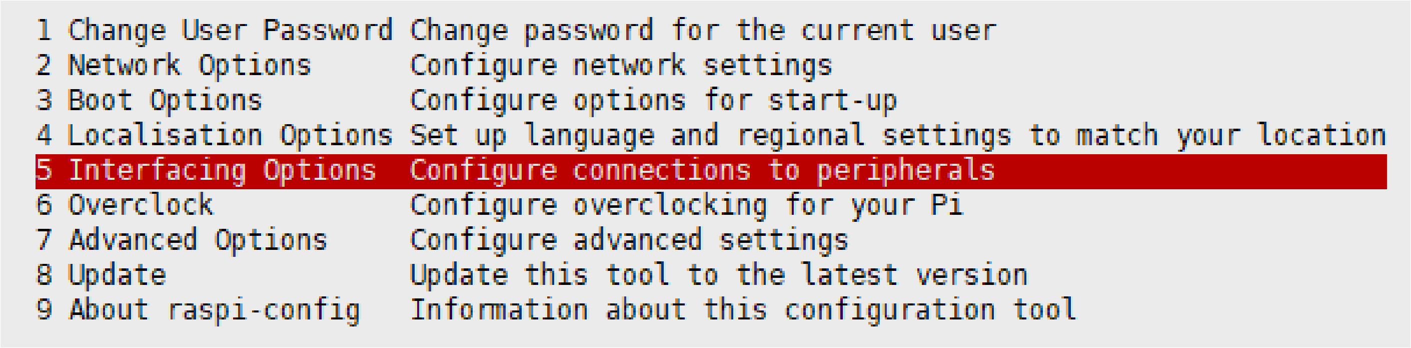
The color of actual cable may be different with the figure here, please connect them according to the pins instead of color.



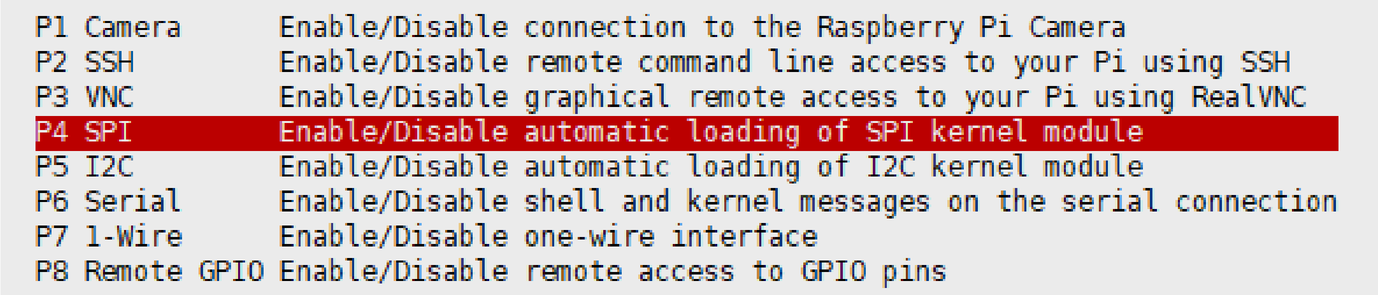
Enable SPI interface

- Open terminal, use command to enter the configuration page

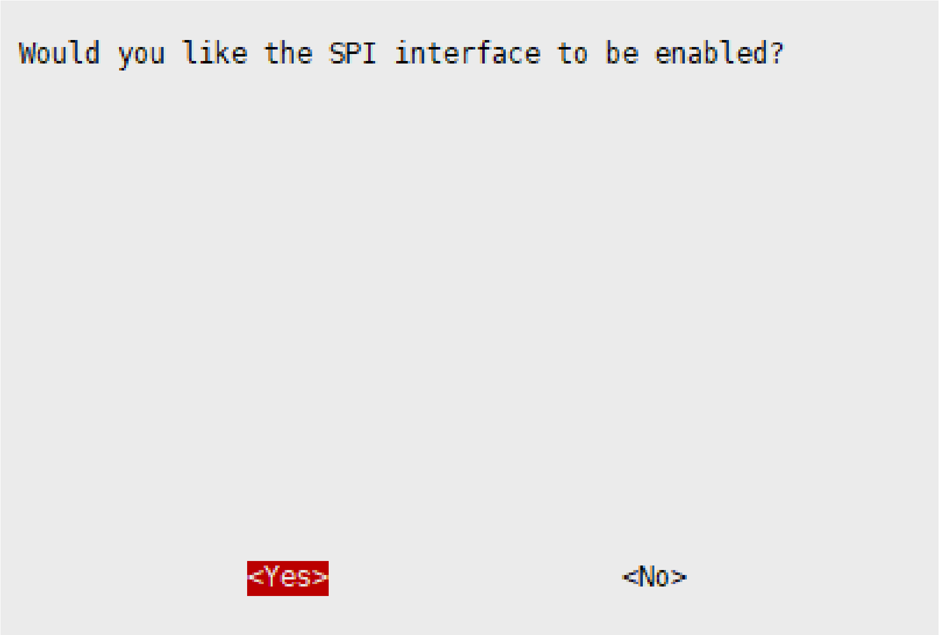
```
sudo raspi-config
Choose Interfacing Options -> SPI -> Yes  to enable SPI interface
```



```
1 Change User Password Change password for the current user
2 Network Options      Configure network settings
3 Boot Options         Configure options for start-up
4 Localisation Options Set up language and regional settings to match your location
5 Interfacing Options  Configure connections to peripherals
6 Overclock            Configure overclocking for your Pi
7 Advanced Options     Configure advanced settings
8 Update               Update this tool to the latest version
9 About raspi-config   Information about this configuration tool
```



```
P1 Camera      Enable/Disable connection to the Raspberry Pi Camera
P2 SSH         Enable/Disable remote command line access to your Pi using SSH
P3 VNC         Enable/Disable graphical remote access to your Pi using RealVNC
P4 SPI         Enable/Disable automatic loading of SPI kernel module
P5 I2C         Enable/Disable automatic loading of I2C kernel module
P6 Serial      Enable/Disable shell and kernel messages on the serial connection
P7 1-Wire      Enable/Disable one-wire interface
P8 Remote GPIO Enable/Disable remote access to GPIO pins
```



```
Would you like the SPI interface to be enabled?

        <Yes>                <No>
```

Reboot Raspberry Pi：

```
sudo reboot
```

Please make sure that SPI interface was not used by other devices

Install Libraries

- Install BCM2835 libraries

```
wget http://www.airspayce.com/mikem/bcm2835/bcm2835-1.68.tar.gz
```

```
tar zxvf bcm2835-1.68.tar.gz
cd bcm2835-1.68/
sudo ./configure
sudo make
sudo make check
sudo make install
#For more details, please refer to http://www.airspayce.com/mikem/bcm2835/
```

- Install wiringPi libraries

```
sudo apt-get install wiringpi
```

For the version of the Raspberry Pi system after May 2019 (the OS version earlier than this date doesn't need to be executed), an upgrade may be required：

```
wget https://project-downloads.drogon.net/wiringpi-latest.deb
sudo dpkg -i wiringpi-latest.deb
gpio -v
#You will get 2.52 information if you install it correctly
```

