

Important Information

Thank you for choosing Freenove products!

Getting Started

If you have not yet downloaded the zip file, associated with this kit, please do so now and unzip it.

Get Support and Offer Input

Freenove provides free and responsive product and technical support, including but not limited to:

- Product quality issues
- Product use and build issues
- Questions regarding the technology employed in our products for learning and education
- Your input and opinions are always welcome
- We also encourage your ideas and suggestions for new products and product improvements

For any of the above, you may send us an email to:

support@freenove.com

Safety and Precautions

Please follow the following safety precautions when using or storing this product:

- Keep this product out of the reach of children under 6 years old.
- This product should be **used only when there is adult supervision present** as young children lack necessary judgment regarding safety and the consequences of product misuse.
- This product contains small parts and parts, which are sharp. This product contains electrically conductive parts. **Use caution with electrically conductive parts near or around power supplies, batteries and powered (live) circuits.**
- When the product is turned ON, activated or tested, some parts will move or rotate. **To avoid injuries to hands and fingers keep them away from any moving parts!**
- It is possible that an improperly connected or shorted circuit may cause overheating. **Should this happen, immediately disconnect the power supply or remove the batteries and do not touch anything until it cools down!** When everything is safe and cool, review the product tutorial to identify the cause.
- Only operate the product in accordance with the instructions and guidelines of this tutorial, otherwise parts may be damaged or you could be injured.
- Store the product in a cool dry place and avoid exposing the product to direct sunlight.
- After use, always turn the power OFF and remove or unplug the batteries before storing.

Any concerns?  support@freenove.com



About Freenove

Freenove provides open source electronic products and services worldwide.

Freenove is committed to assist customers in their education of robotics, programming and electronic circuits so that they may transform their creative ideas into prototypes and new and innovative products. To this end, our services include but are not limited to:

- Educational and Entertaining Project Kits for Robots, Smart Cars and Drones
- Educational Kits to Learn Robotic Software Systems for Arduino, Raspberry Pi and micro:bit
- Electronic Component Assortments, Electronic Modules and Specialized Tools
- **Product Development and Customization Services**

You can find more about Freenove and get our latest news and updates through our website:

<http://www.freenove.com>

sale@freenove.com

Copyright

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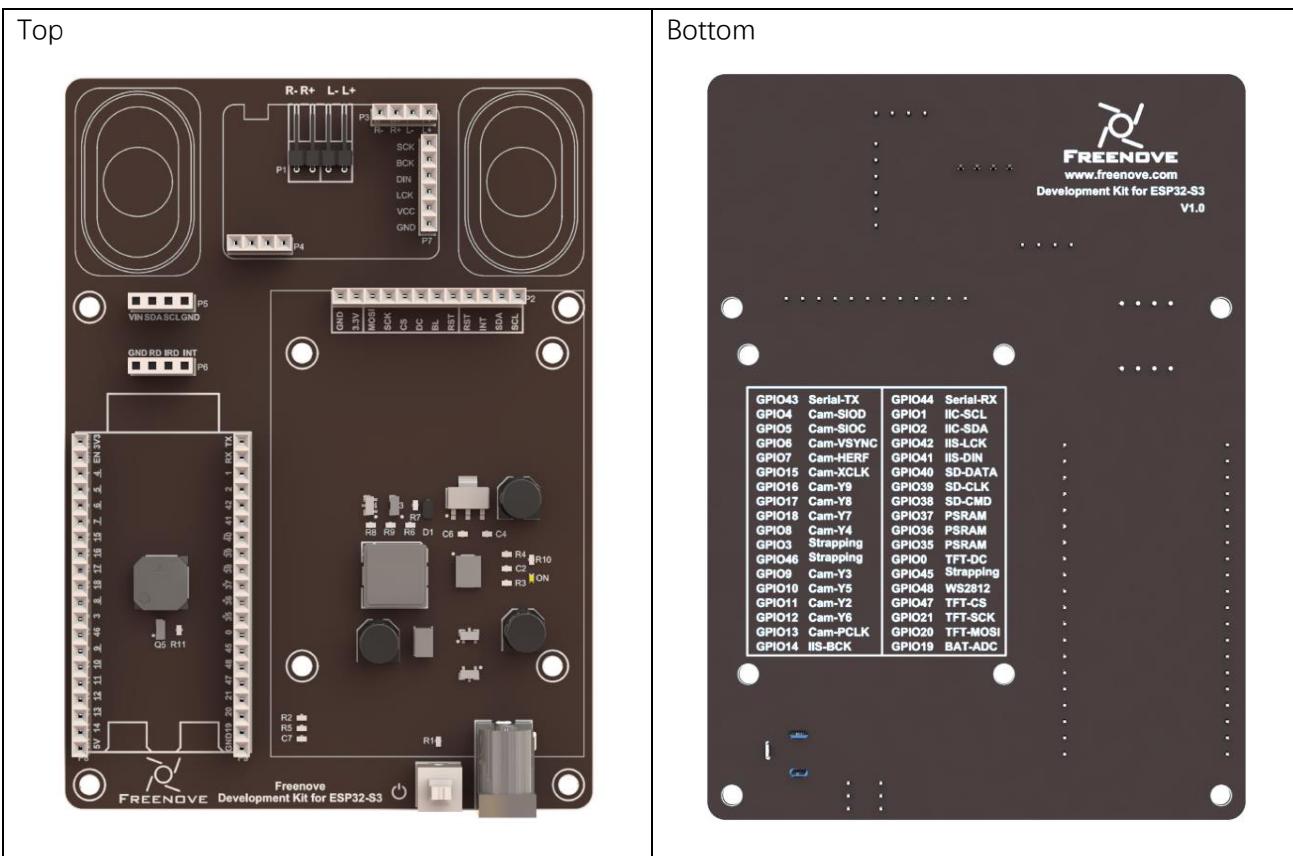
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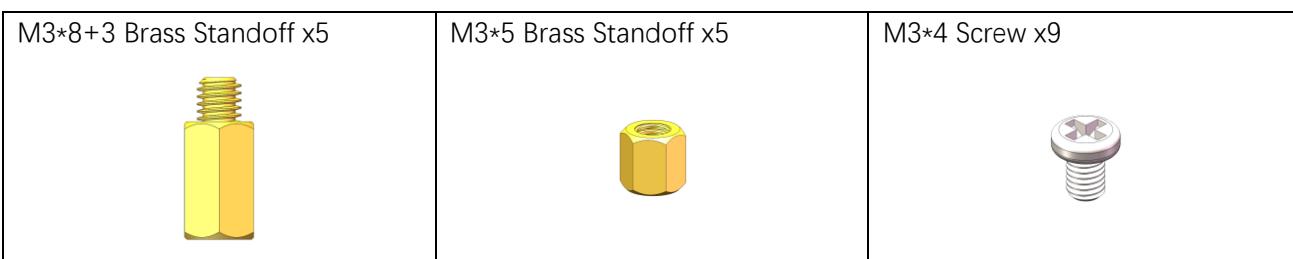
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List

ESP32-S3 WROOM Shield



Machinery Parts



Electronic Parts

Screen	ESP32-S3 WROOM	Camera
MAX30102	Audio Converter& Amplifier	Speaker*2
Card Reader	SD Card	9V Battery Cable
FPC camera cable		Extension board for camera

Tools

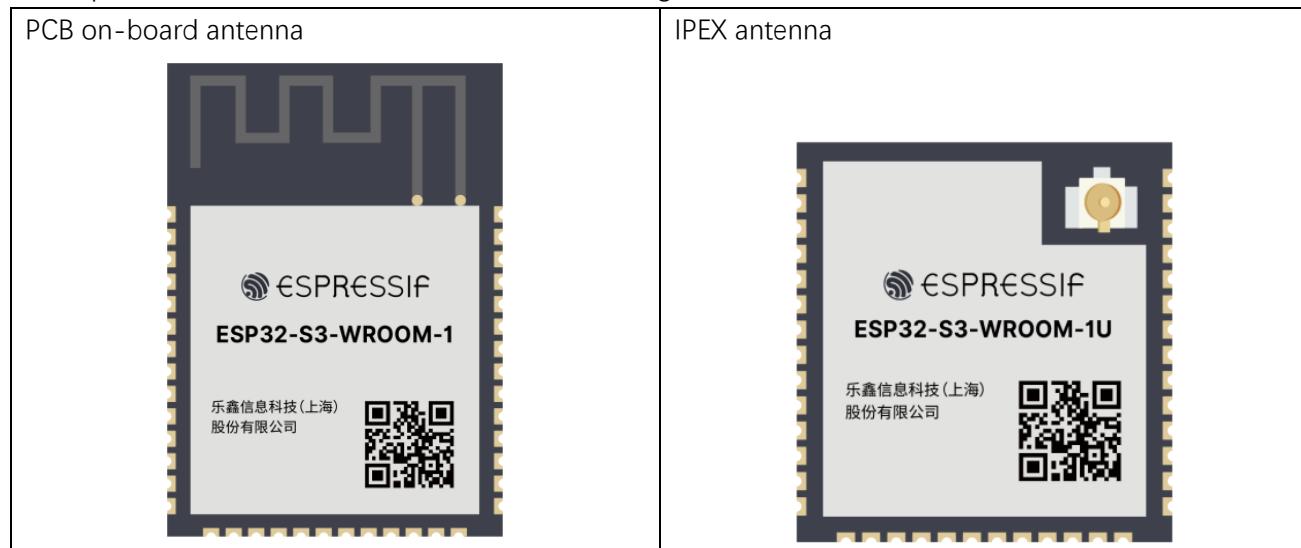
Type-C	3mm Cross Screwdriver

Any concerns? ✉ support@freenove.com

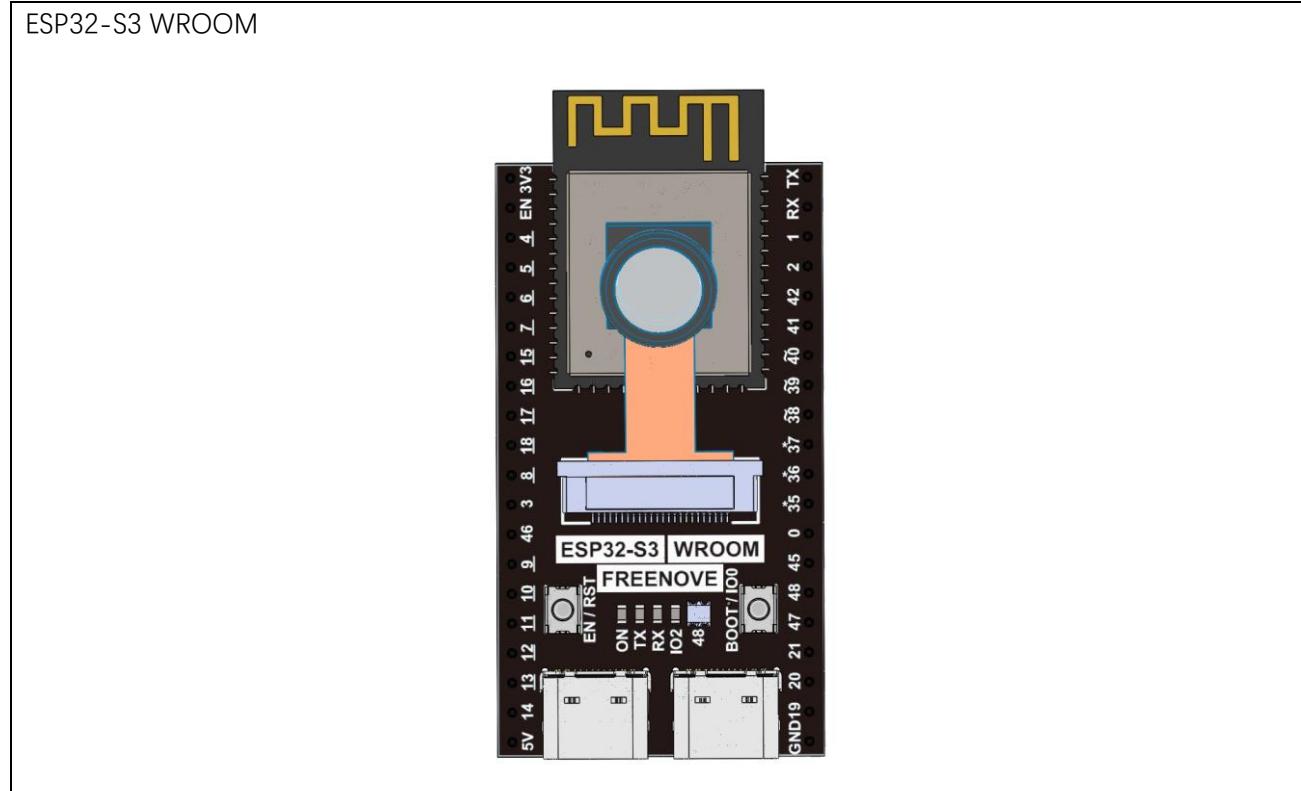
Preface

ESP32-S3 WROOM

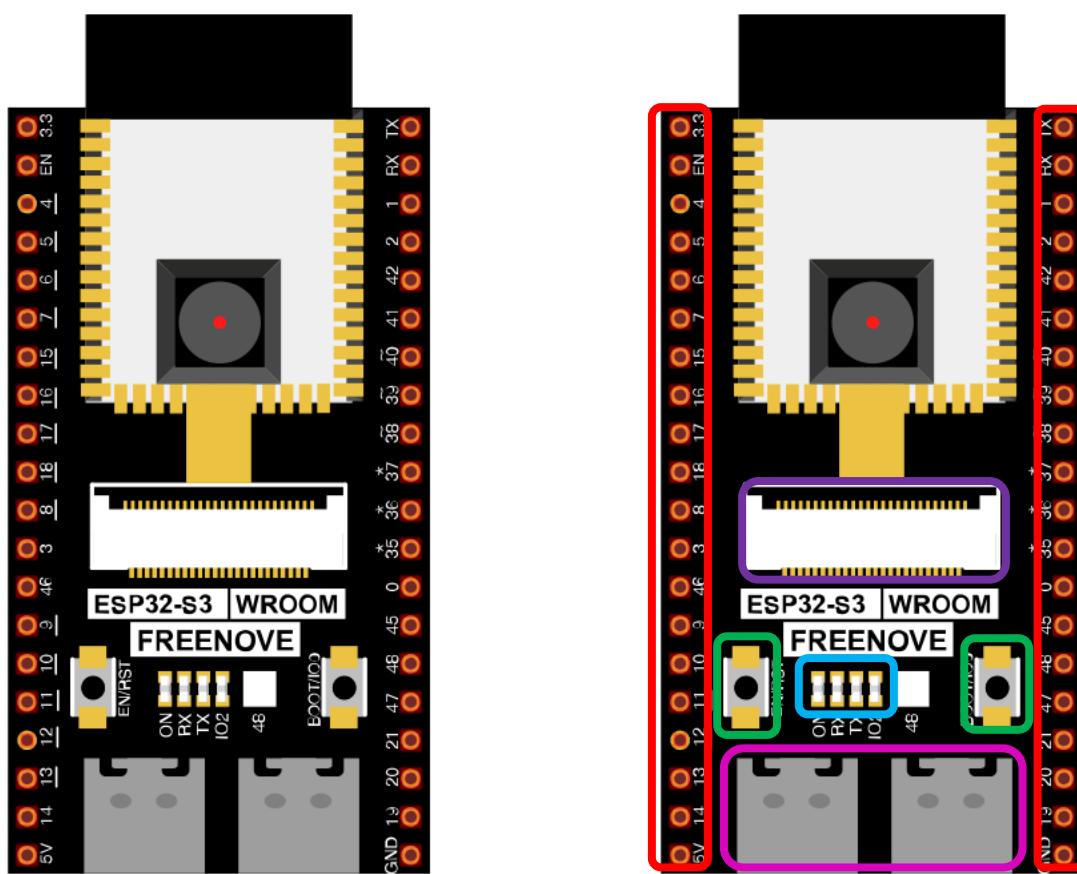
ESP32-S3-WROOM-1 has launched a total of two antenna packages, PCB on-board antenna and IPEX antenna respectively. The PCB on-board antenna is an integrated antenna in the chip module itself, so it is convenient to carry and design. The IPEX antenna is a metal antenna derived from the integrated antenna of the chip module itself, which is used to enhance the signal of the module.



In this tutorial, the ESP32-S3 WROOM is designed based on the PCB on-board antenna-packaged ESP32-S3-WROOM-1 module.



The hardware interfaces of ESP32-S3 WROOM are distributed as follows:



Compare the left and right images. We've boxed off the resources on the ESP32-S3 WROOM in different colors to facilitate your understanding of the ESP32-S3 WROOM.

Box color	Corresponding resources introduction
	GPIO pins
	LED indicators
	Camera interface
	Reset button, Boot mode selection button
	USB ports

For more information, please visit: https://www.espressif.com.cn/sites/default/files/documentation/esp32-s3-wroom-1_wroom-1u_datasheet_en.pdf.

GPIO pins of ESP32-S3 WROOM can be used to interface with external devices and control peripheral circuits.

In the following projects, we only use USB cable to power ESP32-S3 WROOM by default. But you can still power the ESP3-S3 WROOM Shield with external power supply, with a voltage range of 6-12V and current of over 0.5A.

Any concerns? ✉ support@freenove.com

Notes for GPIO

PSRAM Pin

The module on the ESP32-S3-WROOM board utilizes the ESP32-S3R8 chip, which comes with 8MB of external Flash. When using the OPI PSRAM, it should be noted that GPIO35-GPIO37 on the ESP32-S3-WROOM board will not be available for other purposes. However, when OPI PSRAM is not used, GPIO35-GPIO37 on the board can be used as normal GPIO.

ESP32-S3R8 / ESP32-S3R8V	In-package PSRAM (8 MB, Octal SPI)
SPICLK	CLK
SPICS1	CE#
SPIID	DQ0
SPIQ	DQ1
SPIWP	DQ2
SPIHD	DQ3
GPIO33	DQ4
GPIO34	DQ5
GPIO35	DQ6
GPIO36	DQ7
GPIO37	DQS/DM

SDcard Pin

An SDcard slot is integrated on the back of the ESP32-S3-WROOM board, and we can use GPIO38-GPIO40 of ESP32-S3-WROOM to drive SD card.

The SDcard of ESP32-S3-WROOM uses SDMMC, a 1-bit bus driving method, which is integrated in the Arduino IDE, and we can call the "SD_MMC.h" library to drive it. For more details, please refer to the SDcard chapter in this tutorial.

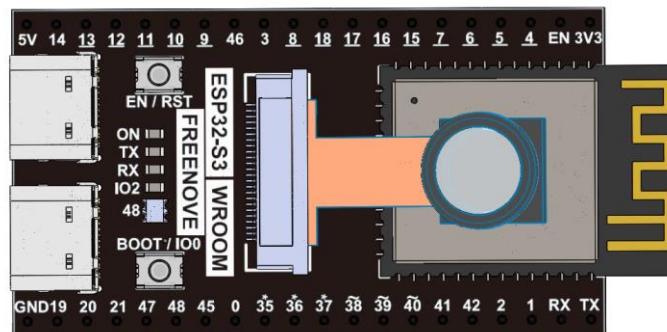
USB Pin

In Micropython, GPIO19 and GPIO20 are dedicated to the USB function of the ESP32S3 and cannot be used for other functions.

Please note that in this product, GPIO19 is used to read the ADC value of the external power supply, and therefore should not be used for USB functions to avoid conflicts.

Cam Pin

When using the camera of our ESP32-S3 WROOM, please check the pins of it. Pins with underlined numbers are used by the camera function, if you want to use other functions besides it, please avoid using them.



CAM_Pin	GPIO_pin
SIOD	GPIO4
SIOC	GPIO5
CSI_VSYNC	GPIO6
CSI_HREF	GPIO7
CSI_Y9	GPIO16
XCLK	GPIO15
CSI_Y8	GPIO17
CSI_Y7	GPIO18
CSI_PCLK	GPIO13
CSI_Y6	GPIO12
CSI_Y2	GPIO11
CSI_Y5	GPIO10
CSI_Y3	GPIO9
CSI_Y4	GPIO8

If you have any questions regarding GPIO information, you can click [here](#) to navigate back to the ESP32-S3 WROOM and view specific GPIO details.

Or check: https://www.espressif.com/sites/default/files/documentation/esp32-s3_datasheet_en.pdf.

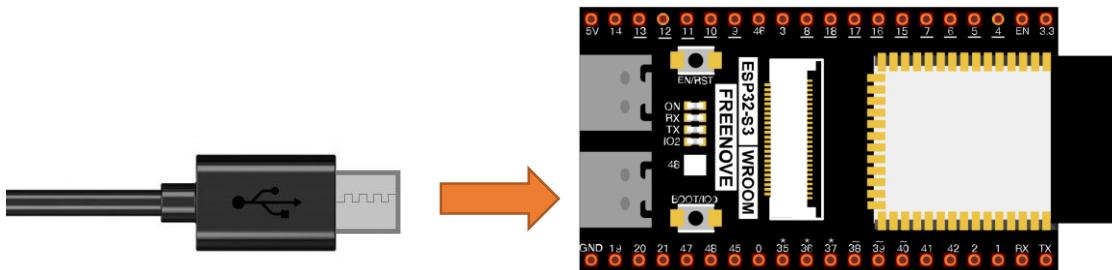
CH343 (Importance)

ESP32-S3 WROOM uses CH343 to download code. Therefore, before using the device, it is necessary to install the CH343 driver on your computer.

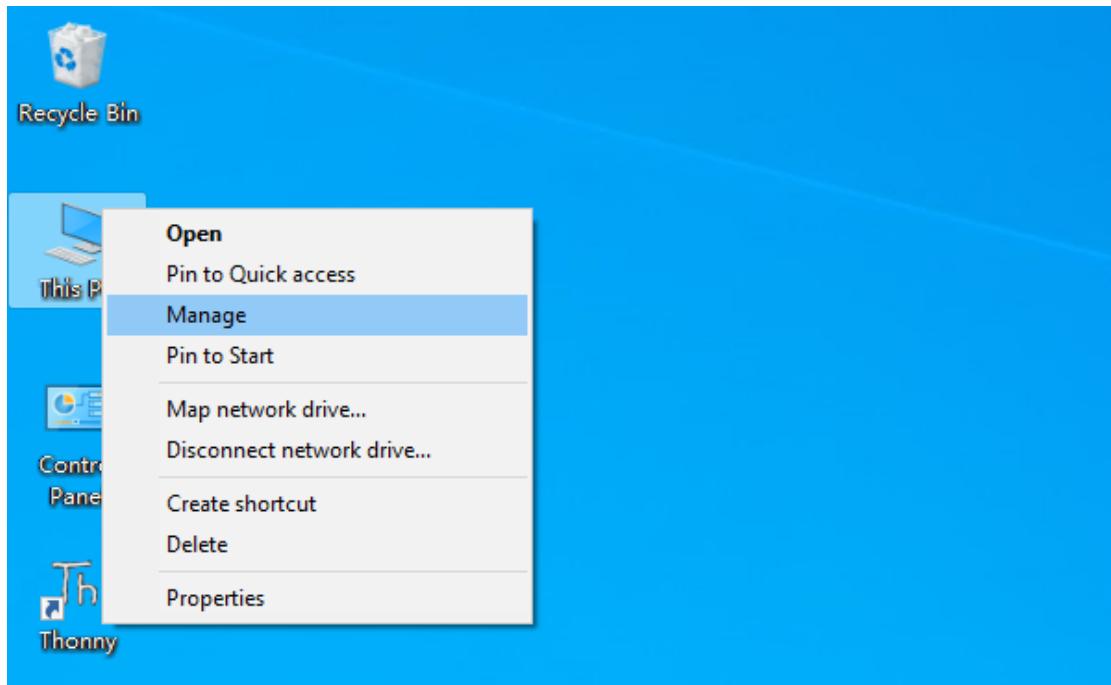
Windows

Check whether CH343 has been installed

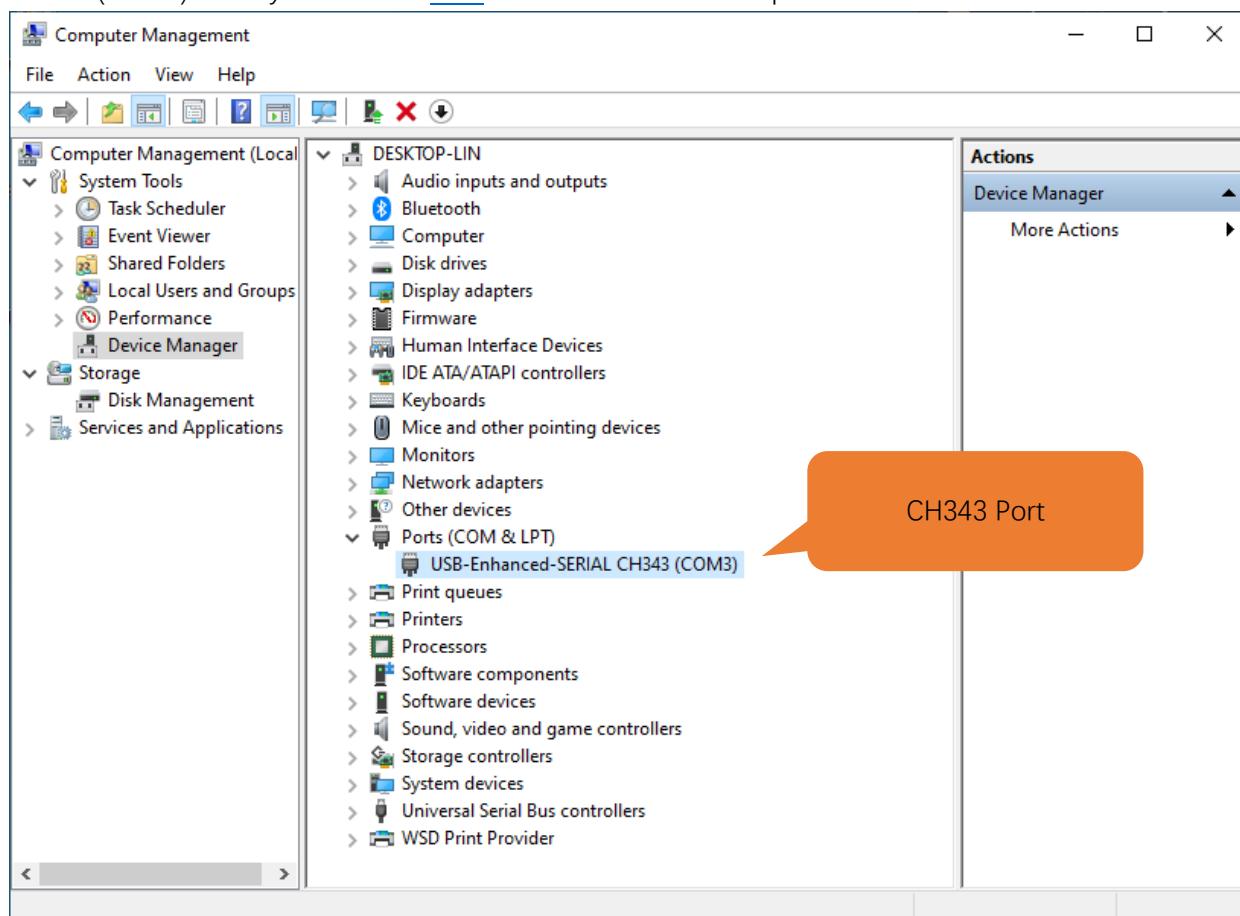
1. Connect your computer and ESP32-S3 WROOM with a USB cable.



2. Turn to the main interface of your computer, select “This PC” and right-click to select “Manage”.



3. Click "Device Manager". If your computer has installed CH343, you can see "USB-Enhances-SERIAL CH343 (COMx)". And you can click [here](#) to move to the next step.



Installing CH343

- First, download CH343 driver, click <http://www.wch-ic.com/search?t=all&q=ch343> to download the appropriate one based on your operating system.

keyword ch343

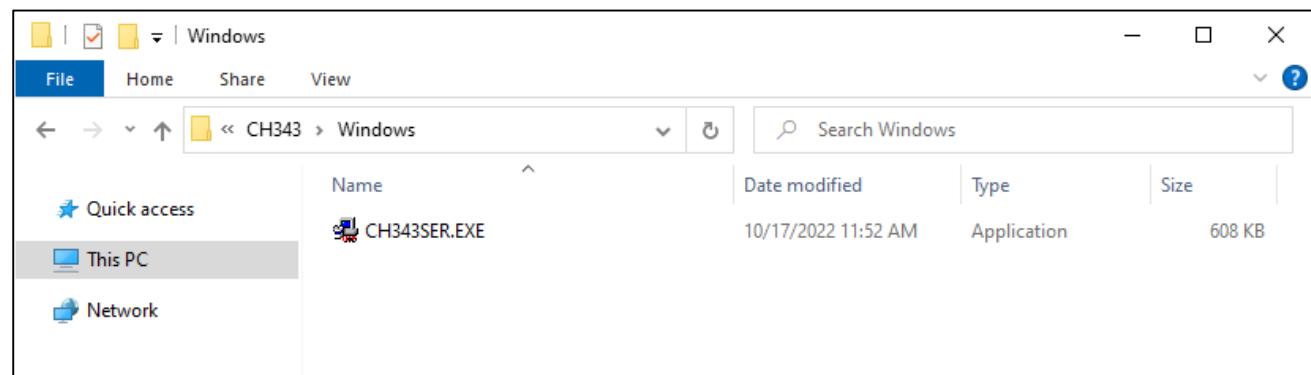
Downloads(8)					
file category	file content	version	upload time		
DataSheet					
CH343DS1.PDF	CH343 datasheet, USB to single serial port, supports up to 6M baud rate, serial port signals support 5V/3.3V/2.5V/1.8V, built-in crystal oscillator. CH343 supports built-in CDC driver in operating system or multi-functional high-speed VCP manufacture driver.	1.5	2021-11-18		
Driver&Tools					
CH343SER.ZIP	For CH342/CH343/CH344/CH347/CH9101/CH9102/CH9103/CH9143, USB to high-speed serial port VCP vendor driver, supports Windows 11/10/8.1/8/7/VISTA/XP/2000	1.61	2022-05-13		
CH343CDC.ZIP	For CH342/CH343/CH344/CH347/CH910X/CH9143/CH9340, USB to CDC serial port driver, supports Windows 11/10/8.1/8/7/VISTA/XP/2000	1.4	2022-05-13		
CH343SER.EXE	For CH342/CH343/CH344/CH347/CH9101/CH9102/CH9103/CH9143, USB to high-speed serial port VCP vendor driver, supports Windows 11/10/8.1/8/7/VISTA/XP/2000	1.61	2022-05-13		
CH34XSER_MAC.ZIP	For CH340/CH342/CH343/CH344/CH347/CH9101/CH9102/CH9103/CH9143, USB to serial port VCP vendor driver of macOS	1.7	2022-05-13		
CH343CDC.EXE	For CH342/CH343/CH344/CH347/CH910X/CH9143/CH9340, USB to CDC serial port driver, supports Windows 11/10/8.1/8/7/VISTA/XP/2000	1.4	2022-05-13		
Application					
CH34xSerCfg.ZIP	USB configuration tool of Windows for CH340/CH342/CH343/CH344/CH347/CH348/CH9101/CH9102/CH9103. Via this tool, the chip's Vendor ID, product ID, maximum current value, BCD version	1.2	2022-05-24		

If you would not like to download the installation package, you can open

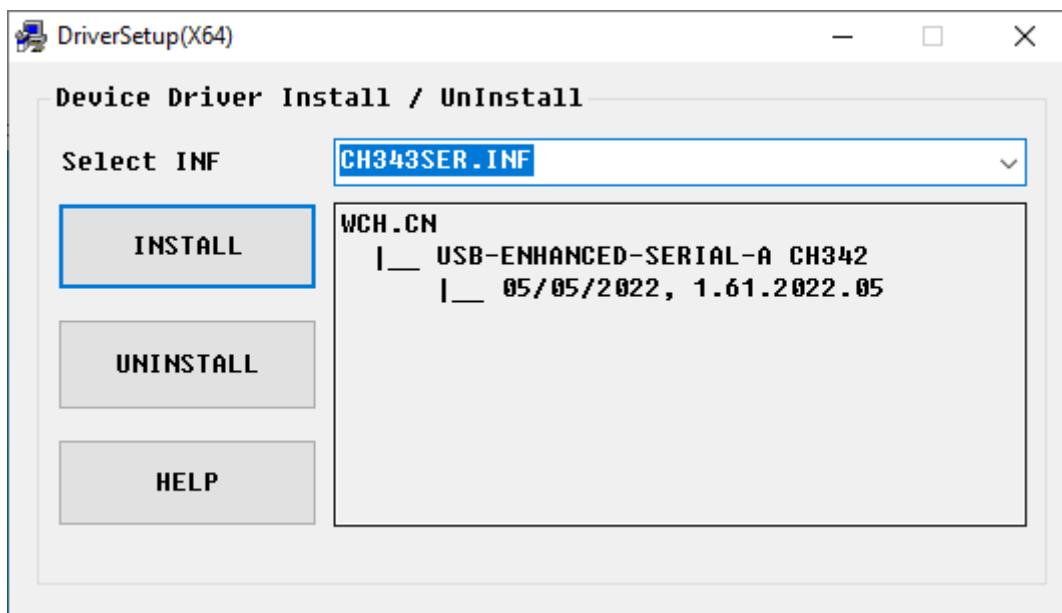
“Freenove_Ultimate_Starter_Kit_for_ESP32_S3/CH343”, we have prepared the installation package.

