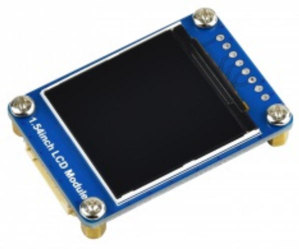
1.54inch LCD Module

Overview

1.54inch LCD Module


1.54inch LCD, SPI interfaces

Introduction

This product provides Raspberry Pi, STM32, Arduino examples.

More

Specification

- Operating voltage: 3.3V/5V (Please ensure that the power supply voltage and logic voltage are consistent, otherwise it will not work properly)
- Interface: SPI
- LCD type: IPS
- Controller: ST7789
- Resolution: 240 (H) RGB x 240 (V)
- Display area: 27.72 （H） x 27.72 （V） mm
- Pixel size: 0.1155 （H） x 0.1155 （V） mm
- Dimension: 50 x 35(mm)

Hardware Connection

Raspberry Pi

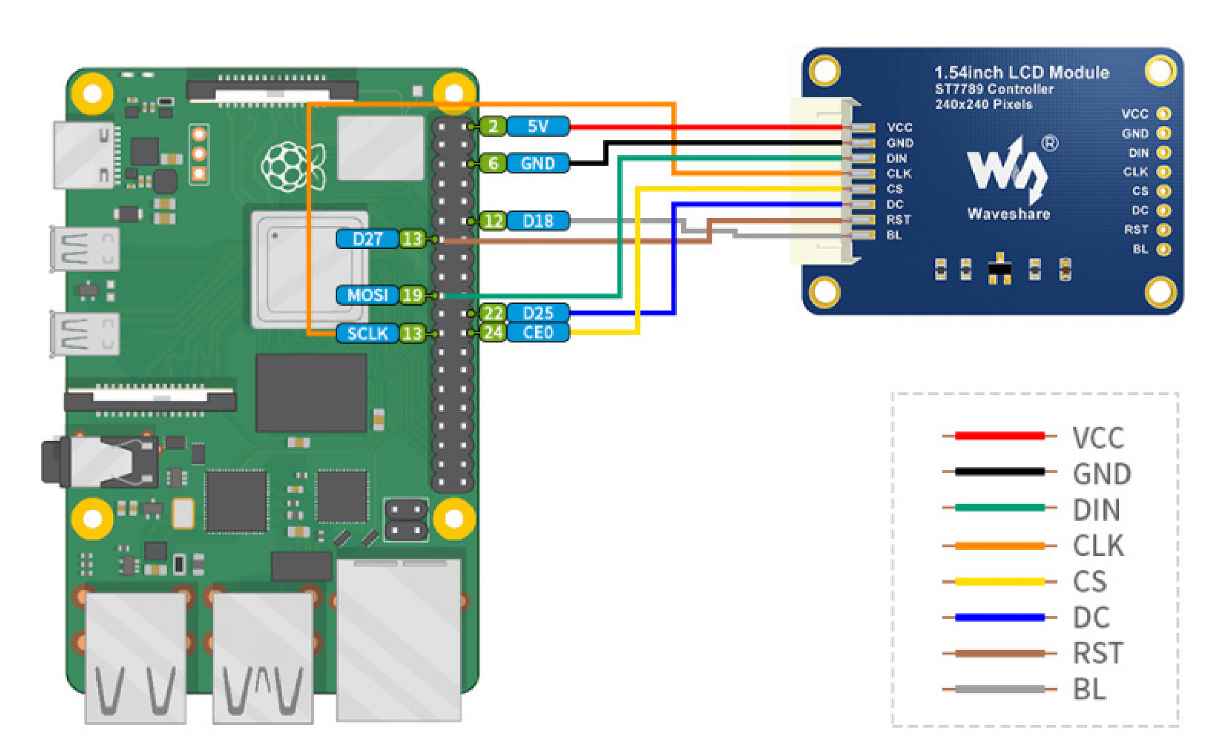
Please connect the LCD to your Raspberry Pi by the 8PIN cable according to the table below
Use the pin header or PH2.0 8PIN interface, you need to connect according to the the following table:

Connect to Raspberry Pi

LCD	Raspberry Pi	
	BCM2835	Board
VCC	5V	5V
GND	GND	GND
DIN	MOSI	19

CLK	SCLK	23
CS	CE0	24
DS	25	22
RST	27	13
BL	18	12

The 1.54inch LCD uses the PH2.0 8PIN interface, which can be connected to the Raspberry Pi according to the above table: (Please connect according to the pin definition table. The color of the wiring in the picture is for reference only, and the actual color shall prevail.)



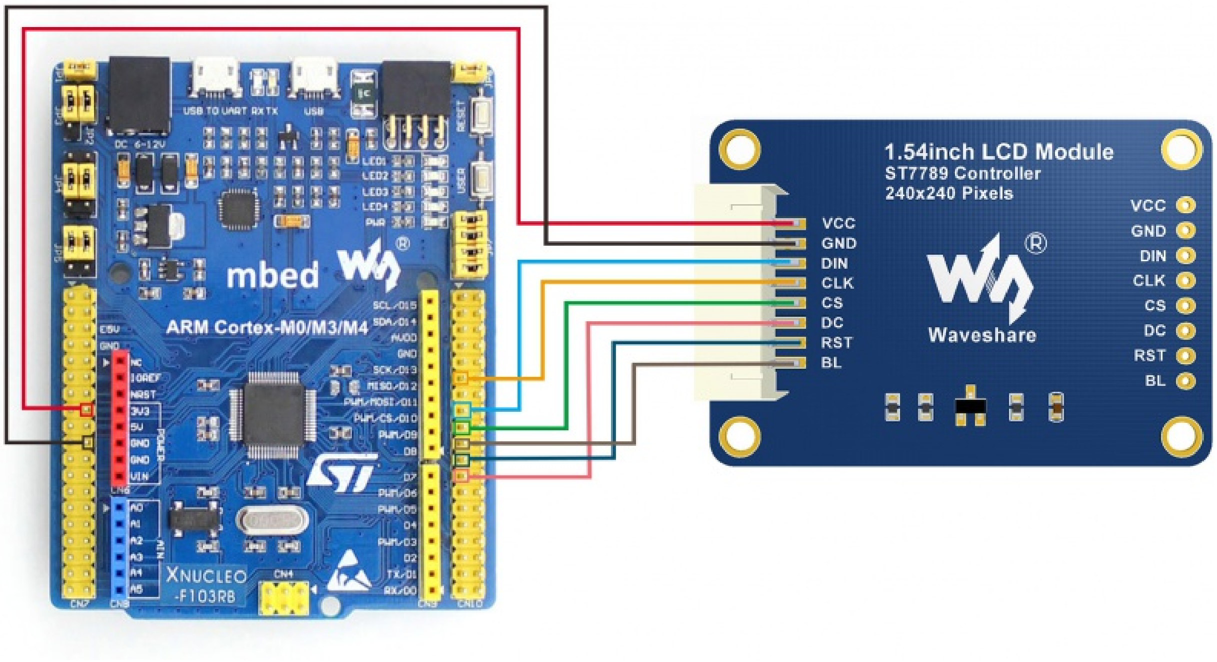
STM32

The example we provide is based on STM32F103RBT6, and the connection method provided is also the corresponding pin of STM32F103RBT6. If you need to transplant the program, please connect according to the actual pin.

STM32F103ZET connection pin correspondence

LCD	STM32
VCC	3.3V
GND	GND
DIN	PA7
CLK	PA5
CS	PB6
DC	PA8
RST	PA9
BL	PC7

Take the XNUCLEO-F103RB development board developed by our company as an example, the connection is as follows:

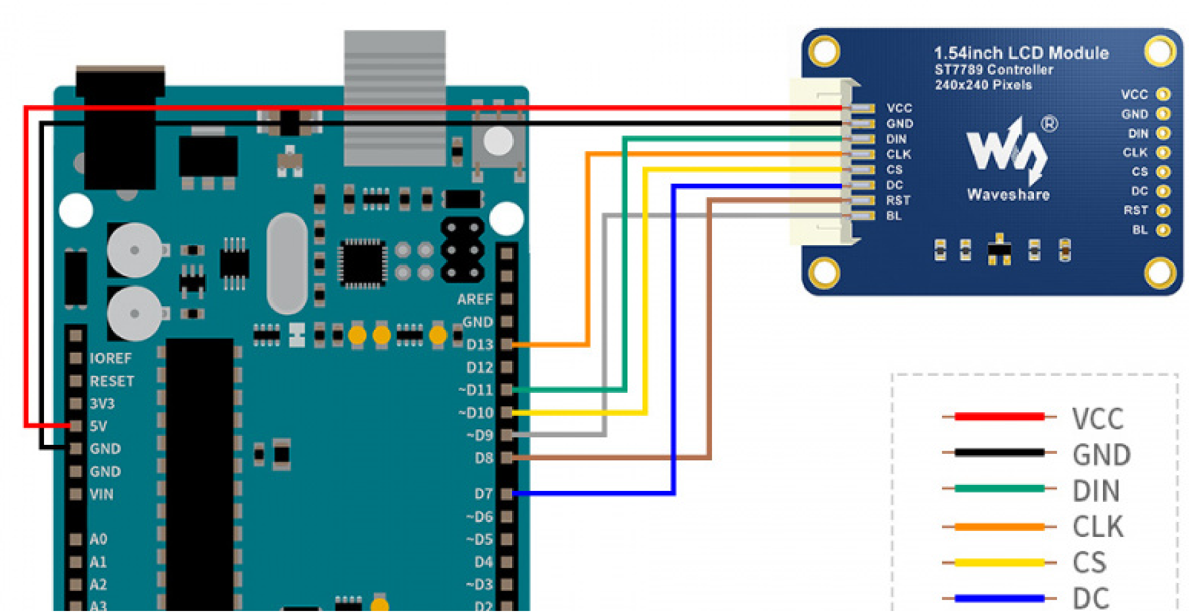


Arduino

Arduino UNO Connection pin correspondence

LCD	UNO
VCC	5V
GND	GND
DIN	D11
CLK	D13
CS	D10
DC	D7
RST	D8
BL	D9

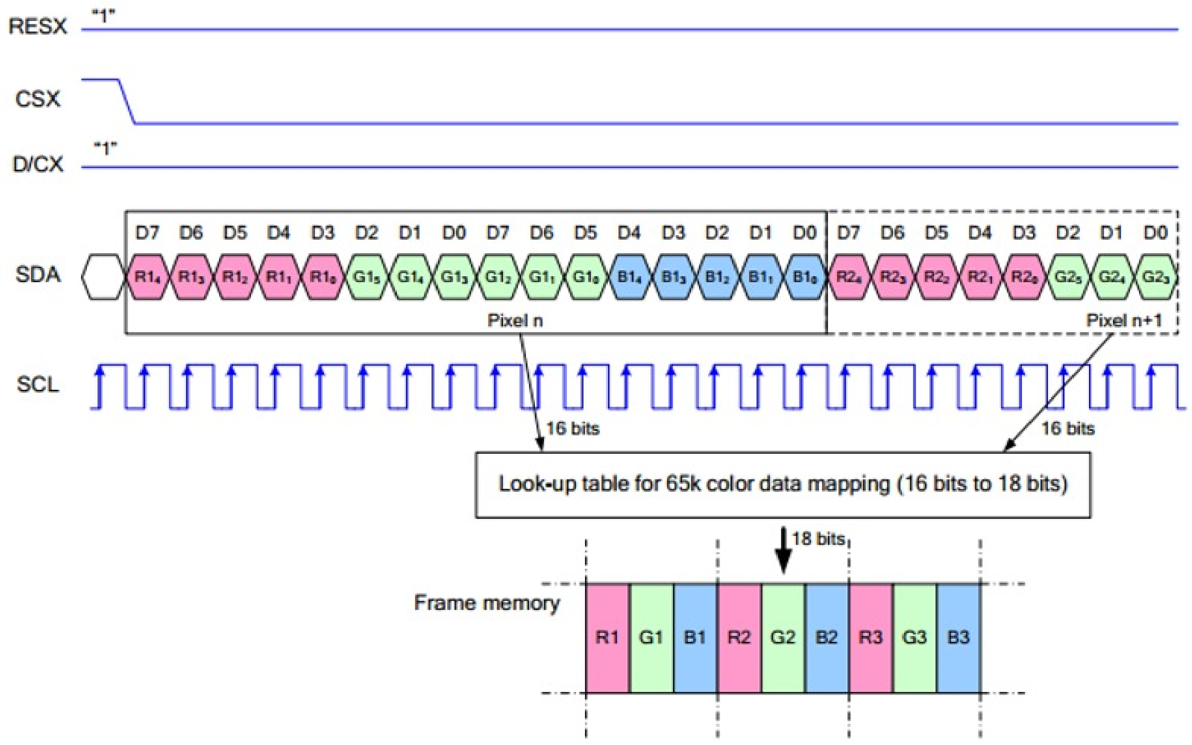
The connection diagram is as follows (click to enlarge):



LCD and the controller

The built-in controller used in this LCD is ST7789VW, which is an LCD controller with 240 x RGB x 320 pixels, while the pixels of this LCD itself is 135 (H)RGB x 240(V). There are two types of horizontal and vertical screens, so the internal RAM of the LCD is not fully used.
The LCD supports 12-bit, 16-bit, and 18-bit input color formats per pixel, namely RGB444, RGB565, and RGB666 three color formats, this routine uses RGB565 color format, which is also a commonly used RGB format
The LCD uses a four-wire SPI communication interface, which can greatly save the GPIO port, and the communication speed will be faster.

Communication Protocol


RESX
"1"
CSX
D/CX
"1"
SDA
SCL
D7 D6 D5 D4 D3 D2 D1 D0 D7 D6 D5 D4 D3 D2 D1 D0 D7 D6 D5 D4 D3 D2 D1 D0
R1₄ R1₃ R1₂ R1₁ R1₀ G1₅ G1₄ G1₃ G1₂ G1₁ G1₀ B1₄ B1₃ B1₂ B1₁ B1₀ R2₄ R2₃ R2₂ R2₁ R2₀ G2₅ G2₄ G2₃
Pixel n
Pixel n+1
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: Different from the traditional SPI protocol, the data line from the slave to the master is hidden since the device only has display requirement.
RESX Is the reset pin, it should be low when powering the module and be higher at other times;
CSX is slave chip select, when CS is low, the chip is enabled.
D/CX is data/command control pin, when DC = 0, write command, when DC = 1, write data
SDA is the data pin for transmitting RGB data, it works as the MOSI pin of SPI interface;

SCL worka s the SCLK pins of SPI interface.
SPI communication has data transfer timing, which is combined by CPHA and CPOL.
CPOL determines the level of the serial synchronous clock at idle state. When CPOL = 0, the level is Low. However, CPOL has little effect to the transmission.
CPHA determines whether data is collected at the first clock edge or at the second clock edge of serial synchronous clock; when CPHL = 0, data is collected at the first clock edge.
There are 4 SPI communication modes. SPI0 is commonly used, in which CPHL = 0, CPOL = 0.

Working with Raspberry Pi

Enable SPI interface

PS: If you are using the system of the Bullseye branch, you need to change "apt-get" to "apt", the system of the Bullseye branch only supports Python3.

- Open the terminal, and use the command to enter the configuration page.

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

Reboot Raspberry Pi:

```
sudo reboot
```

Please make sure the SPI is not occupied by other devices, you can check in the middle of /boot/config.txt

Install Library

If you use the bookworm system, you can only use lgpio library, bcm2835 and wiringPi can't be installed and used.

BCM2835

```
#Open the Raspberry Pi terminal and run the following command
wget http://www.airspayce.com/mikem/bcm2835/bcm2835-1.71.tar.gz
tar zxvf bcm2835-1.71.tar.gz
cd bcm2835-1.71/
sudo ./configure && sudo make && sudo make check && sudo make install
# For more, you can refer to the official website at: http://www.airspayce.com/mike
m/bcm2835/
```

WiringPi

```
#Open the Raspberry Pi terminal and run the following command
cd
sudo apt-get install wiringpi
#For Raspberry Pi systems after May 2019 (earlier than that can be executed withou
t), an upgrade may be required:
wget https://project-downloads.drogon.net/wiringpi-latest.deb
sudo dpkg -i wiringpi-latest.deb
gpio -v
# Run gpio -v and version 2.52 will appear, if it doesn't it means there was an inst
allation error

# Bullseye branch system using the following command:
git clone https://github.com/WiringPi/WiringPi
cd WiringPi
. /build
gpio -v
# Run gpio -v and version 2.70 will appear, if it doesn't it means there was an inst
allation error
```

lgpio

```
#Open the Raspberry Pi terminal and run the following command
wget https://github.com/joan2937/lg/archive/master.zip
unzip master.zip
cd lg-master
sudo make install

# You can refer to the official website for more: https://github.com/gpiozero/lg
```

Python

```
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 spidev
```

Download Examples

Open Raspberry Pi terminal and run the following command:

```
sudo apt-get install unzip -y
sudo wget https://files.waveshare.com/upload/8/8d/LCD_Module_RPI_code.zip
sudo unzip ./LCD_Module_RPI_code.zip
cd LCD_Module_RPI_code/RaspberryPi/
```

Run the demo codes

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

C codes

- Re-compile the demo codes:

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

- The test program of all screens can be called directly by entering the corresponding size:

```
sudo ./main Screen Size
```

Depending on the LCD, one of the following commands should be entered:

```
#0.96inch LCD Module
sudo ./main 0.96
#1.14inch LCD Module
sudo ./main 1.14
#1.28inch LCD Module
sudo ./main 1.28
#1.3inch LCD Module
sudo ./main 1.3
#1.47inch LCD Module
sudo ./main 1.47
#1.54inch LCD Module
sudo ./main 1.54
#1.8inch LCD Module
sudo ./main 1.8
#2inch LCD Module
sudo ./main 2
#2.4inch LCD Module
sudo ./main 2.4
```

python

- Enter the python program directory and run the command ls -l.

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

Test programs for all screens can be viewed, sorted by size:
0inch96_LCD_test.py: 0.96inch LCD test program
1inch14_LCD_test.py: 1.14inch LCD test program
1inch28_LCD_test.py: 1.28inch LCD test program
1inch3_LCD_test.py: 1.3inch LCD test program
1inch47_LCD_test.py: 1.47inch LCD test program
1inch54_LCD_test.py: 1.54inchLCD test program
1inch8_LCD_test.py: 1.8inch LCD test program
2inch_LCD_test.py: 2inch LCD test program
2inch4_LCD_test.py: 2inch4 LCD test program

- Just run the program corresponding to the screen, the program supports python2/3

```
# 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 1inch47_LCD_test.py
sudo python 1inch54_LCD_test.py
sudo python 1inch8_LCD_test.py
sudo python 2inch_LCD_test.py
sudo python 2inch4_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 1inch47_LCD_test.py
sudo python3 1inch54_LCD_test.py
sudo python3 1inch8_LCD_test.py
sudo python3 2inch_LCD_test.py
sudo python3 2inch4_LCD_test.py
```

FBCP Porting

PS: FBCP is currently not compatible with a 64-bit Raspberry Pi system, it is recommended to use a 32-bit system.