- Install Python libraries

```
#python2
sudo apt-get update
sudo apt-get install python-pip
sudo apt-get install python-pil
sudo apt-get install python-numpy
sudo pip install RPi.GPIO
sudo pip install spidev
#python3
sudo apt-get update
sudo apt-get install python3-pip
sudo apt-get install python3-pil
sudo apt-get install python3-numpy
sudo pip3 install RPi.GPIO
sudo pip3 install spidev
```

Download Examples

Open Raspberry Pi terminal and run the following command

```
sudo apt-get install p7zip-full
sudo wget  https://www.waveshare.com/w/upload/a/a8/LCD_Module_RPI_code.7z
```

```
7z x LCD_Module_RPI_code.7z -O./LCD_Module_code
cd LCD_Module_code/RaspberryPi/
```

Run the demo codes

Please go into the RaspberryPi directory (demo codes) first and run the commands in terminal

C codes

- Re-compile the demo codes

```
cd c
sudo make clean
sudo make -j 8
```

This examples are made for multi-dusplay, you can input the type of the LCD when using.

```
sudo ./main <<type of LCD>>
```

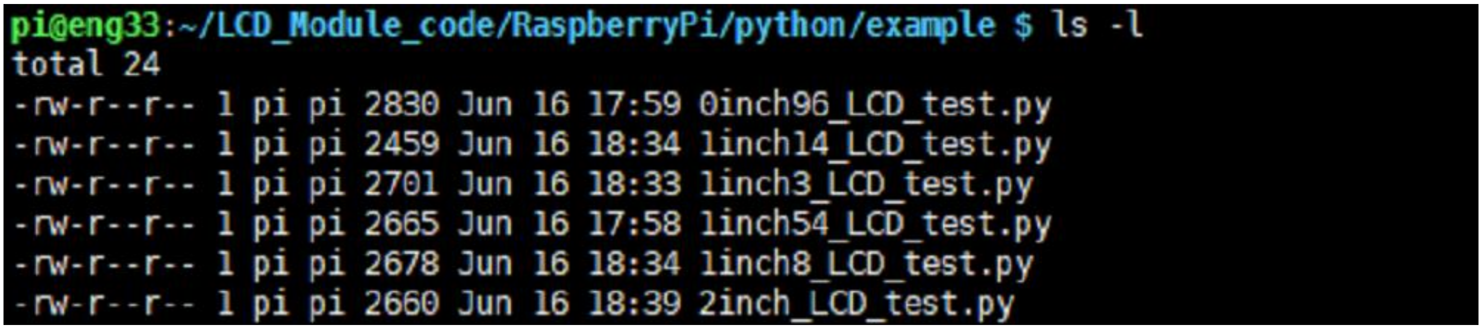
Use the command according to LCD: :

```
sudo ./main 0.96
sudo ./main 1.14
sudo ./main 1.28
sudo ./main 1.3
sudo ./main 1.54
sudo ./main 1.8
sudo ./main 2
```

python

- Enter the python directory and run ls -al

```
cd python/examples
ls -l
```



```
pi@eng33:~/LCD_Module_code/RaspberryPi/python/example $ ls -l
total 24
-rw-r--r-- 1 pi pi 2830 Jun 16 17:59 0inch96_LCD_test.py
-rw-r--r-- 1 pi pi 2459 Jun 16 18:34 1inch14_LCD_test.py
-rw-r--r-- 1 pi pi 2701 Jun 16 18:33 1inch3_LCD_test.py
-rw-r--r-- 1 pi pi 2665 Jun 16 17:58 1inch54_LCD_test.py
-rw-r--r-- 1 pi pi 2678 Jun 16 18:34 1inch8_LCD_test.py
-rw-r--r-- 1 pi pi 2660 Jun 16 18:39 2inch_LCD_test.py
```

You can check all the files which are listed in type:

0inch96_LCD_test.py	0.96inch LCD example
1inch14_LCD_test.py	1.14inch LCD example
1inch28_LCD_test.py	1.28inch LCD example
1inch3_LCD_test.py	1.3inch LCD example
1inch54_LCD_test.py	1.54inchLCD example
1inch8_LCD_test.py	1.8inch LCD example
2inch_LCD_test.py	2inch LCD example

- Run the example

```
# python2
sudo python 0inch96_LCD_test.py
sudo python 1inch14_LCD_test.py
sudo python 1inch28_LCD_test.py
sudo python 1inch3_LCD_test.py
sudo python 1inch54_LCD_test.py
sudo python 1inch8_LCD_test.py
sudo python 2inch_LCD_test.py
# python3
sudo python3 0inch96_LCD_test.py
sudo python3 1inch14_LCD_test.py
sudo python3 1inch28_LCD_test.py
sudo python3 1inch3_LCD_test.py
sudo python3 1inch54_LCD_test.py
sudo python3 1inch8_LCD_test.py
sudo python3 2inch_LCD_test.py
```

FBCP Transplant

The Framebuffer uses a memory area to store the display content, and changes the data in the memory to change the display content.

There is an open-source project on github: fbcp-ili9341. Compared with other fbcp projects, this project uses partial refresh and DMA to achieve a refresh rate of up to 60fps.

Compile and Run

```
sudo apt-get install cmake -y
cd ~
wget https://www.waveshare.com/w/upload/f/f9/Waveshare_fbcp.7z
sudo apt-get install p7zip-full
7z x Waveshare_fbcp.7z
cd waveshare_fbcp
mkdir build
cd build
cmake [options] ..
```

```
make -j
sudo ./fbcp
```

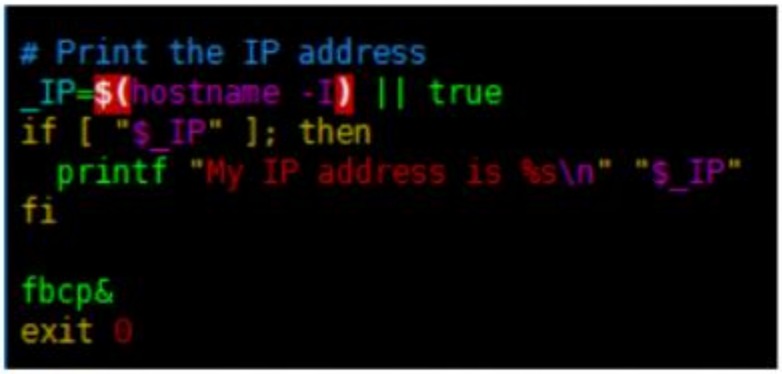
Replace the above cmake [options] .. according to the LCD Module you are using.

```
#0.96inch LCD Module
cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_0INCH96_LCD=ON -DBACKLIGHT_CONTROL=ON -DSTATISTICS=0 ..

#1.14inch LCD Module
cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_1INCH14_LCD=ON -DBACKLIGHT_CONTROL=ON -DSTATISTICS=0 ..

#1.3inch LCD Module
cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_1INCH3_LCD=ON -DBACKLIGHT_CONTROL=ON -DSTATISTICS=0 ..

#1.54inch LCD Module
cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_1INCH54_LCD=ON -DBACKLIGHT_CONTROL=ON -DSTATISTICS=0 ..

#1.8inch LCD Module
cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_1INCH8_LCD=ON -DBACKLIGHT_CONTROL=ON -DSTATISTICS=0 ..

#2inch LCD Module
cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_2INCH_LCD=ON -DBACKLIGHT_CONTROL=ON -DSTATISTICS=0 ..

#2.4inch LCD Module
cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_2INCH4_LCD=ON -DBACKLIGHT_CONTROL=ON -DSTATISTICS=0 ..
```