 Windows	10/17/2022 1:30 PM	File folder
 MAC	10/17/2022 1:30 PM	File folder
 Linux	10/17/2022 1:30 PM	File folder

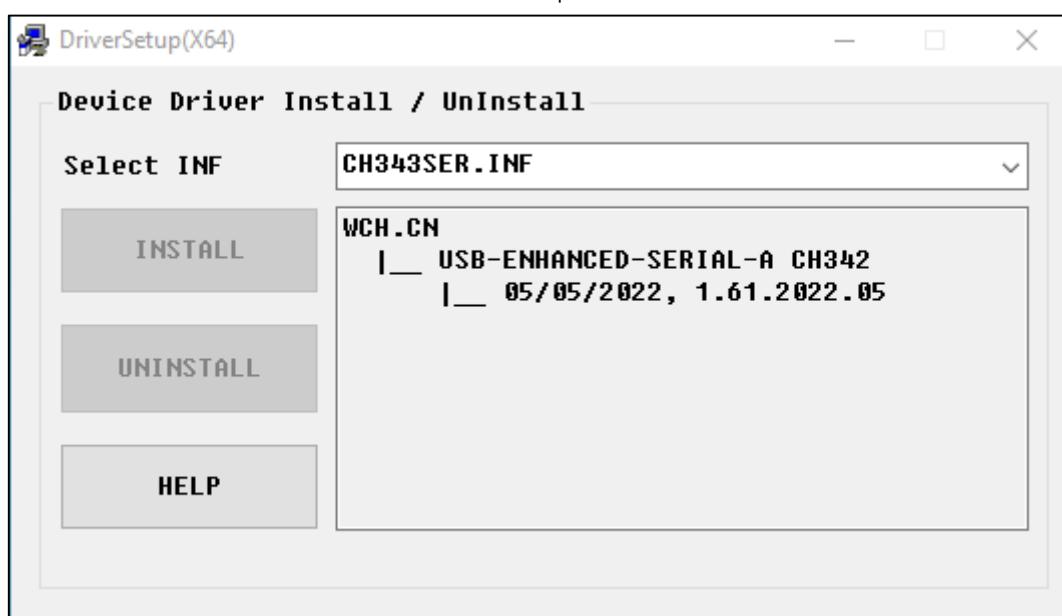
- Open the folder “Freenove_Ultimate_Starter_Kit_for_ESP32_S3/CH343/Windows/”



3. Double click “CH343SER.EXE”.

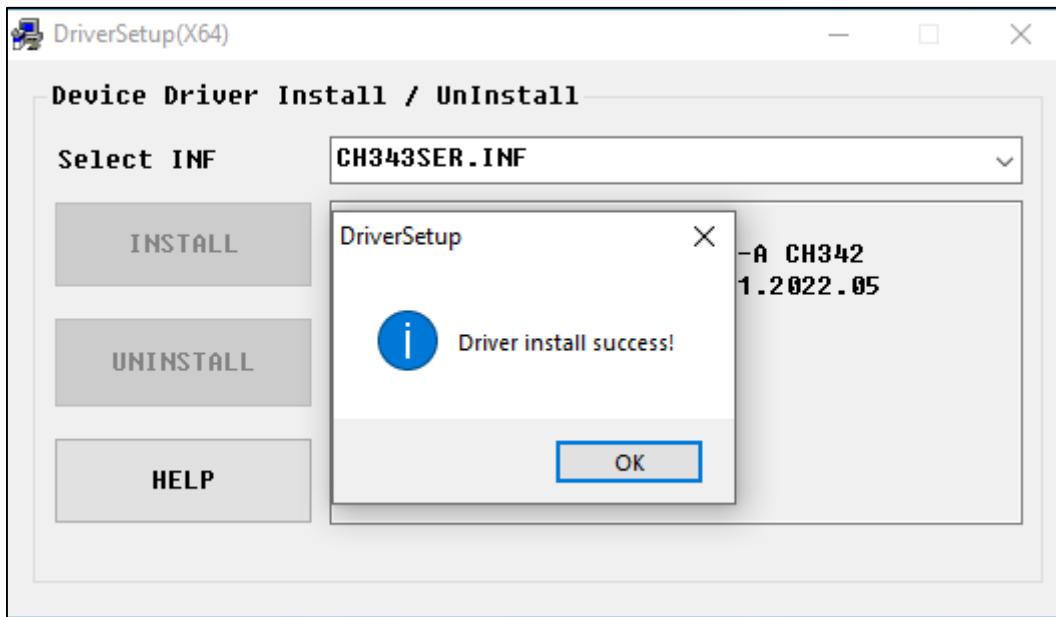


4. Click “INSTALL” and wait for the installation to complete.

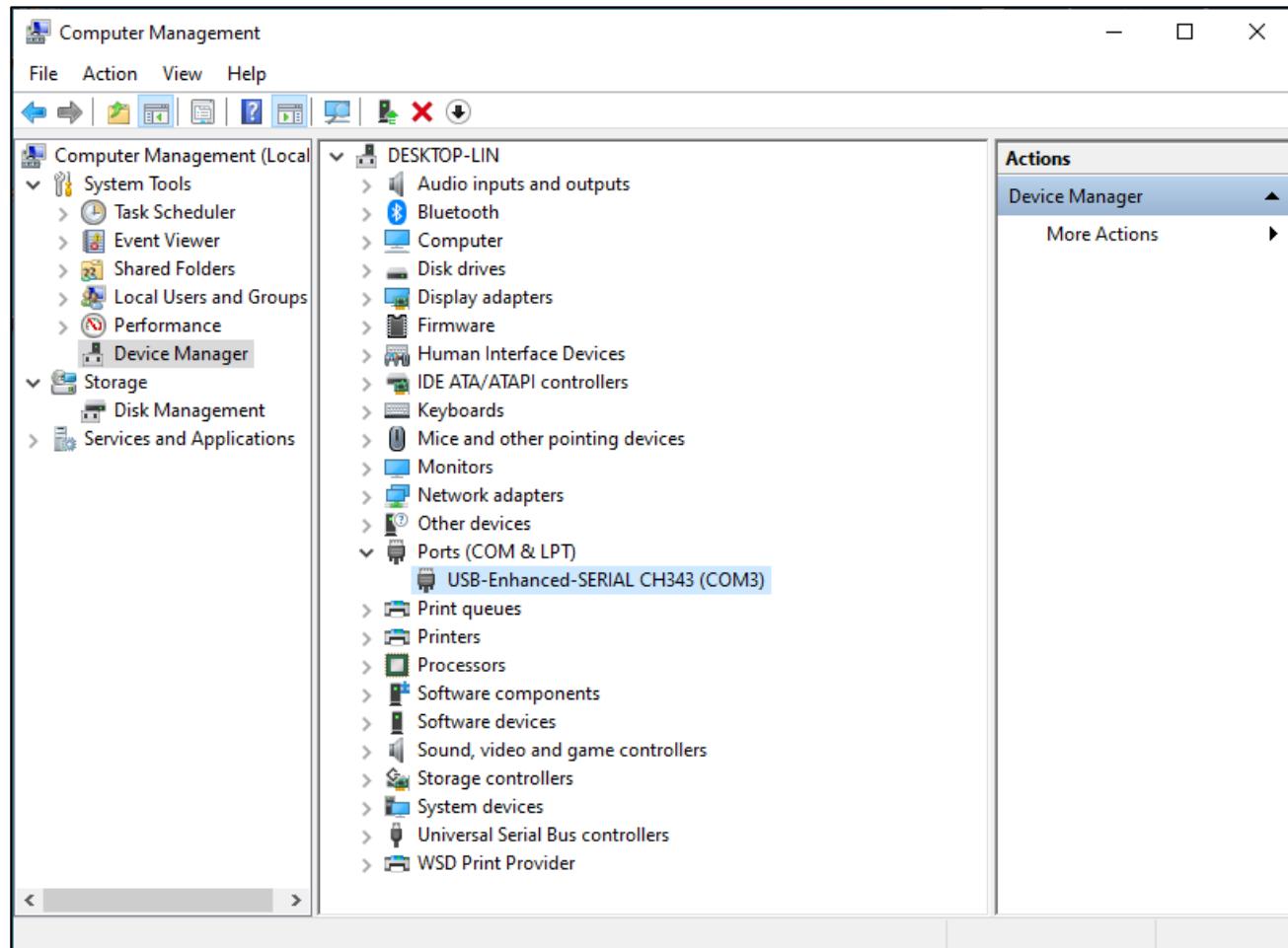




5. Install successfully. Close all interfaces.



6. When ESP32-S3 WROOM is connected to computer, select "This PC", right-click to select "Manage" and click "Device Manager" in the newly pop-up dialog box, and you can see the following interface.



7. So far, CH343 has been installed successfully. Close all dialog boxes.

MAC

First, download CH343 driver. Click <http://www.wch-ic.com/search?t=all&q=ch343> to download the appropriate one based on your operating system.

keyword ch343				
Downloads(8)				
file category	file content	version	upload time	
DataSheet				
CH343DS1.PDF	CH343 datasheet, USB to single serial port, supports up to 6M baud rate, serial port signals support 5V/3.3V/2.5V/1.8V, built-in crystal oscillator. CH343 supports built-in CDC driver in operating system or multi-functional high-speed VCP manufacture driver.	1.5	2021-11-18	
Driver&Tools				
CH343SER.ZIP	For CH342/CH343/CH344/CH347/CH9101/CH9102/CH9103/CH9143, USB to high-speed serial port VCP vendor driver, supports Windows 11/10/8.1/8/7/VISTA/XP/2000	1.61	2022-05-13	
CH343CDC.ZIP	For CH342/CH343/CH344/CH347/CH910X/CH9143/CH9340, USB to CDC serial port	1.4	2022-05-13	
CH343SER.EXE	For CH342/CH343/CH344/CH347/CH9101/CH9102/CH9103/CH9143, USB to high-speed serial port VCP vendor driver, supports Windows 11/10/8.1/8/7/VISTA/XP/2000	1.61	2022-05-13	
CH34XSER_MAC.ZI...	For MAC CH343/CH344/CH347/CH9101/CH9102/CH9103/CH9143, USB to serial port VCP vendor driver of macOS	1.7	2022-05-13	
CH343CDC.EXE	For CH342/CH343/CH344/CH347/CH910X/CH9143/CH9340, USB to CDC serial port driver, supports Windows 11/10/8.1/8/7/VISTA/XP/2000	1.4	2022-05-13	

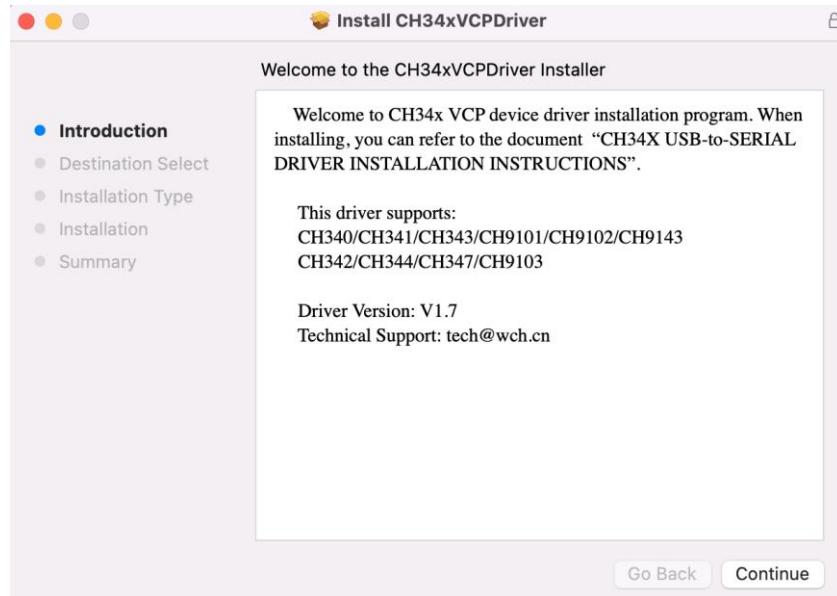
If you would not like to download the installation package, you can open “**Freenove_Ultimate_Starter_Kit_for_ESP32_S3/CH343**”. We have prepared the installation package. Second, open the folder “**Freenove_Ultimate_Starter_Kit_for_ESP32_S3/CH343/MAC/**”



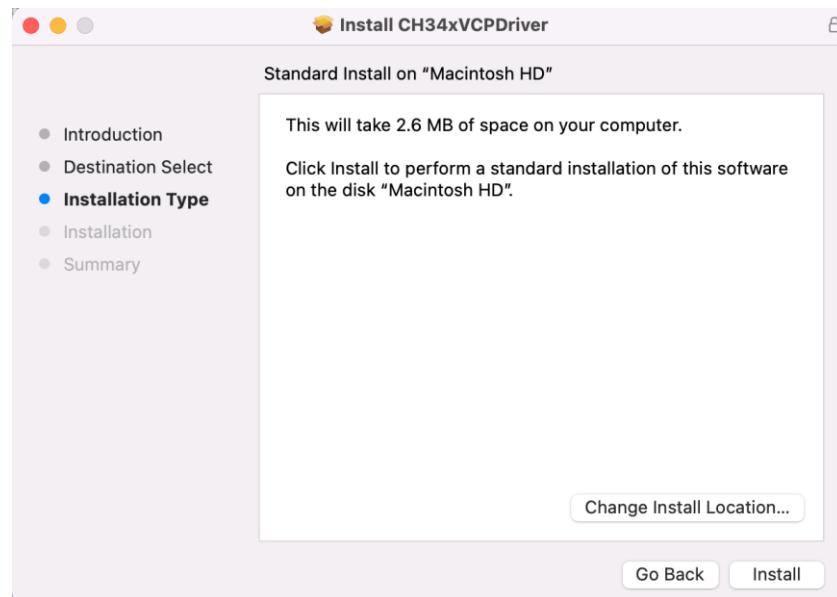
Any concerns? ✉ support@freenove.com



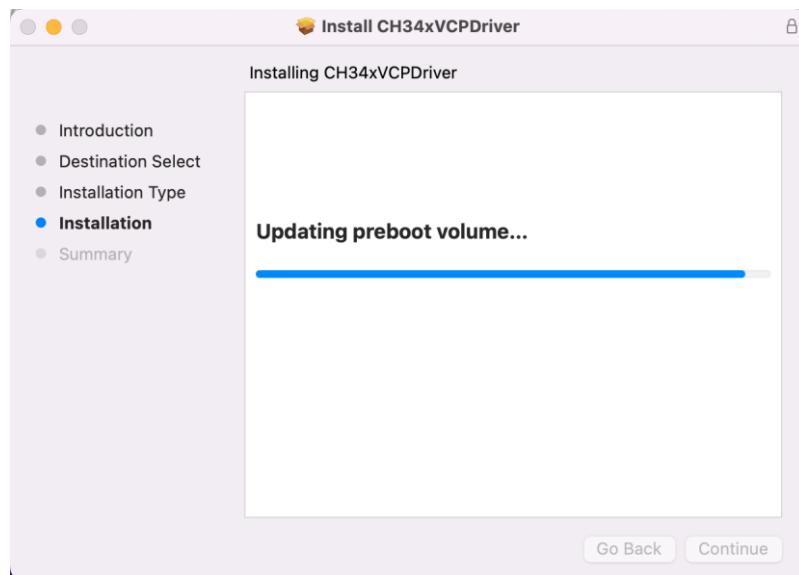
Third, click Continue.



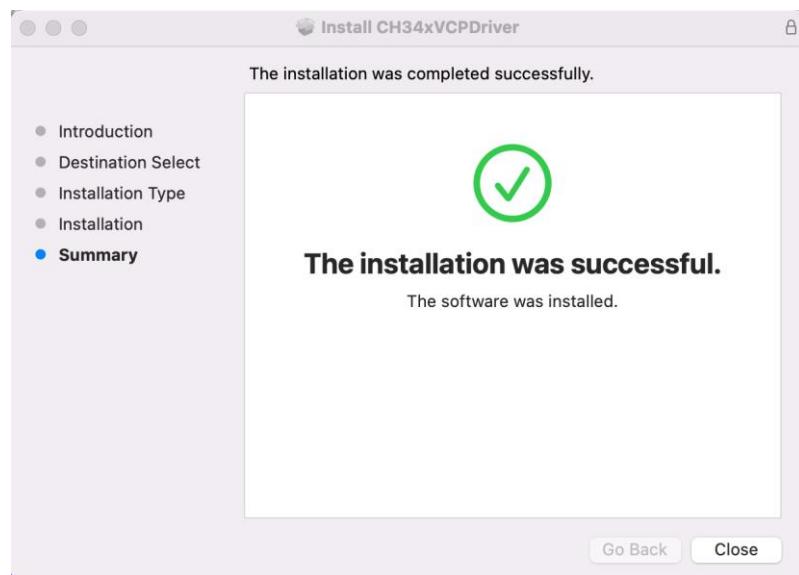
Fourth, click Install.



Then, waiting Finsh.



Finally, restart your PC.



If it fails to be installed with the above steps, you can refer to `readme.pdf` to install it.

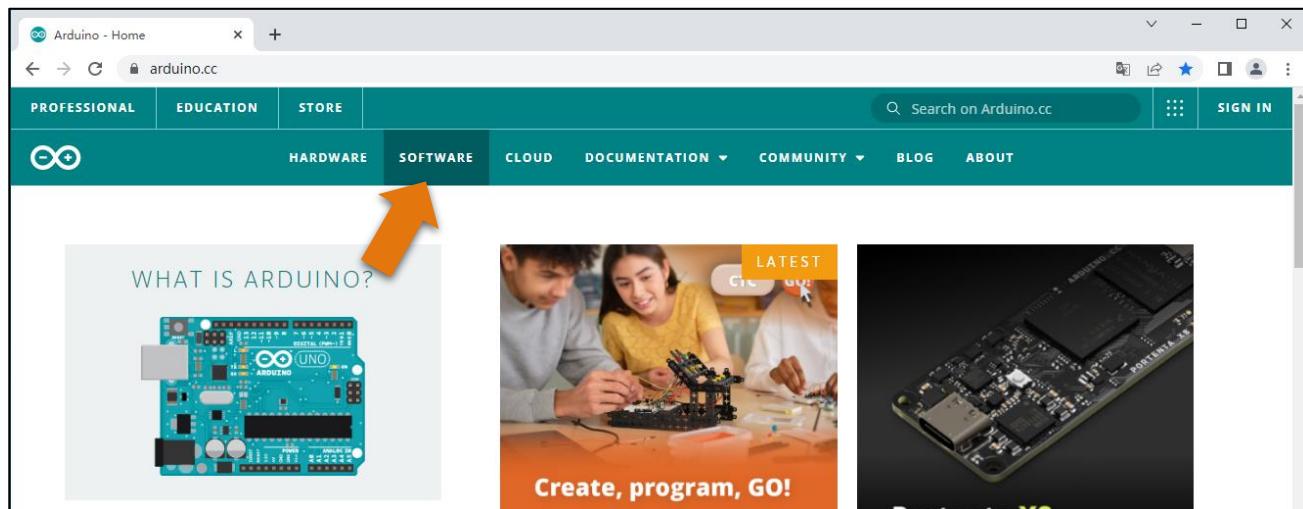


Any concerns? [✉ support@freenove.com](mailto:support@freenove.com)

Programming Software

Arduino Software (IDE) is used to write and upload the code for Arduino Board.

First, install Arduino Software (IDE): visit <https://www.arduino.cc>, click "Download" to enter the download page.



Select and download corresponding installer according to your operating system. If you are a windows user, please select the "Windows" to download and install it correctly.

Arduino IDE 2.0.4

The new major release of the Arduino IDE is faster and even more powerful! In addition to a more modern editor and a more responsive interface it features autocompletion, code navigation, and even a live debugger.

For more details, please refer to the [Arduino IDE 2.0 documentation](#).

Nightly builds with the latest bugfixes are available through the section below.

SOURCE CODE
The Arduino IDE 2.0 is open source and its source code is hosted on [GitHub](#).

DOWNLOAD OPTIONS

- Windows** Win 10 and newer, 64 bits
- Windows** MSI installer
- Windows** ZIP file
- Linux** AppImage 64 bits (X86-64)
- Linux** ZIP file 64 bits (X86-64)
- macOS** Intel, 10.14: "Mojave" or newer, 64 bits
- macOS** Apple Silicon, 11: "Big Sur" or newer, 64 bits

[Release Notes](#)

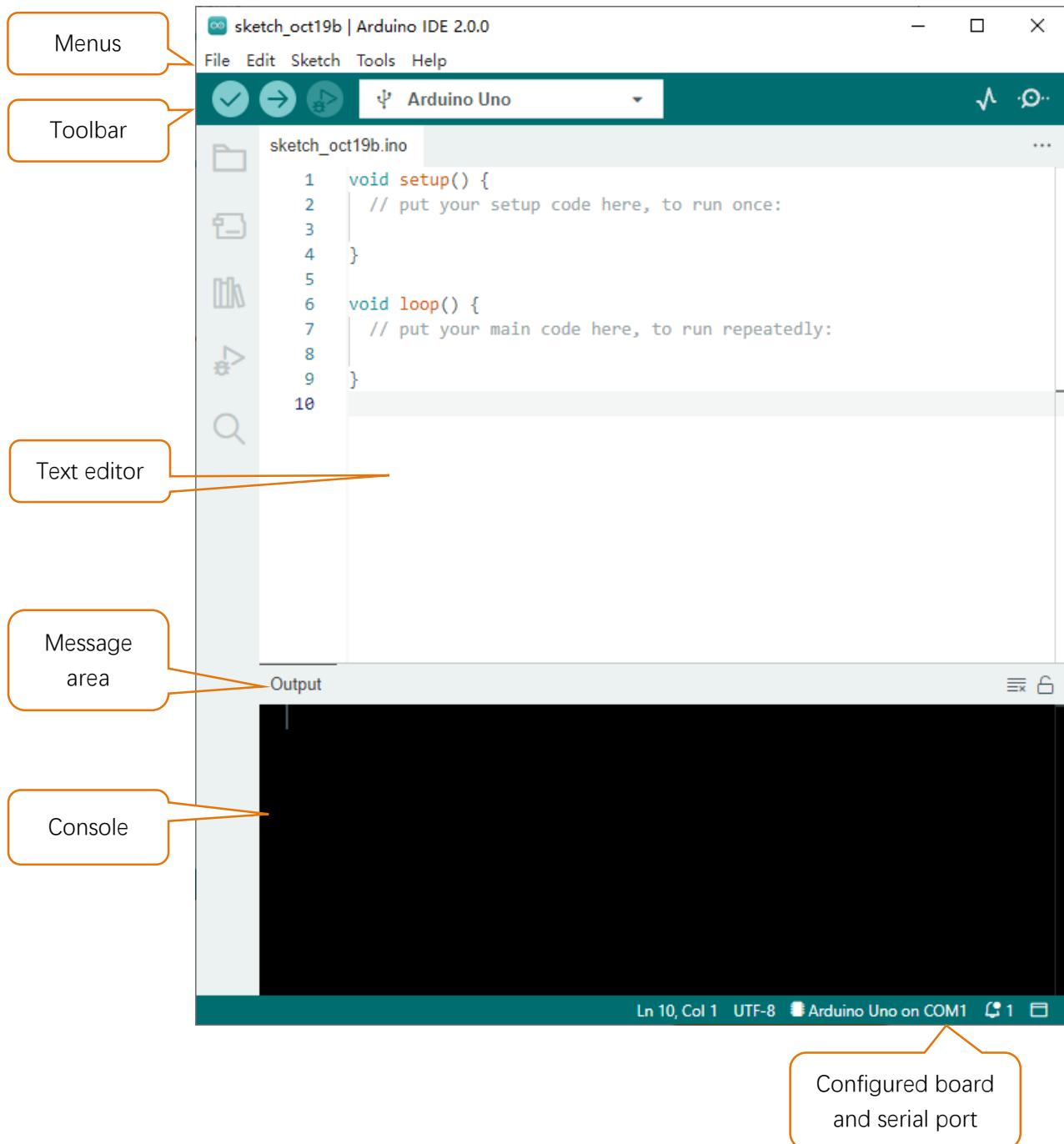
After the download completes, run the installer. For Windows users, there may pop up an installation dialog box of driver during the installation process. When it popes up, please allow the installation.

After installation completes, an Arduino Software shortcut will be generated in the desktop. Run the Arduino Software.

Any concerns? [✉ support@freenove.com](mailto:support@freenove.com)



The interface of Arduino Software is as follows:





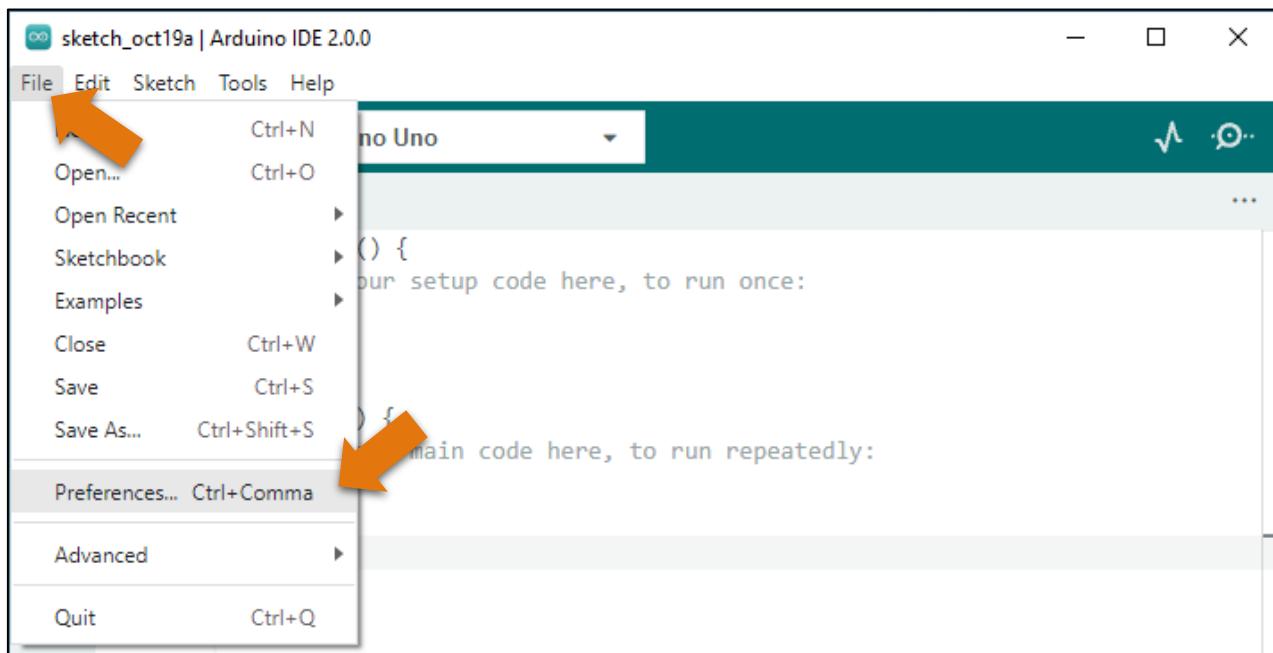
Programs written with Arduino Software (IDE) are called **sketches**. These sketches are written in the text editor and saved with the file extension **.ino**. The editor features text cutting/pasting and searching/replacing. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (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 Check your code for compile errors.
	Upload Compile your code and upload them to the configured board.
	Debug Debug code running on the board. (Some development boards do not support this function)
Arduino Uno	Development board selection Configure the support package and upload port of the development board.
	Serial Plotter Receive serial port data and plot it in a discounted graph.
	Serial Monitor Open the serial monitor.

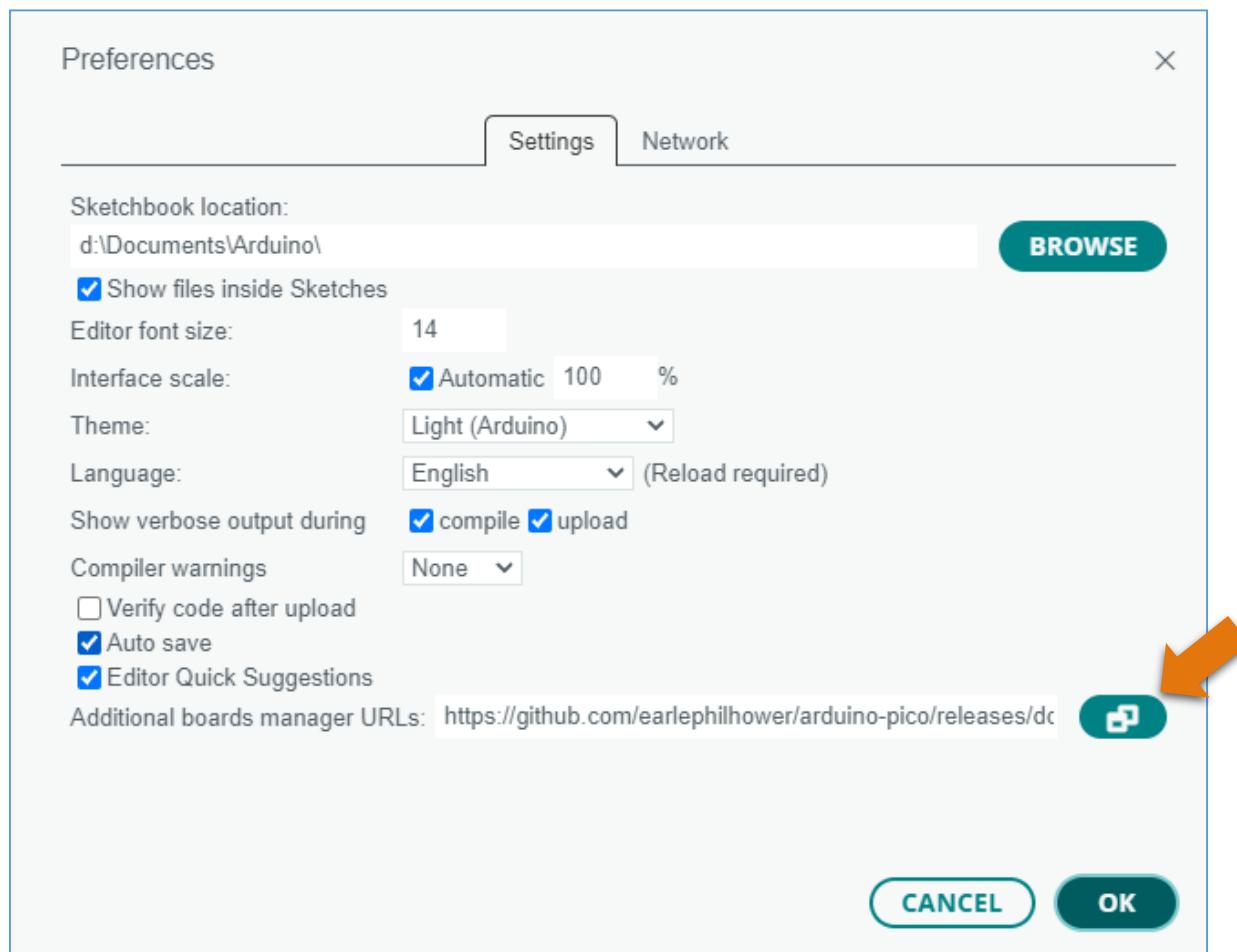
Additional commands are found within the five menus: File, Edit, Sketch, Tools, Help. The menus are context sensitive, which means only those items relevant to the work currently being carried out are available.

Environment Configuration

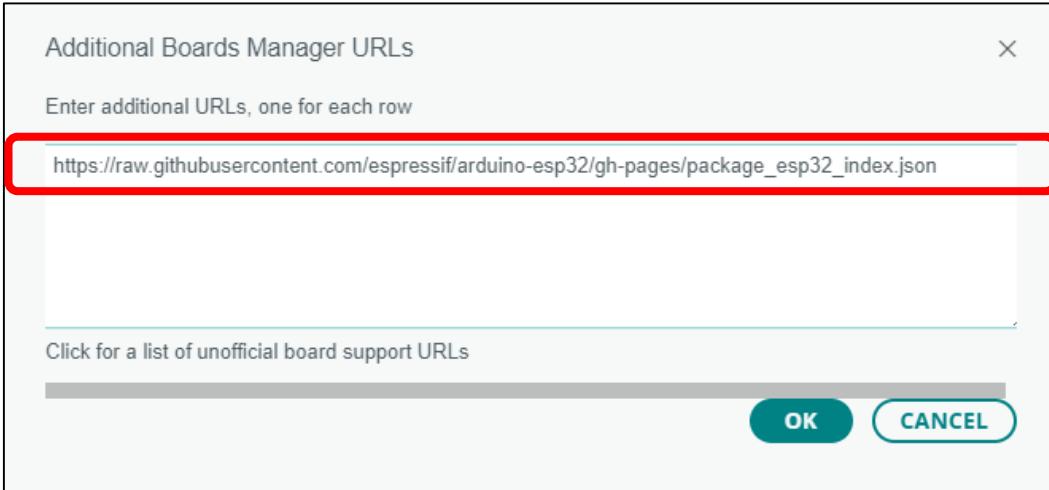
First, open the software platform arduino, and then click File in Menus and select Preferences.



Second, click on the symbol behind "Additional Boards Manager URLs"

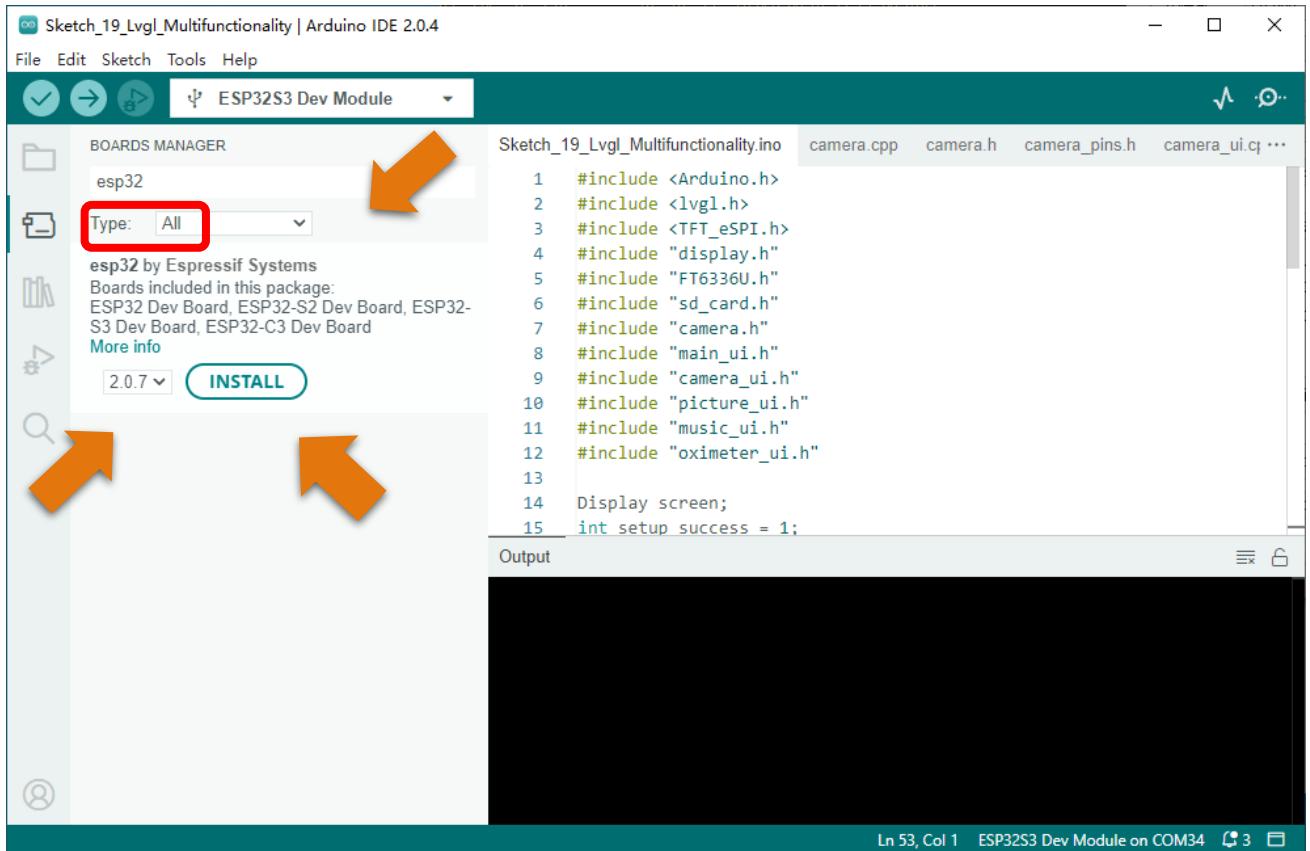


Third, fill in https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json in the new window, click OK, and click OK on the Preferences window again.



Note: if you copy and paste the URL directly, you may lose the "-". Please check carefully to make sure the link is correct.

Fourth, click "Boards Manager". Enter "esp32" in Boards manager, select 2.0.7, and click "INSTALL".

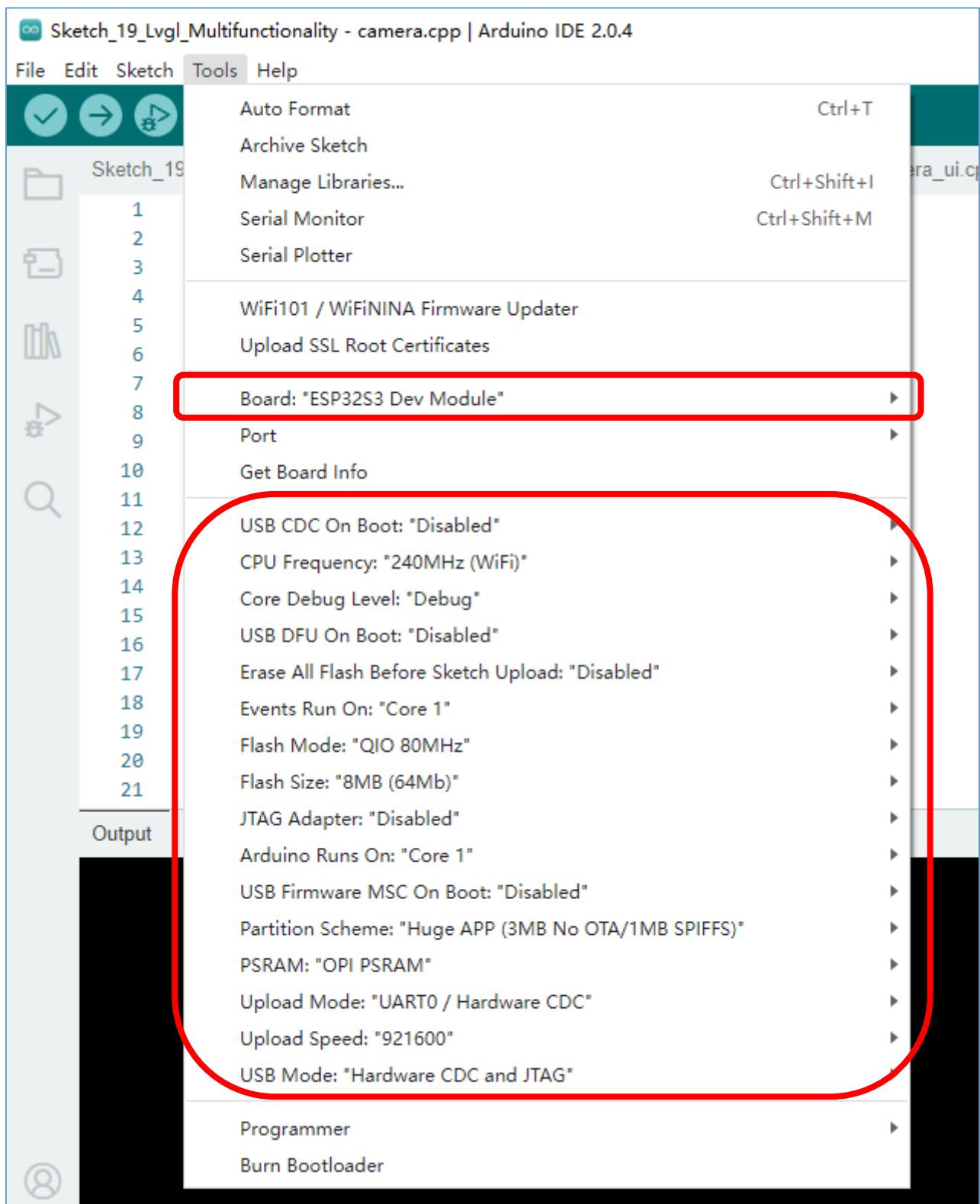


Arduino will download these files automatically. Wait for the installation to complete.