Framebuffer uses a video output device to drive a video display device from a memory buffer containing complete frame data. Simply put, a memory area is used to store the display content, and the display content can be changed by changing the data in the memory.

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

Download Drivers

```
sudo apt-get install cmake -y
cd ~
wget https://files.waveshare.com/upload/1/18/Waveshare_fbcp.zip
unzip Waveshare_fbcp.zip
cd Waveshare_fbcp/
sudo chmod +x ./shell/*
```

Method 1: Use a script (recommended)

Here we have written several scripts that allow users to quickly use fbcp and run corresponding commands according to their own screen.
If you use a script and do not need to modify it, you can ignore the second method below.
Note: The script will replace the corresponding /boot/config.txt and /etc/rc.local and restart, if the user needs, please back up the relevant files in advance.

```
#0.96inch LCD Module
sudo ./shell/waveshare-0inch96
#1.14inch LCD Module
sudo ./shell/waveshare-1inch14
#1.3inch LCD Module
sudo ./shell/waveshare-1inch3
#1.44inch LCD Module
sudo ./shell/waveshare-1inch44
#1.54inch LCD Module
sudo ./shell/waveshare-1inch54
#1.8inch LCD Module
sudo ./shell/waveshare-1inch8
#2inch LCD Module
sudo ./shell/waveshare-2inch
#2.4inch LCD Module
sudo ./shell/waveshare-2inch4
```

Method 2: Manual Configuration

Environment Configuration

Raspberry Pi's vc4-kms-v3d will cause fbcp to fail, so we need to close vc4-kms-v3d before installing it in fbcp.

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

Just block the statement corresponding to the picture below.

A reboot is then required.

```
sudo reboot
```

Compile and run

```
mkdir build
cd build
cmake [options] ..
sudo make -j
sudo ./fbcp
```

Replace it by yourself according to the LCD Module you use, above cmake [options] ..

```
#0.96inch LCD Module
sudo cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_0INCH96_LCD=ON -DBACKLIGHT_CONTROL
=ON -DSTATISTICS=0 ..
#1.14inch LCD Module
sudo cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_1INCH14_LCD=ON -DBACKLIGHT_CONTROL
=ON -DSTATISTICS=0 ..
#1.3inch LCD Module
sudo cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_1INCH3_LCD=ON -DBACKLIGHT_CONTROL=
ON -DSTATISTICS=0 ..
#1.54inch LCD Module
sudo cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_1INCH54_LCD=ON -DBACKLIGHT_CONTROL
=ON -DSTATISTICS=0 ..
#1.8inch LCD Module
sudo cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_1INCH8_LCD=ON -DBACKLIGHT_CONTROL=
ON -DSTATISTICS=0 ..
#2inch LCD Module
sudo cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_2INCH_LCD=ON -DBACKLIGHT_CONTROL=O
N -DSTATISTICS=0 ..
#2.4inch LCD Module
sudo cmake -DSPI_BUS_CLOCK_DIVISOR=20 -DWAVESHARE_2INCH4_LCD=ON -DBACKLIGHT_CONTROL=
ON -DSTATISTICS=0 ..
```

Set up to start automatically

```
sudo cp ~/Waveshare_fbcp/build/fbcp
/usr/local/bin/fbcp
sudo nano /etc/rc.local
```

Add fbcp& before exit 0. Note that you must add "&" to run in the background. Otherwise, the system may not be able to start.

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
```

And then reboot the system:

```
sudo reboot
```

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

API Description

The RaspberryPi series can share a set of programs, because they are all embedded systems, and the compatibility is relatively strong.
The program is divided into bottom-layer hardware interface, middle-layer LCD screen driver, and upper-layer application;

C

Hardware Interface

We have carried out the low-level encapsulation, if you need to know the internal implementation can go to the corresponding directory to check, for the reason the hardware platform and the internal implementation are different.
You can open DEV_Config.c(.h) to see definitions, which in the directory RaspberryPi\c\lib\Config.

```
1. There are three ways for C to drive: BCM2835 library, WiringPi library, and Dev l
ibrary respectively
2. We use Dev libraries by default. If you need to change to BCM2835 or WiringPi lib
raries, please open RaspberryPi\c\Makefile and modify lines 13-15 as follows:
```

- Data type:

```
#define UBYTE      uint8_t
#define UWORD      uint16_t
#define UDOUBLE    uint32_t
```

- Module initialization and exit processing.

```
void DEV_Module_Init(void);
void DEV_Module_Exit(void);
Note:
  Here is some GPIO processing before and after using the LCD screen.
```

- GPIO read and write:

```
void     DEV_Digital_Write(UWORD Pin, UBYTE Value);
UBYTE    DEV_Digital_Read(UWORD Pin);
```

- SPI write data:

```
void DEV_SPI_WriteByte(UBYTE Value);
```

Upper application

If you need to draw pictures or display Chinese and English characters, we provide some basic functions here about some graphics processing in the directory RaspberryPi\c\lib\GUI\GUI_Paint.c(.h).

The fonts can be found in RaspberryPi\c\lib\Fonts directory.

- New Image Properties: Create a new image buffer, this property includes the image buffer name, width, height, flip Angle, and color.

```
void Paint_NewImage(UBYTE *image, UWORD Width, UWORD Height, UWORD Rotate, UWORD Col
or)
Parameters:
      Image: the name of the image buffer, which is actually a pointer to the first
address of the image buffer;
      Width: image buffer Width;
      Height: the Height of the image buffer;
      Rotate: Indicates the rotation Angle of an image
      Color: the initial Color of the image;
```

- Select image buffer: The purpose of the selection is that you can create multiple image attributes, there can be multiple images buffer, you can select each image you create.

```
void Paint_SelectImage(UBYTE *image)
Parameters:
       Image: the name of the image buffer, which is actually a pointer to the first
address of the image buffer;
```

- Image Rotation: Set the rotation Angle of the selected image, preferably after Paint_SelectImage(), you can choose to rotate 0, 90, 180, 270.

```
void Paint_SetRotate(UWORD Rotate)
Parameters:
        Rotate: ROTATE_0, ROTATE_90, ROTATE_180, and ROTATE_270 correspond to 0, 90,
180, and 270 degrees.
```

- Image mirror flip: Set the mirror flip of the selected image. You can choose no mirror, horizontal mirror, vertical mirror, or image center mirror.

```
void Paint_SetMirroring(UBYTE mirror)
Parameters:
        Mirror: indicates the image mirroring mode. MIRROR_NONE, MIRROR_HORIZONTAL,
MIRROR_VERTICAL, MIRROR_ORIGIN correspond to no mirror, horizontal mirror, vertical
mirror, and image center mirror respectively.
```

- Set points of the display position and color in the buffer: here is the core GUI function, processing points display position and color in the buffer.

```
void Paint_SetPixel(UWORD Xpoint, UWORD Ypoint, UWORD Color)
Parameters:
        Xpoint: the X position of a point in the image buffer
        Ypoint: Y position of a point in the image buffer
        Color: indicates the Color of the dot
```

- Image buffer fill color: Fills the image buffer with a color, usually used to flash the screen into blank.

```
void Paint_Clear(UWORD Color)
Parameters:
        Color: fill Color
```

- The fill color of a certain window in the image buffer: the image buffer part of the window filled with a certain color, usually used to fresh the screen into blank, often used for time display, fresh the last second of the screen.

```
void Paint_ClearWindows(UWORD Xstart, UWORD Ystart, UWORD Xend, UWORD Yend, UWORD Co
lor)
Parameters:
        Xstart: the x-starting coordinate of the window
        Ystart: the y-starting coordinate of the window
        Xend: the x-end coordinate of the window
        Yend: the y-end coordinate of the window
        Color: fill Color
```

- Draw point: In the image buffer, draw points on (Xpoint, Ypoint), you can choose the color, the size of the point, the style of the point.

```
void Paint_DrawPoint(UWORD Xpoint, UWORD Ypoint, UWORD Color, DOT_PIXEL Dot_Pixel, D
OT_STYLE Dot_Style)
Parameters:
        Xpoint: indicates the X coordinate of a point.
        Ypoint: indicates the Y coordinate of a point.
        Color: fill Color
        Dot_Pixel: The size of the dot, the demo provides 8 size pointss by default.
              typedef enum {
                 DOT_PIXEL_1X1  = 1,    // 1 x 1
                 DOT_PIXEL_2X2  ,               // 2 X 2
                 DOT_PIXEL_3X3  ,               // 3 X 3
                 DOT_PIXEL_4X4  ,               // 4 X 4
                 DOT_PIXEL_5X5  ,               // 5 X 5
                 DOT_PIXEL_6X6  ,               // 6 X 6
                 DOT_PIXEL_7X7  ,               // 7 X 7
                 DOT_PIXEL_8X8  ,               // 8 X 8
               } DOT_PIXEL;
        Dot_Style: the size of a point that expands from the center of the point or
from the bottom left corner of the point to the right and up.
                 typedef enum {
                     DOT_FILL_AROUND  = 1,
                     DOT_FILL_RIGHTUP,
                  } DOT_STYLE;
```

- Draw line: In the image buffer, draw line from (Xstart, Ystart) to (Xend, Yend), you can choose the color, the width and the style of the line.