Auto-start when Power on

```
sudo cp ~/Fbcp-ili9341/build/fbcp-ili9341 /usr/local/bin/fbcp
sudo nano /etc/rc.local
```

And then add fbcp& before exit 0, as the picture below.



```
# Print the IP address
_IP=$(hostname -I) || true
if [ "$_IP" ]; then
  printf "My IP address is %s\n" "$_IP"
fi

fbcp&
exit 0
```

Set the display resolution

Set the user interface display size in the /boot/config.txt file.

```
sudo nano /boot/config.txt
```

Then add the following lines at the end of the config.txt.

```
hdmi_force_hotplug=1
hdmi_cvt=[options]
hdmi_group=2
hdmi_mode=1
hdmi_mode=87
display_rotate=0
```

Replace the above hdmi_cvt=[options] according to the LCD Module you are using.

```
#2.4inchinch LCD Module & 2inchinch LCD Module
hdmi_cvt=640 480 60 1 0 0 0

#1.8inch LCD Module
hdmi_cvt=400 300 60 1 0 0 0

#1.3inch LCD Module & 1.54inch LCD Module
hdmi_cvt=300 300 60 1 0 0 0

#1.14inch LCD Module
hdmi_cvt=300 170 60 1 0 0 0

#0.96inch LCD Module
hdmi_cvt=300 150 60 1 0 0 0
```

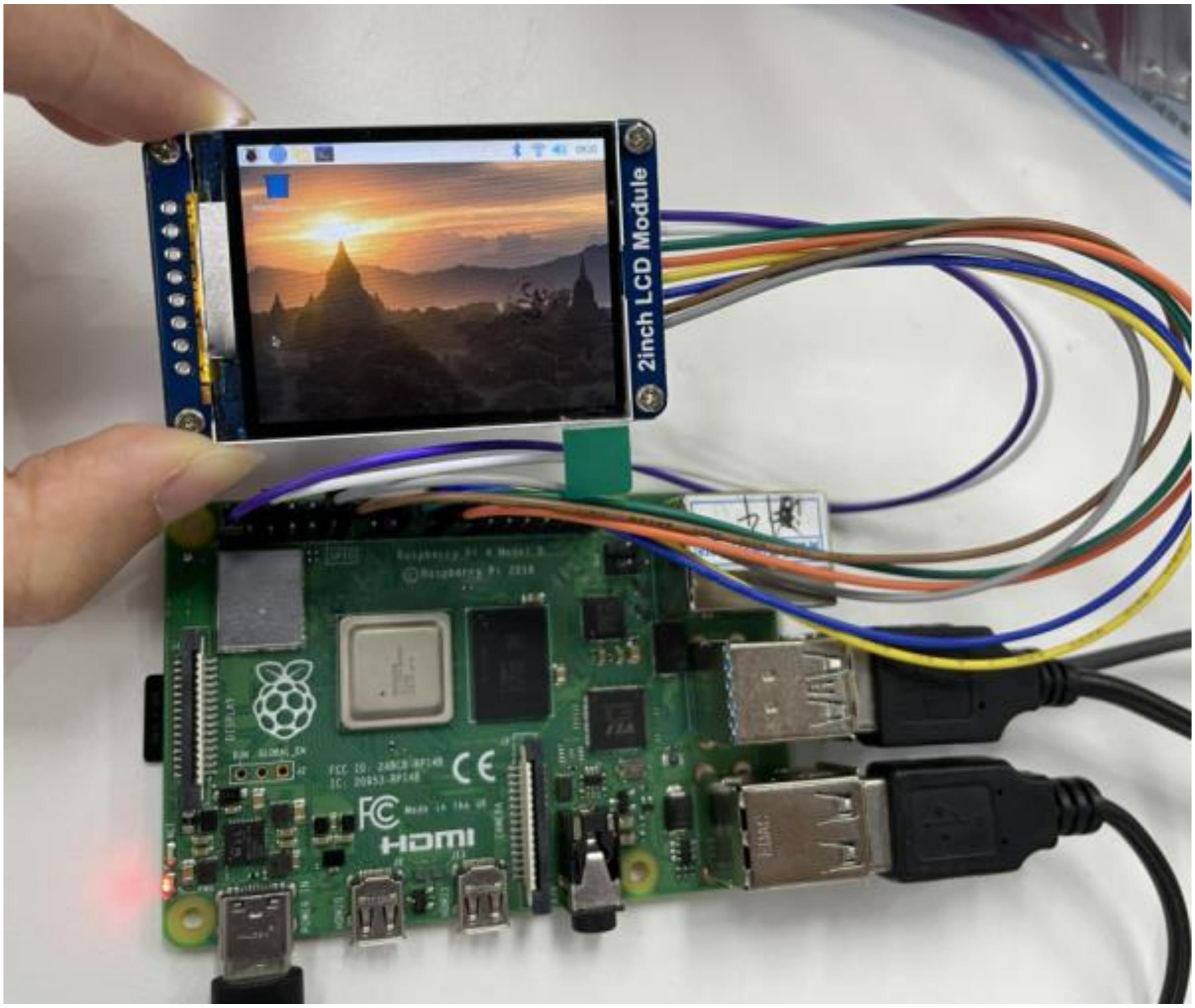
【Note】If you are using Raspberry Pi 4B, you need to comment out the following lines on the [pi4] part. The modification is as below:

```
[pi4]
# Enable DRM VC4 V3D driver on top of the dispmanx display stack
#dtoverlay=vc4-fkms-v3d
#max_framebuffers=2
```

And then reboot the system

```
sudo reboot
```

After rebooting the system, the Raspberry Pi OS user interface will be displayed.