Output

```
Downloading packages
esp32:xtensa-esp32-elf-gcc@esp-2021r2-patch5-8.4.0
esp32:xtensa-esp32s2-elf-gcc@esp-2021r2-patch5-8.4.0
esp32:xtensa-esp32s3-elf-gcc@esp-2021r2-patch5-8.4.0
esp32:riscv32-esp-elf-gcc@esp-2021r2-patch5-8.4.0
esp32:openocd-esp32@v0.11.0-esp32-20221026
esp32:esptool_py@4.5
esp32:mkspiffs@0.2.3
esp32:mklittlefs@3.0.0-gnu12-dc7f933
esp32:esp32@2.0.7
Installing esp32:xtensa-esp32-elf-gcc@esp-2021r2-patch5-8.4.0
Configuring tool.
esp32:xtensa-esp32-elf-gcc@esp-2021r2-patch5-8.4.0 installed
Installing esp32:xtensa-esp32s2-elf-gcc@esp-2021r2-patch5-8.4.0
Configuring tool.
esp32:xtensa-esp32s2-elf-gcc@esp-2021r2-patch5-8.4.0 installed
Installing esp32:xtensa-esp32s3-elf-gcc@esp-2021r2-patch5-8.4.0
Configuring tool.
esp32:xtensa-esp32s3-elf-gcc@esp-2021r2-patch5-8.4.0 installed
Installing esp32:riscv32-esp-elf-gcc@esp-2021r2-patch5-8.4.0
Configuring tool.
esp32:riscv32-esp-elf-gcc@esp-2021r2-patch5-8.4.0 installed
Installing esp32:openocd-esp32@v0.11.0-esp32-20221026
Configuring tool.
esp32:openocd-esp32@v0.11.0-esp32-20221026 installed
Installing esp32:esptool_py@4.5
Configuring tool.
esp32:esptool_py@4.5 installed
Installing esp32:mkspiffs@0.2.3
Configuring tool.
esp32:mkspiffs@0.2.3 installed
Installing esp32:mklittlefs@3.0.0-gnu12-dc7f933
Configuring tool.
esp32:mklittlefs@3.0.0-gnu12-dc7f933 installed
Installing platform esp32:esp32@2.0.7
Configuring platform.
Platform esp32:esp32@2.0.7 installed
```

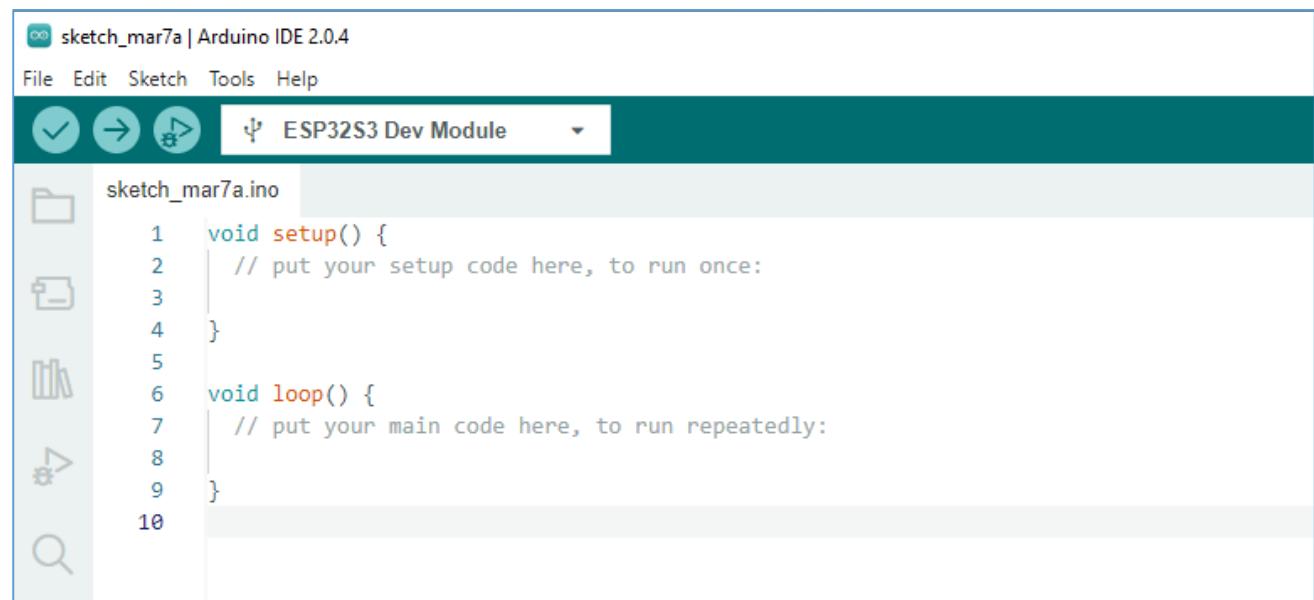
When finishing installation, click Tools in the Menus again and select Board: "ESP32S3 Dev Module", and then you can see information of ESP32-S3.



Library Installation

Before starting the learning process, it is necessary to install some libraries in advance to enable the code to be compiled properly. For convenience, we have already packaged these libraries and placed them in the Freenove Development Kit for ESP32-S3/Libraries folder. Please refer to the following steps to install these libraries into the Arduino IDE.

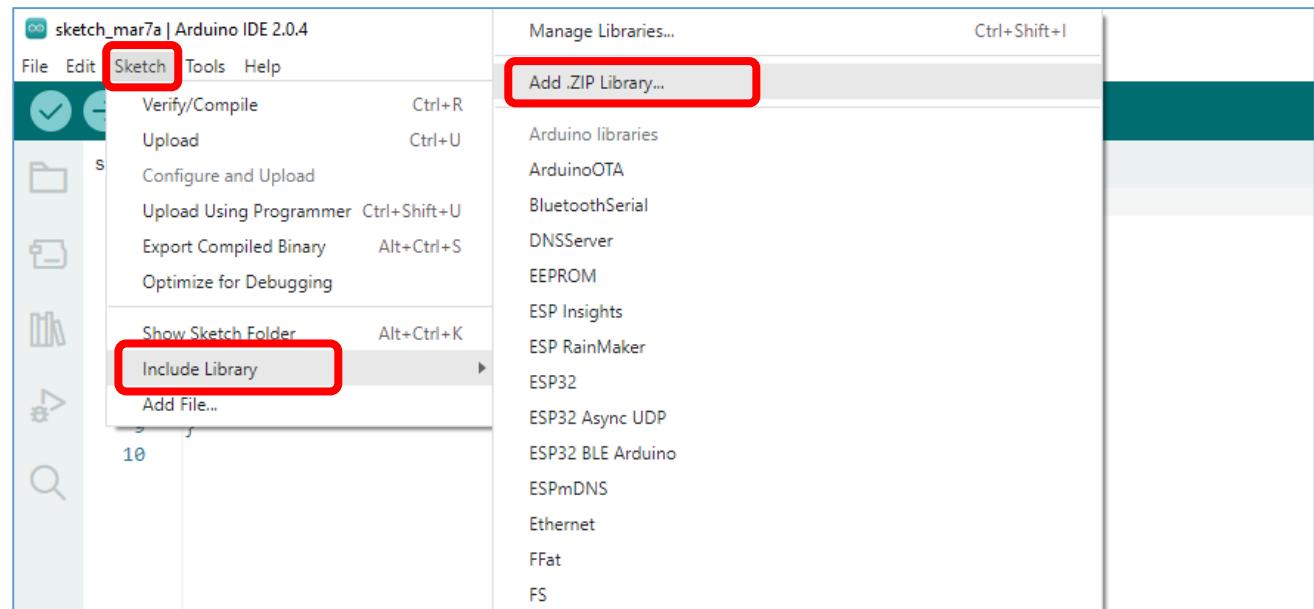
1. Open Arduino IDE.



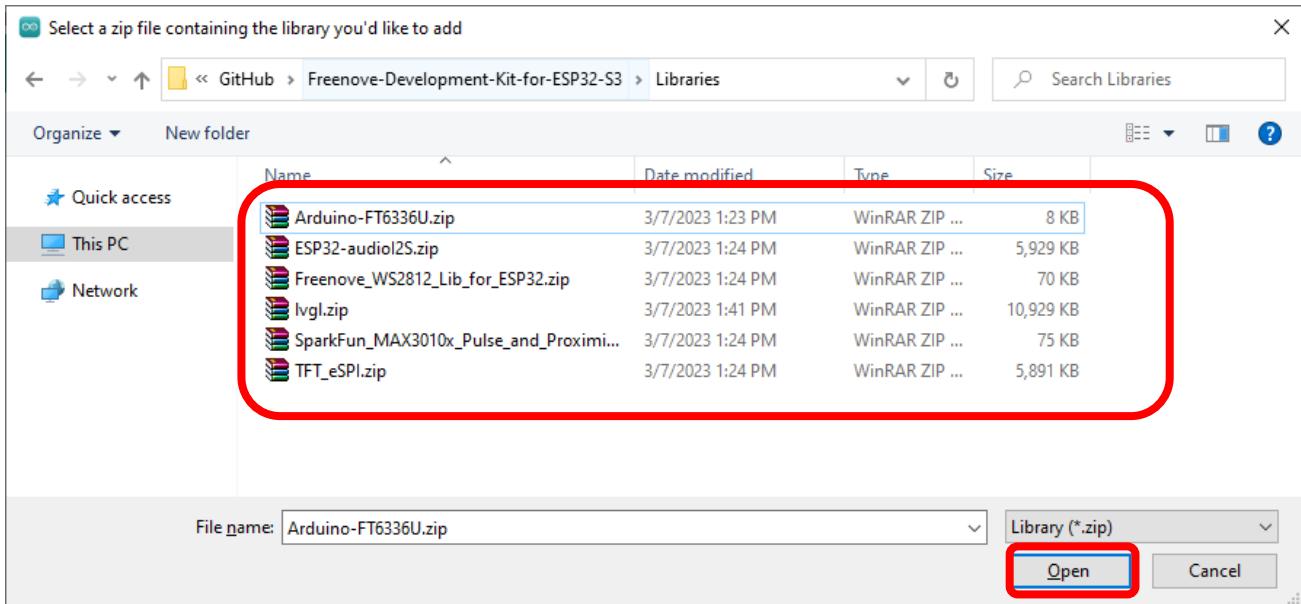
The screenshot shows the Arduino IDE interface. The title bar says "sketch_mar7a | Arduino IDE 2.0.4". The menu bar includes File, Edit, Sketch, Tools, and Help. A toolbar below the menu has icons for upload, verify, and other functions. The main area displays the code for "sketch_mar7a.ino":

```
sketch_mar7a.ino
1 void setup() {
2     // put your setup code here, to run once:
3
4 }
5
6 void loop() {
7     // put your main code here, to run repeatedly:
8
9 }
10
```

2. Select Sketch->Include Library->Add .ZIP library...

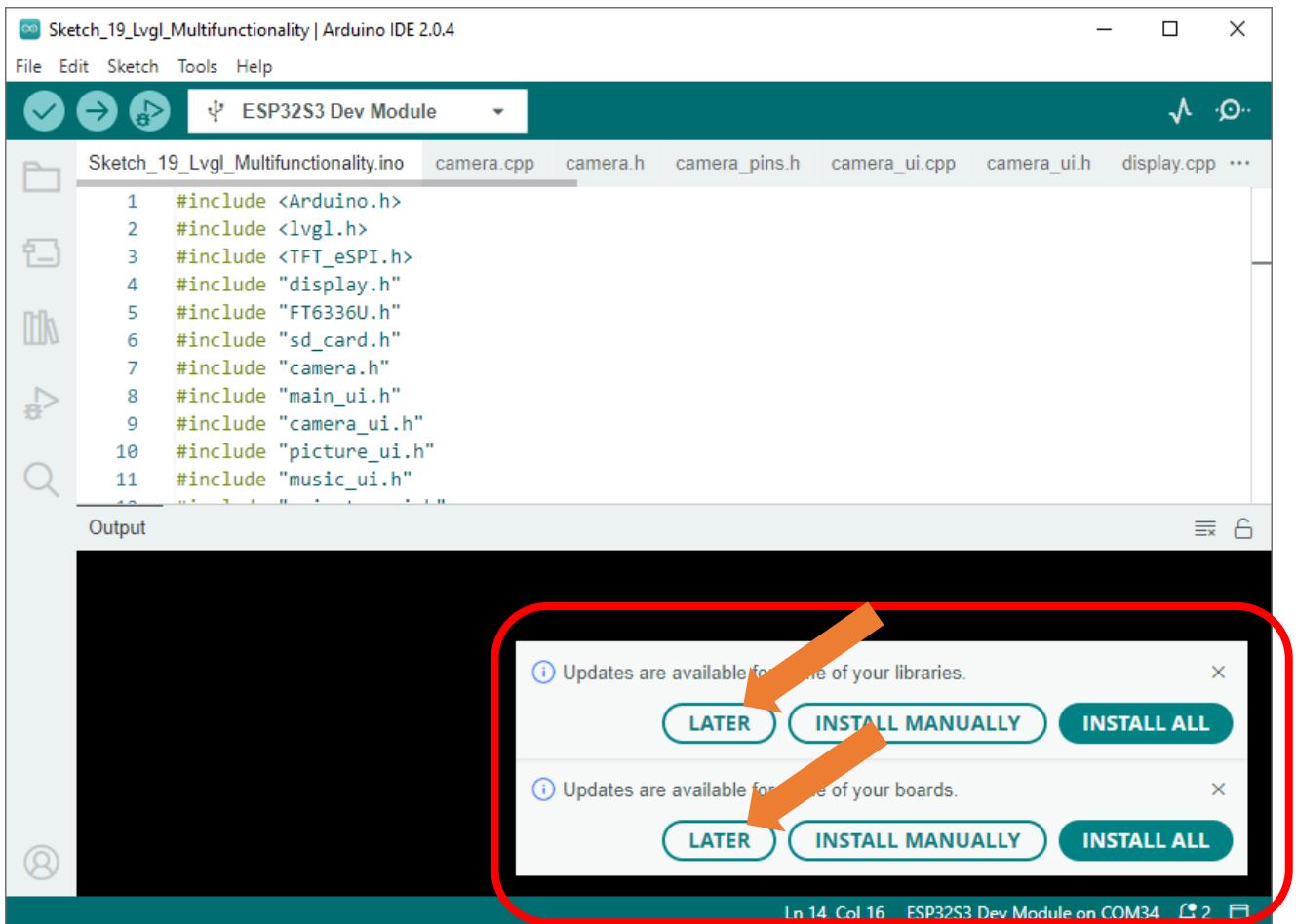


3. On the newly pop-up window, select the files from the **Freenove-Development-Kit-for-ESP32-S3/Libraries**. Click Open to install the library.



4. Repeat the above steps until all the six libraries are installed to Arduino. So far, all libraries have been installed.

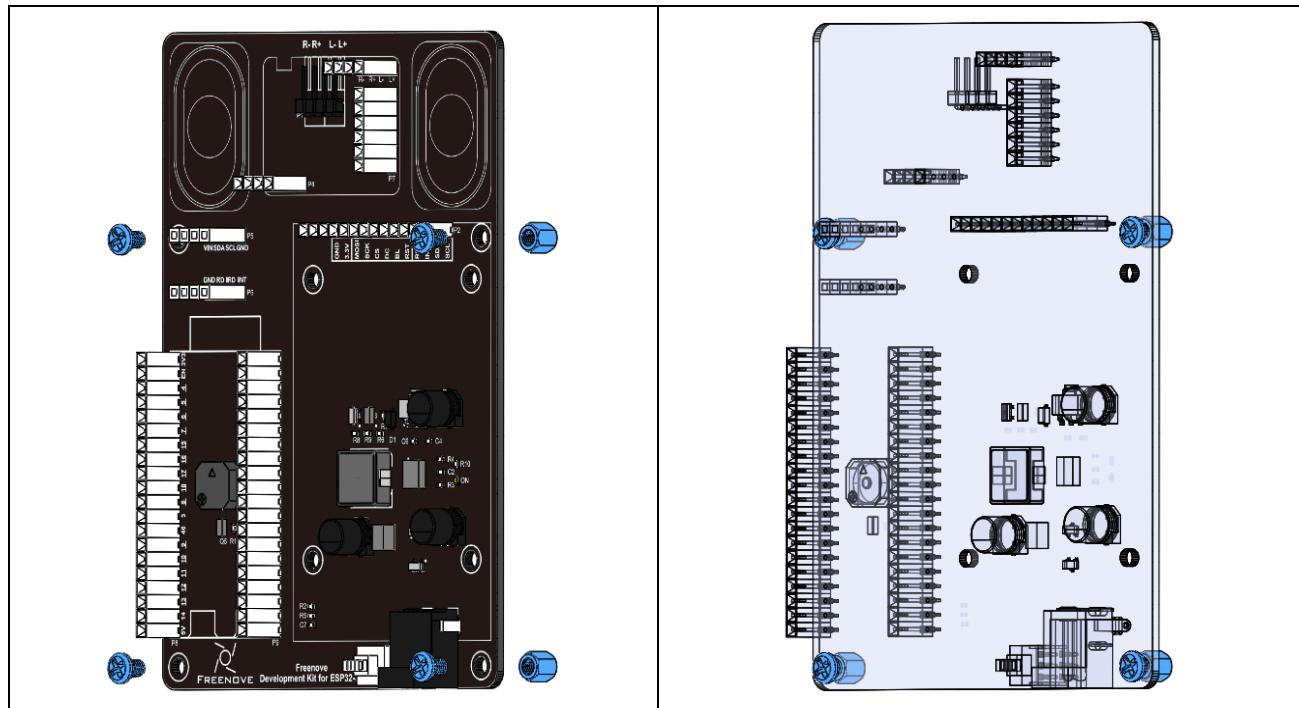
Note: Some libraries are not the latest version. Please do not update them even if it prompts every time you open the IDE. Just click LATER. Otherwise, it may lead the compilation to fail.



Chapter 0 Assembly

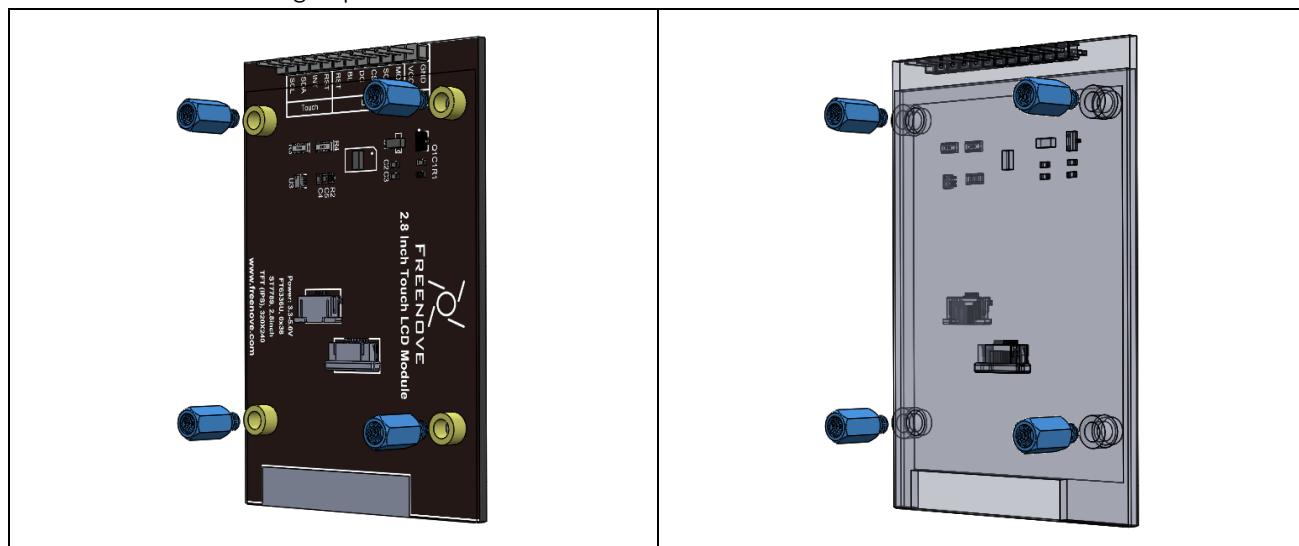
Installation of Brass Standoffs

Mount four M3*5 brass standoffs to the ESP32-S3 WROOM shield with four M3*4 screws, as shown below:

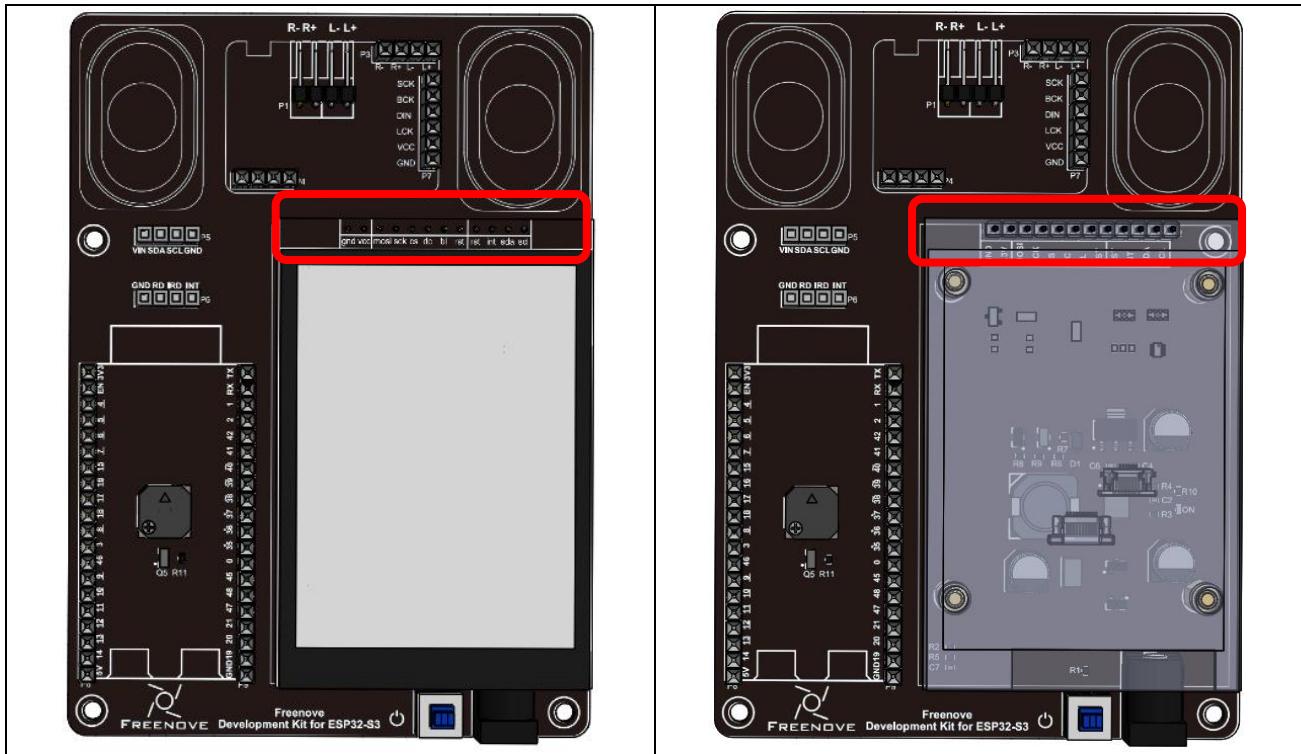


Installation of Screen

Mount four M3*8+3 single-pass standoffs to the back of the screen.

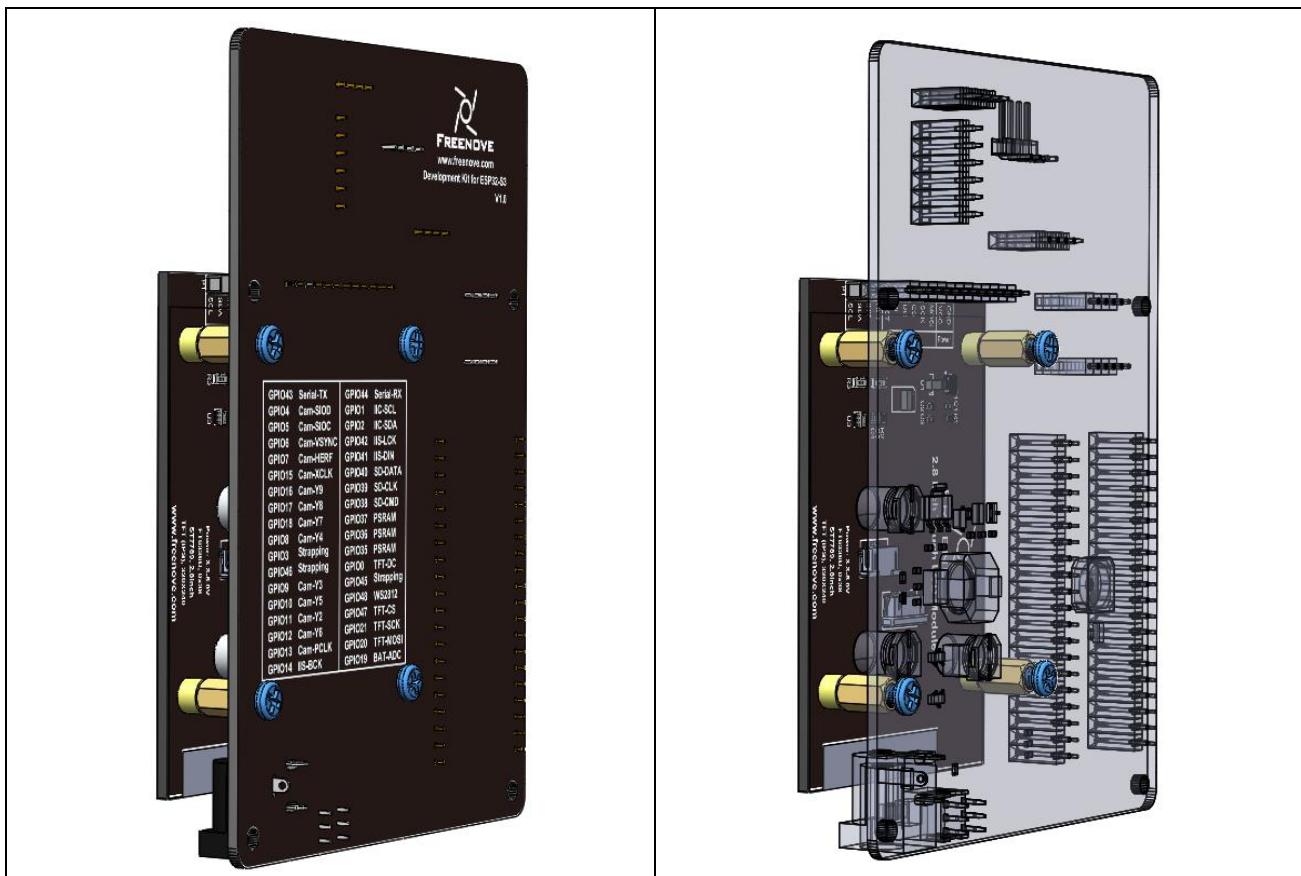


Plug the screen to ESP32-S3 WROOM Shield.



It should be noted that when plugging the screen, you should have the pins in line with each other to avoid misalignment.

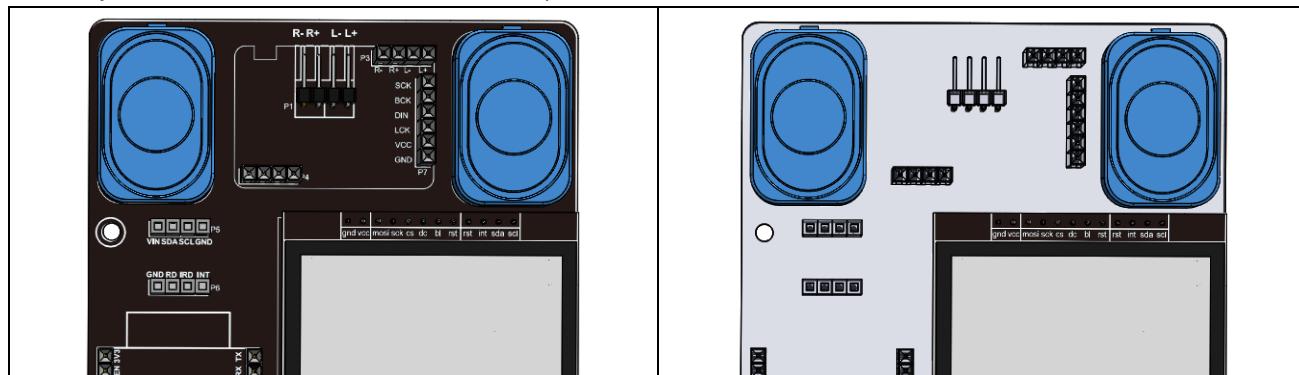
Fix the screen to ESP32-S3 WROOM Shield with four M3*4 screws.



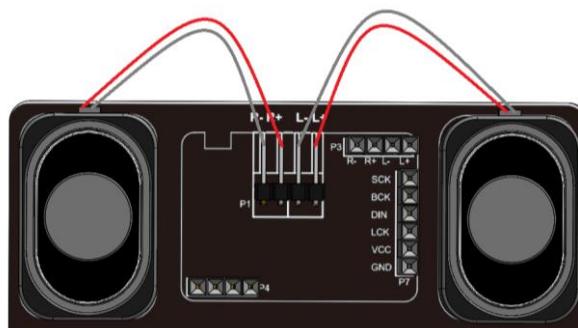
Any concerns? [✉ support@freenove.com](mailto:support@freenove.com)

Installation of Speakers

Carefully tear the sticker on the back of the speakers and attach them to the ESP32-S3 WROOM Shield.

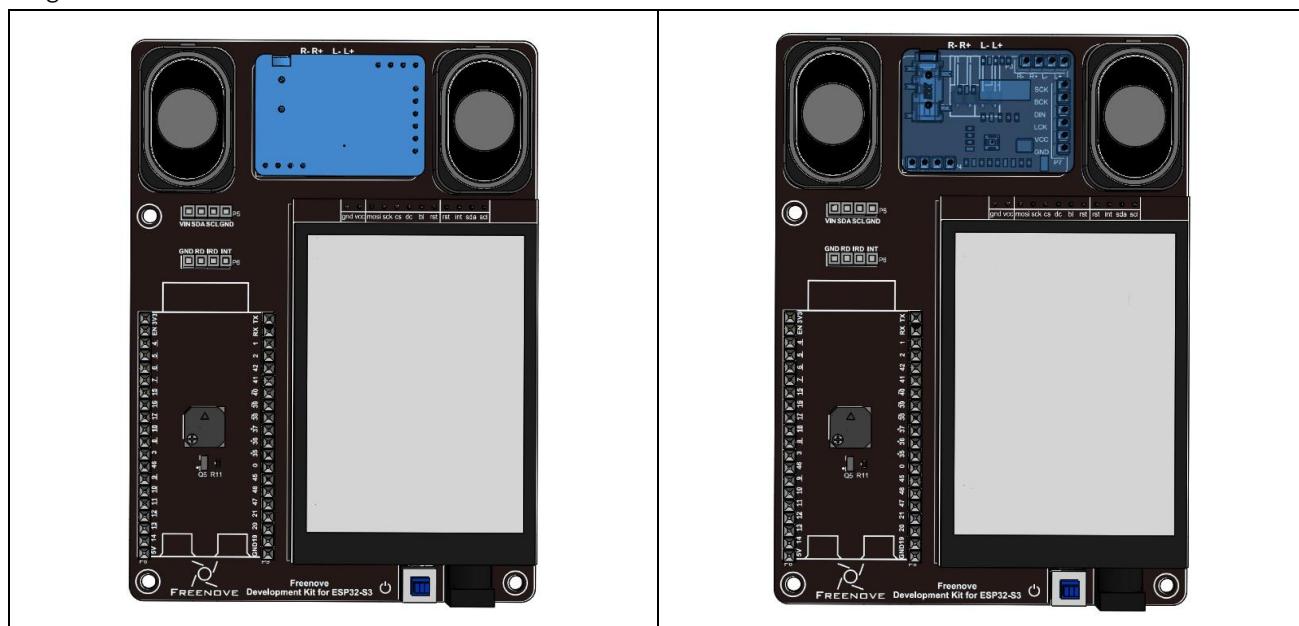


Connect the wires of the speakers to ESP32-S3 WROOM Shield, as shown below:



Installation of the Audio Module

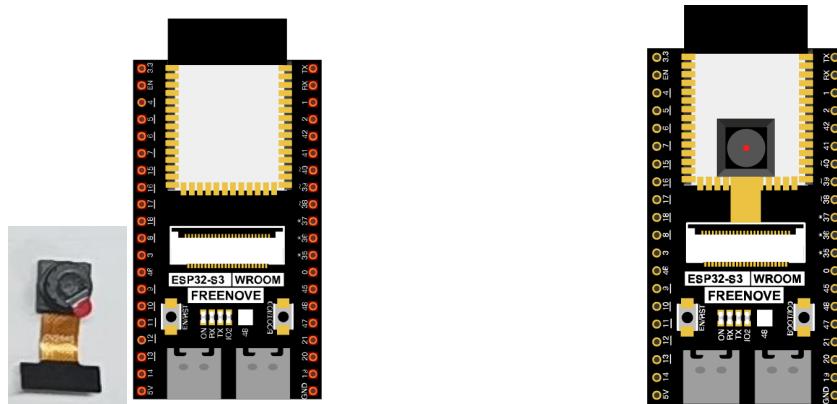
Plug the audio module to the shield.



Any concerns? [✉ support@freenove.com](mailto:support@freenove.com)

Connection of Camera

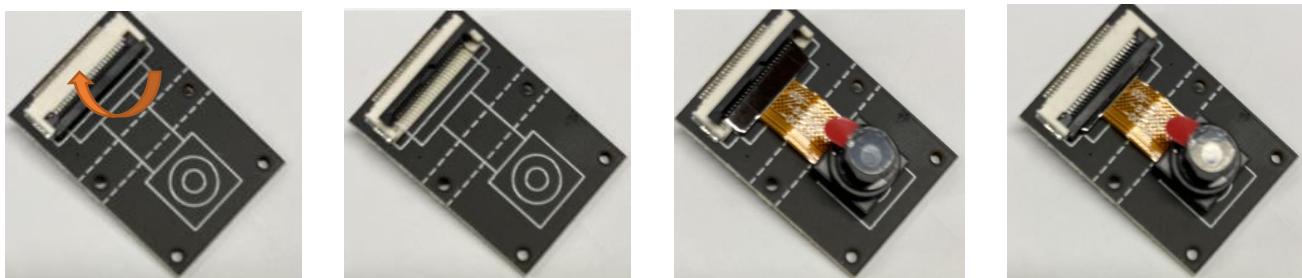
Gently pull up the camera connector and insert the camera module, and then press it down until it clicks into place.



Note:

All cameras in this tutorial are mounted on the esp32s3 board. If you want to extend it, you can mount the camera onto the expansion pad and use the fpc cable to expand.

Connect the camera to its extension board.