```
void Paint_DrawLine(UWORD Xstart, UWORD Ystart, UWORD Xend, UWORD Yend, UWORD Color,
LINE_STYLE Line_Style ,  LINE_STYLE Line_Style)
Parameters:
        Xstart: the x-starting coordinate of a line
        Ystart: the y-starting coordinate of the a line
        Xend: the x-end coordinate of a line
        Yend: the y-end coordinate of a line
        Color: fill Color
        Line_width: The width of the line, the demo provides 8 sizes of width by def
ault.
              typedef enum {
                 DOT_PIXEL_1X1  = 1,    // 1 x 1
                 DOT_PIXEL_2X2  ,               // 2 X 2
                 DOT_PIXEL_3X3  ,               // 3 X 3
                 DOT_PIXEL_4X4  ,               // 4 X 4
                 DOT_PIXEL_5X5  ,               // 5 X 5
                 DOT_PIXEL_6X6  ,               // 6 X 6
                 DOT_PIXEL_7X7  ,               // 7 X 7
                 DOT_PIXEL_8X8  ,               // 8 X 8
              } DOT_PIXEL;
        Line_Style: line style. Select whether the lines are joined in a straight or
dashed way.
              typedef enum {
                 LINE_STYLE_SOLID = 0,
                 LINE_STYLE_DOTTED,
              } LINE_STYLE;
```

- Draw rectangle: In the image buffer, draw a rectangle from (Xstart, Ystart) to (Xend, Yend), you can choose the color, the width of the line, whether to fill the inside of the rectangle.

```
void Paint_DrawRectangle(UWORD Xstart, UWORD Ystart, UWORD Xend, UWORD Yend, UWORD C
olor, DOT_PIXEL Line_width,  DRAW_FILL Draw_Fill)
Parameters:
        Xstart: the starting X coordinate of the rectangle
        Ystart: the starting Y coordinate of the rectangle
        Xend: the x-end coordinate of the rectangle
        Yend: the y-end coordinate of the rectangle
        Color: fill Color
        Line_width: The width of the four sides of a rectangle. And the demo provide
s 8 sizes of width by default.
                typedef enum {
                        DOT_PIXEL_1X1  = 1,     // 1 x 1
                        DOT_PIXEL_2X2  ,                // 2 X 2
                        DOT_PIXEL_3X3  ,                // 3 X 3
                        DOT_PIXEL_4X4   ,                // 4 X 4
                        DOT_PIXEL_5X5   ,                // 5 X 5
                        DOT_PIXEL_6X6   ,                // 6 X 6
                        DOT_PIXEL_7X7   ,                // 7 X 7
                        DOT_PIXEL_8X8   ,                // 8 X 8
                 } DOT_PIXEL;
         Draw_Fill: Fill, whether to fill the inside of the rectangle
              typedef enum {
                        DRAW_FILL_EMPTY = 0,
                        DRAW_FILL_FULL,
              } DRAW_FILL;
```

- Draw circle: In the image buffer, draw a circle of Radius with (X_Center Y_Center) as the center. You can choose the color, the width of the line, and whether to fill the inside of the circle.

```
void Paint_DrawCircle(UWORD X_Center, UWORD Y_Center, UWORD Radius, UWORD Color, DOT
_PIXEL Line_width,  DRAW_FILL Draw_Fill)
Parameters:
        X_Center: the x-coordinate of the center of the circle
        Y_Center: the y-coordinate of the center of the circle
        Radius: indicates the Radius of a circle
        Color: fill Color
        Line_width: The width of the arc, with a default of 8 widths
                typedef enum {
                        DOT_PIXEL_1X1  = 1,     // 1 x 1
                        DOT_PIXEL_2X2   ,                // 2 X 2
                        DOT_PIXEL_3X3   ,                // 3 X 3
                        DOT_PIXEL_4X4   ,                // 4 X 4
                        DOT_PIXEL_5X5   ,                // 5 X 5
                        DOT_PIXEL_6X6   ,                // 6 X 6
                        DOT_PIXEL_7X7   ,                // 7 X 7
                        DOT_PIXEL_8X8   ,                // 8 X 8
                } DOT_PIXEL;
        Draw_Fill: fill, whether to fill the inside of the circle
              typedef enum {
                        DRAW_FILL_EMPTY = 0,
                        DRAW_FILL_FULL,
              } DRAW_FILL;
```

- Write Ascii character: In the image buffer, use (Xstart Ystart) as the left vertex, write an Ascii character, you can select Ascii visual character library, font foreground color, font background color.

```
void Paint_DrawChar(UWORD Xstart, UWORD Ystart, const char Ascii_Char, sFONT* Font,
UWORD Color_Foreground,  UWORD Color_Background)
Parameters:
        Xstart: the x-coordinate of the left vertex of a character
        Ystart: the Y-coordinate of the left vertex of a character
        Ascii_Char: indicates the Ascii character
        Font: Ascii visual character library, in the Fonts folder the demo provides
the following Fonts:
                Font8: 5*8 font
                Font12: 7*12 font
                Font16: 11*16 font
                Font20: 14*20 font
                Font24: 17*24 font
        Color_Foreground: Font color
        Color_Background: indicates the background color
```

- Write English string: In the image buffer, use (Xstart Ystart) as the left vertex, write a string of English characters, you can choose Ascii visual character library, font foreground color, font background color.

```
void Paint_DrawString_EN(UWORD Xstart, UWORD Ystart, const char * pString, sFONT* Fo
nt, UWORD Color_Foreground,  UWORD Color_Background)
Parameters:
        Xstart: the x-coordinate of the left vertex of a character
        Ystart: the Y coordinate of the font's left vertex
        PString: string, string is a pointer
        Font: Ascii visual character library, in the Fonts folder the demo provides
the following Fonts:
                Font8: 5*8 font
                Font12: 7*12 font
                Font16: 11*16 font
                Font20: 14*20 font
                Font24: 17*24 font
        Color_Foreground: Font color
        Color_Background: indicates the background color
```

- Write Chinese string: in the image buffer, use (Xstart Ystart) as the left vertex, write a string of Chinese characters, you can choose character font, font foreground color, and font background color of the GB2312 encoding.

```
void Paint_DrawString_CN(UWORD Xstart, UWORD Ystart, const char * pString, cFONT* fo
nt, UWORD Color_Foreground,  UWORD Color_Background)
Parameters:
        Xstart: the x-coordinate of the left vertex of a character
        Ystart: the Y coordinate of the font's left vertex
        PString: string, string is a pointer
        Font: GB2312 encoding character Font library, in the Fonts folder the demo p
rovides the following Fonts:
                Font12CN: ASCII font 11*21, Chinese font 16*21
                Font24CN: ASCII font24 *41, Chinese font 32*41
        Color_Foreground: Font color
        Color_Background: indicates the background color
```

- Write numbers: In the image buffer,use (Xstart Ystart) as the left vertex, write a string of numbers, you can choose Ascii visual character library, font foreground color, font background color.

```
void Paint_DrawNum(UWORD Xpoint, UWORD Ypoint, double Nummber, sFONT* Font, UWORD Di
git, UWORD Color_Foreground,   UWORD Color_Background)
Parameters:
        Xpoint: the x-coordinate of the left vertex of a character
        Ypoint: the Y coordinate of the left vertex of the font
        Nummber: indicates the number displayed, which can be a decimal
        Digit: It's a decimal number
        Font: Ascii visual character library, in the Fonts folder the demo provides
the following Fonts:
                Font8: 5*8 font
                Font12: 7*12 font
                Font16: 11*16 font
                Font20: 14*20 font
                Font24: 17*24 font
        Color_Foreground: Font color
        Color_Background: indicates the background color
```

- Display time: in the image buffer,use (Xstart Ystart) as the left vertex, display time,you can choose Ascii visual character font, font foreground color, font background color.

```
void Paint_DrawTime(UWORD Xstart, UWORD Ystart, PAINT_TIME *pTime, sFONT* Font, UWOR
D Color_Background,  UWORD Color_Foreground)
Parameters:
        Xstart: the x-coordinate of the left vertex of a character
        Ystart: the Y coordinate of the font's left vertex
        PTime: display time, A time structure is defined here, as long as the hours,
minutes, and seconds are passed to the parameters;
        Font: Ascii visual character library, in the Fonts folder the demo provides
the following Fonts:
                Font8: 5*8 font
                Font12: 7*12 font
                Font16: 11*16 font
                Font20: 14*20 font
                Font24: 17*24 font
        Color_Foreground: Font color
        Color_Background: indicates the background color
```

- Read the local bmp image and write it to the cache.

For Linux operating systems such as Raspberry Pi, you can read and write pictures. For Raspberry Pi, in the directory: RaspberryPi\c\lib\GUI\GUI_BMPfile.c(.h).

```
UBYTE GUI_ReadBmp(const char *path, UWORD Xstart, UWORD Ystart)
parameter:
       path: the relative path of the BMP image
       Xstart: The X coordinate of the left vertex of the image, generally 0 is pass
```

```
ed by default
       Ystart: The Y coordinate of the left vertex of the picture, generally 0 by de
fault
```

Testing Code for Users

For Raspberry Pi, in the directory: RaspberryPi\c\examples, for all the test code;

If you need to run the 0.96-inch LCD test program, you need to add 0.96 as a parameter when running the main demo.
Re-execute in Linux command mode as follows:

```
make clean
make
sudo ./main 0.96
```

Python (for Raspberry Pi)

Works with python and python3.
For python, his calls are not as complicated as C.
Raspberry Pi: RaspberryPi\python\lib\

lcdconfig.py

- Module initialization and exit processing.