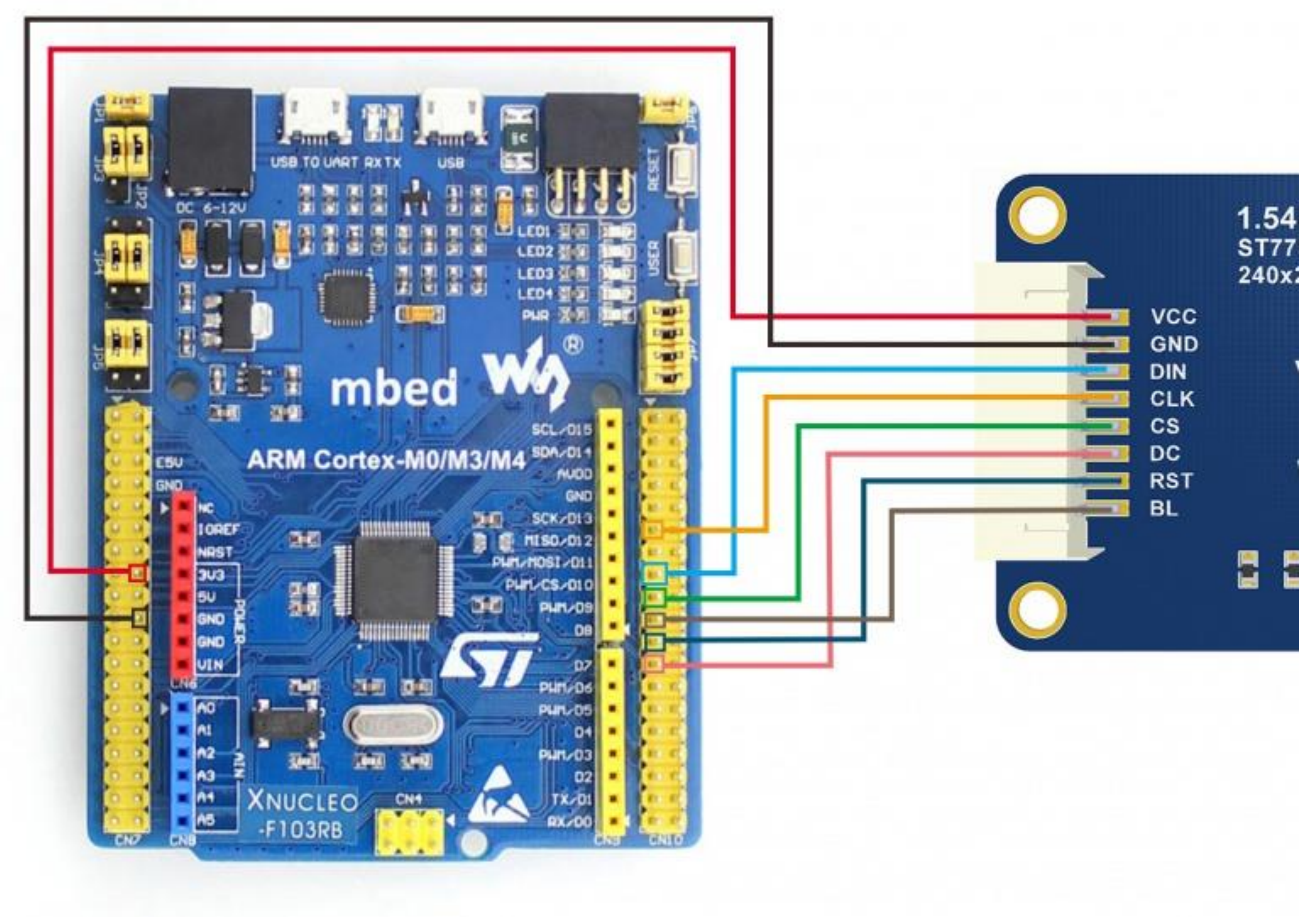


Hardware Coonnection

The examples are based on STM32F103RBT6 as well as the connection table. If you want to use other MCU, you need to port the project and change the connection according to the actual hardware.

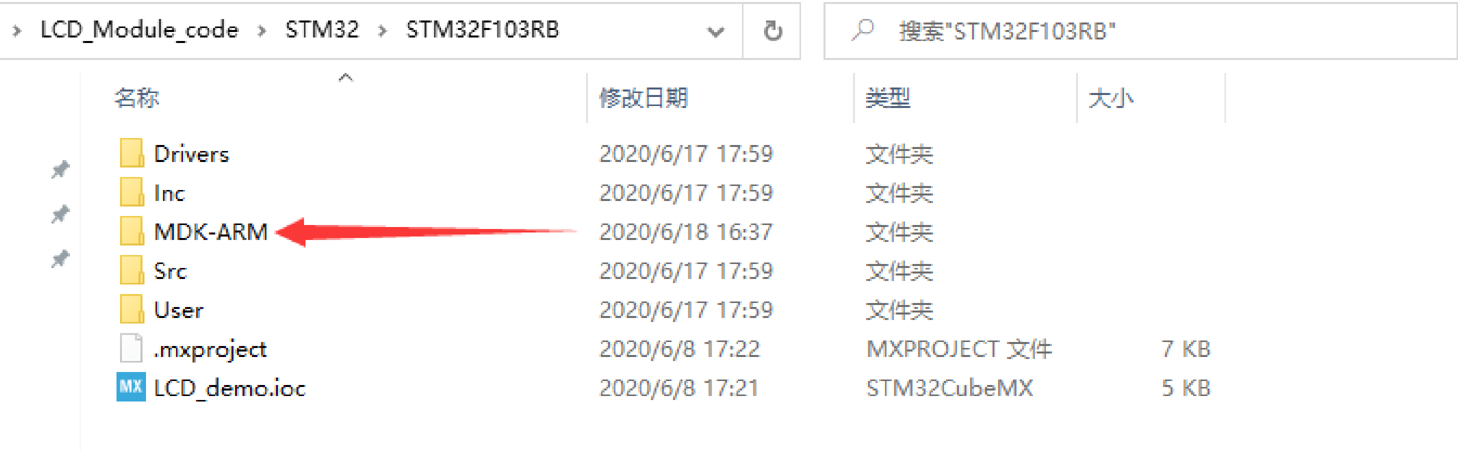
Connect to STM32F103RBT6	
LCD	STM32
VCC	3.3V/5V
GND	GND
DIN	PA7
CLK	PA5
CS	PB6
DC	PA8
RST	PA9
BL	PC7