Plug one end of the camera cable into the camera extension board. **Pay attention to blue side.**

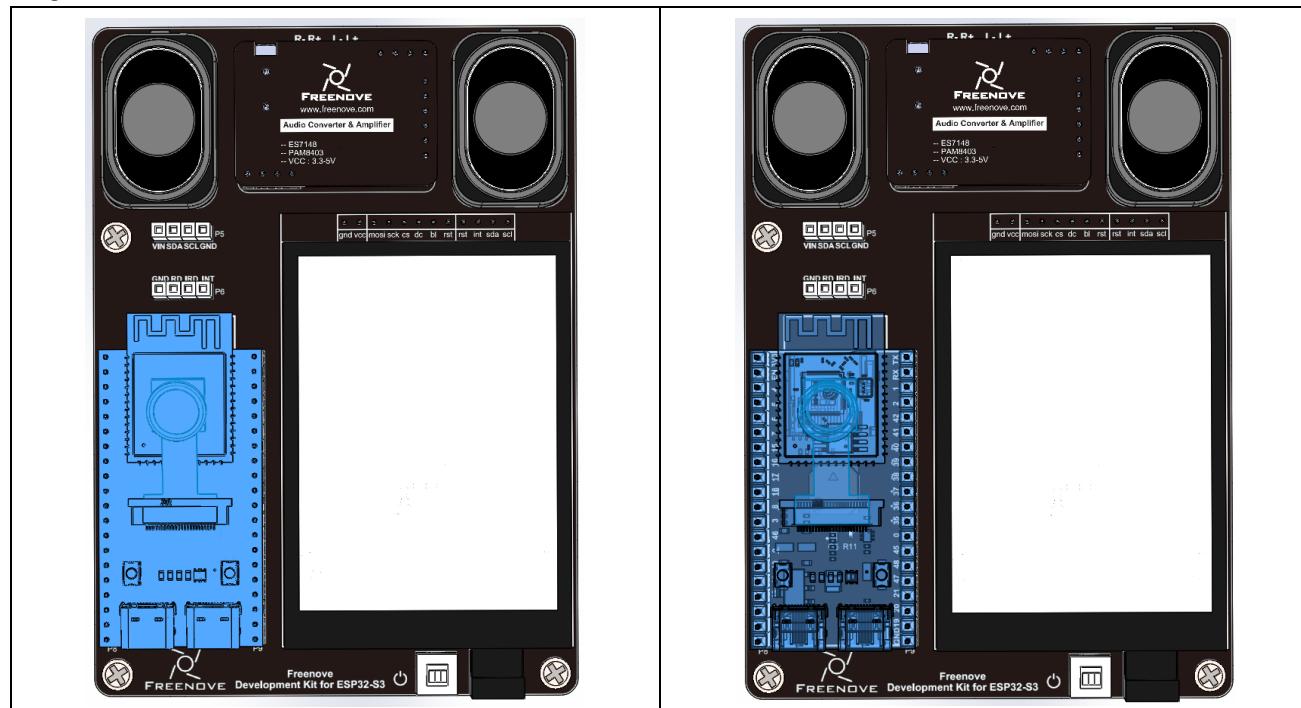


Plug the other end into the ESP32.



Connection of ESP32-S3 WROOM

Plug the ESP32-S3 WROOM to the shield.



When installing the ESP32-S3 WROOM, ensure that the ESP32-S3 wroom is not improperly installed.

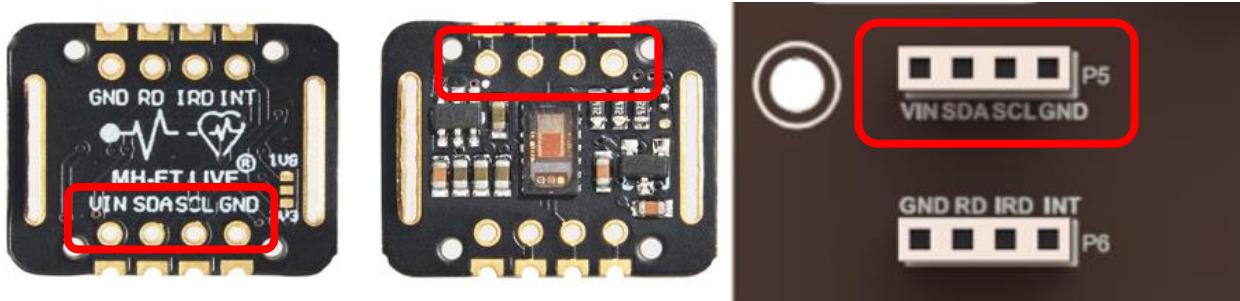
Connection of MAX30102

Plug the MAX30102 to the shield.



Important notes:

The MAX30102 module should not be connected reversely, otherwise it may affect the circuit, or even cause damages. It must be connected strictly according to the texts on the board. Make sure the pins are connected pin to pin.



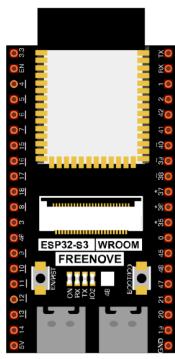
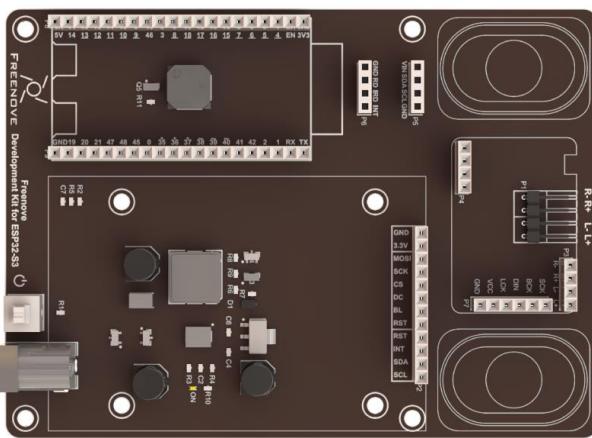
Chapter1 ADC Test

In this chapter, we will learn how to use ESP32-S3 to read analog signals.

Project 1.1 Read the Voltage of Power

In this project, we will use the ADC function of ESP32-S3 to read the voltage value of the power and print it out through the serial monitor.

Component List

ESP32-S3 WROOM x1	ESP32-S3 WROOM Shield x1	
		
9V Battery Cable x1	9V battery x1 (Not included in the kit, prepared by yourself)	
		

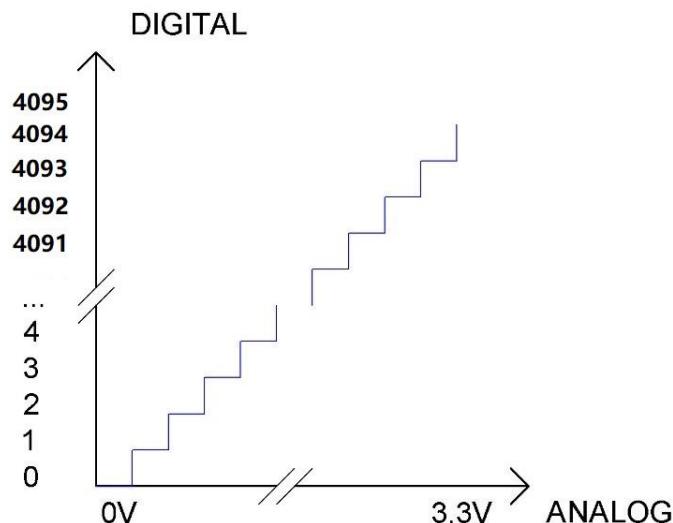
Please Note: Batteries need to be prepared by yourself. We do not provide batteries. ESP32-S3 WROOM Shield features with a DC005 interface, whose size is 5.5x2.1cm. If using an external power supply, ensure that its voltage ranges between 6-12V and that the current is greater than 0.5A.



Related knowledge

ADC

An ADC is an electronic integrated circuit used to convert analog signals such as voltages to digital or binary form consisting of 1s and 0s. The range of our ADC on ESP32-S3 is 12 bits, which means it can represent a resolution of up to $2^{12}=4096$, which is the number of discrete values that the ADC can represent within its range (3.3V). The range of analog values corresponds to ADC values. So the more bits the ADC has, the denser the partition of analog will be and the greater the precision of the resulting conversion.



Subsection 1: the analog in rang of 0V---3.3/4095 V corresponds to digital 0;

Subsection 2: the analog in rang of 3.3/4095 V---2*3.3 /4095V corresponds to digital 1;

...

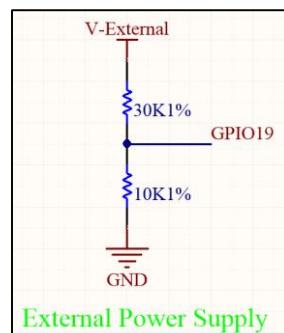
The following analog will be divided accordingly.

The conversion formula is as follows:

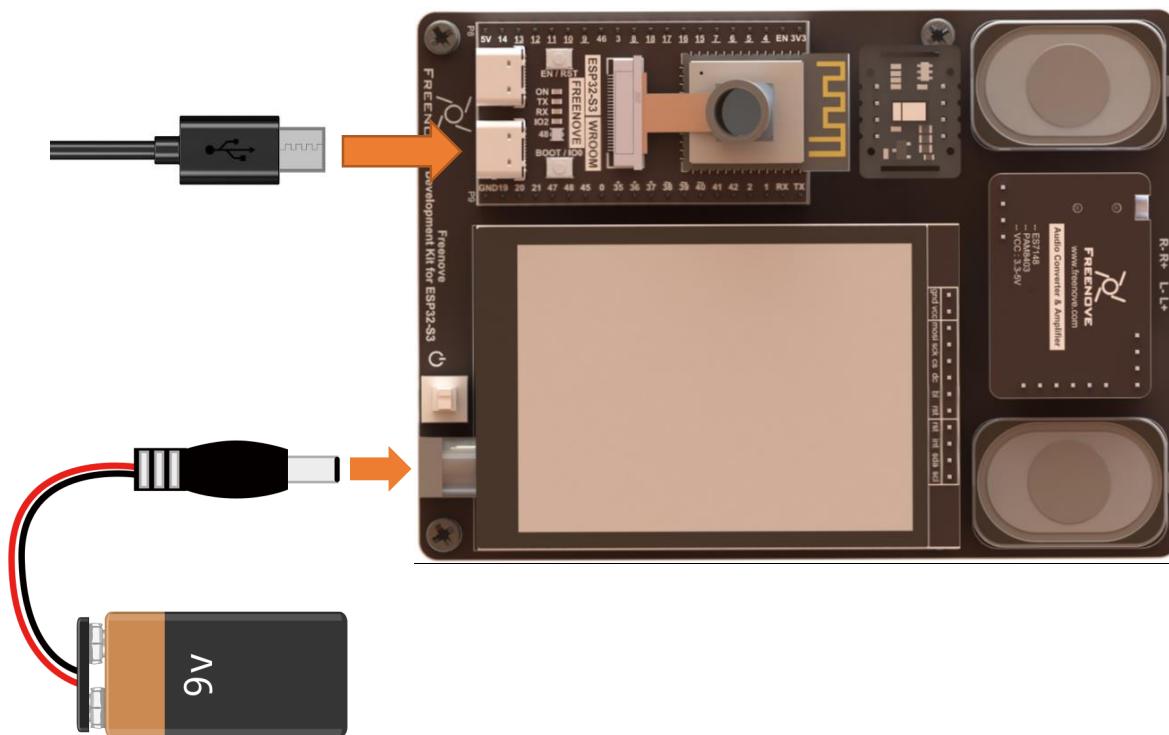
$$ADC\ Value = \frac{\text{Analog\ Voltage}}{3.3} * 4095$$

Circuit

Schematic diagram



Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com



Sketch

Any concerns? ✉ support@freenove.com

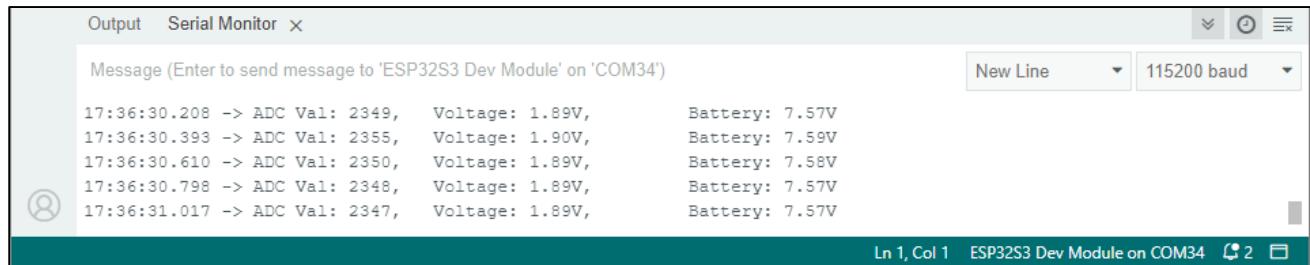
Sketch_01_ADC_Battery

```

Sketch_01_ADC_Battery | Arduino IDE 2.0.4
File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_01_ADC_Battery.ino
7 #define PIN_ANALOG_IN 19
8 void setup() {
9   Serial.begin(115200);
10 }
11
12 void loop() {
13   int adcVal = analogRead(PIN_ANALOG_IN);      //Gets the raw adc value.
14   double voltage = adcVal / 4095.0 * 3.3;        //Convert to the voltage value at the detection point.
15   double battery = voltage * 4.0;              //There is only 1/4 battery voltage at the detection point.
16   Serial.printf("ADC Val: %d, \t Voltage: %.2fV, \t Battery: %.2fV\r\n", adcVal, voltage, battery);
17   delay(200);
18 }

```

Download the code to ESP32-S3 WROOM, open the serial monitor, and set the baud rate to 115200. Turn on the power switch, as shown in the following figure.



When there is no external power supply connected, the voltage measured on GPIO19 pin is around 4V, which is supplied to V-External through the circuitry on the ESP32-S3 WROOM Shield from the USB power supply. This is a normal phenomenon.

The following is the code:

```

1 #define PIN_ANALOG_IN 19
2 void setup() {
3   Serial.begin(115200);
4 }
5
6 void loop() {
7   int adcVal = analogRead(PIN_ANALOG_IN); //Gets the raw adc value.
8   double voltage = adcVal/4095.0*3.3; //Convert to the voltage value at the detection point.
9   double battery = voltage * 4.0; //There is only 1/4 battery voltage at the detection point.
10  Serial.printf("ADC Val: %d, \t Voltage: %.2fV, \t Battery: %.2fV\r\n", adcVal, voltage,
11  battery);
12  delay(200);
13 }

```

In loop(), use the analogRead() function to obtain the input ADC value of the potentiometer, calculate the voltage value of the Power according to the formula in the previous knowledge point, and print it out through the serial port.

```
7 int adcVal = analogRead(PIN_ANALOG_IN); //Gets the raw adc value.  
8 double voltage = adcVal/4095.0*3.3; //Convert to the voltage value at the detection point.  
9 double battery = voltage * 4.0; //There is only 1/4 battery voltage at the detection point.  
10 Serial.printf("ADC Val: %d, \t Voltage: %.2fV, \t Battery: %.2fV\r\n", adcVal, voltage,  
battery);
```

Reference

```
uint16_t analogRead(uint8_t pin);
```

Reads the value from the specified analog pin. Return the analog reading on the pin. (0-4095 for 12 bits).

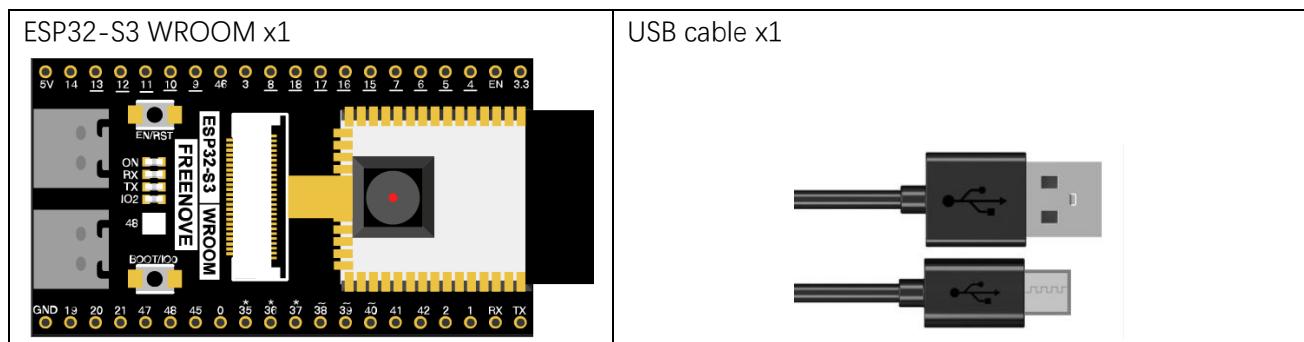
Chapter 2 WS2812

In this chapter, we will learn to use the onboard WS2812. Make the RGB LEDs to emit various color via a pin.

Project 2.1 WS2812

Learn the basic usage of WS2812 and use it to flash red, green, blue and white.

Component List

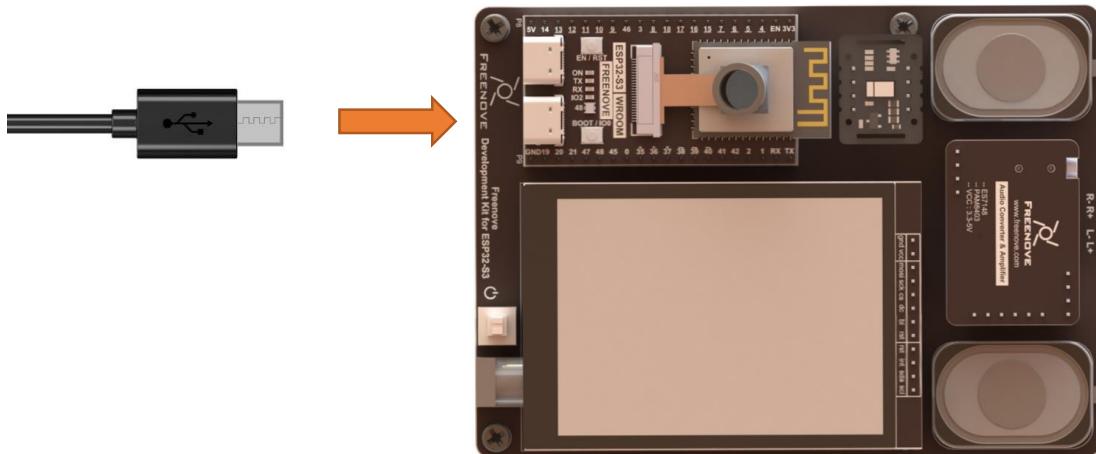


Related knowledge

A WS2812 integrates 3 LEDs of red, green and blue colors, and each LED supports 256 levels of brightness adjustment, which means WS2812 can emit $2^{24} = 16,777,216$ different colors.

Circuit

Connect Freenove ESP32 to your computer using the USB cable.

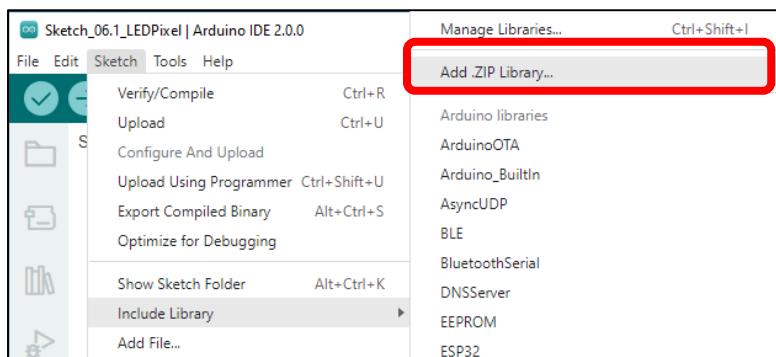


Sketch

This code uses a library named "Freenove_WS2812_Lib_for_ESP32". If you have not yet installed it, please do so first.

How to install the library

Open Arduino IDE, click Sketch → Include Library → Add .ZIP Library. In the pop-up window, find the file named "./Libraries/Freenove_WS2812_Lib_for_ESP32.Zip" which locates in this directory, and click OPEN.



Sketch_02_WS2812

```

1 // ****
2 Filename : WS2812
3 Description : The control board carries ws2812, showing colors such as red, green, blue and white.
4 Author : www.freenove.com
5 Modification: 2023/02/22
6 ****
7 #include "Freenove_WS2812_Lib_for_ESP32.h"
8
9 #define LEDS_COUNT 1
10#define LEDS_PIN 48
11#define CHANNEL 0
12
13 Freenove_ESP32_WS2812 strip = Freenove_ESP32_WS2812(LEDS_COUNT, LEDS_PIN, CHANNEL, TYPE_GRB);
14
15 u8 m_color[5][3] = { {255, 0, 0}, {0, 255, 0}, {0, 0, 255}, {255, 255, 255}, {0, 0, 0} };
16 int delayval = 100;
17
18 void setup() {
19     strip.begin();
20     strip.setBrightness(10);
21 }
22 void loop() {
23     for (int j = 0; j < 5; j++) {
24         for (int i = 0; i < LEDS_COUNT; i++) {
25             strip.setLedColorData(i, m_color[j][0], m_color[j][1], m_color[j][2]);
26             strip.show();
27             delay(delayval);
28         }
29         delay(500);
30     }
31 }

```

Output

```

Writing at 0x0004a0f1... (100 %)
Wrote 251440 bytes (140779 compressed) at 0x00010000 in 3.1 seconds (effective 651.1 kbit/s)...
Hash of data verified.

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

```

Ln 21, Col 2 ESP32S3 Dev Module on COM34 3



Download the code to ESP32-S3 WROOM and LED WS2812 begins to light up in red, green, blue, white and black.

The following is the program code:

```

1 #include "Freenove_WS2812_Lib_for_ESP32.h"
2
3 #define LEDS_COUNT 1 // The number of led
4 #define LEDS_PIN    48 // define the pin connected to the Freenove 8 led strip
5 #define CHANNEL     0 // RMT channel
6
7 Freenove_ESP32_WS2812 strip = Freenove_ESP32_WS2812(LEDS_COUNT, LEDS_PIN, CHANNEL, TYPE_GRB);
8
9 u8 m_color[5][3] = { {255, 0, 0}, {0, 255, 0}, {0, 0, 255}, {255, 255, 255}, {0, 0, 0} };
10 int delayval = 100;
11
12 void setup() {
13     strip.begin();
14     strip.setBrightness(10);
15 }
16 void loop() {
17     for (int j = 0; j < 5; j++) {
18         for (int i = 0; i < LEDS_COUNT; i++) {
19             strip.setLedColorData(i, m_color[j][0], m_color[j][1], m_color[j][2]);
20             strip.show();
21             delay(delayval);
22         }
23         delay(500);
24     }
25 }
```

To use some libraries, first you need to include their header file.

```
1 #include "Freenove_WS2812_Lib_for_ESP32.h"
```

Define the pins connected to the ws2812, the number of LEDs and RMT channel values.

```

3 #define LEDS_COUNT 1 // The number of led
4 #define LEDS_PIN    48 // define the pin connected to the Freenove 8 led strip
5 #define CHANNEL     0 // RMT channel
```

Use the above parameters to create a WS2812 object strip.

```
7 Freenove_ESP32_WS2812 strip = Freenove_ESP32_WS2812(LEDS_COUNT, LEDS_PIN, CHANNEL, TYPE_GRB);
```

Define the color values to be used, such as red, green, blue, white, and black.

```
9 u8 m_color[5][3] = { {255, 0, 0}, {0, 255, 0}, {0, 0, 255}, {255, 255, 255}, {0, 0, 0} };
```

Define a variable to set the time interval for each led to light up. The smaller the value is, the faster it will light up.

```
10 int delayval = 50;
```

Initialize strip() in setup() and set the brightness.

```

13 strip.begin();
14 strip.setBrightness(10);
```

In the loop(), there are two “for” loops, the internal for loop is to light the LED one by one, and the external one to switch colors. strip.setLedColorData() is used to set the color, but it does not change immediately. Only when strip.show() is called will the color data be sent to the LED to change the color.

```

17   for (int j = 0; j < 5; j++) {
18     for (int i = 0; i < LEDS_COUNT; i++) {
19       strip.setLedColorData(i, m_color[j][0], m_color[j][1], m_color[j][2]);
20       strip.show();
21       delay(delayval);
22     }
23     delay(500);
24 }
```

Reference

Freenove_ESP32_WS2812(u16 n = 8, u8 pin_gpio = 2, u8 chn = 0, LED_TYPE t = TYPE_GRB)

Constructor to create a ws2812 object.

Before each use of the constructor, please add “#include "Freenove_WS2812_Lib_for_ESP32.h"

Parameters

n: The number of led.

pin_gpio: A pin connected to an led.

Chn: RMT channel, which has eight channels, 0-7, and uses channel by default. This means that you can use eight ws2812 modules for the display at the same time, and these modules do not interfere with each other

t: Types of LED.

TYPE_RGB: The sequence of ws2812 module loading color is red, green and blue.

TYPE_RBG: The sequence of ws2812 module loading color is red, blue and green.

TYPE_GRB: The sequence of ws2812 module loading color is green, red and blue.

TYPE_GBR: The sequence of ws2812 module loading color is green, blue and red.

TYPE_BRG: The sequence of ws2812 module loading color is blue, red and green.

TYPE_BGR: The sequence of ws2812 module loading color is blue, green and red.

void begin(void);

Initialize the LEDPixel object

```

void setLedColorData (u8 index, u8 r, u8 g, u8 b);
void setLedColorData (u8 index, u32 rgb);
void setLedColor (u8 index, u8 r, u8 g, u8 b);
void setLedColor (u8 index, u32 rgb);
```

Set the color of led with order number n.

void show(void);

Send the color data to the led and display the set color immediately.

void setBrightness(uint8_t);

Set the brightness of the LED.

If you want to learn more about this library, you can visit the following website:

https://github.com/Freenove/Freenove_WS2812_Lib_for_ESP32



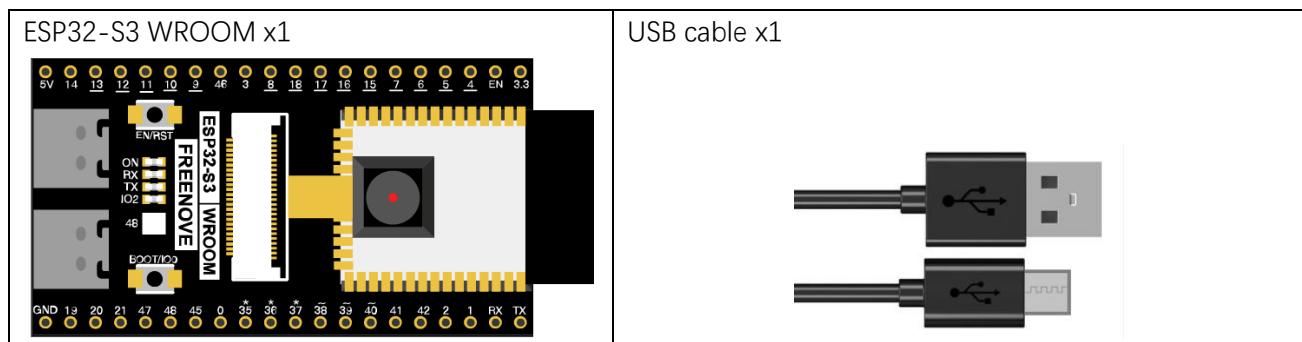
Chapter 3 Camera Web Server

In this section, we take ESP32-S3's video function as an example to study.

Project 3.1 Camera Web Server

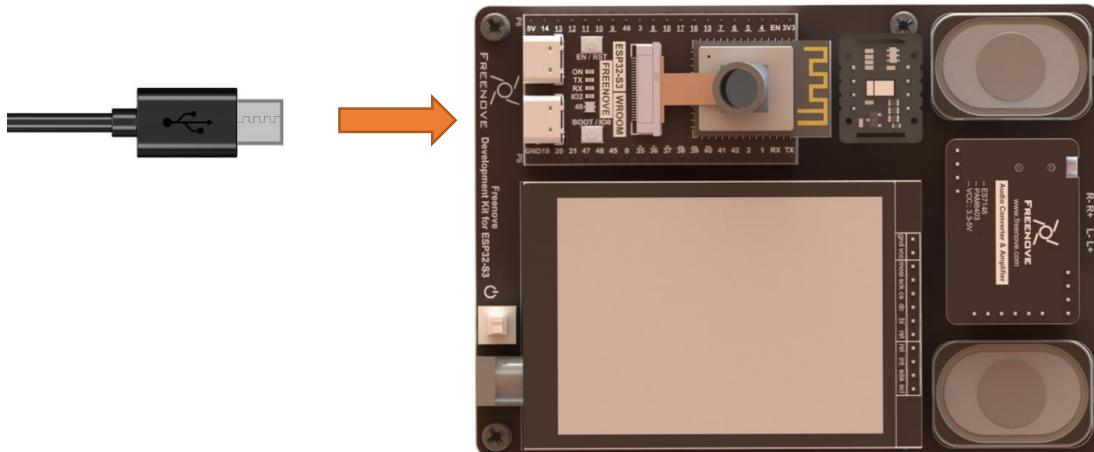
Connect ESP32-S3 using USB and check its IP address through serial monitor. Use web page to access IP address to obtain video and image data.

Component List



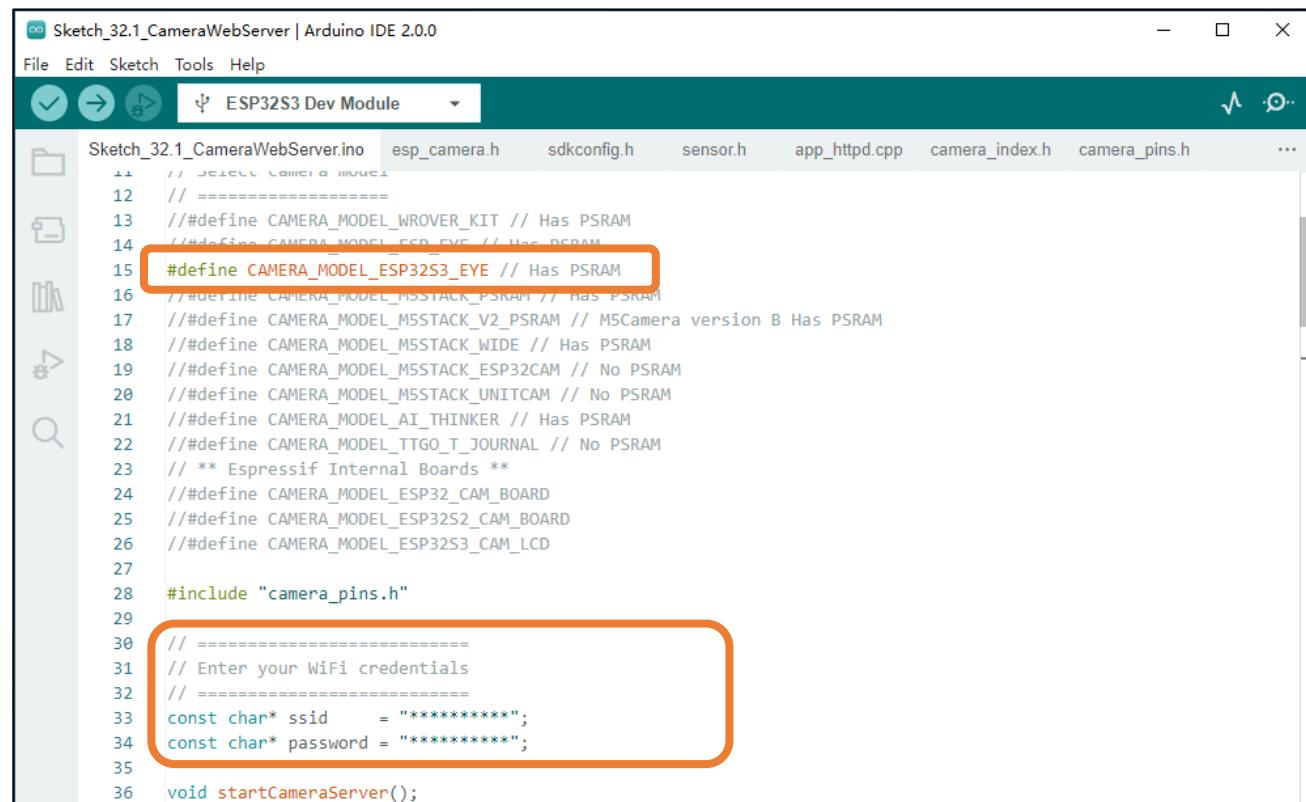
Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.



Sketch

Sketch_03_CameraWebServer



```

Sketch_32.1_CameraWebServer | Arduino IDE 2.0.0
File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_32.1_CameraWebServer.ino esp_camera.h sdkconfig.h sensor.h app_httpd.cpp camera_index.h camera_pins.h ...
1 // =====
2 // =====
3 //define CAMERA_MODEL_WROVER_KIT // Has PSRAM
4 //define CAMERA_MODEL_ESP_EYE // Has PSRAM
5 #define CAMERA_MODEL_ESP32S3_EYE // Has PSRAM
6 //define CAMERA_MODEL_M5STACK_PSRAM // Has PSRAM
7 //define CAMERA_MODEL_M5STACK_V2_PSRAM // M5Camera version B Has PSRAM
8 //define CAMERA_MODEL_M5STACK_WIDE // Has PSRAM
9 //define CAMERA_MODEL_M5STACK_ESP32CAM // No PSRAM
10 //define CAMERA_MODEL_M5STACK_UNITCAM // No PSRAM
11 //define CAMERA_MODEL_AI_THINKER // Has PSRAM
12 //define CAMERA_MODEL_TTGO_T_JOURNAL // No PSRAM
13 // ** Espressif Internal Boards **
14 //define CAMERA_MODEL_ESP32_CAM_BOARD
15 //define CAMERA_MODEL_ESP32S2_CAM_BOARD
16 //define CAMERA_MODEL_ESP32S3_CAM_LCD
17
18 #include "camera_pins.h"
19
20 // =====
21 // Enter your WiFi credentials
22 // =====
23 const char* ssid      = "*****";
24 const char* password = "*****";
25
26 void startCameraServer();
27
28
29
30
31
32
33
34
35
36

```

Before running the program, please modify your router's name and password marked in the illustration above to make sure that your Sketch can compile and work successfully.

Compile and upload codes to ESP32-S3, open the serial monitor and set the baud rate to 115200, and the serial monitor will print out a network address.



```

Output Serial Monitor ×
Message (Ctrl + Enter to send message to 'ESP32S3 Dev Module' on 'COM3') New Line 115200 baud
ESP-ROM: esp32s3-20210327
Build: Mar 27 2021
rst:0x1 (POWERON), boot:0x8 (SPI_FAST_FLASH_BOOT)
SPIWP:0xee
mode:DIO, clock div:1
load:0x3fce3808, len:0x43c
load:0x403c9700, len:0xbec
load:0x403cc700, len:0x2a3c
entry 0x403c98d8

...
WiFi connected
Camera Ready! Use 'http://192.168.1.233' to connect

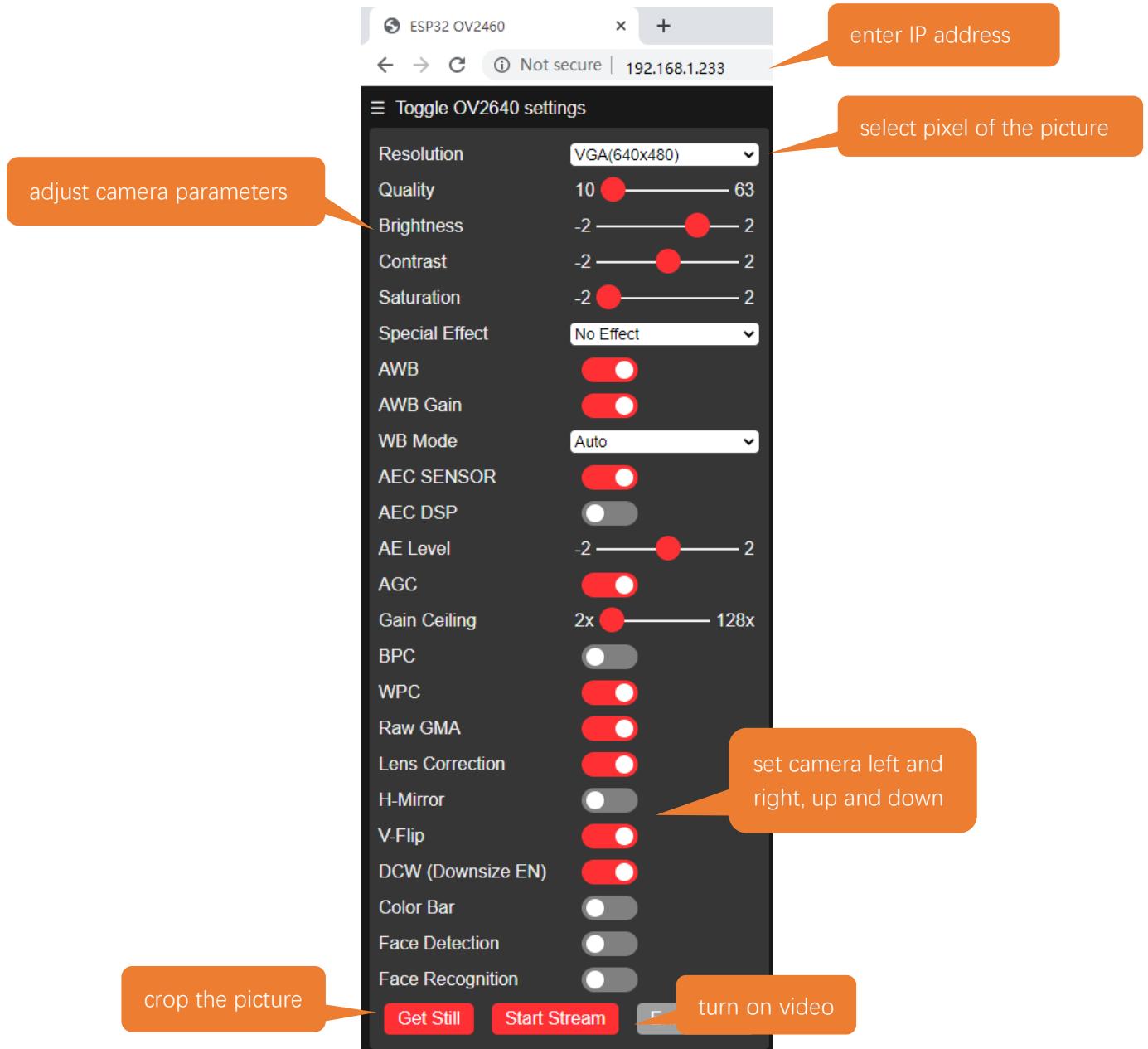
```

If your ESP32-S3 is in the process of connecting to router (dots are printed continuously), but the IP address does not show up, please re-check whether the router name and password have been entered correctly and press the reset key on ESP32-S3 WROOM to wait for a successful connection prompt.