```
def module_init()
def module_exit()
Note:
1. Here is some GPIO processing before and after using the LCD screen.
2. The module_init() function is automatically called in the INIT () initializer on
the LCD, but the module_exit() function needs to be called by itself.
```

- GPIO read and write:

```
def  digital_write(pin, value)
def  digital_read(pin)
```

- SPI write data.

```
def spi_writebyte(data)
```

- xxx_LCD_test.py (xxx indicates the size, if it is a 0.96inch LCD, it is 0inch96_LCD_test.py, and so on)

python is in the following directory:
Raspberry Pi: RaspberryPi\python\examples\

If your python version is python2 and you need to run the 0.96inch LCD test program, re-execute it as follows in linux command mode:

```
sudo python 0inch96_LCD_test.py
```

If your python version is python3 and you need to run the 0.96inch LCD test program, re-execute the following in linux command mode:

```
sudo python3 0inch96_LCD_test.py
```

About Rotation Settings

If you need to set the screen rotation in the python program, you can set it by the statement im_r= image1.rotate(270).

```
im_r= image1.rotate(270)
```

Rotation effect, take 1.54 as an example, the order is 0°, 90°, 180°, 270°

GUI Functions

Python has an image library PIL official library link, it does not need to write code from the logical layer like C and can directly call to the image library for image processing. The following will take a 1.54-inch LCD as an example, we provide a brief description of the demo.

- It needs to use the image library and install the library.

```
sudo apt-get install python3-pil
```

And then import the library

```
from PIL import Image,ImageDraw,ImageFont.
```

Among them, Image is the basic library, ImageDraw is the drawing function, and ImageFont is the text function.

- Define an image cache to facilitate drawing, writing, and other functions on the picture.

```
image1 = Image.new("RGB", (disp.width, disp.height), "WHITE")
```

The first parameter defines the color depth of the image, which is defined as "1" to indicate the bitmap of one-bit depth. The second parameter is a tuple that defines the width and height of the image. The third parameter defines the default color of the buffer, which is defined as "WHITE".

- Create a drawing object based on Image1 on which all drawing operations will be performed on here.

```
draw = ImageDraw.Draw(image1)
```

- Draw a line.

```
draw.line([(20, 10),(70, 60)], fill = "RED",width = 1)
```

The first parameter is a four-element tuple starting at (0, 0) and ending at (127,0). Draw a line. Fill ="0" means the color of the line is white.

- Draw a rectangle.

```
draw.rectangle([(20,10),(70,60)],fill = "WHITE",outline="BLACK")
```

The first argument is a tuple of four elements. (20,10) is the coordinate value in the upper left corner of the rectangle, and (70,60) is the coordinate value in the lower right corner of the rectangle. Fill =" WHITE" means BLACK inside, and outline="BLACK" means the color of the outline is black.

- Draw a circle.

```
draw.arc((150,15,190,55),0, 360, fill =(0,255,0)
```

Draw an inscribed circle in the square, the first parameter is a tuple of 4 elements, with (150, 15) as the upper left corner vertex of the square, (190, 55) as the lower right corner vertex of the square, specifying the level median line of the rectangular frame is the angle of 0 degrees, the second parameter indicates the starting angle, the third parameter indicates the ending angle, and fill = 0 indicates that the color of the line is white. If the figure is not square according to the coordination, you will get an ellipse.

Besides the arc function, you can also use the chord function for drawing a solid circle.

```
draw.ellipse((150,65,190,105), fill = 0)
```

The first parameter is the coordination of the enclosing rectangle. The second and third parameters are the beginning and end degrees of the circle. The fourth parameter is the fill color of the circle.

- Character.

The ImageFont module needs to be imported and instantiated:

```
Font1 = ImageFont.truetype("../Font/Font01.ttf",25)
Font2 = ImageFont.truetype("../Font/Font01.ttf",35)
Font3 = ImageFont.truetype("../Font/Font02.ttf",32)
```

You can use the fonts of Windows or other fonts which is in ttc format..
Note: Each character library contains different characters; If some characters cannot be displayed, it is recommended that you can refer to the encoding set ro used. To draw English characters, you can directly use the fonts; for Chinese characters, you need to add a symbol u:

```
draw.text((40, 50), 'WaveShare', fill = (128,255,128),font=Font2)
text= u"微雪电子"
draw.text((74, 150),text, fill = "WHITE",font=Font3)
```

The first parameter is a tuple of 2 elements, with (40, 50) as the left vertex, the font is Font2, and the fill is the font color. You can directly make fill = "WHITE", because the regular color value is already defined Well, of course, you can also use fill = (128,255,128), the parentheses correspond to the values of the three RGB colors so that you can precisely control the color you want. The second sentence shows Waveshare Electronics, using Font3, the font color is white.

- read local image

```
image = Image.open('../pic/LCD_1inch28.jpg')
```

The parameter is the image path.

- Other functions.

For more information, you can refer to http://effbot.org/imagingbook pil

Using with STM32

Software Description

- The demo is developed based on the HAL library. Download the demo, find the STM32 program file directory, and open the LCD_demo.uvprojx in the STM32\STM32F103RBT6\MDK-ARM directory to check the program.

- Open main.c, you can see all the test programs, remove the comments in front of the test programs on the corresponding screen, and recompile and download.

LCD_0in96_test() 0.96inch LCD test program

LCD_1in14_test() 1.14inch LCD test program

LCD_1in28_test() 1.28inch LCD test program

LCD_1in3_test() 1.3 inch LCD test program

LCD_1in54_test() 1.54inch LCD test program

LCD_1in8_test() 1.8inch LCD test program

LCD_2in_test() 2inch LCD test program

Program Description

Underlying Hardware Interface

- Data type

```
#define UBYTE      uint8_t
```

```
#define UWORD      uint16_t
#define UDOUBLE    uint32_t
```

- Module initialization and exit processing

```
UBYTE   System_Init(void);
void    System_Exit(void);
Note:
1. Here is some GPIO processing before and after using the LCD screen.
2. After the System_Exit(void) function is used, the OLED display will be turned of
f;
```

- Write and read GPIO

```
void    DEV_Digital_Write(UWORD Pin, UBYTE Value);
UBYTE   DEV_Digital_Read(UWORD Pin);
```

- SPI writes data

```
UBYTE    SPI4W_Write_Byte(uint8_t value);
```

The upper application

For the screen, if you need to draw pictures, display Chinese and English characters, display pictures, etc., you can use the upper application to do, and we provide some basic functions here about some graphics processing in the directory STM32\STM32F103RB\User\GUI_DEV\GUI_Paint.c(.h).
Note: Because of the size of the internal RAM of STM32 and Arduino, the GUI is directly written to the RAM of the LCD.

The character font GUI dependent is in the directory STM32\STM32F103RB\User\Fonts

- New Image Properties: Create a new image property, this property includes the image buffer name, width, height, flip Angle, and color.

```
void Paint_NewImage(UWORD Width, UWORD Height, UWORD Rotate, UWORD Color)
Parameters:
    Width: image buffer Width;
    Height: the Height of the image buffer;
    Rotate: Indicates the rotation Angle of an image
    Color: the initial Color of the image;
```

- Set the clear screen function, usually call the clear function of LCD directly.

```
void Paint_SetClearFuntion(void (*Clear)(UWORD));
parameter:
    Clear: Pointer to the clear screen function, used to quickly clear the screen to
a certain color;
```

- Set the drawing pixel function

```
void Paint_SetDisplayFuntion(void (*Display)(UWORD,UWORD,UWORD));
parameter:
    Display: Pointer to the pixel drawing function, which is used to write data to t
he specified location in the internal RAM of the LCD;
```

- Select image buffer: the purpose of the selection is that you can create multiple image attributes, image buffer can exist multiple, and you can select each image you create.

```
void Paint_SelectImage(UBYTE *image)
Parameters:
    Image: the name of the image cache, which is actually a pointer to the first add
ress of the image buffer
```

- Image Rotation: Set the selected image rotation Angle, preferably after Paint_SelectImage(), you can choose to rotate 0, 90, 180, 270.

```
void Paint_SetRotate(UWORD Rotate)
Parameters:
    Rotate: ROTATE_0, ROTATE_90, ROTATE_180, and ROTATE_270 correspond to 0, 90, 18
0, and 270 degrees respectively;
```

- Image mirror flip: Set the mirror flip of the selected image. You can choose no mirror, horizontal mirror, vertical mirror, or image center mirror.

```
void Paint_SetMirroring(UBYTE mirror)
Parameters:
    Mirror: indicates the image mirroring mode. MIRROR_NONE, MIRROR_HORIZONTAL, MIRR
OR_VERTICAL, MIRROR_ORIGIN correspond to no mirror, horizontal mirror, vertical mirr
or, and about image center mirror respectively.
```

- Set points of display position and color in the buffer: here is the core GUI function, processing points display position and color in the buffer.

```
void Paint_SetPixel(UWORD Xpoint, UWORD Ypoint, UWORD Color)
Parameters:
    Xpoint: the X position of a point in the image buffer
    Ypoint: Y position of a point in the image buffer
    Color: indicates the Color of the dot
```

- Image buffer fill color: Fills the image buffer with a color, usually used to flash the screen into blank.