Use Waveshare XNUCLEO-F103RB as examples



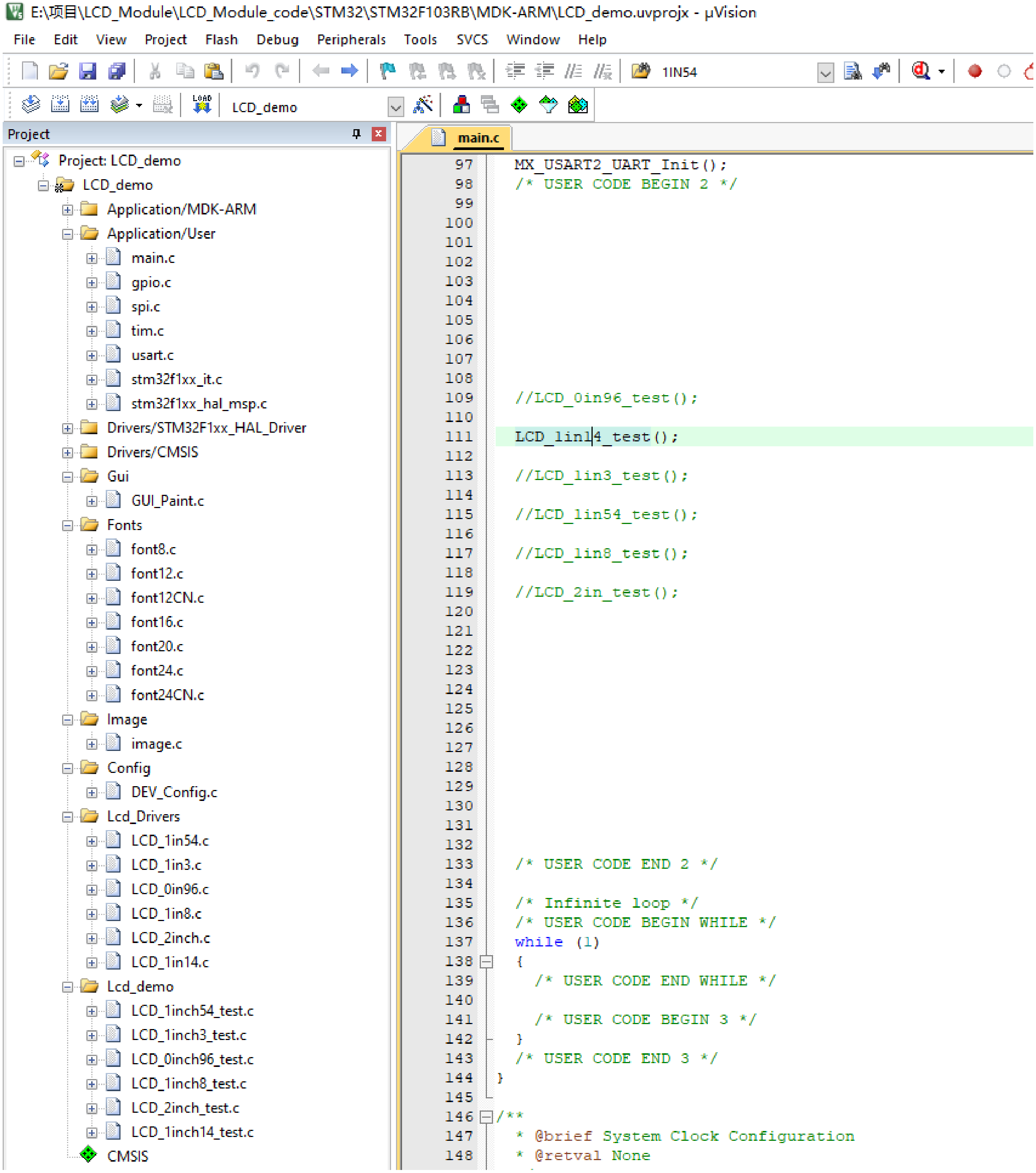
About the examples

The examples use HAL libraries. Download demo codes, unzip, and find the STM32 projects. Open LCD_demo.uvprojx which is located in STM32\STM32F103RBT6\MDK-ARM directory by Keil project



名称	修改日期	类型	大小
Drivers	2020/6/17 17:59	文件夹	
Inc	2020/6/17 17:59	文件夹	
MDK-ARM	2020/6/18 16:37	文件夹	
Src	2020/6/17 17:59	文件夹	
User	2020/6/17 17:59	文件夹	
.mxproject	2020/6/8 17:22	MXPROJECT 文件	7 KB
LCD_demo.ioc	2020/6/8 17:21	STM32CubeMX	5 KB

Open main.c file, you can configure the types for actual displays, recompile the project and download it to your board.



```
  MX_USART2_UART_Init();
  /* USER CODE BEGIN 2 */










  //LCD_0in96_test();

  LCD_1in14_test();

  //LCD_1in3_test();

  //LCD_1in54_test();

  //LCD_1in8_test();

  //LCD_2in_test();














  /* USER CODE END 2 */

  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {
    /* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
  }
  /* USER CODE END 3 */
}

/**
  * @brief System Clock Configuration
  * @retval None
```

LCD_0in96_test()	0.96inch LCD example
LCD_1in14_test()	1.14inch LCD example
LCD_1in28_test()	1.28inch LCD example
LCD_1in3_test()	1.3inch LCD example
LCD_1in54_test()	1.54inch LCD example
LCD_1in8_test()	1.8inch LCD example

LCD_2in_test() 2inchLCDexample

Arduino

- Download examples from wiki. Unzip it. The path of Arduino examples is ~/Arduino UNO/...
- Copyt the folders in Arduino directory to 【Installation directory】/libraries/ (Generally the installation directory is C:\Program Files (x86)\Arduino\libraries)
- Open Arduino IDE software, and click File -> Examples to check if LCD_2inch codes are there.
- The development board used is Arduino UNO.

Hardware connection

2inch LCD	UNO PLUS
VCC	5V
GND	GND
DIN	D11
CLK	D12
CS	D10
DC	D7
RST	D8
BL	D9

Expected result

1. The display is cleaned to white
2. Display numbers and strings
3. Draw a rectangle
4. Draw a line
5. Draw five circles
6. Display a 70x70 image

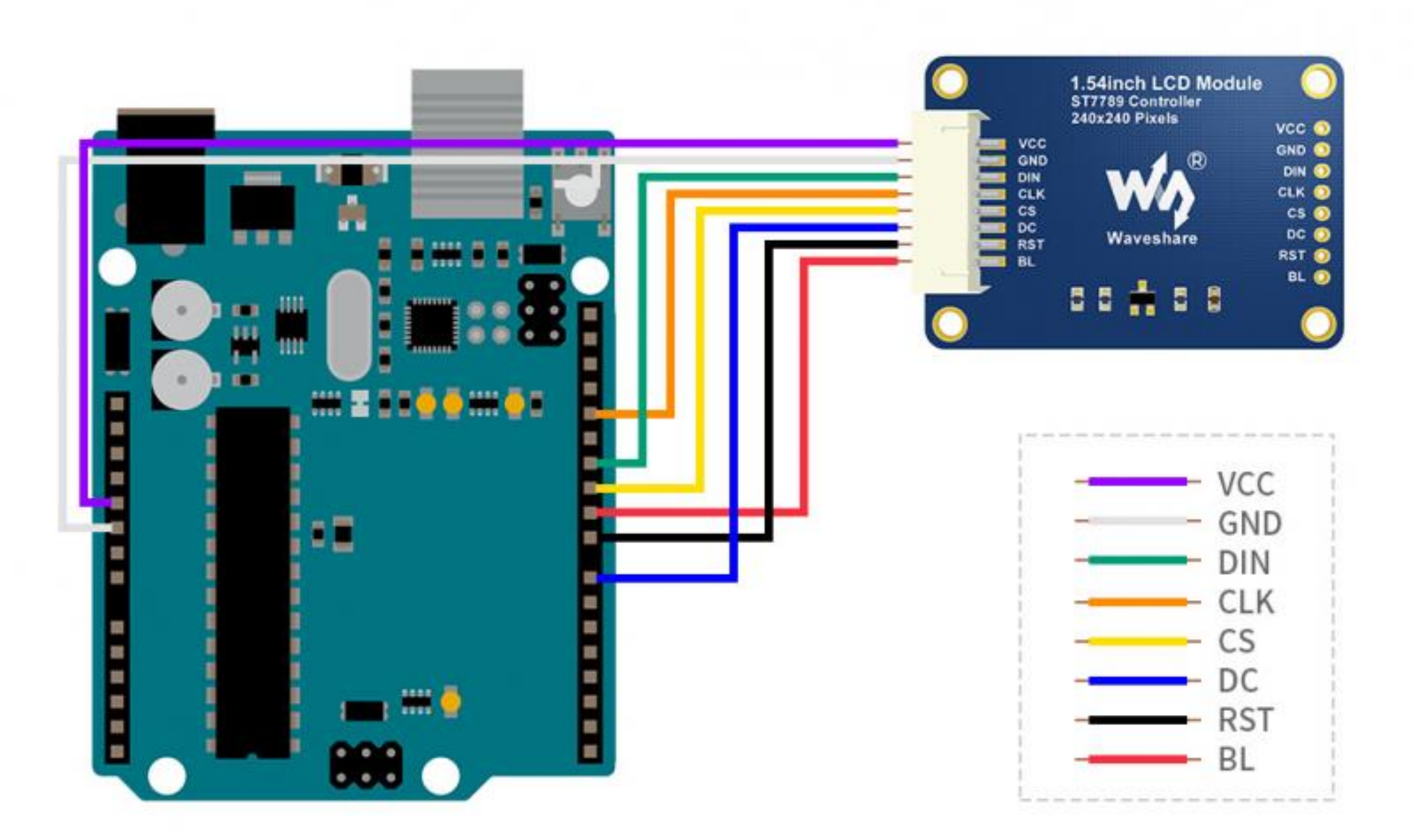
7. The examples are tested in Arduino UNO, if you want to use other versions of the Arduino, you need to change the connection according to the actual boards.