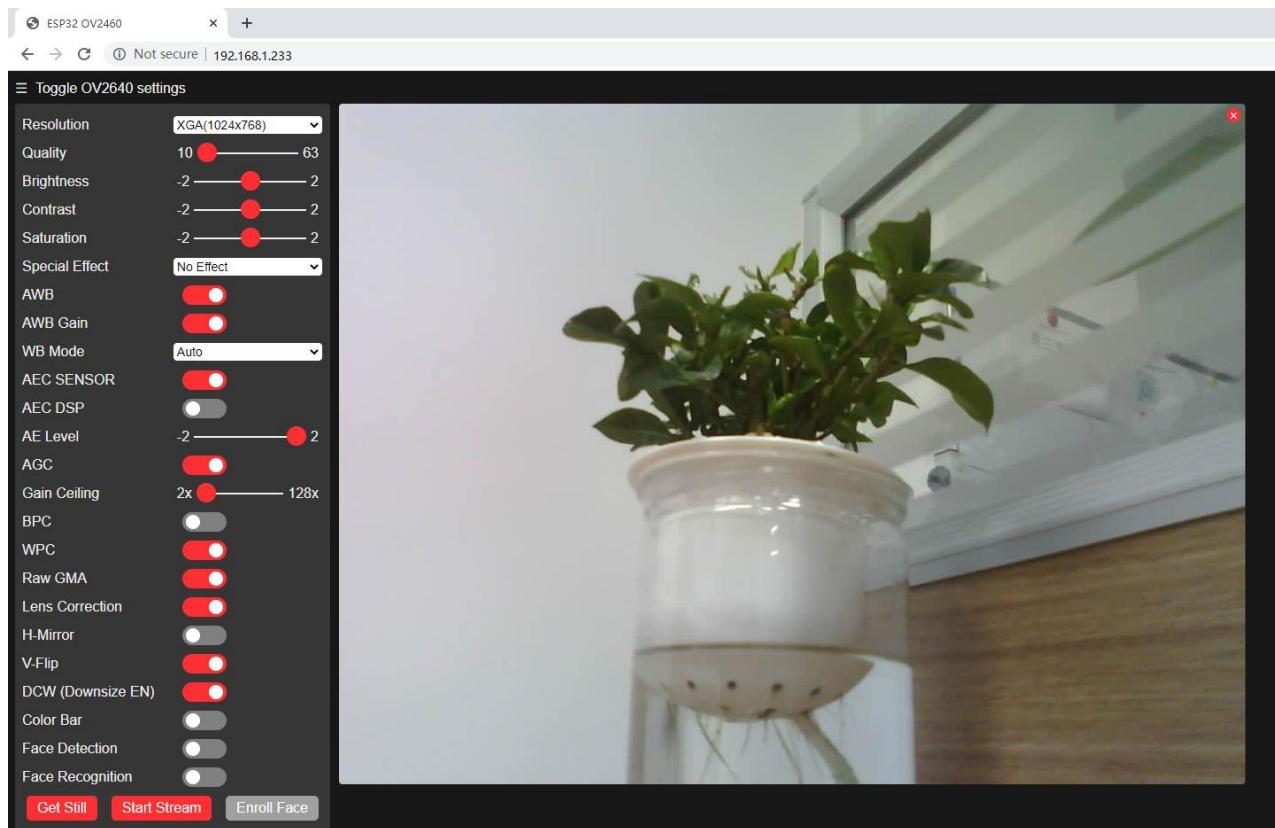
Any concerns? ✉ support@freenove.com



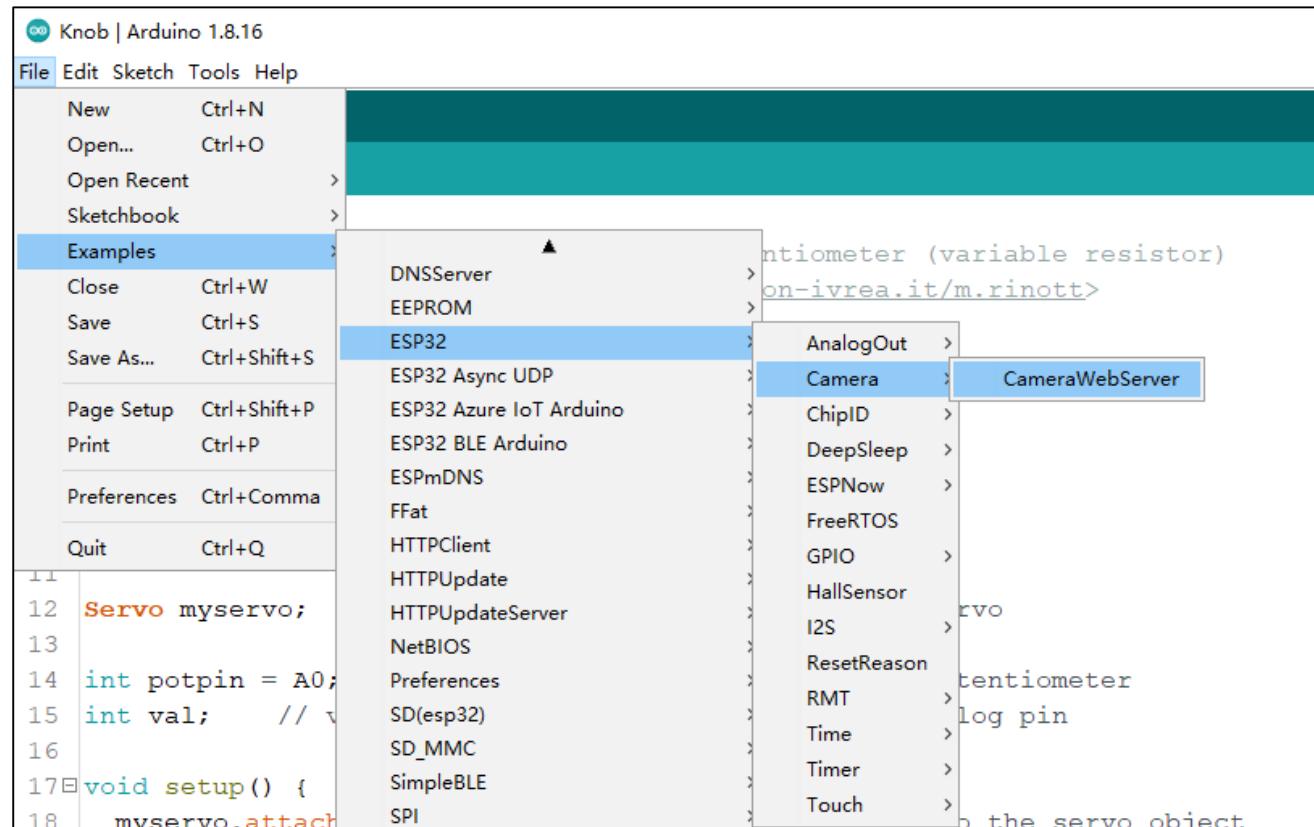
Open a web browser, enter the IP address printed by the serial monitor in the address bar, and access it. Taking the Google browser as an example, here is what the browser prints out after successful access to ESP32-S3's IP.



Click on Start Stream. The result is as shown below.



Note: If sketch compilation fails due to ESP32-S3 support package, try to run the example sketch as per the image below. This sketch is the same as the one described in the tutorial above.



Any concerns? ✉ support@freenove.com

The following is the main program code. You need include other code files in the same folder when write your own code.

```
1 #include "esp_camera.h"
2 #include <WiFi.h>
3
4 // =====
5 // Select camera model
6 // =====
7 //#define CAMERA_MODEL_WROVER_KIT // Has PSRAM
8 //#define CAMERA_MODEL_ESP_EYE // Has PSRAM
9 #define CAMERA_MODEL_ESP32S3_EYE // Has PSRAM
10 //#define CAMERA_MODEL_M5STACK_PSRAM // Has PSRAM
11 //#define CAMERA_MODEL_M5STACK_V2_PSRAM // M5Camera version B Has PSRAM
12 //#define CAMERA_MODEL_M5STACK_WIDE // Has PSRAM
13 //#define CAMERA_MODEL_M5STACK_ESP32CAM // No PSRAM
14 //#define CAMERA_MODEL_M5STACK_UNITCAM // No PSRAM
15 //#define CAMERA_MODEL_AI_THINKER // Has PSRAM
16 //#define CAMERA_MODEL_TTGO_T_JOURNAL // No PSRAM
17 // ** Espressif Internal Boards **
18 //#define CAMERA_MODEL_ESP32_CAM_BOARD
19 //#define CAMERA_MODEL_ESP32S2_CAM_BOARD
20 //#define CAMERA_MODEL_ESP32S3_CAM_LCD
21
22 #include "camera_pins.h"
23
24 // =====
25 // Enter your WiFi credentials
26 // =====
27 const char* ssid      = "*****";
28 const char* password = "*****";
29
30 void startCameraServer();
31
32 void setup() {
33     Serial.begin(115200);
34     Serial.setDebugOutput(true);
35     Serial.println();
36
37     camera_config_t config;
38     config.ledc_channel = LEDC_CHANNEL_0;
39     config.ledc_timer = LEDC_TIMER_0;
40     config.pin_d0 = Y2_GPIO_NUM;
41     config.pin_d1 = Y3_GPIO_NUM;
42     config.pin_d2 = Y4_GPIO_NUM;
```

```
43 config.pin_d3 = Y5_GPIO_NUM;
44 config.pin_d4 = Y6_GPIO_NUM;
45 config.pin_d5 = Y7_GPIO_NUM;
46 config.pin_d6 = Y8_GPIO_NUM;
47 config.pin_d7 = Y9_GPIO_NUM;
48 config.pin_xclk = XCLK_GPIO_NUM;
49 config.pin_pclk = PCLK_GPIO_NUM;
50 config.pin_vsync = VSYNC_GPIO_NUM;
51 config.pin_href = HREF_GPIO_NUM;
52 config.pin_sscb_sda = SIOD_GPIO_NUM;
53 config.pin_sscb_scl = SIOC_GPIO_NUM;
54 config.pin_pwdn = PWDN_GPIO_NUM;
55 config.pin_reset = RESET_GPIO_NUM;
56 config.xclk_freq_hz = 2000000;
57 config.frame_size = FRAMESIZE_SXGA;
58 config.pixel_format = PIXFORMAT_JPEG; // for streaming
59 config.grab_mode = CAMERA_GRAB_WHEN_EMPTY;
60 config.fb_location = CAMERA_FB_IN_PSRAM;
61 config.jpeg_quality = 12;
62 config.fb_count = 1;
63
64 // if PSRAM IC present, init with UXGA resolution and higher JPEG quality
65 // for larger pre-allocated frame buffer.
66 if(psramFound()){
67     config.jpeg_quality = 10;
68     config.fb_count = 2;
69     config.grab_mode = CAMERA_GRAB_LATEST;
70 } else {
71     // Limit the frame size when PSRAM is not available
72     config.frame_size = FRAMESIZE_HVGA;
73     config.fb_location = CAMERA_FB_IN_DRAM;
74 }
75
76 // camera init
77 esp_err_t err = esp_camera_init(&config);
78 if (err != ESP_OK) {
79     Serial.printf("Camera init failed with error 0x%x", err);
80     return;
81 }
82
83 sensor_t * s = esp_camera_sensor_get();
84 // initial sensors are flipped vertically and colors are a bit saturated
85 s->set_vflip(s, 1); // flip it back
86 s->set_brightness(s, 1); // up the brightness just a bit
```

```

87     s->set_saturation(s, -1); // lower the saturation
88
89     WiFi.begin(ssid, password);
90     WiFi.setSleep(false);
91
92     while (WiFi.status() != WL_CONNECTED) {
93         delay(500);
94         Serial.print(".");
95     }
96     Serial.println("");
97     Serial.println("WiFi connected");
98
99     startCameraServer();
100
101    Serial.print("Camera Ready! Use 'http://");
102    Serial.print(WiFi.localIP());
103    Serial.println(" to connect");
104 }
105
106 void loop() {
107     // Do nothing. Everything is done in another task by the web server
108     delay(10000);
109 }
```

Add procedure files and API interface files related to ESP32-S3 camera.

```

1 #include "esp_camera.h"
2 #include <WiFi.h>
...
9 #define CAMERA_MODEL_ESP32S3_EYE // Has PSRAM
...
11 #include "camera_pins.h"
```

Enter the name and password of your router.

```

13 const char *ssid      = "*****"; //input your wifi name
14 const char *password = "*****"; //input your wifi passwords
```

Initialize serial port, set baud rate to 115200; open the debug and output function of the serial.

```

21 Serial.begin(115200);
22 Serial.setDebugOutput(true);
23 Serial.println();
```

Configure parameters including interface pins of the camera. Note: It is not recommend changing them.

```

37 camera_config_t config;
38 config.ledc_channel = LEDC_CHANNEL_0;
39 config.ledc_timer = LEDC_TIMER_0;
40 config.pin_d0 = Y2_GPIO_NUM;
41 config.pin_d1 = Y3_GPIO_NUM;
42 config.pin_d2 = Y4_GPIO_NUM;
```

```

43 config.pin_d3 = Y5_GPIO_NUM;
44 config.pin_d4 = Y6_GPIO_NUM;
45 config.pin_d5 = Y7_GPIO_NUM;
46 config.pin_d6 = Y8_GPIO_NUM;
47 config.pin_d7 = Y9_GPIO_NUM;
48 config.pin_xclk = XCLK_GPIO_NUM;
49 config.pin_pclk = PCLK_GPIO_NUM;
50 config.pin_vsync = VSYNC_GPIO_NUM;
51 config.pin_href = HREF_GPIO_NUM;
52 config.pin_sscb_sda = SIOD_GPIO_NUM;
53 config.pin_sscb_scl = SIOC_GPIO_NUM;
54 config.pin_pwdn = PWDN_GPIO_NUM;
55 config.pin_reset = RESET_GPIO_NUM;
56 config.xclk_freq_hz = 2000000;
57 config.frame_size = FRAMESIZE_SXGA;
58 config.pixel_format = PIXFORMAT_JPEG; // for streaming
59 config.grab_mode = CAMERA_GRAB_WHEN_EMPTY;
60 config.fb_location = CAMERA_FB_IN_PSRAM;
61 config.jpeg_quality = 12;
62 config.fb_count = 1;

```

ESP32-S3 connects to the router and prints a successful connection prompt. If it does not connect successfully, press the reset key on the ESP32-S3 WROOM.

```

89 WiFi.begin(ssid, password);
90 WiFi.setSleep(false);

91

92 while (WiFi.status() != WL_CONNECTED) {
93     delay(500);
94     Serial.print(".");
95 }
96 Serial.println("");
97 Serial.println("WiFi connected");

```

Open the video streams server function of the camera and print its IP address via serial port.

```

99 startCameraServer();
100
101 Serial.print("Camera Ready! Use 'http://");
102 Serial.print(WiFi.localIP());
103 Serial.println(" to connect");

```



Configure the display image information of the camera.

The set_vflip() function sets whether the image is flipped 180°, with 0 for no flip and 1 for flip 180°.

The set_brightness() function sets the brightness of the image, with values ranging from -2 to 2.

The set_saturation() function sets the color saturation of the image, with values ranging from -2 to 2.

```

36 sensor_t * s = esp_camera_sensor_get();
37 s->set_vflip(s, 1);           //flip it back
38 s->set_brightness(s, 1);     //up the brightness just a bit
39 s->set_saturation(s, -1);   //lower the saturation

```

Modify the resolution and sharpness of the images captured by the camera. The sharpness ranges from 10 to 63, and the smaller the number, the sharper the picture. The larger the number, the blurrier the picture. Please refer to the table below.

	config.frame_size = FRAMESIZE_VGA; config.jpeg_quality = 10;
--	---

Reference

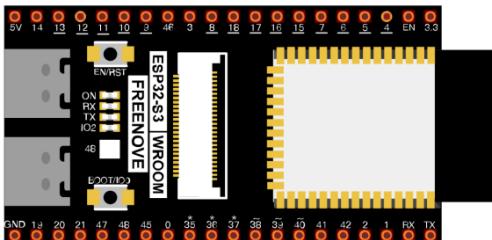
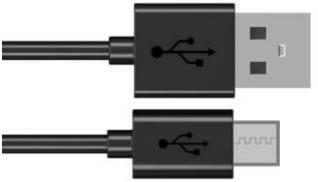
Image resolution	Sharpness	Image resolution	Sharpness
FRAMESIZE_96X96	96x96	FRAMESIZE_HVGA	480x320
FRAMESIZE_QQVGA	160x120	FRAMESIZE_VGA	640x480
FRAMESIZE_QCIF	176x144	FRAMESIZE_SVGA	800x600
FRAMESIZE_HQVGA	240x176	FRAMESIZE_XGA	1024x768
FRAMESIZE_240X240	240x240	FRAMESIZE_HD	1280x720
FRAMESIZE_QVGA	320x240	FRAMESIZE_SXGA	1280x1024
FRAMESIZE_CIF	400x296	FRAMESIZE_UXGA	1600x1200

Chapter 4 Read and Write the SDcard

An SDcard slot is integrated on the back of the ESP32-S3 WROOM. In this chapter, we learn how to use ESP32-S3 to read and write SDcard.

Project 4.1 SDMMC Test

Component List

ESP32-S3 WROOM x1	USB cable x1
	
SD card x1	Card reader x1 (random color)

Component knowledge

SD card read and write method

The ESP32-S3 offers two methods for accessing the SD card: SPI interface and SDMMC interface. The SPI mode requires 4 IOs to access the SD card, while the SDMMC interface supports both one-bit and four-bit bus modes. In the one-bit bus mode of SDMMC, only 3 IOs are required to access the SD card; while, the four-bit bus mode of SDMMC requires 6 IOs to access the SD card.

The above three methods can all be used to access the SD card, the difference of which lies in the speed. When accessing an SD card, the fastest reading and writing speed is achieved under the four-bit bus mode of SDMMC. The one-bit bus mode of SDMMC offers a slightly slower access speed of around 80% compared to the four-bit bus mode. The slowest access speed is observed with the SPI mode, which offers only around 50% of the speed of the four-bit bus mode of SDMMC.

For most applications, we recommend using the one-bit bus mode because it requires the least number of IO pins while still providing good performance and speed.



Format SD card

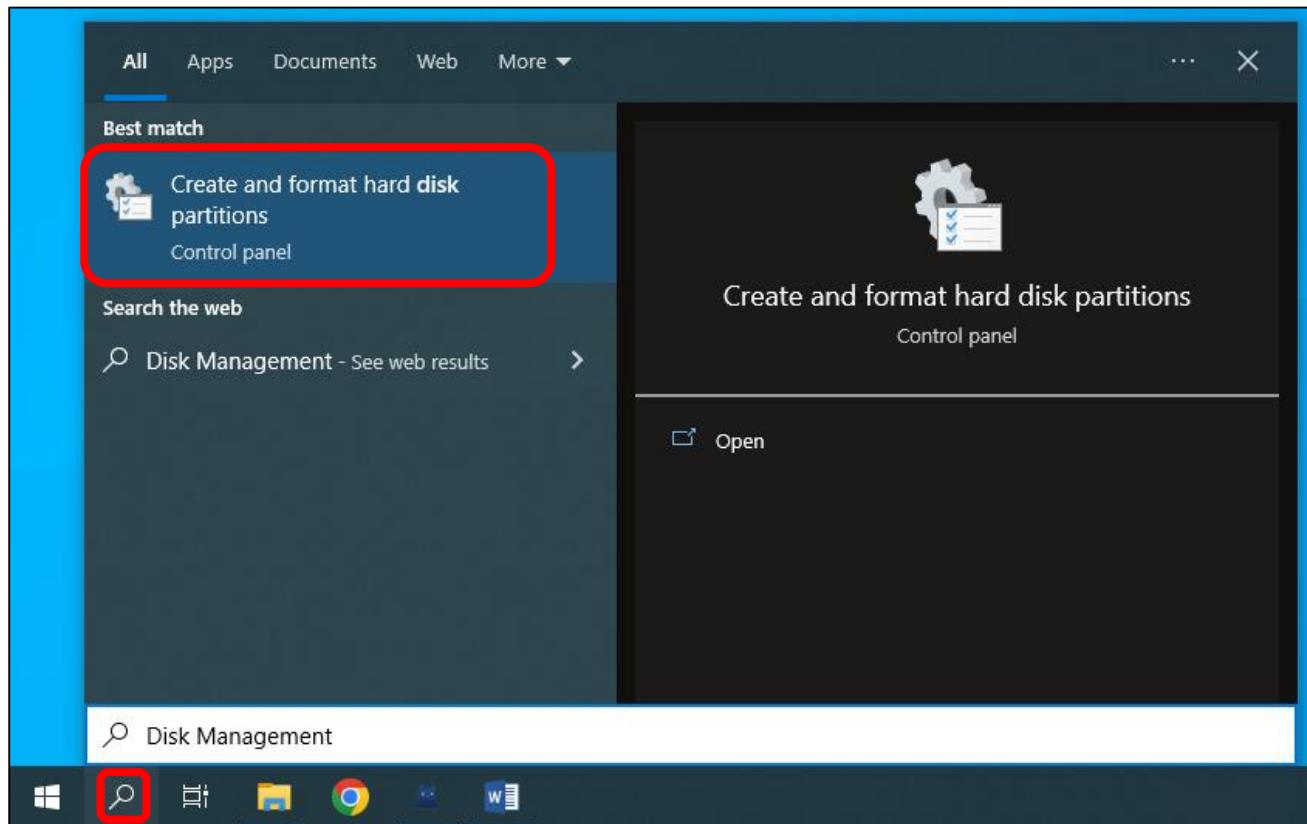
To begin the project, it is essential to prepare a blank SD card and a card reader. Before proceeding, we need to create a drive letter for the SD card and format it. The following steps provide a guide on how to accomplish this on different computer systems. Please follow the guide that corresponds to your computer.

Note that this step requires a card reader and a blank SD card. Please ensure that you have these components available before proceeding.

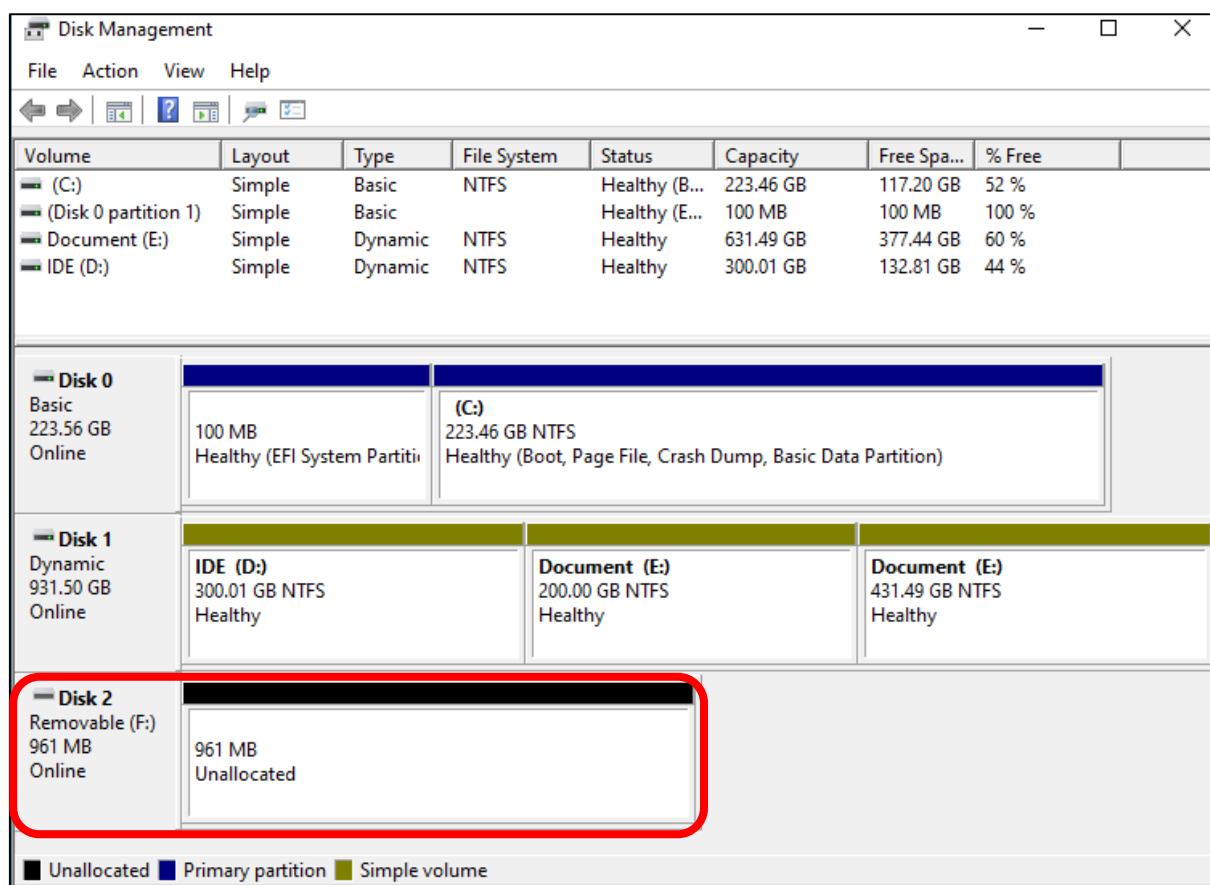
Windows

Insert the SD card into the card reader, and then insert the card reader into the computer.

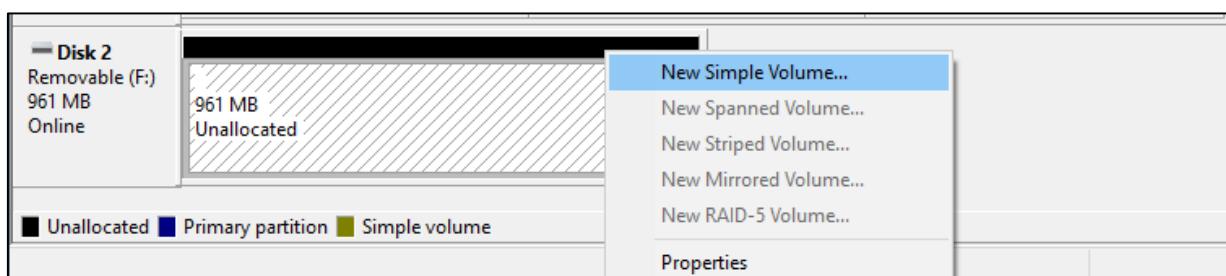
In the Windows search box, enter "Disk Management" and select "Create and format hard disk partitions".



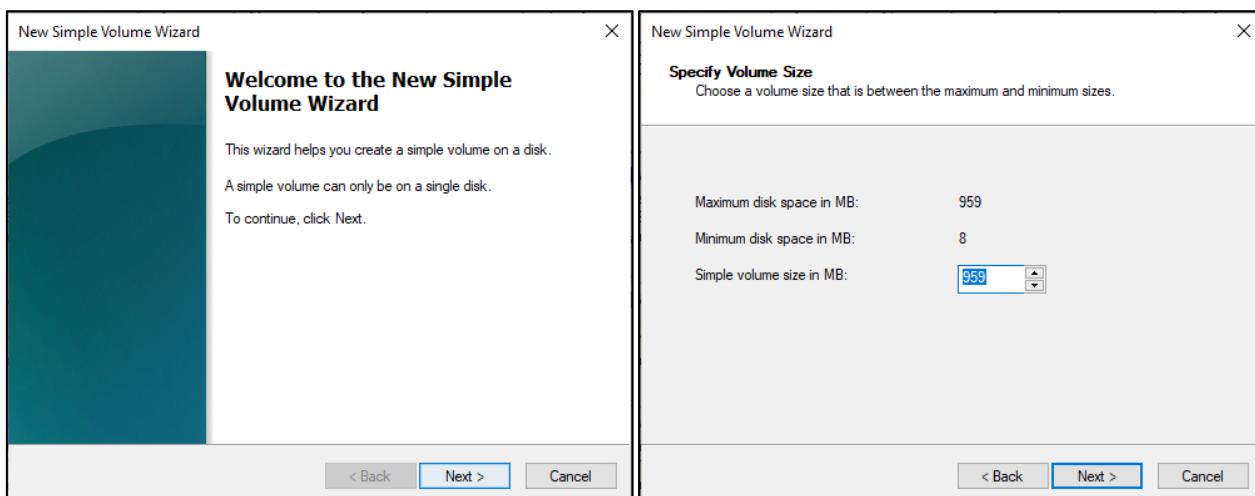
In the newly opened window, locate an unallocated volume with a size close to 1GB.



Click to select the volume, right-click and select "New Simple Volume".



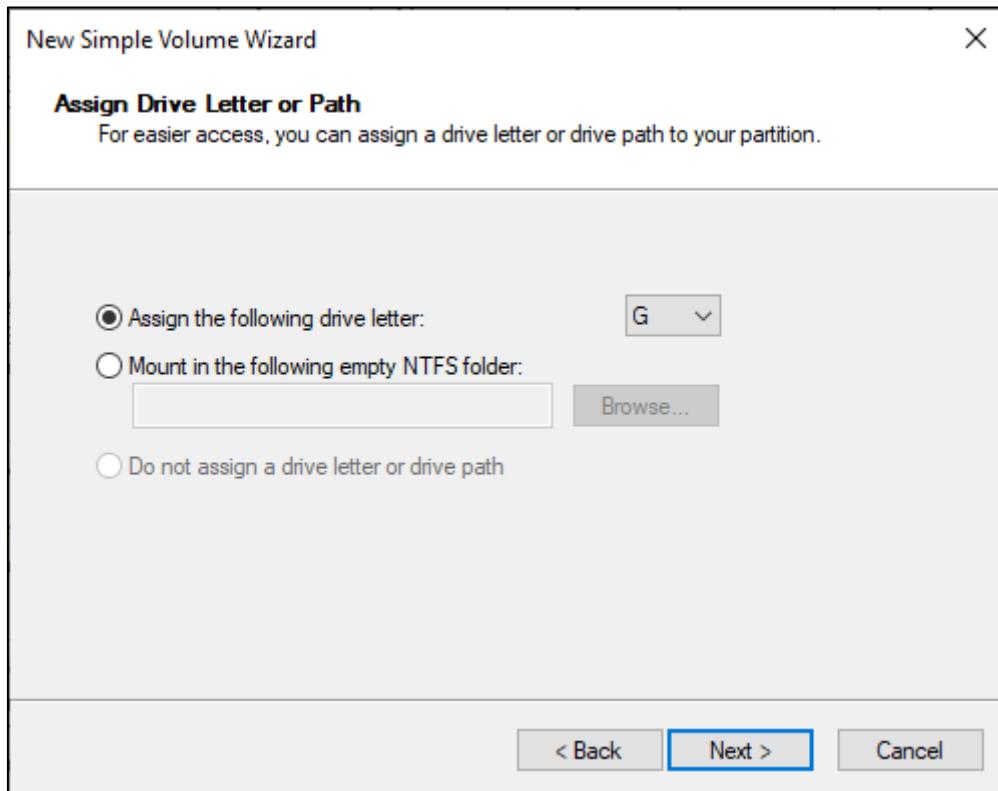
Click Next.



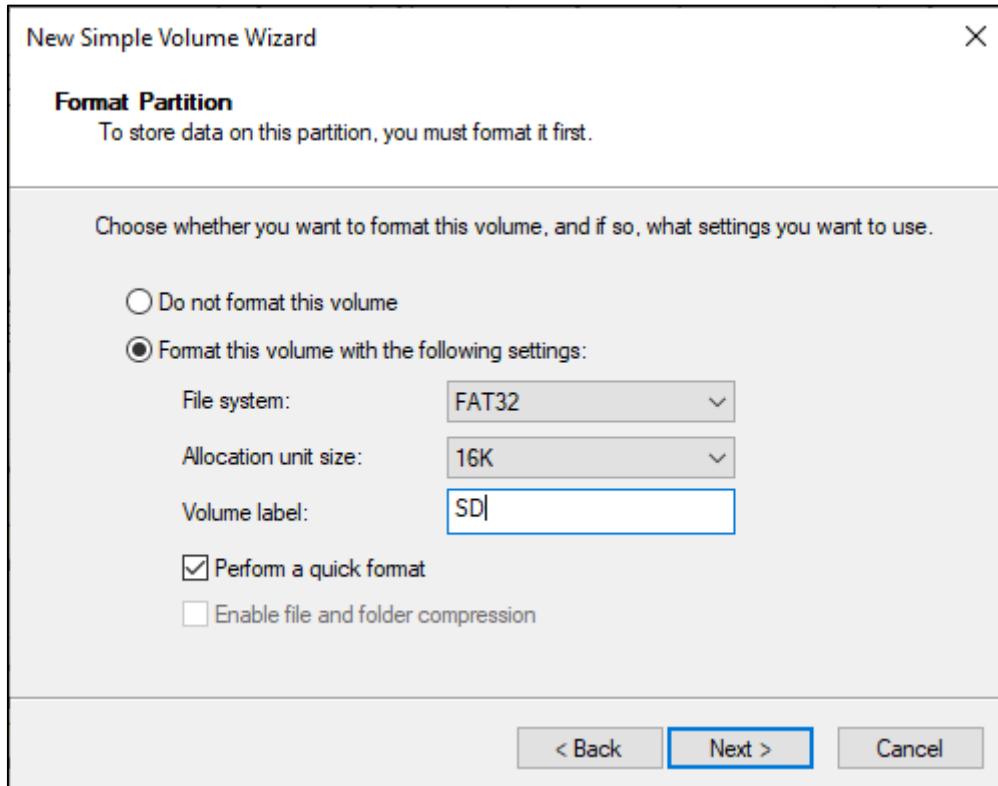
Any concerns? [✉ support@freenove.com](mailto:support@freenove.com)



On the right-hand side, you can select a preferred drive letter for the SD card or simply proceed with the default setting by clicking on the "Next" button.

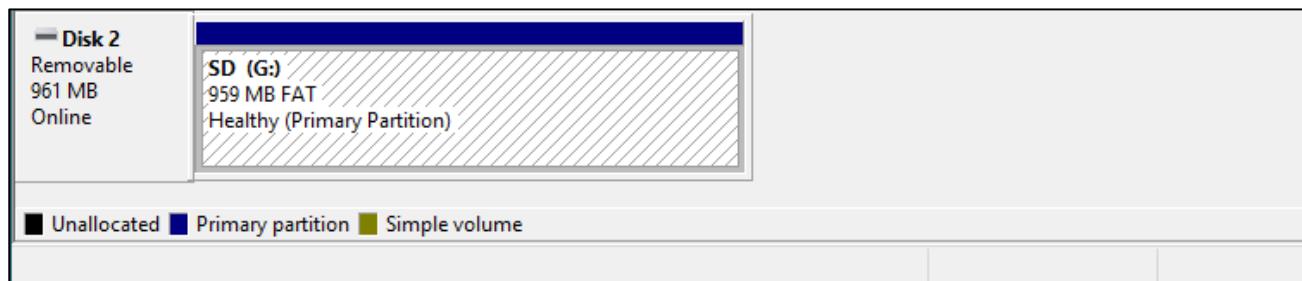


When formatting the SD card, select the file system as FAT (or FAT32) and set the allocation unit size to 16K. You can set the volume label to any name of your choice. Once you have made these selections, click on the "Next" button to proceed.