```
void Paint_Clear(UWORD Color)
Parameters:
    Color: fill Color
```

- Image buffer part of the window filling color: the image buffer part of the window filled with a certain color, generally as a window whitewashing function, often used for time display, whitewashing on a second

```
void Paint_ClearWindows(UWORD Xstart, UWORD Ystart, UWORD Xend, UWORD Yend, UWORD Co
lor)
Parameters:
    Xstart: the x-starting coordinate of the window
    Ystart: indicates the Y starting point of the window
    Xend: the x-end coordinate of the window
    Yend: indicates the y-end coordinate of the window
    Color: fill Color
```

- Draw points: In the image buffer, draw points on (Xpoint, Ypoint), you can choose the color, the size of the point, and the style of the point.

```
void Paint_DrawPoint(UWORD Xpoint, UWORD Ypoint, UWORD Color, DOT_PIXEL Dot_Pixel, D
OT_STYLE Dot_Style)
Parameters:
    Xpoint: indicates the X coordinate of a point
    Ypoint: indicates the Y coordinate of a point
    Color: fill Color
    Dot_Pixel: The size of the dot, providing a default of eight size points
        typedef enum {
            DOT_PIXEL_1X1   = 1,        // 1 x 1
            DOT_PIXEL_2X2  ,            // 2 X 2
            DOT_PIXEL_3X3  ,            // 3 X 3
            DOT_PIXEL_4X4  ,            // 4 X 4
            DOT_PIXEL_5X5  ,            // 5 X 5
            DOT_PIXEL_6X6  ,            // 6 X 6
            DOT_PIXEL_7X7  ,            // 7 X 7
            DOT_PIXEL_8X8  ,            // 8 X 8
        } DOT_PIXEL;
    Dot_Style: the size of a point that expands from the center of the point or from
the bottom left corner of the point to the right and up
        typedef enum {
            DOT_FILL_AROUND  = 1,
            DOT_FILL_RIGHTUP,
        } DOT_STYLE;
```

- Line drawing: In the image buffer, a line from (Xstart, Ystart) to (Xend, Yend), you can choose the color, line width, and line style.

```
void Paint_DrawLine(UWORD Xstart, UWORD Ystart, UWORD Xend, UWORD Yend, UWORD Color,
LINE_STYLE Line_Style ,  LINE_STYLE Line_Style)
Parameters:
    Xstart: the x-starting coordinate of a line
    Ystart: indicates the Y starting point of a line
    Xend: x-terminus of a line
    Yend: the y-end coordinate of a line
    Color: fill Color
    Line_width: The width of the line, which provides a default of eight widths
        typedef enum {
            DOT_PIXEL_1X1   = 1,        // 1 x 1
            DOT_PIXEL_2X2  ,            // 2 X 2
            DOT_PIXEL_3X3  ,            // 3 X 3
            DOT_PIXEL_4X4  ,            // 4 X 4
            DOT_PIXEL_5X5  ,            // 5 X 5
            DOT_PIXEL_6X6  ,            // 6 X 6
            DOT_PIXEL_7X7  ,            // 7 X 7
            DOT_PIXEL_8X8  ,            // 8 X 8
        } DOT_PIXEL;
    Line_Style: line style. Select whether the lines are joined in a straight or das
hed way
        typedef enum {
            LINE_STYLE_SOLID = 0,
            LINE_STYLE_DOTTED,
        } LINE_STYLE;
```

- Draw a rectangle: In the image buffer, draw a rectangle from (Xstart, Ystart) to (Xend, Yend), you can choose the color, the width of the line, and whether to fill the inside of the rectangle.

```
void Paint_DrawRectangle(UWORD Xstart, UWORD Ystart, UWORD Xend, UWORD Yend, UWORD C
olor, DOT_PIXEL Line_width,  DRAW_FILL Draw_Fill)
Parameters:
        Xstart: the starting X coordinate of the rectangle
        Ystart: indicates the Y starting point of the rectangle
        Xend: X terminus of the rectangle
        Yend: specifies the y-end coordinate of the rectangle
        Color: fill Color
        Line_width: The width of the four sides of a rectangle. Default eight widths
```

```
are provided
            typedef enum {
                DOT_PIXEL_1X1   = 1,    // 1 x 1
                DOT_PIXEL_2X2  ,                // 2 X 2
                DOT_PIXEL_3X3  ,                // 3 X 3
                DOT_PIXEL_4X4  ,                // 4 X 4
                DOT_PIXEL_5X5  ,                // 5 X 5
                DOT_PIXEL_6X6  ,                // 6 X 6
                DOT_PIXEL_7X7  ,                // 7 X 7
                DOT_PIXEL_8X8  ,                // 8 X 8
            } DOT_PIXEL;
        Draw_Fill: Fill, whether to fill the inside of the rectangle
            typedef enum {
                DRAW_FILL_EMPTY = 0,
                DRAW_FILL_FULL,
            } DRAW_FILL;
```

- Draw circle: In the image buffer, draw a circle of Radius with (X_Center Y_Center) as the center. You can choose the color, the width of the line, and whether to fill the inside of the circle.

```
void Paint_DrawCircle(UWORD X_Center, UWORD Y_Center, UWORD Radius, UWORD Color, DOT
_PIXEL Line_width,  DRAW_FILL Draw_Fill)
Parameters:
    X_Center: the x-coordinate of the center of a circle
    Y_Center: Y coordinate of the center of a circle
    Radius: indicates the Radius of a circle
    Color: fill Color
    Line_width: The width of the arc, with a default of 8 widths
        typedef enum {
            DOT_PIXEL_1X1  = 1,         // 1 x 1
            DOT_PIXEL_2X2  ,            // 2 X 2
            DOT_PIXEL_3X3  ,            // 3 X 3
            DOT_PIXEL_4X4  ,            // 4 X 4
            DOT_PIXEL_5X5  ,            // 5 X 5
            DOT_PIXEL_6X6  ,            // 6 X 6
            DOT_PIXEL_7X7  ,            // 7 X 7
            DOT_PIXEL_8X8  ,            // 8 X 8
        } DOT_PIXEL;
    Draw_Fill: fill, whether to fill the inside of the circle
        typedef enum {
            DRAW_FILL_EMPTY = 0,
            DRAW_FILL_FULL,
        } DRAW_FILL;
```

- Write Ascii character: In the image buffer, at (Xstart Ystart) as the left vertex, write an Ascii character, you can select Ascii visual character library, font foreground color, and font background color.

```
void Paint_DrawChar(UWORD Xstart, UWORD Ystart, const char Ascii_Char, sFONT* Font,
UWORD Color_Foreground,  UWORD Color_Background)
Parameters:
    Xstart: the x-coordinate of the left vertex of a character
    Ystart: the Y coordinate of the font's left vertex
    Ascii_Char: indicates the Ascii character
    Font: Ascii visual character library, in the Fonts folder provides the following
Fonts:
        Font8: 5*8 font
        Font12: 7*12 font
        Font16: 11*16 font
        Font20: 14*20 font
        Font24: 17*24 font
    Color_Foreground: Font color
    Color_Background: indicates the background color
```

- Write English string: In the image buffer, use (Xstart Ystart) as the left vertex, write a string of English characters, can choose Ascii visual character library, font foreground color, font background color.

```
void Paint_DrawString_EN(UWORD Xstart, UWORD Ystart, const char * pString, sFONT* Fo
nt, UWORD Color_Foreground,  UWORD Color_Background)
Parameters:
    Xstart: the x-coordinate of the left vertex of a character
    Ystart: the Y coordinate of the font's left vertex
    PString: string, string is a pointer
    Font: Ascii visual character library, in the Fonts folder provides the following
Fonts:
        Font8: 5*8 font
        Font12: 7*12 font
        Font16: 11*16 font
        Font20: 14*20 font
        Font24: 17*24 font
     Color_Foreground: Font color
     Color_Background: indicates the background color
```

- Write Chinese string: in the image buffer, use (Xstart Ystart) as the left vertex, write a string of Chinese characters, you can choose GB2312 encoding character font, font foreground color, and font background color.

```
void Paint_DrawString_CN(UWORD Xstart, UWORD Ystart, const char * pString, cFONT* fo
nt, UWORD Color_Foreground,  UWORD Color_Background)
Parameters:
    Xstart: the x-coordinate of the left vertex of a character
    Ystart: the Y coordinate of the font's left vertex
    PString: string, string is a pointer
    Font: GB2312 encoding character Font library, in the Fonts folder provides the f
ollowing Fonts:
        Font12CN: ASCII font 11*21, Chinese font 16*21
        Font24CN: ASCII font24 *41, Chinese font 32*41
    Color_Foreground: Font color
    Color_Background: indicates the background color
```

- Write numbers: In the image buffer, use (Xstart Ystart) as the left vertex, write a string of numbers, you can choose Ascii visual character library, font foreground color, and font background color.

```
void Paint_DrawNum(UWORD Xpoint, UWORD Ypoint, double Nummber, sFONT* Font, UWORD Di
git, UWORD Color_Foreground,   UWORD Color_Background)
Parameters:
    Xpoint: the x-coordinate of the left vertex of a character
    Ypoint: the Y coordinate of the left vertex of the font
    Nummber: indicates the number displayed, which can be a decimal
    Digit: It's a decimal number
    Font: Ascii visual character library, in the Fonts folder provides the following
Fonts:
        Font8: 5*8 font
        Font12: 7*12 font
        Font16: 11*16 font
        Font20: 14*20 font
        Font24: 17*24 font
    Color_Foreground: Font color
    Color_Background: indicates the background color
```

- Display time: in the image buffer, use (Xstart Ystart) as the left vertex, display time, you can choose Ascii visual character font, font foreground color, and font background color.