8. Hardware Connection

9. Arduino UNO连接引脚对应关系

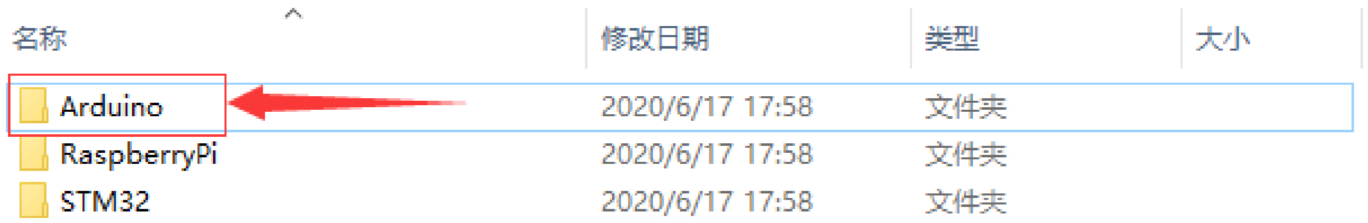
LCD	UNO
VCC	5V/3.3V
GND	GND

DIN	D11
CLK	D13
CS	D10
DC	D7
RST	D8
BL	D9



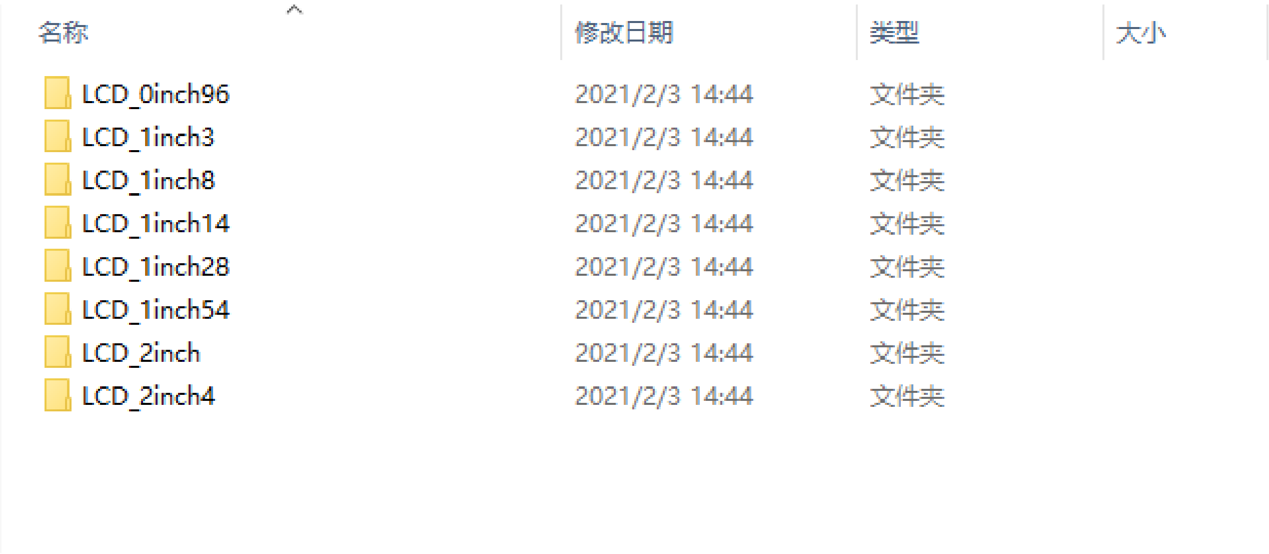
Run the example

Download the demo codes and unzip it. The Arduino project is located in ~/Arduino/...



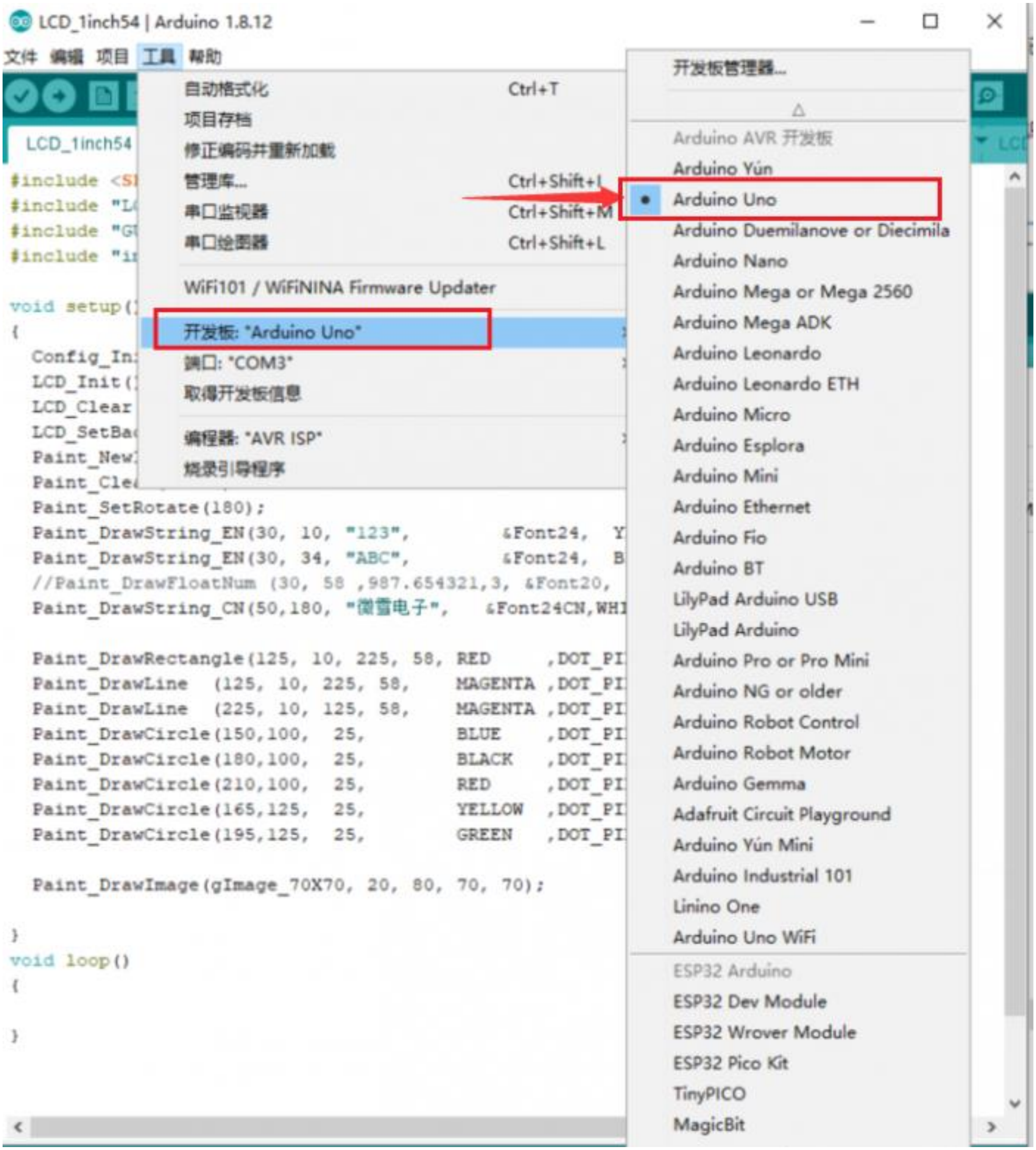
名称	修改日期	类型	大小
Arduino	2020/6/17 17:58	文件夹	
RaspberryPi	2020/6/17 17:58	文件夹	
STM32	2020/6/17 17:58	文件夹	