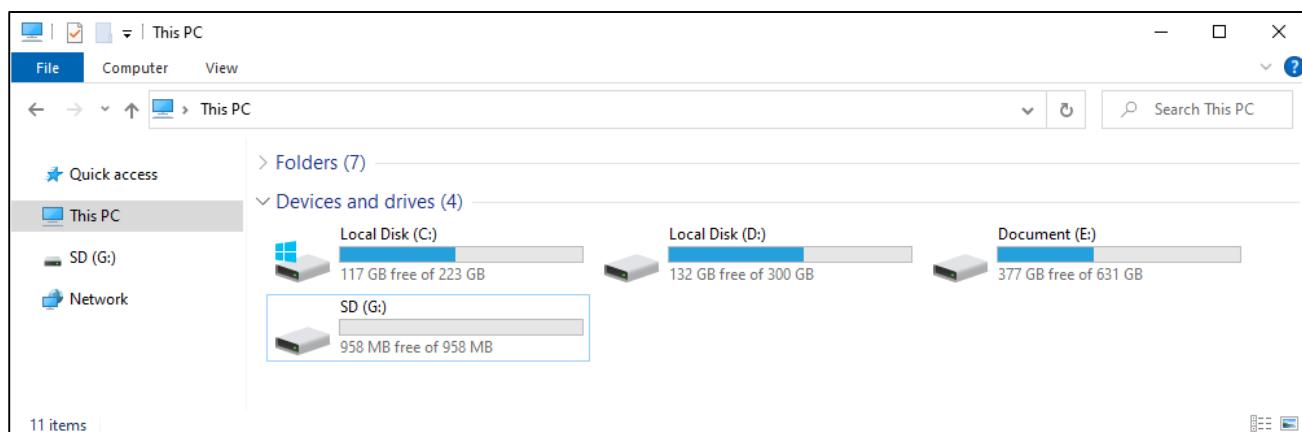


Any concerns? [✉ support@freenove.com](mailto:support@freenove.com)

Click Finish. Wait for the SD card initialization to complete.



After completing the formatting process, you should be able to see the SD card in the "This PC" section of your computer.

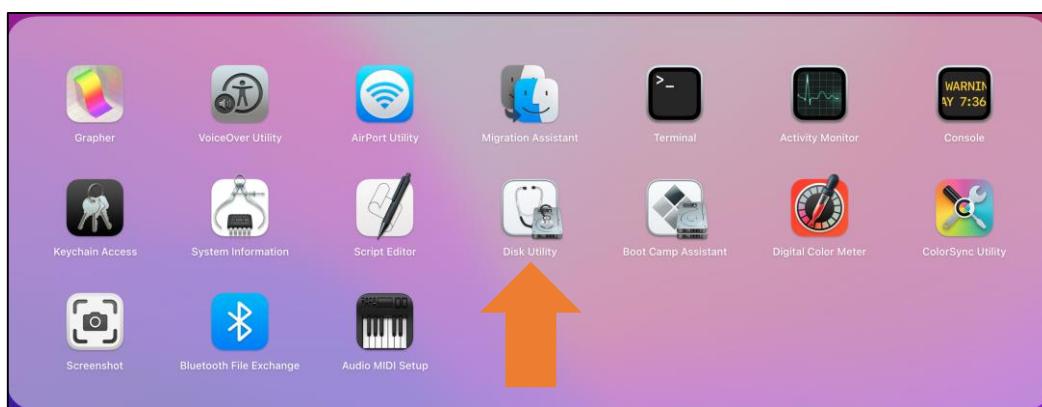


MAC

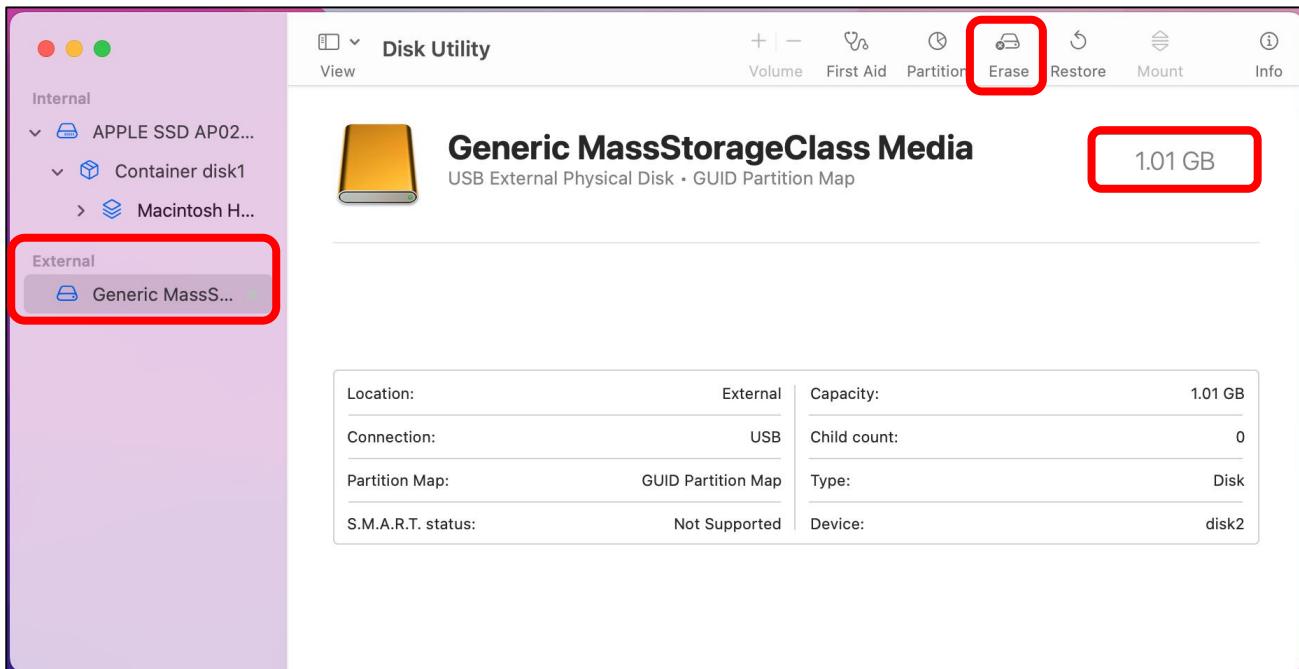
Insert the SD card into the card reader and then insert the card reader into your computer. Some computers may display a prompt with the following message. In this case, please click on the "Ignore" option to proceed.



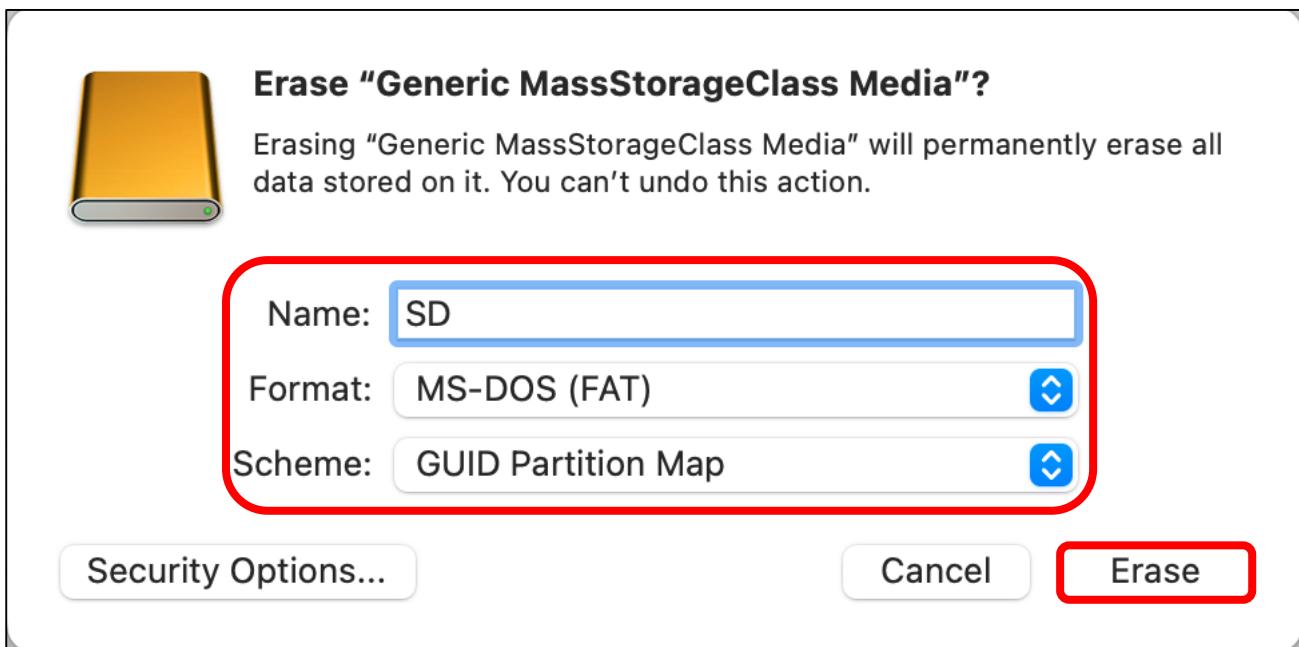
Find "Disk Utility" in the MAC system and click to open it.



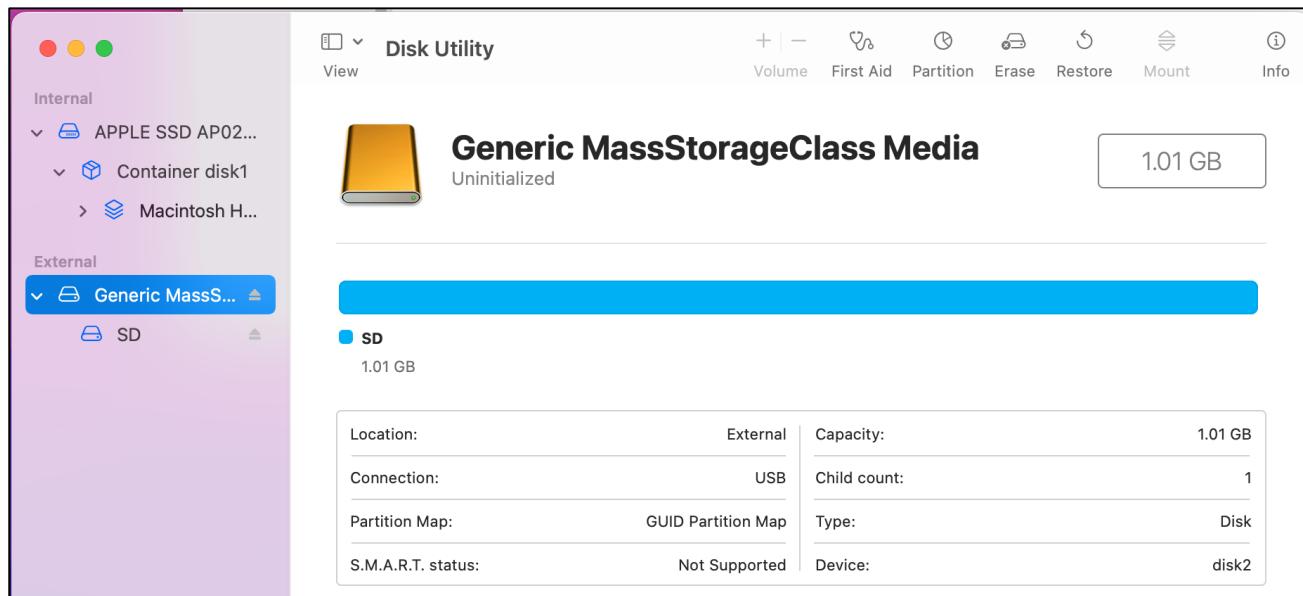
Select "Generic MassStorageClass Media", note that its size is about 1G. It is important to select the correct item to avoid accidentally erasing the wrong device. Once you have verified that you have selected the correct device, click on the "Erase" button to proceed with erasing the SD card.



Select the configuration as shown in the figure below, and then click "Erase".

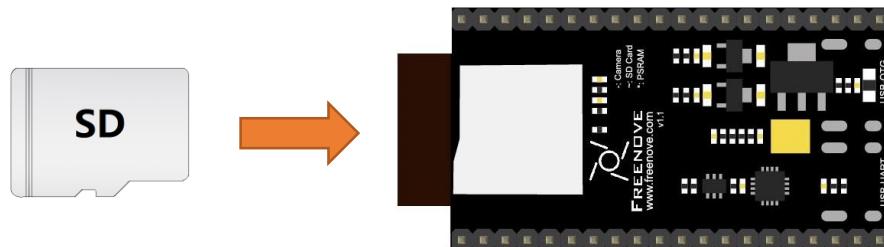


Please wait for the formatting process to complete. Once it is finished, the interface should resemble the image below. You should now be able to see a new disk named "SD" on your desktop.

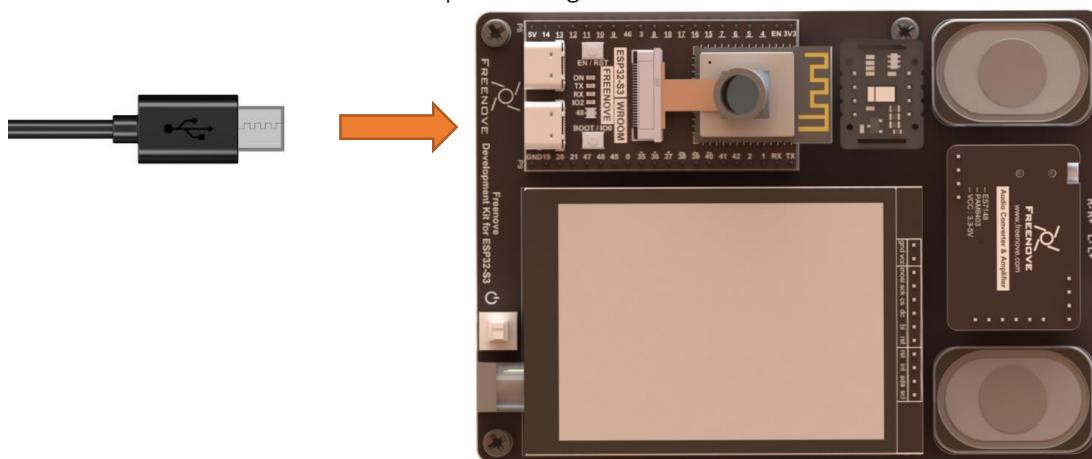


Circuit

Before connecting the USB cable, insert the SD card into the SD card slot on the back of the ESP32-S3.



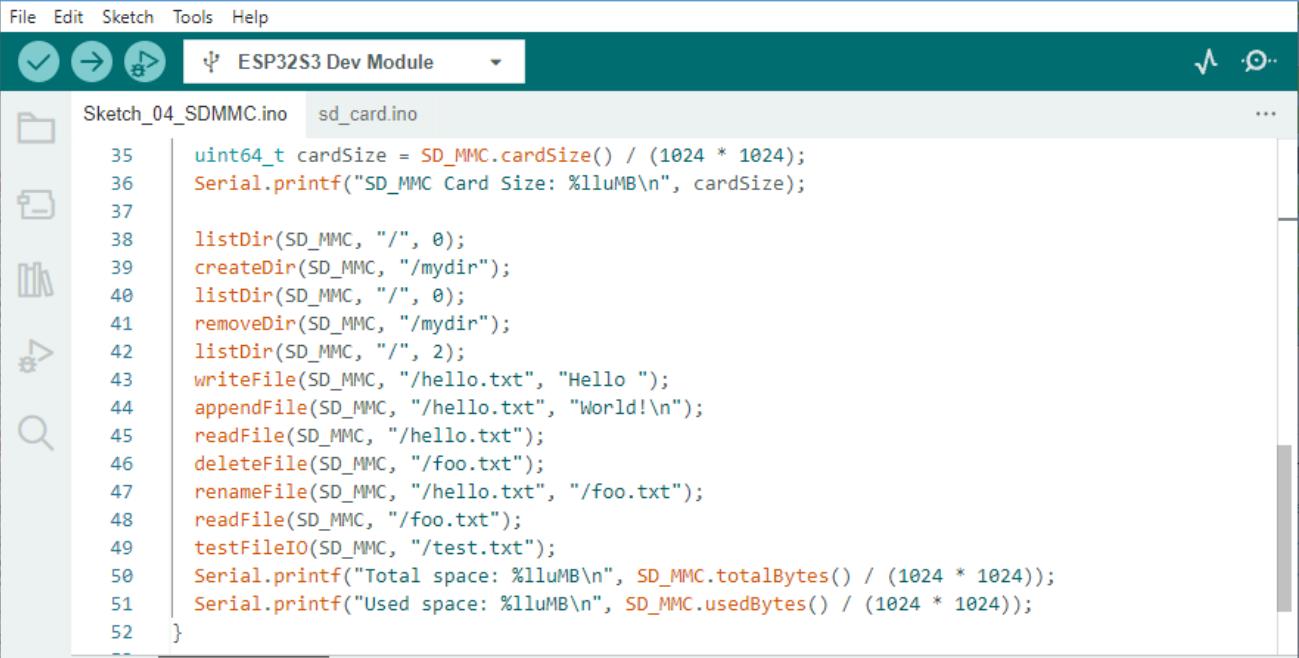
Connect Freenove ESP32-S3 to the computer using the USB cable.



Sketch

Any concerns? ✉ support@freenove.com

Sketch_04_SDMMC



```

File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_04_SDMMC.ino sd_card.ino ...
35  uint64_t cardSize = SD_MMC.cardSize() / (1024 * 1024);
36  Serial.printf("SD_MMC Card Size: %lluMB\n", cardSize);
37
38  listDir(SD_MMC, "/", 0);
39  createDir(SD_MMC, "/mydir");
40  listDir(SD_MMC, "/", 0);
41  removeDir(SD_MMC, "/mydir");
42  listDir(SD_MMC, "/", 2);
43  writeFile(SD_MMC, "/hello.txt", "Hello ");
44  appendFile(SD_MMC, "/hello.txt", "World!\n");
45  readFile(SD_MMC, "/hello.txt");
46  deleteFile(SD_MMC, "/foo.txt");
47  renameFile(SD_MMC, "/hello.txt", "/foo.txt");
48  readFile(SD_MMC, "/foo.txt");
49  testFileIO(SD_MMC, "/test.txt");
50  Serial.printf("Total space: %lluMB\n", SD_MMC.totalBytes() / (1024 * 1024));
51  Serial.printf("Used space: %lluMB\n", SD_MMC.usedBytes() / (1024 * 1024));
52 }

```

Compile and upload the code to ESP32-S3-WROOM, open the serial monitor, and press the RST button on the board.

You can see the printout as shown below.

```

Listing directory: /
DIR : System Volume Information
FILE: test.txt  SIZE: 1048576
FILE: foo.txt  SIZE: 13
DIR : mydir
Removing Dir: /mydir
Dir removed
Listing directory: /
DIR : System Volume Information
Listing directory: /System Volume Information
FILE: WPSettings.dat  SIZE: 12
FILE: IndexerVolumeGuid  SIZE: 76
FILE: test.txt  SIZE: 1048576
FILE: foo.txt  SIZE: 13
Writing file: /hello.txt
File written
Appending to file: /hello.txt
Message appended
Reading file: /hello.txt
Read from file: Hello World!
Deleting file: /foo.txt
File deleted
Renaming file /hello.txt to /foo.txt
File renamed
Reading file: /foo.txt
Read from file: Hello World!
1048576 bytes read for 549 ms
1048576 bytes written for 1172 ms
Total space: 960MB
Used space: 1MB

```

The following is the program code:

```
1 #include "FS.h"
2 #include "SD_MMC.h"
3
4 #define SD_MMC_CMD 38 //Please do not modify it.
5 #define SD_MMC_CLK 39 //Please do not modify it.
6 #define SD_MMC_DO 40 //Please do not modify it.
7
8 void setup() {
9     Serial.begin(115200);
10    SD_MMC.setPins(SD_MMC_CLK, SD_MMC_CMD, SD_MMC_DO);
11    int error = SD_MMC.begin("/sdcard", true, true, SDMMC_FREQ_DEFAULT, 5);
12    if (!error) {
13        Serial.printf("Card Mount Failed: %d\r\n", error);
14        return;
15    }
16    Serial.println("Card Mount Success.");
17    uint8_t cardType = SD_MMC.cardType();
18
19    if (cardType == CARD_NONE) {
20        Serial.println("No SD_MMC card attached");
21        return;
22    }
23
24    Serial.print("SD_MMC Card Type: ");
25    if (cardType == CARD_MMC) {
26        Serial.println("MMC");
27    } else if (cardType == CARD_SD) {
28        Serial.println("SDSC");
29    } else if (cardType == CARD_SDHC) {
30        Serial.println("SDHC");
31    } else {
32        Serial.println("UNKNOWN");
33    }
34
35    uint64_t cardSize = SD_MMC.cardSize() / (1024 * 1024);
36    Serial.printf("SD_MMC Card Size: %lluMB\r\n", cardSize);
37
38    listDir(SD_MMC, "/", 0);
39    createDir(SD_MMC, "/mydir");
40    listDir(SD_MMC, "/", 0);
41    removeDir(SD_MMC, "/mydir");
42    listDir(SD_MMC, "/", 2);
43    writeFile(SD_MMC, "/hello.txt", "Hello ");
```

```

44     appendFile(SD_MMC, "/hello.txt", "World!\n");
45     readFile(SD_MMC, "/hello.txt");
46     deleteFile(SD_MMC, "/foo.txt");
47     renameFile(SD_MMC, "/hello.txt", "/foo.txt");
48     readFile(SD_MMC, "/foo.txt");
49     testFileIO(SD_MMC, "/test.txt");
50     Serial.printf("Total space: %luMB\n", SD_MMC.totalBytes() / (1024 * 1024));
51     Serial.printf("Used space: %luMB\n", SD_MMC.usedBytes() / (1024 * 1024));
52 }
53
54 void loop() {
55 }
```

Add the SD card drive header file.

```

1 #include "FS.h"
2 #include "SD_MMC.h"
```

The drive pins of the SD card are pre-defined and should not be modified as they are fixed. Altering the pins may result in errors or malfunctions while accessing the SD card.

```

4 #define SD_MMC_CMD 38 //Please do not modify it.
5 #define SD_MMC_CLK 39 //Please do not modify it.
6 #define SD_MMC_DO 40 //Please do not modify it.
```

Initialize the serial port function. Sets the drive pin for SDMMC one-bit bus mode.

```

9     Serial.begin(115200);
10    SD_MMC.setPins(SD_MMC_CLK, SD_MMC_CMD, SD_MMC_DO);
```

Set the mount point of the SD card, set SDMMC to one-bit bus mode, and set the read and write speed to 20MHz.

```

11    int error = SD_MMC.begin("/sdcard", true, true, SDMMC_FREQ_DEFAULT, 5);
12    if (!error) {
13        Serial.printf("Card Mount Failed: %d\r\n", error);
14        return;
15    }
```

Get the type of SD card and print it out through the serial port.

```

18    uint8_t cardType = SD_MMC.cardType();
19    if (cardType == CARD_NONE) {
20        Serial.println("No SD_MMC card attached");
21        return;
22    }
23
24    Serial.print("SD_MMC Card Type: ");
25    if (cardType == CARD_MMC) {
26        Serial.println("MMC");
27    } else if (cardType == CARD_SD) {
28        Serial.println("SDSC");
29    } else if (cardType == CARD_SDHC) {
```

```

30     Serial.println("SDHC");
31 } else {
32     Serial.println("UNKNOWN");
33 }
```

Call the listDir() function to read the folder and file names in the SD card, and print them out through the serial port. This function can be found in "sd_read_write.cpp".

```
38 listDir(SD_MMC, "/", 0);
```

Call createDir() to create a folder, and call removeDir() to delete a folder.

```

39 createDir(SD_MMC, "/mydir");
40 removeDir(SD_MMC, "/mydir");
```

Call writeFile() to write any content to the txt file. If there is no such file, create this file first.

Call appendFile() to append any content to txt.

Call readFile() to read the content in txt and print it via the serial port.

```

43 writeFile(SD_MMC, "/hello.txt", "Hello ");
44 appendFile(SD_MMC, "/hello.txt", "World!\n");
45 readFile(SD_MMC, "/hello.txt");
```

Call deleteFile() to delete a specified file.

Call renameFile() to copy a file and rename it.

```

46 deleteFile(SD_MMC, "/foo.txt");
47 renameFile(SD_MMC, "/hello.txt", "/foo.txt");
```

Call the testFileIO() function to test the time it takes to read 512 bytes and the time it takes to write 2048*512 bytes of data.

```
49 testFileIO(SD_MMC, "/test.txt");
```

Print the total size and used size of the SD card via the serial port.

```

50 Serial.printf("Total space: %lluMB\r\n", SD_MMC.totalBytes() / (1024 * 1024));
51 Serial.printf("Used space: %lluMB\r\n", SD_MMC.usedBytes() / (1024 * 1024));
```

If you are interesting in the implementation of functions, you can check them out here.



```

Sketch_04_SDMMC - sd_card.ino | Arduino IDE 2.0.4
File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_04_SDMMC.ino sd_card.ino
1 #include "Arduino.h"
2
3 > void listDir(fs::FS &fs, const char * dirname, uint8_t levels){...
32 }
33
34 > void createDir(fs::FS &fs, const char * path){...
41 }
42
43 > void removeDir(fs::FS &fs, const char * path){ ...
50 }
51
52 > void readFile(fs::FS &fs, const char * path){ ...
65 }
```



Chapter 5 Play SD card music

In the previous study, we have learned how to use the SD card. Now we are going to learn to play the music in the SD card.

Project 5.1 SDMMC Music

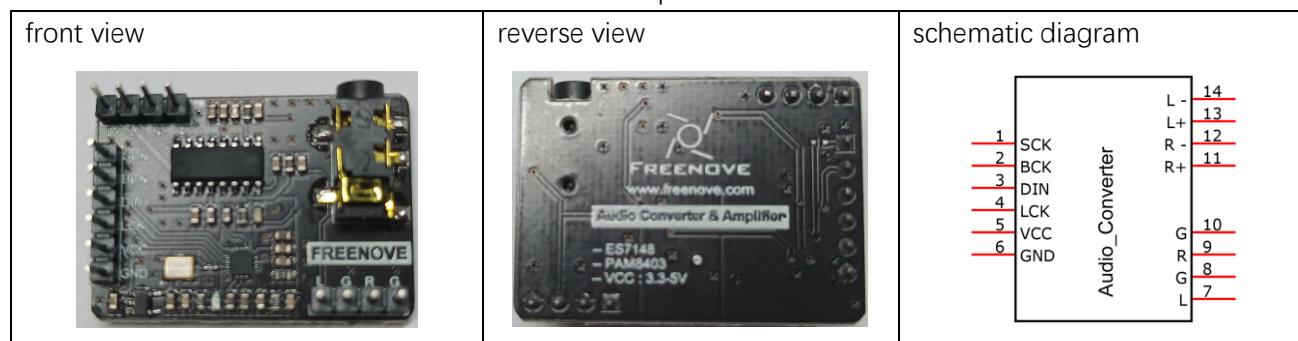
In this project, we will read files in mp3 format from SD card, decode them through ESP32-S3, and use Audio Converter & Amplifier module to transcode into stereo output.

Component List

ESP32-S3 WROOM x1	USB cable x1	SDcard x1
Card reader x1 (random color)	Audio Converter & Amplifier	Speaker
ESP32-S3 WROOM Shield x1	9V battery x1 (Not included in the kit, prepared by yourself)	9V battery cable x1

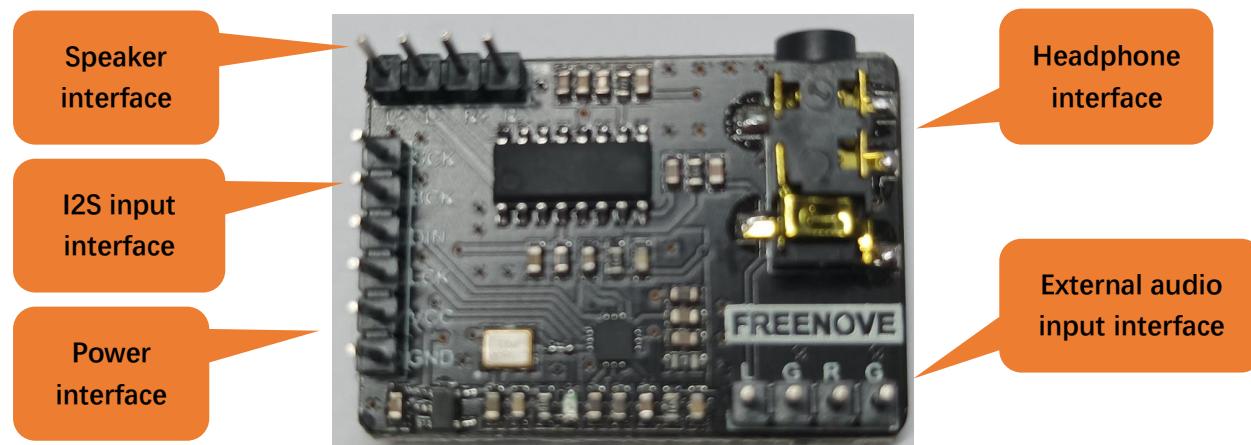
Component knowledge

Here are the front and back of Audio Converter & Amplifier module.



Interface description for Audio Converter & Amplifier module

Pin	Name	Introductions
1	SCK	System clock input
2	BCK	Audio data bit clock input
3	DIN	Audio data input
4	LCK	Audio data word clock input
5	VCC	Power input, 3.3V~5.0V
6	GND	Power Ground
7	L	External audio left channel input
8	G	Power Ground
9	R	External audio right channel input
10	G	Power Ground
11	R+	Positive pole of right channel horn
12	R-	Negative pole of right channel horn
13	L+	Positive pole of left channel horn
14	L-	Negative pole of left channel horn





Speaker interface: The board features two speaker groups, namely Group L (L+ & L-) and Group R (R+ & R-), for connecting the left and right channel speakers. Each speaker interface can be connected to either Group L or Group R. However, it is important to note that connecting one interface to Group L will render the other interface incompatible with Group R. This could cause the module to malfunction, and therefore should be avoided.

Headphone interface: the interface to connect the headphones.

I2S input interface: connect to a device with I2S, transcoding audio data into DAC audio signals.

External audio input interface: connect to external audio equipment. amplifying externally input audio signals.

Power interface: connect to external power supply. The external power supply selected should fall within the range of 3.3V-5.0V.

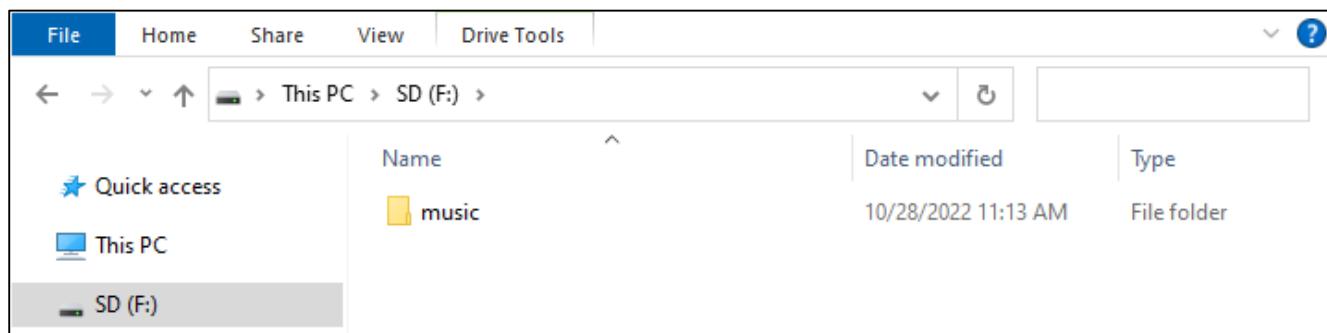
Circuit

Before compiling code, we should copy music to SD card first, as illustrated below.

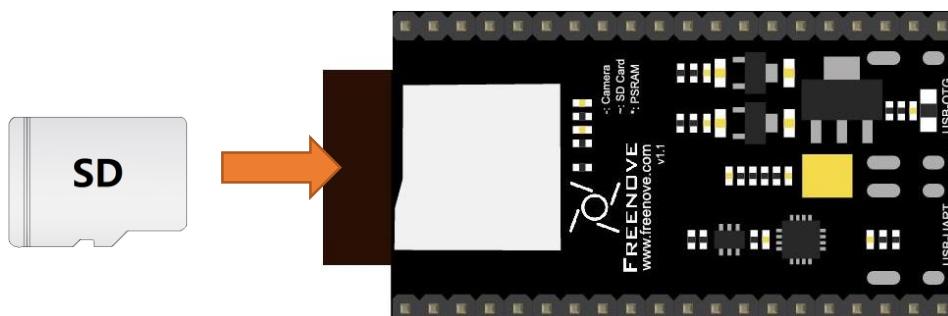
We have placed a folder called "music" in:

Freenove-Development-Kit-for-ESP32-S3\Sketch\Sketch_05_I2S_Audio,

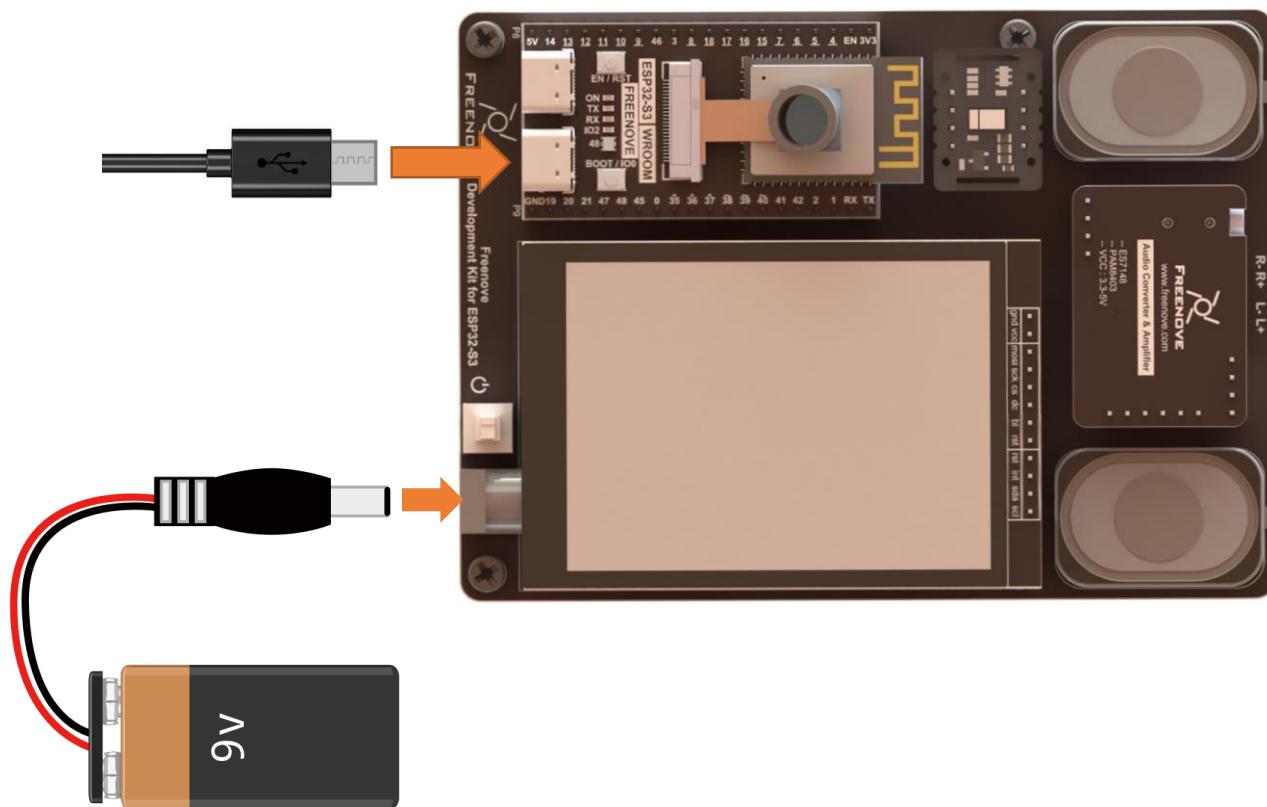
please copy this folder to the SD card.



Before connecting the USB cable, insert the SD card into the SD card slot on the back of the ESP32-S3.