```
void Paint_DrawTime(UWORD Xstart, UWORD Ystart, PAINT_TIME *pTime, sFONT* Font, UWOR
D Color_Background,  UWORD Color_Foreground)
Parameters:
    Xstart: the x-coordinate of the left vertex of a character
    Ystart: the Y coordinate of the font's left vertex
    PTime: display time, here defined as a good time structure, as long as the hour,
minute, and second bits of data to the parameter;
    Font: Ascii visual character library, in the Fonts folder provides the following
Fonts:
        Font8: 5*8 font
        Font12: 7*12 font
        Font16: 11*16 font
        Font20: 14*20 font
        Font24: 17*24 font
    Color_Foreground: Font color
    Color_Background: indicates the background color
```

Arduino Software Description

Note: The demos are all tested on Arduino uno. If you need other types of Arduino, you need to determine whether the connected pins are correct.

Template: Arduino IDE Installation Steps

Run program

In the product encyclopedia interface downloadthe program, and then unzip it. The Arduino program is located at ~/Arduino/...

Please select the corresponding program according to the LCD screen model to open

You can view test programs for all screen sizes, sorted by size:

For example, a 1.54-inch LCD Module. Open the LCD_1inch54 folder and run the LCD_1inch54.ino file.
Open the program, and select the development board model Arduino UNO

Select the corresponding COM port

Then click to compile and download

Program Description

Document Introduction

Take Arduino UNO controlling a 1.54-inch LCD as an example, open the Arduino\LCD_1inch54 directory:

Of which:
LCD_1inch54.ino: open with Arduino IDE;
LCD_Driver.cpp(.h): is the driver of the LCD screen;
DEV_Config.cpp(.h): It is the hardware interface definition, which encapsulates the read and write pin levels, SPI transmission data, and pin initialization;
font8.cpp, font12.cpp, font16.cpp, font20.cpp, font24.cpp, font24CN.cpp, fonts.h: fonts for characters of different sizes;

image.cpp(.h): is the image data, which can convert any BMP image into a 16-bit true color image array through Img2Lcd (downloadable in the development data).
The program is divided into bottom-layer hardware interface, middle-layer LCD screen driver, and upper-layer application;

Underlying hardware interface

The hardware interface is defined in the two files DEV_Config.cpp(.h), and functions such as read and write pin level, delay, and SPI transmission are encapsulated.

- write pin level

```
void DEV_Digital_Write(int pin, int value)
```

The first parameter is the pin, and the second is the high and low levels.

- Read pin level

```
int DEV_Digital_Read(int pin)
```

The parameter is the pin, and the return value is the level of the read pin.

- Delay

```
DEV_Delay_ms(unsigned int delaytime)
```

millisecond level delay.

- SPI output data

```
DEV_SPI_WRITE(unsigned char data)
```

The parameter is char type, occupying 8 bits.

The Upper Application

For the screen, if you need to draw pictures, display Chinese and English characters, display pictures, etc., you can use the upper application to do, and we provide some basic functions here about some graphics processing in the directory GUI_Paint.c(.h)
Note: Because of the size of the internal RAM of STM32 and Arduino, the GUI is directly written to the RAM of the LCD.

The fonts used by the GUI all depend on the font*.cpp(h) files under the same file

- New Image Properties: Create a new image property, this property includes the image buffer name, width, height, flip Angle, color.

```
void Paint_NewImage(UWORD Width, UWORD Height, UWORD Rotate, UWORD Color)
Parameters:
    Width: image buffer Width;
    Height: the Height of the image buffer;
    Rotate: Indicates the rotation Angle of an image
    Color: the initial Color of the image;
```

- Set the clear screen function, usually call the clear function of LCD directly.

```
void Paint_SetClearFuntion(void (*Clear)(UWORD));
parameter:
    Clear: Pointer to the clear screen function, used to quickly clear the screen to
a certain color;
```

- Set the drawing pixel function.

```
void Paint_SetDisplayFuntion(void (*Display)(UWORD,UWORD,UWORD));
parameter:
    Display: Pointer to the pixel drawing function, which is used to write data to t
he specified location in the internal RAM of the LCD;
```

- Select image buffer: the purpose of the selection is that you can create multiple image attributes, an image buffer can exist multiple, and you can select each image you create.

```
void Paint_SelectImage(UBYTE *image)
Parameters:
    Image: the name of the image cache, which is actually a pointer to the first add
ress of the image buffer
```

- Image Rotation: Set the selected image rotation Angle, preferably after Paint_SelectImage(), you can choose to rotate 0, 90, 180, 270.

```
void Paint_SetRotate(UWORD Rotate)
Parameters:
    Rotate: ROTATE_0, ROTATE_90, ROTATE_180, and ROTATE_270 correspond to 0, 90, 18
0, and 270 degrees respectively;
```

- Image mirror flip: Set the mirror flip of the selected image. You can choose no mirror, horizontal mirror, vertical mirror, or image center mirror.

```
void Paint_SetMirroring(UBYTE mirror)
Parameters:
    Mirror: indicates the image mirroring mode. MIRROR_NONE, MIRROR_HORIZONTAL, MIRR
OR_VERTICAL, MIRROR_ORIGIN correspond to no mirror, horizontal mirror, vertical mirr
or, and about image center mirror respectively.
```

- Set points of display position and color in the buffer: here is the core GUI function, processing points display position and color in the buffer.

```
void Paint_SetPixel(UWORD Xpoint, UWORD Ypoint, UWORD Color)
Parameters:
    Xpoint: the X position of a point in the image buffer
    Ypoint: Y position of a point in the image buffer
    Color: indicates the Color of the dot
```

- Image buffer fill color: Fills the image buffer with a color, usually used to flash the screen into blank.

```
void Paint_ClearWindows(UWORD Xstart, UWORD Ystart, UWORD Xend, UWORD Yend, UWORD Co
lor)
Parameters:
    Xstart: the x-starting coordinate of the window
    Ystart: indicates the Y starting point of the window
    Xend: the x-end coordinate of the window
    Yend: indicates the y-end coordinate of the window
    Color: fill Color
```

- Draw points: In the image buffer, draw points on (Xpoint, Ypoint), you can choose the color, the size of the point, and the style of the point.

```
void Paint_DrawPoint(UWORD Xpoint, UWORD Ypoint, UWORD Color, DOT_PIXEL Dot_Pixel, D
OT_STYLE Dot_Style)
Parameters:
    Xpoint: indicates the X coordinate of a point
    Ypoint: indicates the Y coordinate of a point
    Color: fill Color
    Dot_Pixel: The size of the dot, providing a default of eight size points
        typedef enum {
                DOT_PIXEL_1X1  = 1,             // 1 x 1
                DOT_PIXEL_2X2  ,                // 2 X 2
                DOT_PIXEL_3X3  ,                // 3 X 3
                DOT_PIXEL_4X4  ,                // 4 X 4
                DOT_PIXEL_5X5  ,                // 5 X 5
                DOT_PIXEL_6X6  ,                // 6 X 6
                DOT_PIXEL_7X7  ,                // 7 X 7
                DOT_PIXEL_8X8  ,                // 8 X 8
        } DOT_PIXEL;
    Dot_Style: the size of a point that expands from the center of the point or from
the bottom left corner of the point to the right and up
        typedef enum {
                DOT_FILL_AROUND  = 1,
                DOT_FILL_RIGHTUP,
        } DOT_STYLE;
```

- Line drawing: In the image buffer, a line from (Xstart, Ystart) to (Xend, Yend), you can choose the color, line width, and line style.

```
void Paint_DrawLine(UWORD Xstart, UWORD Ystart, UWORD Xend, UWORD Yend, UWORD Color,
LINE_STYLE Line_Style ,  LINE_STYLE Line_Style)
Parameters:
        Xstart: the x-starting coordinate of a line
        Ystart: indicates the Y starting point of a line
        Xend: x-terminus of a line
        Yend: the y-end coordinate of a line
        Color: fill Color
        Line_width: The width of the line, which provides a default of eight widths
                typedef enum {
                        DOT_PIXEL_1X1  = 1,             // 1 x 1
                        DOT_PIXEL_2X2  ,                // 2 X 2
                        DOT_PIXEL_3X3  ,                // 3 X 3
                        DOT_PIXEL_4X4  ,                // 4 X 4
                        DOT_PIXEL_5X5  ,                // 5 X 5
                        DOT_PIXEL_6X6  ,                // 6 X 6
                        DOT_PIXEL_7X7  ,                // 7 X 7
                        DOT_PIXEL_8X8  ,                // 8 X 8
                    } DOT_PIXEL;
        Line_Style: line style. Select whether the lines are joined in a straight or
dashed way
                typedef enum {
                        LINE_STYLE_SOLID = 0,
                        LINE_STYLE_DOTTED,
                } LINE_STYLE;
```

- Draw a rectangle: In the image buffer, draw a rectangle from (Xstart, Ystart) to (Xend, Yend), you can choose the color, the width of the line, and whether to fill the inside of the rectangle.