Run the project according to the actual display type



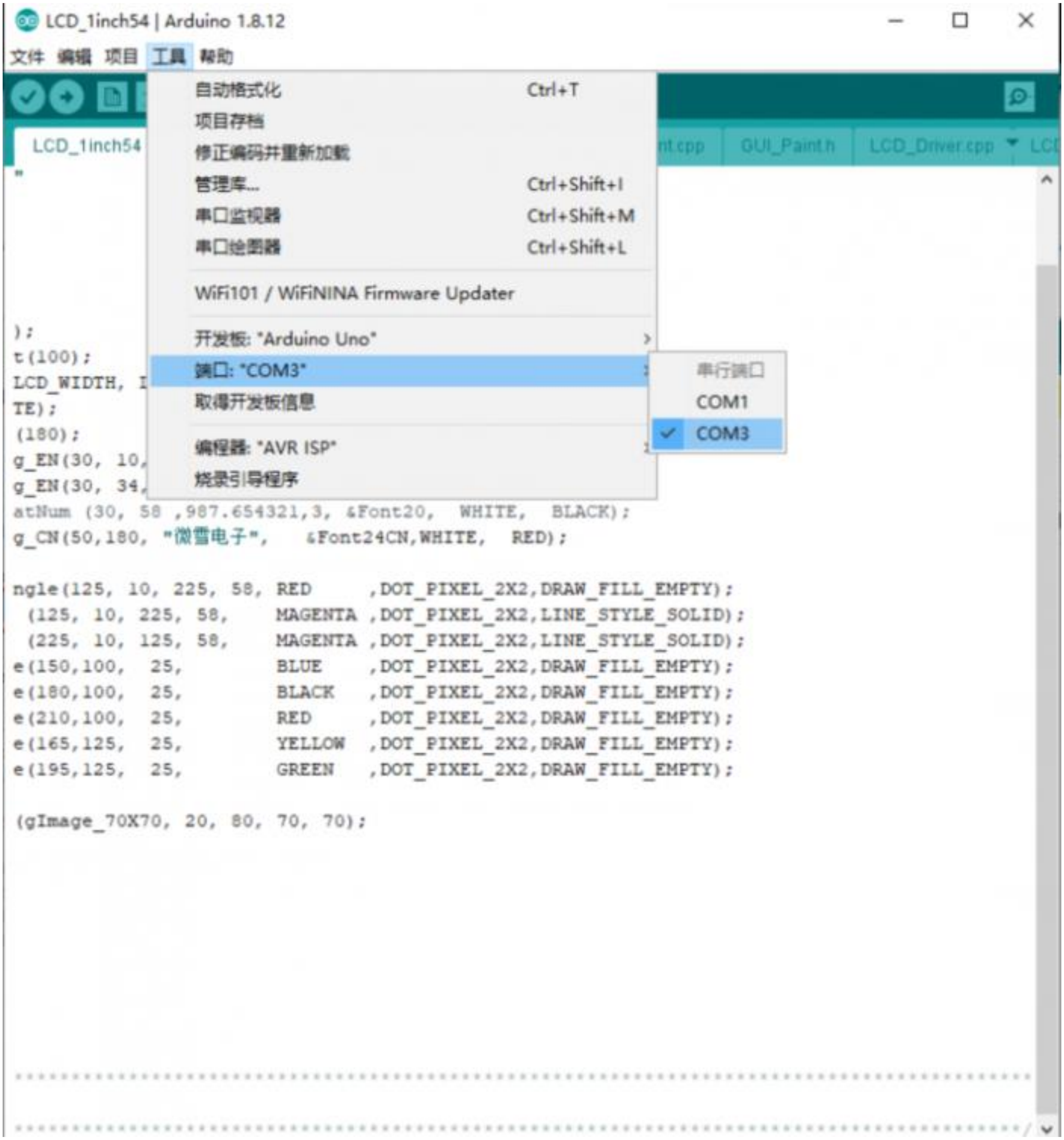
名称	修改日期	类型	大小
LCD_0inch96	2021/2/3 14:44	文件夹	
LCD_1inch3	2021/2/3 14:44	文件夹	
LCD_1inch8	2021/2/3 14:44	文件夹	
LCD_1inch14	2021/2/3 14:44	文件夹	
LCD_1inch28	2021/2/3 14:44	文件夹	
LCD_1inch54	2021/2/3 14:44	文件夹	
LCD_2inch	2021/2/3 14:44	文件夹	
LCD_2inch4	2021/2/3 14:44	文件夹	

For examples: 1.54inch LCD Module. Enter the LCD_1inch54 directory and run the LCD_1inch54.ino file
Run the project and choose Arduino UNO as Board