Plug the audio module to the board. Connect Freenove ESP32-S3 to the computer with the USB cable. Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com

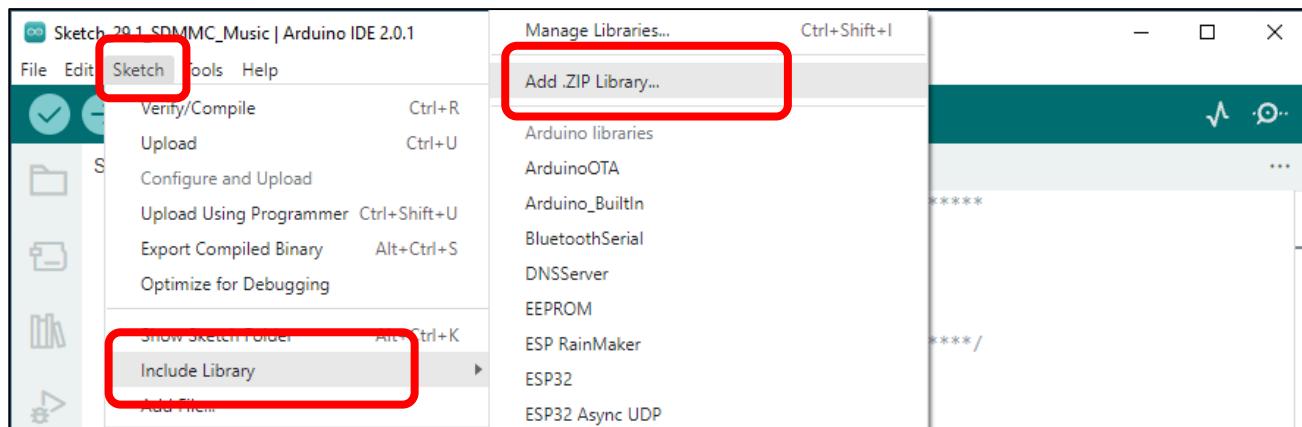


Sketch

How to install the library

In this project, we will use the ESP32-audiol2S.zip library to decode the audio files in the SD card, and then output the audio signal through IIS. If you have not installed this library, please follow the steps below to install it.

Open arduino->Sketch->Include library-> Add .ZIP Library.



In the newly opened window, select "Freenove-Development-Kit-for-ESP32-S3Libraries\ESP32-audioI2S.zip" and click "Open".

Name	Date modified
Arduino-FT6336U.zip	3/7/2023 1:23 PM
ESP32-audioI2S.zip	3/7/2023 1:24 PM
Freenove_W32012_Lib_for_ESP32.zip	3/7/2023 1:24 PM
lvgl.zip	3/7/2023 1:41 PM
SparkFun_MAX3010x_Pulse_and_Proximity.zip	3/7/2023 1:24 PM
TFT_eSPI.zip	3/7/2023 1:24 PM

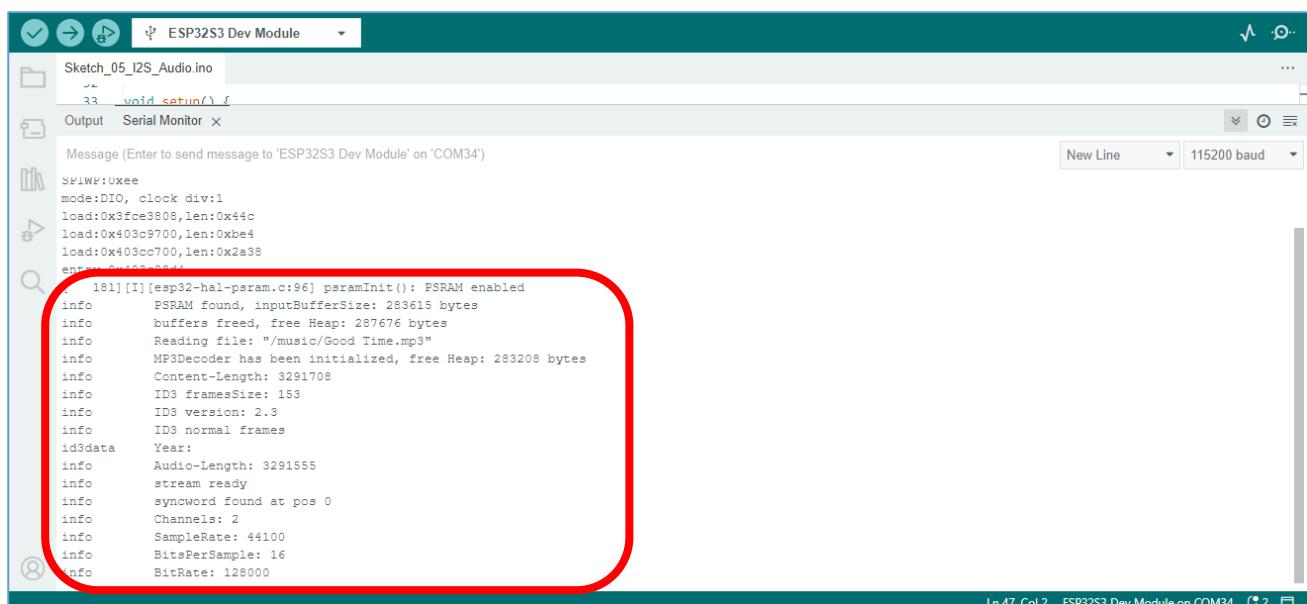
Sketch\Sketch_05_I2S_Audio

Click the upload button to upload the code to ESP32-S3.



Note: If the music fails to play, please check whether the name and path of the music is correct.

Compile and upload the code to the ESP32-S3 WROOM and open the serial monitor. It takes a few seconds to initialize the program. When you see the messages as below, it means that ESP32-S3 has started parsing the mp3 in sd card and started playing music through iis.



The following is the program code:

```
1 #include "Arduino.h"
2 #include "Audio.h"
3 #include "FS.h"
4 #include "SD_MMC.h"
5
6 #define SD_MMC_CMD 38
7 #define SD_MMC_CLK 39
8 #define SD_MMC_DO 40
9 #define I2S_BCLK 42
10 #define I2S_DOUT 41
11 #define I2S_LRC 14
12
13 Audio audio;
14
15 void setup() {
16     Serial.begin(115200);
17     SD_MMC.setPins(SD_MMC_CLK, SD_MMC_CMD, SD_MMC_DO);
18     if (!SD_MMC.begin("/sdcard", true, true, SDMMC_FREQ_DEFAULT, 5)) {
19         Serial.println("Card Mount Failed");
20         return;
21     }
22     audio.setPinout(I2S_BCLK, I2S_LRC, I2S_DOUT);
23     audio.setVolume(12); // 0...21
24     audio.connecttoFS(SD_MMC, "/music/Good Time.mp3");
25 }
26
27 void loop() {
28     audio.loop();
29     if (Serial.available()) { // put streamURL in serial monitor
30         audio.stopSong();
31         String r = Serial.readString();
32         r.trim();
33         if (r.length() > 5) audio.connecttoFS(SD_MMC, r.c_str());
34         log_i("free heap=%i", ESP.getFreeHeap());
35     }
36 }
37
38 // optional
39 void audio_info(const char *info) {
40     Serial.print("info      "); Serial.println(info);
41 }
42 void audio_id3data(const char *info) { //id3 metadata
43     Serial.print("id3data      "); Serial.println(info);
```

```

44 }
45 void audio_eof_mp3(const char *info) { //end of file
46   Serial.print("eof_mp3      "); Serial.println(info);
47 }
48 void audio_showstation(const char *info) {
49   Serial.print("station      "); Serial.println(info);
50 }
51 void audio_showstreamtitle(const char *info) {
52   Serial.print("streamtitle  "); Serial.println(info);
53 }
54 void audio_bitrate(const char *info) {
55   Serial.print("bitrate      "); Serial.println(info);
56 }
57 void audio_commercial(const char *info) { //duration in sec
58   Serial.print("commercial   "); Serial.println(info);
59 }
60 void audio_icyurl(const char *info) { //homepage
61   Serial.print("icyurl      "); Serial.println(info);
62 }
63 void audio_lasthost(const char *info) { //stream URL played
64   Serial.print("lasthost     "); Serial.println(info);
65 }

```

Add music decoding header files and SD card drive files.

```

1 #include "Arduino.h"
2 #include "Audio.h"
3 #include "FS.h"
4 #include "SD_MMC.h"

```

Define the drive pins for SD card and IIS. Note that the SD card driver pins cannot be modified, but the IIS drive pins can be modified.

```

6 #define SD_MMC_CMD 38
7 #define SD_MMC_CLK 39
8 #define SD_MMC_DO  40
9 #define I2S_BCLK  42
10 #define I2S_DOUT  41
11 #define I2S_LRC   14

```

Declare an audio decoding object, associate it with the pin, set the volume, and set the decoding object.

```

13 Audio audio;
...
39   audio.setPinout(I2S_BCLK, I2S_LRC, I2S_DOUT);
40   audio.setVolume(12); // 0...21
41   audio.connecttoFS(SD_MMC, "/music/Good Time.mp3");

```

Continuously play music until the current track finishes. Upon receiving data through the serial port, remove any leading or trailing spaces and use the audio object to decode the data.

```
45     audio.loop();
46     if (Serial.available()) { // put streamURL in serial monitor
47         audio.stopSong();
48         String r = Serial.readString();
49         r.trim();
50         if (r.length() > 5) audio.connecttoFS(SD_MMC, r.c_str());
51         log_i("free heap=%i", ESP.getFreeHeap());
52     }
```

In other words, if you want to switch the music in the SD card, you can directly input the song through the serial port.



These functions are used to print information about audio decoding. If you don't want to see this information in the serial port, you can simply comment out these functions."

```
67 void audio_info(const char *info);
71 void audio_id3data(const char *info);
75 void audio_eof_mp3(const char *info);
79 void audio_showstation(const char *info);
83 void audio_showstreamtitle(const char *info);
87 void audio_bitrate(const char *info);
91 void audio_commercial(const char *info);
95 void audio_icyurl(const char *info);
99 void audio_lasthost(const char *info);
```

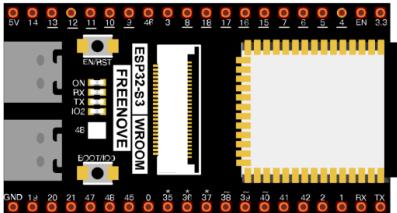
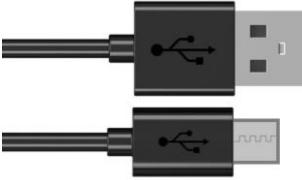
Chapter 6 MAX30102

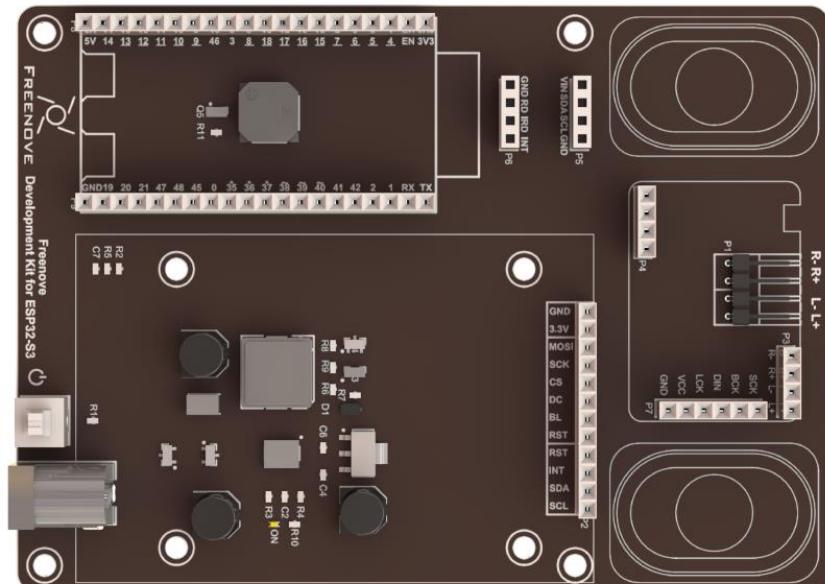
In this section, we will explore how to utilize the MAX30102 module to measure human heart rate and blood oxygen saturation.

Project 6.1 MAX30102

In this project, we will read data from MAX30102, process the data, and print it out via serial communication.

Component List

ESP32-S3 WROOM x1	USB cable x1	Max30102
		

ESP32-S3 WROOM Shield x1


Component knowledge

MAX30102 is a module that integrates a pulse oximeter and biometric sensor for monitoring. It includes a red LED and an infrared LED, a photodetector, optical components, and low-noise electronic circuitry with ambient light suppression. It is typically used for heart rate and blood oxygen sensing in wearable devices, and can be worn on the fingertip, earlobe, and wrist.

The MAX30102 module uses the I2C communication interface to transmit the collected data to devices such as Arduino and ESP32 for heart rate and blood oxygen calculations.



When the MAX30102 is operating, it emits red and infrared light. As these lights pass through human tissue, the varying levels of light transmission caused by pulsating blood vessels can be detected by the module's photodetectors. These signals are then converted into electrical signals, amplified, and output to the main control chip.

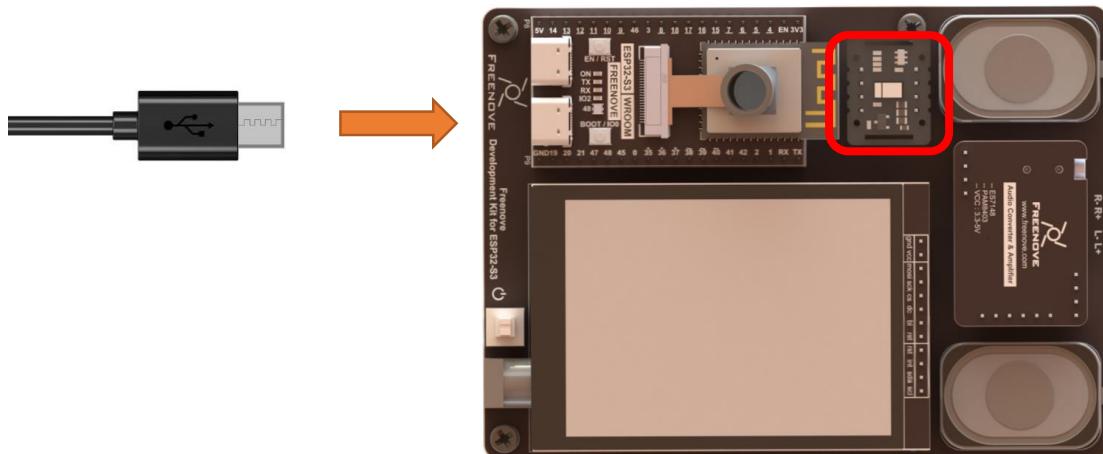
To obtain the data, we only need to access the I2C address of the blood oxygen module using the I2C protocol. The default I2C address for MAX30102 is 0x57.

Introduction to the pins of Max30102 module

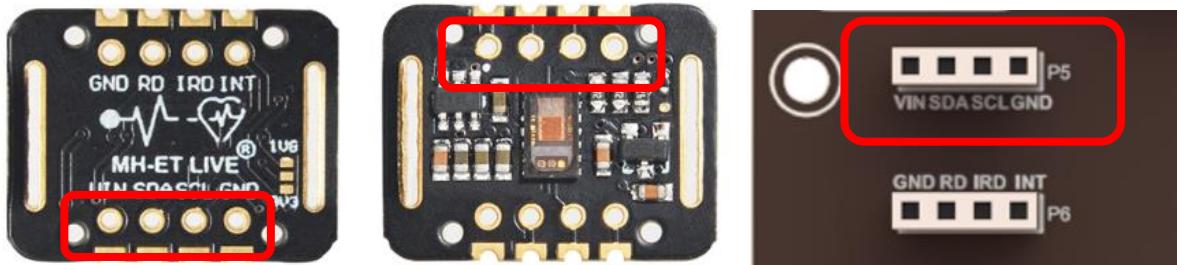
Pin	Name	Introductions
1	Vin	Power input, 3.3V~5.0V
2	SDA	I2C data pin, connect to I2C data line
3	SCL	I2C clock pin, connect to I2C clock line
4	GND	Power Ground
5	INT	Interrupt signal pin of MAX30102 chip
6	IRD	Ground of RED LED, not connected by default
7	RD	Ground of IR LED, not connected by default
8	GND	Power Ground

Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.



Please note that when installing the MAX30102 module, it is crucial not to connect it reversely. Doing so may cause adverse effects on the circuit or even damage it. Please follow the marks on the board strictly and make sure that the pins are installed PIN to PIN.



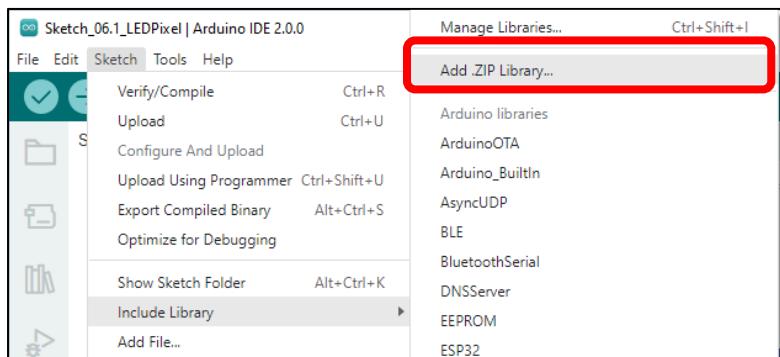
Sketch

This code uses a library named "SparkFun_MAX3010x_Pulse_and_Proximity_Sensor_Library". If you have not installed it, please do so first.

How to install the library

Open Arduino IDE, click Sketch → Include Library → Add .ZIP Library. In the pop-up window, find the file named "Freenove-Development-Kit-for-ESP32-S3\Libraries\

SparkFun_MAX3010x_Pulse_and_Proximity_Sensor_Library.Zip" which locates in this directory, and click OPEN.



Any concerns? ✉ support@freenove.com

Sketch_06_HeartRate

The screenshot shows the Arduino IDE interface with the following details:

- Title Bar:** Sketch_06_HeartRate | Arduino IDE 2.0.4
- Toolbar:** Includes icons for Save, Upload, and a dropdown menu set to "ESP32S3 Dev Module".
- File Menu:** File, Edit, Sketch, Tools, Help.
- Sketch List:** Sketch_06_HeartRate.ino, License.ino
- Code Area:**

```

26 #include <Wire.h>
27 #include "MAX30105.h"
28 #include "heartRate.h"
29
30 #define IIC_SDA 2
31 #define IIC_SCL 1
32
33 MAX30105 particleSensor;
34
35 const byte RATE_SIZE = 4; //Increase this for more averaging. 4 is good.
36 byte rates[RATE_SIZE]; //Array of heart rates
37 byte rateSpot = 0;
38 long lastBeat = 0; //Time at which the last beat occurred
39
40 float beatsPerMinute;
41 int beatAvg;
42
43 void setup()
44 {
45     Serial.begin(115200);
46     Serial.println("Initializing...");
47     Wire.begin(IIC_SDA, IIC_SCL);
48     // Initialize sensor
49     if (!particleSensor.begin(Wire, I2C_SPEED_FAST)) //Use default I2C port, 400kHz speed
50     {
51         Serial.println("MAX30105 was not found. Please check wiring/power. ");
52         while (1);
53     }
    
```
- Output Area:**

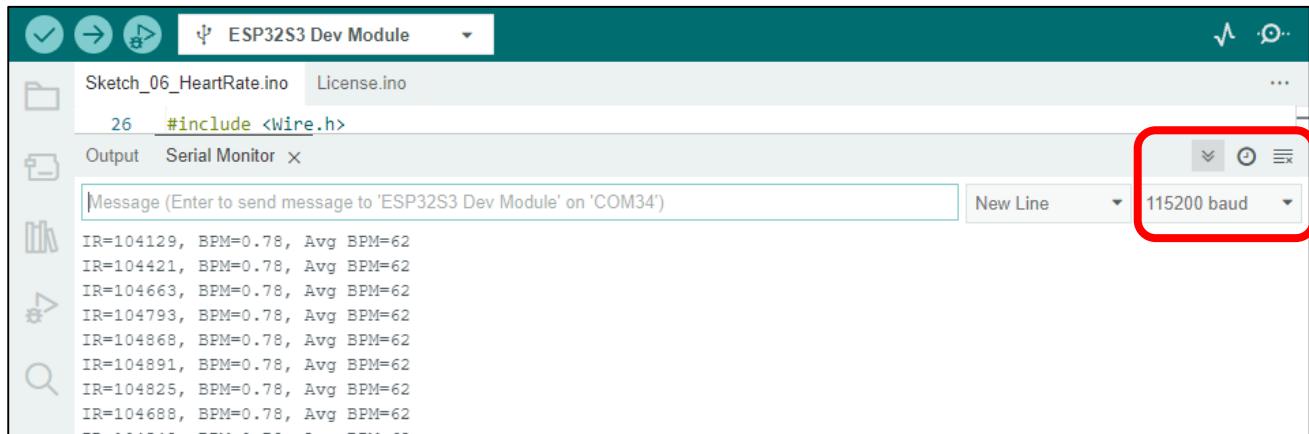
```

Writing at 0x000459cc... (80 %)
Writing at 0x0004bc56... (90 %)
Writing at 0x000513e6... (100 %)
Wrote 288160 bytes (161490 compressed) at 0x00010000 in 2.9 seconds (effective 807.9 kbit/s)...
Hash of data verified.

Leaving...
Hard resetting via RTS pin...
    
```
- Status Bar:** Ln 47, Col 4 ESP32S3 Dev Module on COM34

Click Upload to upload the code to ESP32-S3, and then open the serial port monitor. Set the baud rate to 115200 and gently place the tip of your finger on the Max30102 chip. As shown in the picture below.





The following is the program code:

```

1 #include <Wire.h>
2 #include "MAX30105.h"
3 #include "heartRate.h"
4
5 #define IIC_SDA 2
6 #define IIC_SCL 1
7
8 MAX30105 particleSensor;
9
10 const byte RATE_SIZE = 4; //Increase this for more averaging. 4 is good.
11 byte rates[RATE_SIZE]; //Array of heart rates
12 byte rateSpot = 0;
13 long lastBeat = 0; //Time at which the last beat occurred
14
15 float beatsPerMinute;
16 int beatAvg;
17
18 void setup() {
19   Serial.begin(115200);
20   Serial.println("Initializing...");
21   Wire.begin(IIC_SDA, IIC_SCL);
22   // Initialize sensor
23   if (!particleSensor.begin(Wire, I2C_SPEED_FAST)) { //Use default I2C port, 400kHz speed
24     Serial.println("MAX30105 was not found. Please check wiring/power. ");
25     while (1);
26   }
27   Serial.println("Place your index finger on the sensor with steady pressure.");
28
29   particleSensor.setup(); //Configure sensor with default settings
30   particleSensor.setPulseAmplitudeRed(0x0A); //Turn Red LED to low to indicate sensor is
running
31   particleSensor.setPulseAmplitudeGreen(0); //Turn off Green LED

```

```

32 }
33
34 void loop() {
35     long irValue = particleSensor.getIR();
36     if (checkForBeat(irValue) == true) {
37         //We sensed a beat!
38         long delta = millis() - lastBeat;
39         lastBeat = millis();
40         beatsPerMinute = 60 / (delta / 1000.0);
41         if (beatsPerMinute < 255 && beatsPerMinute > 20) {
42             rates[rateSpot++] = (byte)beatsPerMinute; //Store this reading in the array
43             rateSpot %= RATE_SIZE; //Wrap variable
44             //Take average of readings
45             beatAvg = 0;
46             for (byte x = 0 ; x < RATE_SIZE ; x++)
47                 beatAvg += rates[x];
48             beatAvg /= RATE_SIZE;
49         }
50     }
51     Serial.print("IR=");
52     Serial.print(irValue);
53     Serial.print(", BPM=");
54     Serial.print(beatsPerMinute);
55     Serial.print(", Avg BPM=");
56     Serial.print(beatAvg);
57
58     if (irValue < 50000)
59         Serial.print(" No finger?");
60     Serial.println();
61 }
```

To use some libraries, first you need to include their header file.

```

1 #include <Wire.h>
2 #include "MAX30105.h"
3 #include "heartRate.h"
```

Define I2C pins to communicate with MAX30102 module.

```

5 #define IIC_SDA 2
6 #define IIC_SCL 1
```

Declare an object to manipulate the data that I2C reads and writes to Max30102.

```

8 MAX30105 particleSensor;
```

Initialize I2C and call I2C to initialize the Max30102 module.

```

21 Wire.begin(IIC_SDA, IIC_SCL);
22 // Initialize sensor
23 if (!particleSensor.begin(Wire, I2C_SPEED_FAST)) {//Use default I2C port, 400kHz speed
24     Serial.println("MAX30105 was not found. Please check wiring/power. ");
```

Any concerns? ✉ support@freenove.com

```
25     while (1);
26 }
```

Configure Max30102 module.

```
29     particleSensor.setup(); //Configure sensor with default settings
30     particleSensor.setPulseAmplitudeRed(0x0A); //Turn Red LED to low to indicate sensor is
31     running
32     particleSensor.setPulseAmplitudeGreen(0); //Turn off Green LED
```

Obtain the infrared raw data of Max30102 module.

```
35     long irValue = particleSensor.getIR();
```

Calculate the number of heartbeats per minute and the average number of heartbeats.

We need to consider the fluctuation of data caused by factors such as the location and area of our finger that is in contact with the MAX30102 during each measurement. Therefore, it is more accurate to use the method of summing up and averaging the data to obtain a person's heart rate

```
36     if (checkForBeat(irValue) == true) {
37         //We sensed a beat!
38         long delta = millis() - lastBeat;
39         lastBeat = millis();
40         beatsPerMinute = 60 / (delta / 1000.0);
41         if (beatsPerMinute < 255 && beatsPerMinute > 20) {
42             rates[rateSpot++] = (byte)beatsPerMinute; //Store this reading in the array
43             rateSpot %= RATE_SIZE; //Wrap variable
44             //Take average of readings
45             beatAvg = 0;
46             for (byte x = 0 ; x < RATE_SIZE ; x++)
47                 beatAvg += rates[x];
48             beatAvg /= RATE_SIZE;
49         }
50     }
```

Print out the processed data via serial port.

```
51     Serial.print("IR=");
52     Serial.print(irValue);
53     Serial.print(", BPM=");
54     Serial.print(beatsPerMinute);
55     Serial.print(", Avg BPM=");
56     Serial.print(beatAvg);
```

When the raw data value is smaller than 50,000, it is generally considered that the finger has been removed from the MAX30102 module.

```
58     if (irValue < 50000)
59         Serial.print(" No finger?");
```

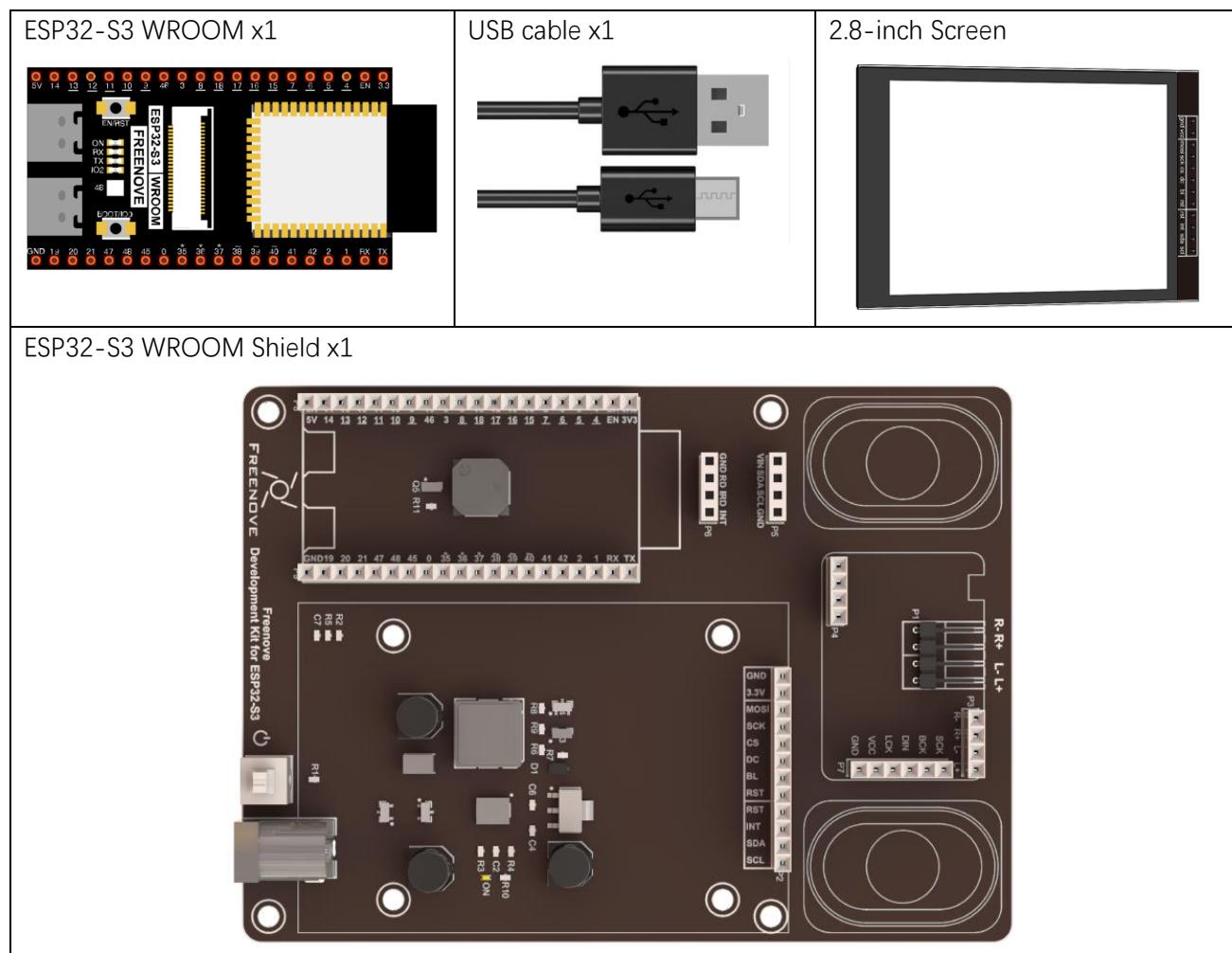
Chapter 7 Driving Freenove 2.8-Inch Screen

From this chapter, we start to learn the use of screens.

Project 7.1 Screen Display Function

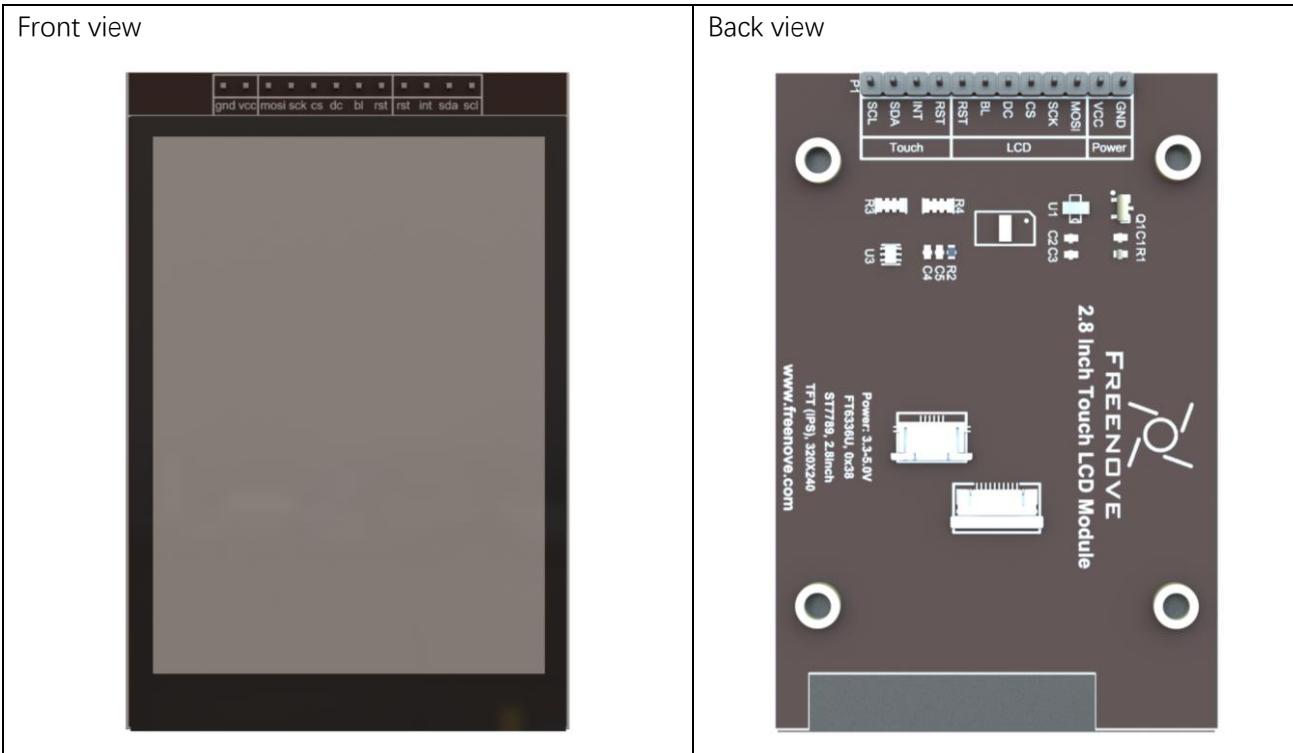
In this project, we will learn how to drive a screen and display information on it.

Component List



Component knowledge

Below are the front and back photos of the Freenove 2.8-inch screen.



Introduction to the pins of Freenove 2.8-inch screen

Pin	Name	Introductions
1	GND	Power Ground
2	VCC	Power input, 3.3V~5.0V
3	MOSI	Connecting to MOSI of SPI line, used to receive data of mcu.
4	SCK	Connecting to SCK of SPI line, used to receive clock signal of mcu.
5	CS	Connecting to CS of SPI line, used to enable/disable SPI communication.
6	DC	Command and data control pin, differentiate commands and data via high and low levels.
7	BL	Screen backlight control pin, enabled with low level by default
8	RST	Screen driver reset pin
9	RST	Touch driver reset pin
10	INT	Touch interrupt pin
11	SDA	Connect to I2C data line
12	SCL	Connect to I2C clock line

Freenove screen uses SPI protocol to drive screen display content and uses I2C protocol to obtain touch information from the screen..

For more details, please refer to

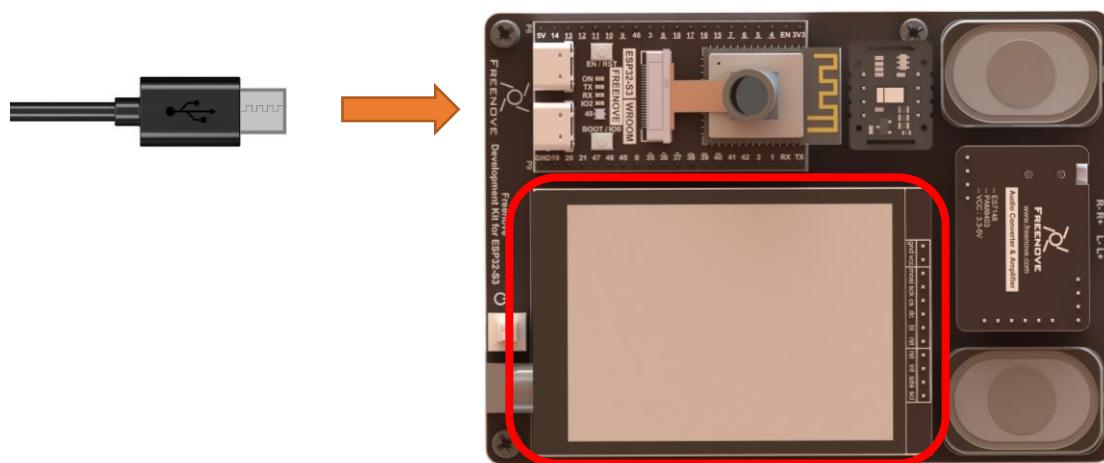
[Freenove-Development-Kit-for-ESP32-S3\Datasheet\ST7789V_SPEC_V1.0.pdf](#)

[Freenove-Development-Kit-for-ESP32-S3\Datasheet\FocalTech-FT6336U.pdf](#)

Any concerns? [✉ support@freenove.com](mailto:support@freenove.com)

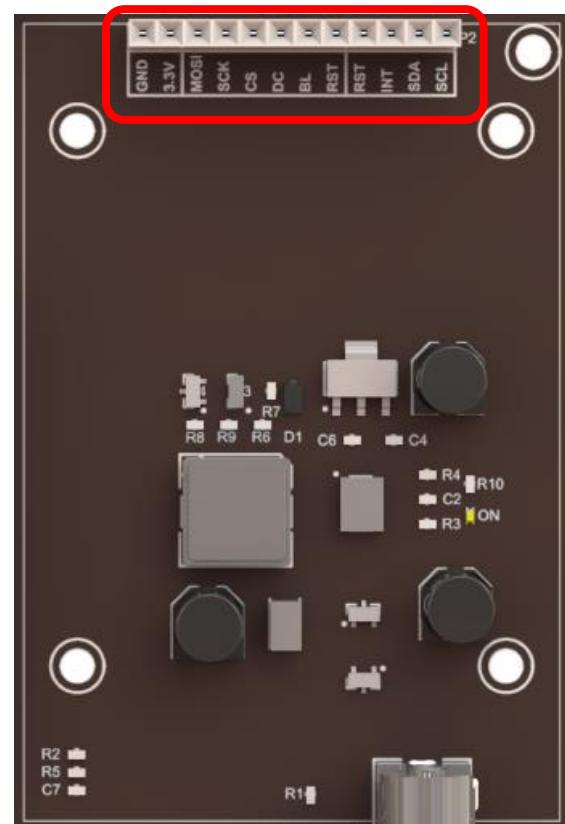
Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.