```
void Paint_DrawRectangle(UWORD Xstart, UWORD Ystart, UWORD Xend, UWORD Yend, UWORD C
olor, DOT_PIXEL Line_width,  DRAW_FILL Draw_Fill)
Parameters:
        Xstart: the starting X coordinate of the rectangle
        Ystart: indicates the Y starting point of the rectangle
        Xend: X terminus of the rectangle
        Yend: specifies the y-end coordinate of the rectangle
        Color: fill Color
        Line_width: The width of the four sides of a rectangle. Default eight widths
are provided
        typedef enum {
                DOT_PIXEL_1X1  = 1,             // 1 x 1
                DOT_PIXEL_2X2  ,                // 2 X 2
                DOT_PIXEL_3X3  ,                // 3 X 3
                DOT_PIXEL_4X4  ,                // 4 X 4
                DOT_PIXEL_5X5  ,                // 5 X 5
                DOT_PIXEL_6X6  ,                // 6 X 6
                DOT_PIXEL_7X7  ,                // 7 X 7
                DOT_PIXEL_8X8  ,                // 8 X 8
        } DOT_PIXEL;
        Draw_Fill: Fill, whether to fill the inside of the rectangle
        typedef enum {
                DRAW_FILL_EMPTY = 0,
                DRAW_FILL_FULL,
        } DRAW_FILL;
```

- Draw circle: In the image buffer, draw a circle of Radius with (X_Center Y_Center) as the center. You can choose the color, the width of the line, and whether to fill the inside of the circle.

```
void Paint_DrawCircle(UWORD X_Center, UWORD Y_Center, UWORD Radius, UWORD Color, DOT
_PIXEL Line_width,  DRAW_FILL Draw_Fill)
```

```
Parameters:
        X_Center: the x-coordinate of the center of a circle
        Y_Center: Y coordinate of the center of a circle
        Radius: indicates the Radius of a circle
        Color: fill Color
        Line_width: The width of the arc, with a default of 8 widths
        typedef enum {
                DOT_PIXEL_1X1  = 1,             // 1 x 1
                DOT_PIXEL_2X2  ,                // 2 X 2
                DOT_PIXEL_3X3  ,                // 3 X 3
                DOT_PIXEL_4X4  ,                // 4 X 4
                DOT_PIXEL_5X5  ,                // 5 X 5
                DOT_PIXEL_6X6  ,                // 6 X 6
                DOT_PIXEL_7X7  ,                // 7 X 7
                DOT_PIXEL_8X8  ,                // 8 X 8
        } DOT_PIXEL;
        Draw_Fill: fill, whether to fill the inside of the circle
        typedef enum {
                DRAW_FILL_EMPTY = 0,
                DRAW_FILL_FULL,
        } DRAW_FILL;
```

- Write Ascii character: In the image buffer, at (Xstart Ystart) as the left vertex, write an Ascii character, you can select Ascii visual character library, font foreground color, and font background color.

```
void Paint_DrawChar(UWORD Xstart, UWORD Ystart, const char Ascii_Char, sFONT* Font,
UWORD Color_Foreground,  UWORD Color_Background)
Parameters:
        Xstart: the x-coordinate of the left vertex of a character
        Ystart: the Y coordinate of the font's left vertex
        Ascii_Char: indicates the Ascii character
        Font: Ascii visual character library, in the Fonts folder provides the follo
wing Fonts:
                Font8: 5*8 font
                Font12: 7*12 font
                Font16: 11*16 font
                Font20: 14*20 font
                Font24: 17*24 font
        Color_Foreground: Font color
        Color_Background: indicates the background color
```

- Write English string: In the image buffer, use (Xstart Ystart) as the left vertex, write a string of English characters, can choose Ascii visual character library, font foreground color, and font background color.

```
void Paint_DrawString_EN(UWORD Xstart, UWORD Ystart, const char * pString, sFONT* Fo
nt, UWORD Color_Foreground,  UWORD Color_Background)
Parameters:
        Xstart: the x-coordinate of the left vertex of a character
        Ystart: the Y coordinate of the font's left vertex
        PString: string, string is a pointer
        Font: Ascii visual character library, in the Fonts folder provides the follo
wing Fonts:
                Font8: 5*8 font
                Font12: 7*12 font
                Font16: 11*16 font
                Font20: 14*20 font
                Font24: 17*24 font
        Color_Foreground: Font color
        Color_Background: indicates the background color
```

- Write Chinese string: in the image buffer, use (Xstart Ystart) as the left vertex, and write a string of Chinese characters, you can choose GB2312 encoding character font, font foreground color, and font background color.

```
void Paint_DrawString_CN(UWORD Xstart, UWORD Ystart, const char * pString, cFONT* fo
nt, UWORD Color_Foreground,  UWORD Color_Background)
Parameters:
        Xstart: the x-coordinate of the left vertex of a character
        Ystart: the Y coordinate of the font's left vertex
        PString: string, string is a pointer
        Font: GB2312 encoding character Font library, in the Fonts folder provides t
he following Fonts:
                Font12CN: ASCII font 11*21, Chinese font 16*21
                Font24CN: ASCII font24 *41, Chinese font 32*41
                Color_Foreground: Font color
                Color_Background: indicates the background color
```

- Write numbers: In the image buffer, use (Xstart Ystart) as the left vertex, write a string of numbers, you can choose Ascii visual character library, font foreground color, and font background color.

```
void Paint_DrawNum(UWORD Xpoint, UWORD Ypoint, double Nummber, sFONT* Font, UWORD Di
git, UWORD Color_Foreground,   UWORD Color_Background)
Parameters:
        Xpoint: the x-coordinate of the left vertex of a character
        Ypoint: the Y coordinate of the left vertex of the font
        Nummber: indicates the number displayed, which can be a decimal
        Digit: It's a decimal number
        Font: Ascii visual character library, in the Fonts folder provides the follo
wing Fonts:
                Font8: 5*8 font
                Font12: 7*12 font
                Font16: 11*16 font
                Font20: 14*20 font
                Font24: 17*24 font
        Color_Foreground: Font color
        Color_Background: indicates the background color
```

- Write numbers with decimals: at (Xstart Ystart) as the left vertex, write a string of numbers with decimals, you can choose Ascii code visual character font, font foreground color, font background color

```
void Paint_DrawFloatNum(UWORD Xpoint, UWORD Ypoint, double Nummber, UBYTE Decimal_Po
int, sFONT* Font, UWORD Color_Foreground, UWORD Color_Background);
parameter:
         Xstart: the X coordinate of the left vertex of the character
         Ystart: Y coordinate of the left vertex of the font
         Nummber: the displayed number, which is saved in double type here
         Decimal_Point: Displays the number of digits after the decimal point
         Font: Ascii code visual character font library, the following fonts are pro
vided in the Fonts folder:
                Font8: 5*8 font
                Font12: 7*12 font
                Font16: 11*16 font
                Font20: 14*20 font
                Font24: 17*24 font
        Color_Foreground: font color
        Color_Background: background color
```

- Display time: in the image buffer,use (Xstart Ystart) as the left vertex, display time, you can choose Ascii visual character font, font foreground color, and font background color.

```
void Paint_DrawTime(UWORD Xstart, UWORD Ystart, PAINT_TIME *pTime, sFONT* Font, UWOR
D Color_Background,  UWORD Color_Foreground)
Parameters:
        Xstart: the x-coordinate of the left vertex of a character
        Ystart: the Y coordinate of the font's left vertex
        PTime: display time, here defined as a good time structure, as long as the h
our, minute, and second bits of data to the parameter;
        Font: Ascii visual character library, in the Fonts folder provides the follo
wing Fonts:
                Font8: 5*8 font
                Font12: 7*12 font
                Font16: 11*16 font
                Font20: 14*20 font
                Font24: 17*24 font
        Color_Foreground: Font color
        Color_Background: indicates the background color
```

- Display image: at (Xstart Ystart) as the left vertex, display an image whose width is W_Image and height is H_Image;

```
void Paint_DrawImage(const unsigned char *image, UWORD xStart, UWORD yStart, UWORD W
_Image, UWORD H_Image)
parameter:
       image: image address, pointing to the image information you want to display
```

```
        Xstart: the X coordinate of the left vertex of the character
        Ystart: Y coordinate of the left vertex of the font
        W_Image: Image width
        H_Image: Image height
```

VisionFive2

Adaptive Model

- 0.96inch LCD Module
- 1.14inch LCD Module
- 1.28inch LCD Module
- 1.3inch LCD Module
- 1.54inch LCD Module
- 1.8inch LCD Module
- 2inch LCD Module
- 2.4inch LCD Module

Hardware Connection

VisionFive2 Pin Connection

LCD	VisionFive2 Board Pin No.
VCC	3.3V
GND	GND

DIN	19
CLK	23
CS	24
DC	22
RST	13
BL	12

Install Corresponding Libraries

```
apt-get install pip
pip install VisionFive.gpio
apt-get install python3-numpy
apt-get install python3-pil
```

Demo Download

```
apt-get install p7zip-full
wget https://files.waveshare.com/upload/e/e9/LCD_Module_code.7z
7z x LCD_Module_code.7z -o./LCD_Module_code
cd LCD_Module_code/VisionFive/python/example/
```

Run the Corresponding Demo According to the Screen You Purchased

```
python3 0inch96_LCD_test.py
python3 1inch14_LCD_test.py
python3 1inch28_LCD_test.py
python3 1inch3_LCD_test.py
python3 1inch54_LCD_test.py
python3 1inch8_LCD_test.py
python3 2inch_LCD_test.py
python3 2inch4_LCD_test.py
```

Resources

Documents

- Schematic
- ST7789VW Datasheet
- 2D Drawing
- 3D Drawing

Demo codes

- Demo codes

Software

- lcd Chinese Character Modulo Software
- Image2Lcd Image Modulo Software

Support

Technical Support

If you need technical support or have any feedback/review, please click the **Submit Now** button to submit a ticket, Our support team will check and reply to you within 1 to 2 working days. Please be patient as we make every effort to help you to resolve the issue.
Working Time: 9 AM - 6 AM GMT+8 (Monday to Friday)

Submit Now

Login / Create Account