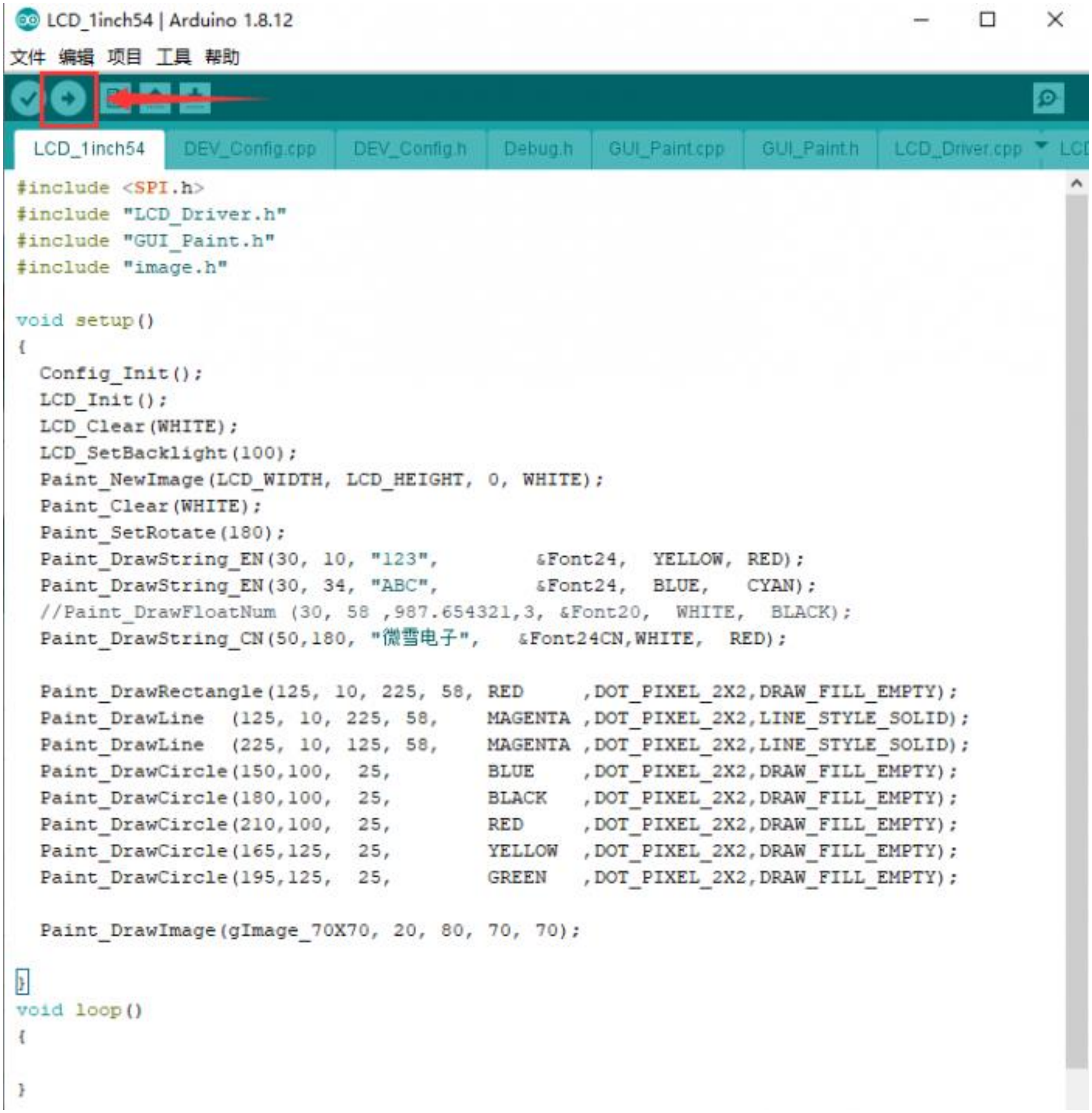
```
#include <SI
#include "L(
#include "GU
#include "ir

void setup()
{
  Config_In:
  LCD_Init()
  LCD_Clear
  LCD_SetBa(
  Paint_New!
  Paint_Cle(
  Paint_SetRotate(180);
  Paint_DrawString_EN(30, 10, "123",        &Font24,  Y
  Paint_DrawString_EN(30, 34, "ABC",        &Font24,  B
  //Paint_DrawFloatNum (30, 58 ,987.654321,3, &Font20,
  Paint_DrawString_CN(50,180, "微雪电子",    &Font24CN,WHI

  Paint_DrawRectangle(125, 10, 225, 58, RED     ,DOT_PI
  Paint_DrawLine  (125, 10, 225, 58,    MAGENTA ,DOT_PI
  Paint_DrawLine  (225, 10, 125, 58,    MAGENTA ,DOT_PI
  Paint_DrawCircle(150,100,  25,        BLUE    ,DOT_PI
  Paint_DrawCircle(180,100,  25,        BLACK   ,DOT_PI
  Paint_DrawCircle(210,100,  25,        RED     ,DOT_PI
  Paint_DrawCircle(165,125,  25,        YELLOW  ,DOT_PI
  Paint_DrawCircle(195,125,  25,        GREEN   ,DOT_PI

  Paint_DrawImage(gImage_70X70, 20, 80, 70, 70);

}
void loop()
{

}
```

Select the COM Port according to your Device Manager



```
"
);
t(100);
LCD_WIDTH, I
TE);
(180);
g_EN(30, 10,
g_EN(30, 34,
atNum (30, 58 ,987.654321,3, &Font20,  WHITE,  BLACK);
g_CN(50,180, "微雪电子",   &Font24CN,WHITE,  RED);

ngle(125, 10, 225, 58, RED     ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
 (125, 10, 225, 58,    MAGENTA ,DOT_PIXEL_2X2,LINE_STYLE_SOLID);
 (225, 10, 125, 58,    MAGENTA ,DOT_PIXEL_2X2,LINE_STYLE_SOLID);
e(150,100,  25,        BLUE    ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
e(180,100,  25,        BLACK   ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
e(210,100,  25,        RED     ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
e(165,125,  25,        YELLOW  ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
e(195,125,  25,        GREEN   ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);

(gImage_70X70, 20, 80, 70, 70);
```

Compile and download it to your board



```
#include <SPI.h>
#include "LCD_Driver.h"
#include "GUI_Paint.h"
#include "image.h"

void setup()
{
  Config_Init();
  LCD_Init();
  LCD_Clear(WHITE);
  LCD_SetBacklight(100);
  Paint_NewImage(LCD_WIDTH, LCD_HEIGHT, 0, WHITE);
  Paint_Clear(WHITE);
  Paint_SetRotate(180);
  Paint_DrawString_EN(30, 10, "123",        &Font24,  YELLOW, RED);
  Paint_DrawString_EN(30, 34, "ABC",        &Font24,  BLUE,   CYAN);
  //Paint_DrawFloatNum (30, 58 ,987.654321,3, &Font20,  WHITE,  BLACK);
  Paint_DrawString_CN(50,180, "微雪电子",   &Font24CN,WHITE,  RED);

  Paint_DrawRectangle(125, 10, 225, 58, RED     ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
  Paint_DrawLine  (125, 10, 225, 58,    MAGENTA ,DOT_PIXEL_2X2,LINE_STYLE_SOLID);
  Paint_DrawLine  (225, 10, 125, 58,    MAGENTA ,DOT_PIXEL_2X2,LINE_STYLE_SOLID);
  Paint_DrawCircle(150,100,  25,        BLUE    ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
  Paint_DrawCircle(180,100,  25,        BLACK   ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
  Paint_DrawCircle(210,100,  25,        RED     ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
  Paint_DrawCircle(165,125,  25,        YELLOW  ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);
  Paint_DrawCircle(195,125,  25,        GREEN   ,DOT_PIXEL_2X2,DRAW_FILL_EMPTY);

  Paint_DrawImage(gImage_70X70, 20, 80, 70, 70);

}
void loop()
{

}
```

Resources

Document

- schematic
- Datasheet

Demo codes

- Demo codes

3D Drawing

- 2inch LCD Module 3D drawing