Note:

When connecting the screen to the ESP32-S3 WROOM Shield, please ensure that the pins are aligned with the marks before applying power to avoid damaging the screen.



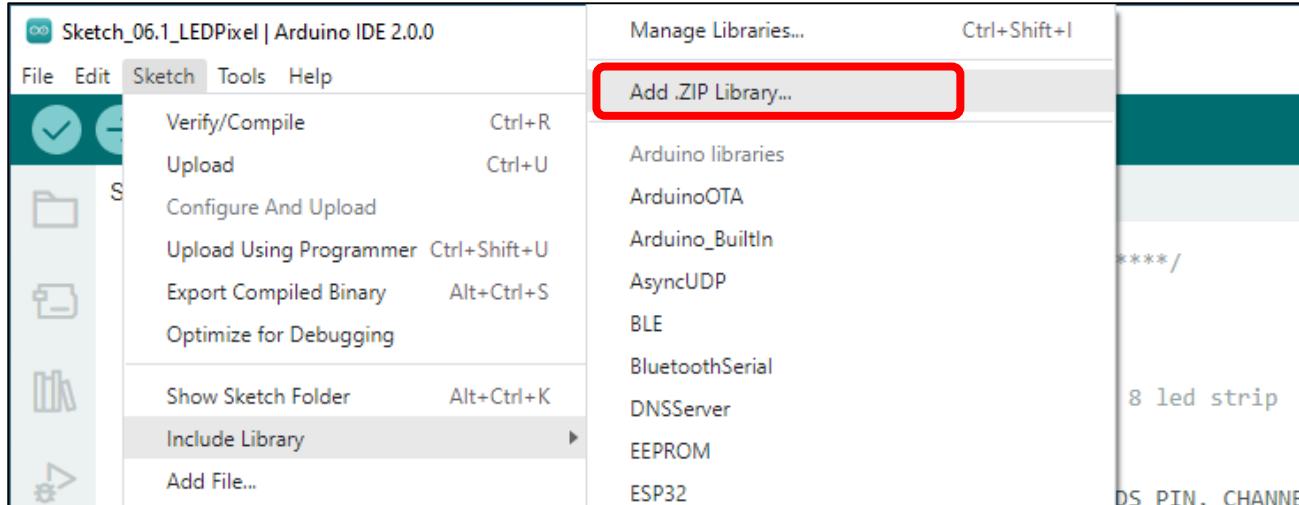


Sketch

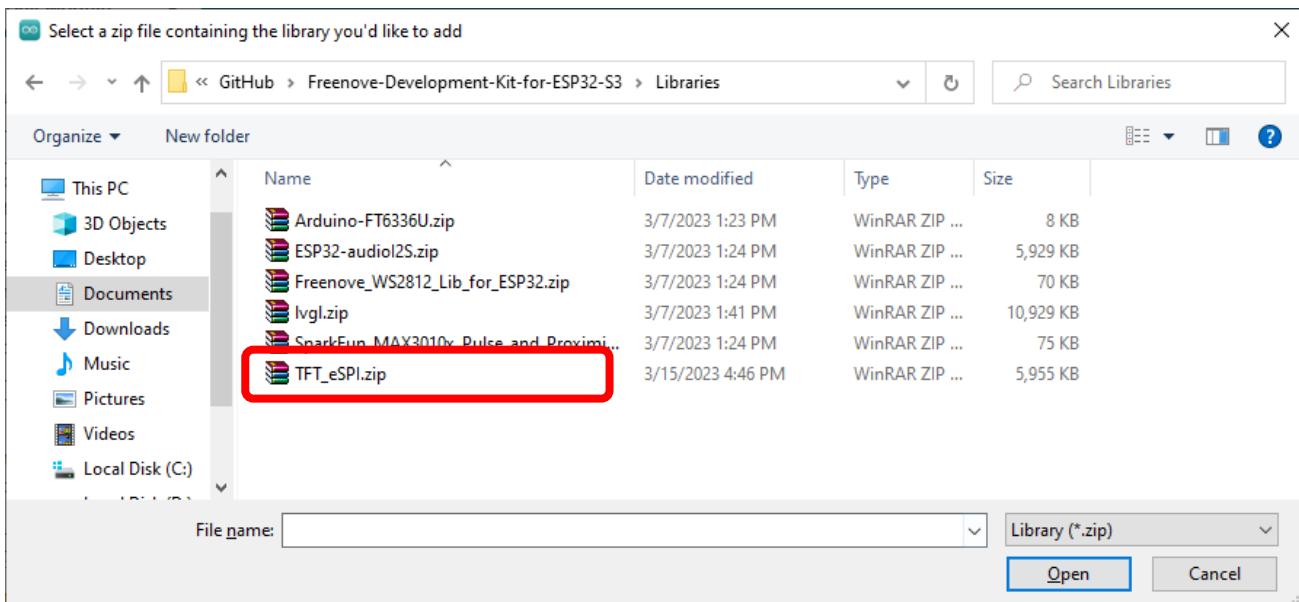
This code uses a library named "TFT_eSPI". If you have not installed it, please do so first.

How to install the library

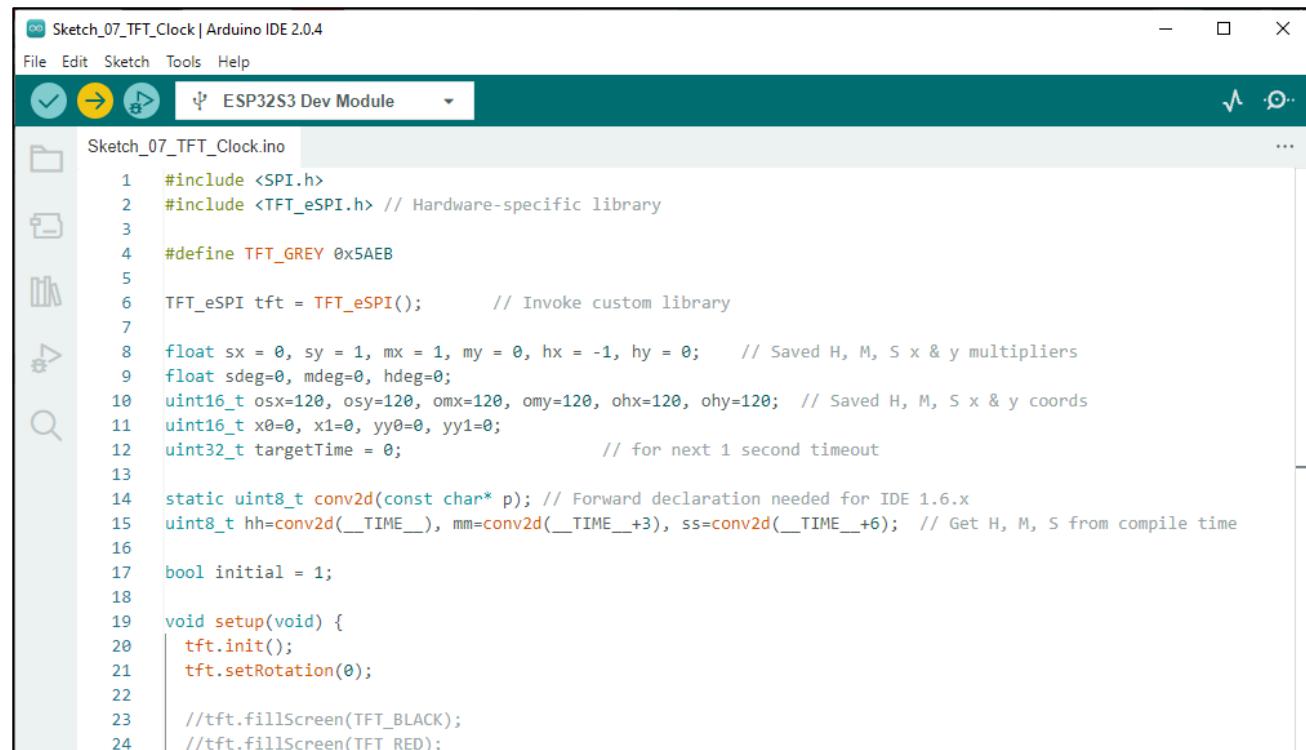
Open Arduino IDE, click Sketch → Include Library → Add .ZIP Library. In the pop-up window, find the file named "**Freenove-Development-Kit-for-ESP32-S3\Libraries\TFT_eSPI.Zip**", which locates in this directory, and click OPEN.



Select TFT_eSPI.zip and click Open.



Sketch_07_TFT_Clock



```

Sketch_07_TFT_Clock | Arduino IDE 2.0.4
File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_07_TFT_Clock.ino
1 #include <SPI.h>
2 #include <TFT_eSPI.h> // Hardware-specific library
3
4 #define TFT_GREY 0x5AEB
5
6 TFT_eSPI tft = TFT_eSPI(); // Invoke custom library
7
8 float sx = 0, sy = 1, mx = 1, my = 0, hx = -1, hy = 0; // Saved H, M, S x & y multipliers
9 float sdeg=0, mdeg=0, hdeg=0;
10 uint16_t osx=120, osy=120, omx=120, omy=120, ohx=120, ohy=120; // Saved H, M, S x & y coords
11 uint16_t x0=0, x1=0, yy0=0, yy1=0;
12 uint32_t targetTime = 0; // for next 1 second timeout
13
14 static uint8_t conv2d(const char* p); // Forward declaration needed for IDE 1.6.x
15 uint8_t hh=conv2d(__TIME__), mm=conv2d(__TIME__+3), ss=conv2d(__TIME__+6); // Get H, M, S from compile time
16
17 bool initial = 1;
18
19 void setup(void) {
20     tft.init();
21     tft.setRotation(0);
22
23     //tft.fillScreen(TFT_BLACK);
24     //tft.fillScreen(TFT_RED);

```

Click "Upload" to upload the code to the ESP32-S3. Wait for the code to finish uploading, and the screen will display a clock as shown in the following figure.



The following is the program code:

1	#include <SPI.h>
2	#include <TFT_eSPI.h> // Hardware-specific library
3	
4	#define TFT_GREY 0x5AEB
5	
6	TFT_eSPI tft = TFT_eSPI(); // Invoke custom library
7	
8	float sx = 0, sy = 1, mx = 1, my = 0, hx = -1, hy = 0; // Saved H, M, S x & y multipliers

```
9 float sdeg=0, mdeg=0, hdeg=0;
10 uint16_t osx=120, osy=120, omx=120, omy=120, ohx=120, ohy=120; // Saved H, M, S x & y coords
11 uint16_t x0=0, x1=0, yy0=0, yy1=0;
12 uint32_t targetTime = 0; // for next 1 second timeout
13
14 static uint8_t conv2d(const char* p); // Forward declaration needed for IDE 1.6.x
15 uint8_t hh=conv2d(__TIME__), mm=conv2d(__TIME__+3), ss=conv2d(__TIME__+6); // Get H, M, S
from compile time
16
17 bool initial = 1;
18
19 void setup(void) {
20     tft.init();
21     tft.setRotation(0);
22
23 //tft.fillScreen(TFT_BLACK);
24 //tft.fillScreen(TFT_RED);
25 //tft.fillScreen(TFT_GREEN);
26 //tft.fillScreen(TFT_BLUE);
27 //tft.fillScreen(TFT_BLACK);
28 tft.fillScreen(TFT_GREY);
29
30 tft.setTextColor(TFT_WHITE, TFT_GREY); // Adding a background colour erases previous text
automatically
31
32 // Draw clock face
33 tft.fillCircle(120, 120, 118, TFT_GREEN);
34 tft.fillCircle(120, 120, 110, TFT_BLACK);
35
36 // Draw 12 lines
37 for(int i = 0; i<360; i+= 30) {
38     sx = cos((i-90)*0.0174532925);
39     sy = sin((i-90)*0.0174532925);
40     x0 = sx*114+120;
41     yy0 = sy*114+120;
42     x1 = sx*100+120;
43     yy1 = sy*100+120;
44
45     tft.drawLine(x0, yy0, x1, yy1, TFT_GREEN);
46 }
47
48 // Draw 60 dots
49 for(int i = 0; i<360; i+= 6) {
50     sx = cos((i-90)*0.0174532925);
```

```
51     sy = sin((i-90)*0.0174532925);
52     x0 = sx*102+120;
53     yy0 = sy*102+120;
54     // Draw minute markers
55     tft.drawPixel(x0, yy0, TFT_WHITE);
56
57     // Draw main quadrant dots
58     if(i==0 || i==180) tft.fillCircle(x0, yy0, 2, TFT_WHITE);
59     if(i==90 || i==270) tft.fillCircle(x0, yy0, 2, TFT_WHITE);
60 }
61
62 tft.fillCircle(120, 121, 3, TFT_WHITE);
63
64 tft.drawCentreString("Freenove", 70, 260, 4);
65 tft.drawString("V1.0", 200, 280, 2);
66 targetTime = millis() + 1000;
67 }
68
69 void loop() {
70     if (targetTime < millis()) {
71         targetTime += 1000;
72         ss++;           // Advance second
73         if (ss==60) {
74             ss=0;
75             mm++;           // Advance minute
76             if(mm>59) {
77                 mm=0;
78                 hh++;           // Advance hour
79                 if (hh>23) {
80                     hh=0;
81                 }
82             }
83         }
84
85         // Pre-compute hand degrees, x & y coords for a fast screen update
86         sdeg = ss*6;           // 0-59 -> 0-354
87         mdeg = mm*6+sdeg*0.01666667; // 0-59 -> 0-360 - includes seconds
88         hdeg = hh*30+mdeg*0.0833333; // 0-11 -> 0-360 - includes minutes and seconds
89         hx = cos((hdeg-90)*0.0174532925);
90         hy = sin((hdeg-90)*0.0174532925);
91         mx = cos((mdeg-90)*0.0174532925);
92         my = sin((mdeg-90)*0.0174532925);
93         sx = cos((sdeg-90)*0.0174532925);
94         sy = sin((sdeg-90)*0.0174532925);
```

```

95
96     if (ss==0 || initial) {
97         initial = 0;
98         // Erase hour and minute hand positions every minute
99         tft.drawLine(ohx, ohy, 120, 121, TFT_BLACK);
100        ohx = hx*62+121;
101        ohy = hy*62+121;
102        tft.drawLine(omx, omy, 120, 121, TFT_BLACK);
103        omx = mx*84+120;
104        omy = my*84+121;
105    }
106
107    // Redraw new hand positions, hour and minute hands not erased here to avoid flicker
108    tft.drawLine(osx, osy, 120, 121, TFT_BLACK);
109    osx = sx*90+121;
110    osy = sy*90+121;
111    tft.drawLine(osx, osy, 120, 121, TFT_RED);
112    tft.drawLine(ohx, ohy, 120, 121, TFT_WHITE);
113    tft.drawLine(omx, omy, 120, 121, TFT_WHITE);
114    tft.drawLine(osx, osy, 120, 121, TFT_RED);
115
116    tft.fillCircle(120, 121, 3, TFT_RED);
117 }
118 }
119
120 static uint8_t conv2d(const char* p) {
121     uint8_t v = 0;
122     if ('0' <= *p && *p <= '9')
123         v = *p - '0';
124     return 10 * v + *++p - '0';
125 }
```

To use some libraries, first you need to include their header files.

```

1 #include <SPI.h>
2 #include <TFT_eSPI.h> // Hardware-specific library
```

Declare a tft object for operating the screen.

```

6 TFT_eSPI tft = TFT_eSPI(); // Invoke custom library
```

TIME represents the current time at which the code was uploaded. The function conv2d is used to convert a string to a number.

```

14 static uint8_t conv2d(const char* p); // Forward declaration needed for IDE 1.6.x
15 uint8_t hh=conv2d(__TIME__), mm=conv2d(__TIME__+3), ss=conv2d(__TIME__+6); // Get H, M, S
from compile time
```

Initialize the screen and set not to rotate. The values 0-3 represent screen rotations of 0, 90, 180, and 270 degrees, respectively.

```

20 tft.init();
```

```
21    tft.setRotation(0);
```

Screen filling function. It can be used to set the background color of the screen.

```
28    tft.fillScreen(TFT_GREY);
```

Before using a font, first use the setTextColor function to set the font and its background color.

```
30    tft.setTextColor(TFT_WHITE, TFT_GREY); // Adding a background colour erases previous text  
      automatically
```

Draw a circle and fill it with color. Use two circles of different sizes to overlap and create the framework for the clock.

```
33    tft.fillCircle(120, 120, 118, TFT_GREEN); // (x, y, r, color)  
34    tft.fillCircle(120, 120, 110, TFT_BLACK);
```

Draw a line. The starting and ending coordinates, as well as the desired color are needed.

```
45    tft.drawLine(x0, yy0, x1, yy1, TFT_GREEN); // (xs, ys, xe, ye, color)
```

Draw a dot, the coordinate and color of which need to be input.

```
45    tft.drawPixel(x0, yy0, TFT_WHITE);
```

Display strings on the screen. The size of text can be set to 2 or 4.

```
64    tft.drawString("Freenove", 70, 260, 4); // (string, x, y, font)
```

For more detailed usage, please refer to: https://github.com/Bodmer/TFT_eSPI

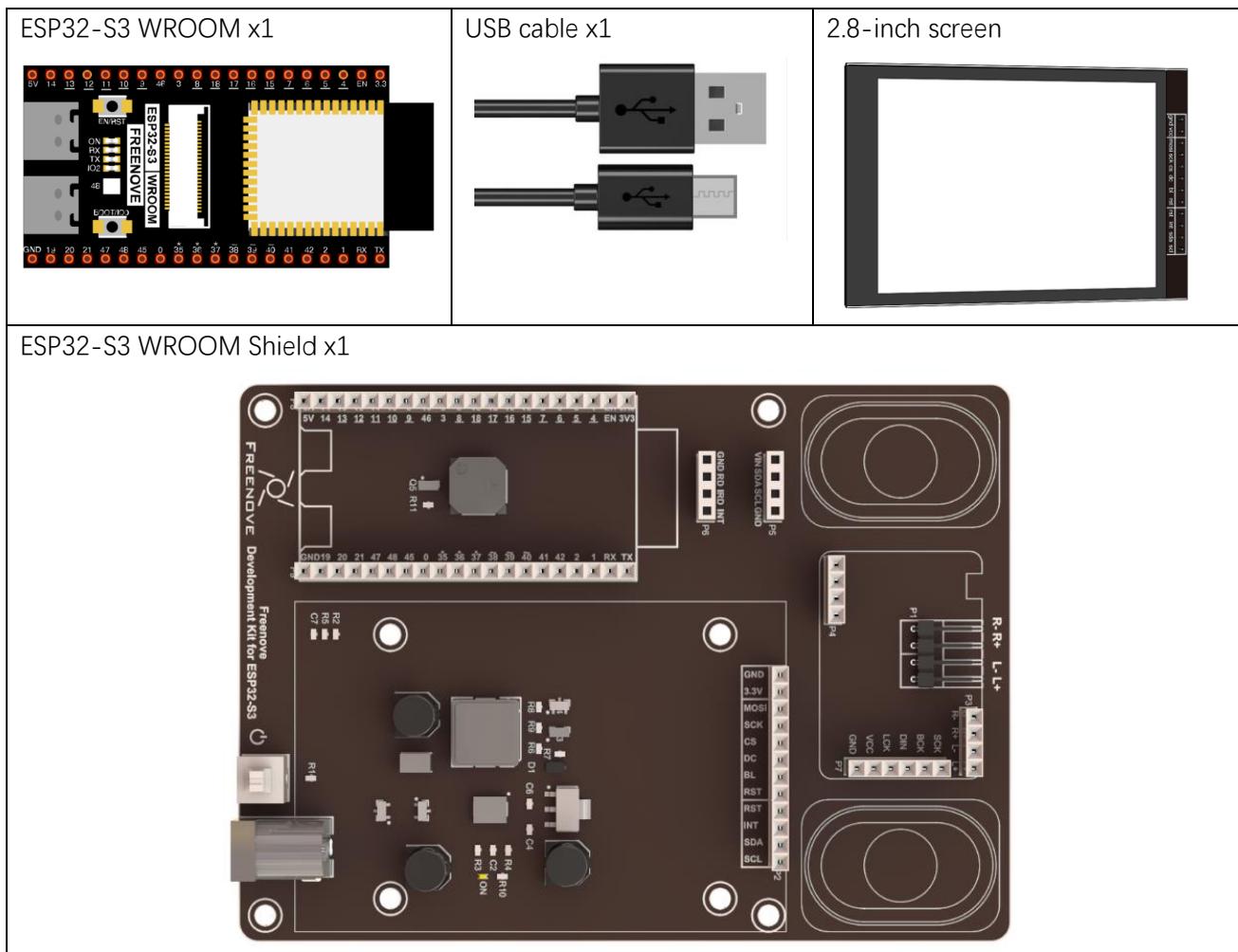
Chapter 8 Touch of Freenove 2.8-Inch Screen

In this chapter, we will learn the usage of screen touch function.

Project 8.1 Touch Function of the Screen

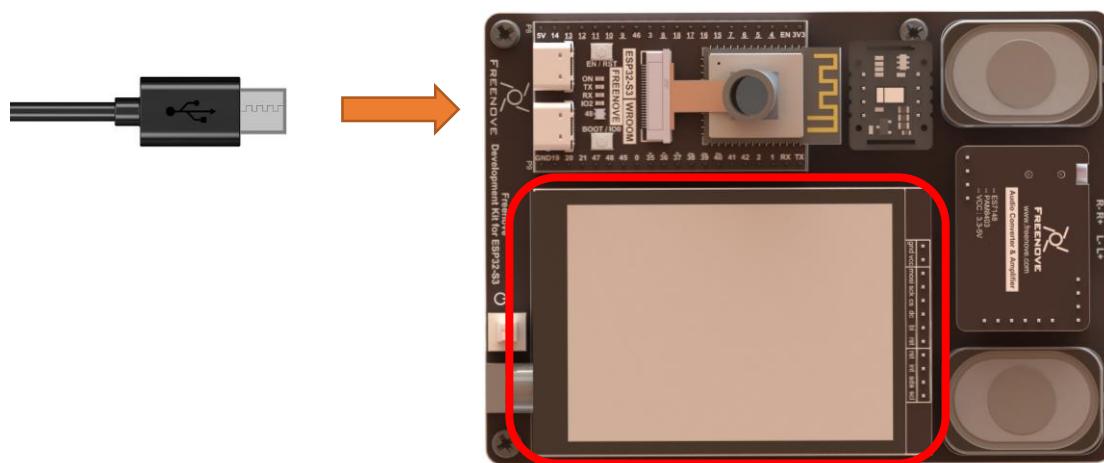
In this project, we will learn to obtain touch data from a screen and print them out through serial port.

Component List



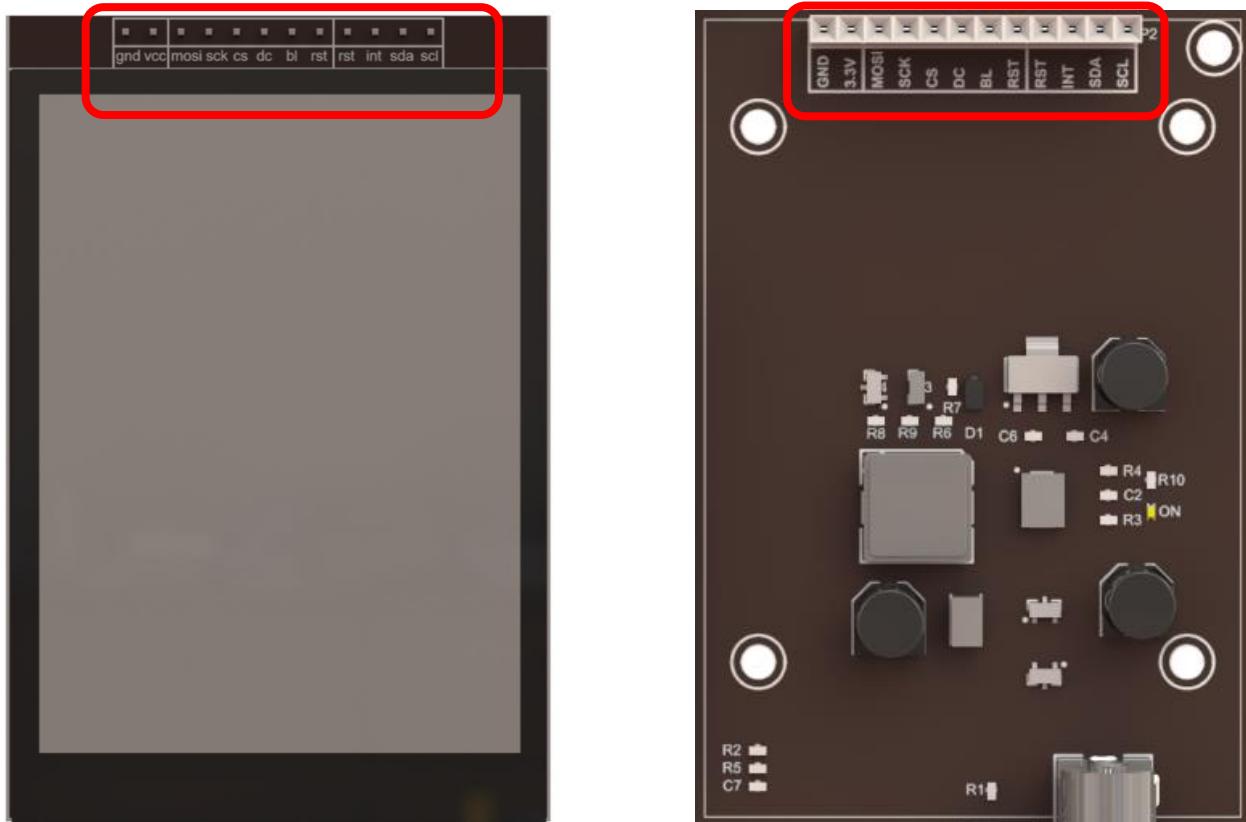
Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.



Note:

When connecting the screen to the ESP32-S3 WROOM Shield, please ensure that the pins are aligned with the marks before applying power to avoid damaging the screen.

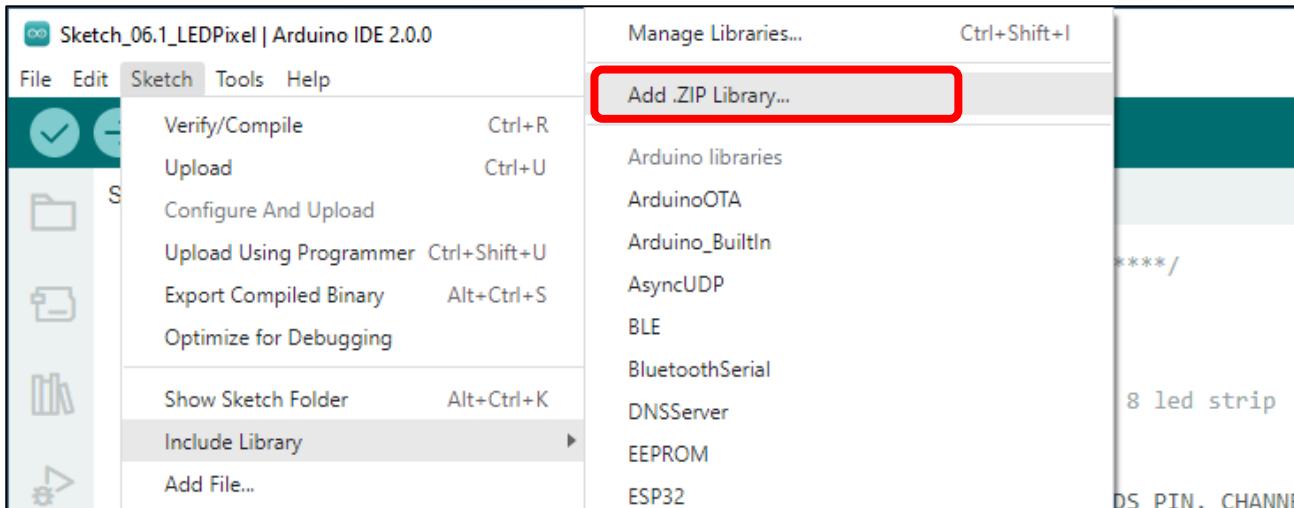


Sketch

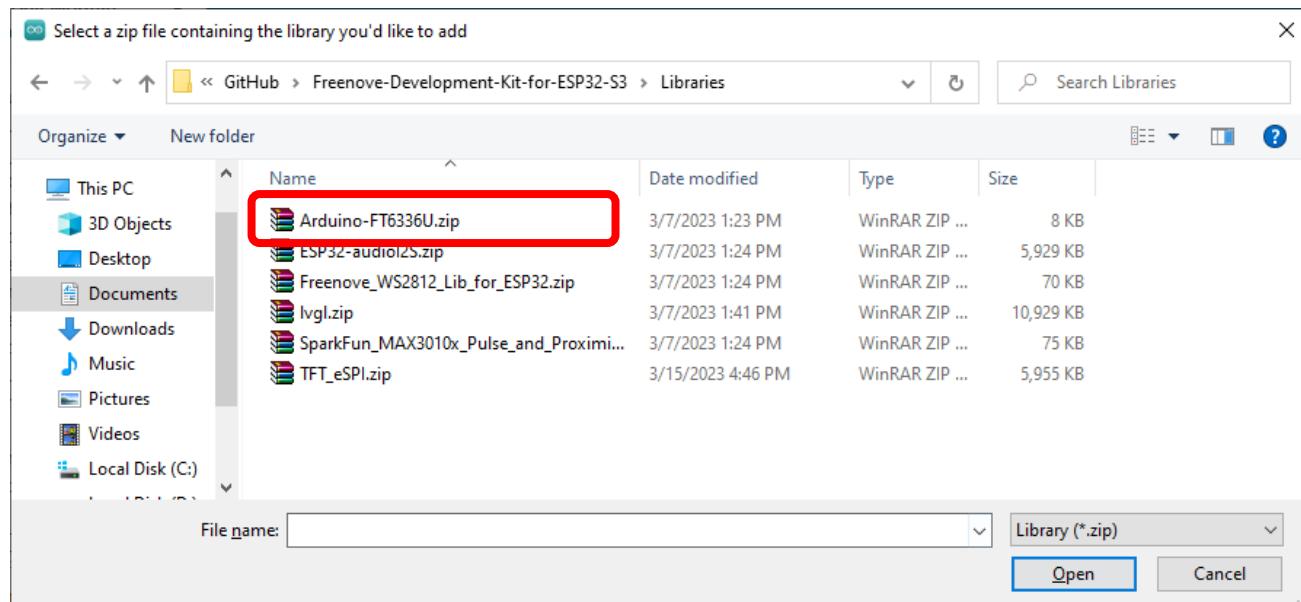
This code uses a library named "**Arduino-FT6336U**". If you have not installed it, please do so first.

How to install the library

Open Arduino IDE, click Sketch → Include Library → Add .ZIP Library. In the pop-up window, find the file named "**Freenove-Development-Kit-for-ESP32-S3\Libraries\Arduino-FT6336U.Zip**", which locates in this directory, and click OPEN.



Select Arduino-FT6336U.zip and click Open.



Sketch_08_Touch

```

Sketch_08_Touch | Arduino IDE 2.0.4
File Edit Sketch Tools Help
Sketch_08_Touch.ino
1 #include "FT6336U.h"
2
3 #define I2C_SDA 2
4 #define I2C_SCL 1
5 #define RST_N_PIN -1
6 #define INT_N_PIN -1
7
8 FT6336U ft6336u(I2C_SDA, I2C_SCL, RST_N_PIN, INT_N_PIN);
9 FT6336U_TouchPointType tp;
10 int state = 0;
11
12 void setup() {
13     Serial.begin(115200);
14     ft6336u.begin();
15     Serial.print("FT6336U Firmware Version: ");
16     Serial.println(ft6336u.read_firmware_id());
17     Serial.print("FT6336U Device Mode: ");
18     Serial.println(ft6336u.read_device_mode());
19 }
20
21 void loop() {
22     tp = ft6336u.scan();
23     char tempString[128];
24     sprintf(tempString, "FT6336U TD Count %d / TD1 (%d, %4d, %4d) / TD2 (%d, %4d, %4d)\r\n", tp.touch_count, t
25     Serial.print(tempString);
26     delay(100);
27 }

```

Click Upload to upload the code to ESP32-S3. After code completes uploading, open the serial monitor, long press or tap the screen, and you can see the messages as below:

Output Serial Monitor X

Message (Enter to send message to 'ESP32S3 Dev Module' on 'COM34')

```

FT6336U TD Count 0 / TD1 (2, 136, 183) / TD2 (2, 255, 4095)
FT6336U TD Count 1 / TD1 (0, 124, 169) / TD2 (2, 255, 4095)
FT6336U TD Count 1 / TD1 (1, 89, 146) / TD2 (2, 255, 4095)
FT6336U TD Count 1 / TD1 (1, 86, 145) / TD2 (2, 255, 4095)
FT6336U TD Count 1 / TD1 (1, 85, 144) / TD2 (2, 255, 4095)
FT6336U TD Count 1 / TD1 (1, 84, 143) / TD2 (2, 255, 4095)
FT6336U TD Count 1 / TD1 (1, 73, 133) / TD2 (2, 255, 4095)
FT6336U TD Count 0 / TD1 (2, 73, 133) / TD2 (2, 255, 4095)
FT6336U TD Count 0 / TD1 (2, 73, 133) / TD2 (2, 255, 4095)
FT6336U TD Count 0 / TD1 (2, 73, 133) / TD2 (2, 255, 4095)
FT6336U TD Count 0 / TD1 (2, 73, 133) / TD2 (2, 255, 4095)
FT6336U TD Count 0 / TD1 (2, 73, 133) / TD2 (2, 255, 4095)
FT6336U TD Count 0 / TD1 (0, 132, 166) / TD2 (2, 255, 4095)
FT6336U TD Count 1 / TD1 (1, 115, 149) / TD2 (2, 255, 4095)
FT6336U TD Count 1 / TD1 (1, 112, 146) / TD2 (2, 255, 4095)

```



The following is the program code:

```

1 #include "FT6336U.h"
2
3 #define I2C_SDA 2
4 #define I2C_SCL 1
5 #define RST_N_PIN -1
6 #define INT_N_PIN -1
7
8 FT6336U ft6336u(I2C_SDA, I2C_SCL, RST_N_PIN, INT_N_PIN);
9 FT6336U_TouchPointType tp;
10 int state = 0;
11
12 void setup() {
13     Serial.begin(115200);
14     ft6336u.begin();
15     Serial.print("FT6336U Firmware Version: ");
16     Serial.println(ft6336u.read_firmware_id());
17     Serial.print("FT6336U Device Mode: ");
18     Serial.println(ft6336u.read_device_mode());
19 }
20 void loop() {
21     tp = ft6336u.scan();
22     char tempString[128];
23     sprintf(tempString, "FT6336U TD Count %d / TD1 (%d, %4d, %4d) / TD2 (%d, %4d, %4d)\r\n",
24             tp.touch_count, tp.tp[0].status, tp.tp[0].x, tp.tp[0].y, tp.tp[1].status, tp.tp[1].x,
25             tp.tp[1].y);
26     Serial.print(tempString);
27     delay(100);
28 }
```

To use some libraries, first you need to include their header files.

```
1 #include "FT6336U.h"
```

Declare an `ft6336u` object to read the touch chip data. Define a touch data type to receive data.

```

8 FT6336U ft6336u(I2C_SDA, I2C_SCL, RST_N_PIN, INT_N_PIN);
9 FT6336U_TouchPointType tp;
```

Initialize the touch chip.

```
14     ft6336u.begin();
```

Non-blocking scan function, store scan results in `tp`.

```
21     tp = ft6336u.scan();
```

Combine and print the captured touchdata.

```

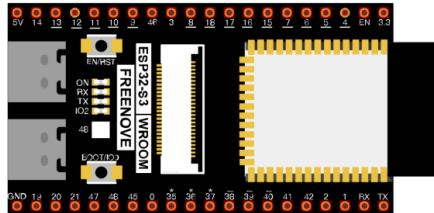
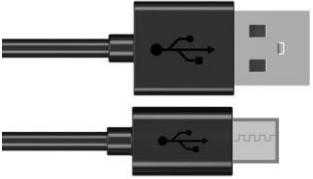
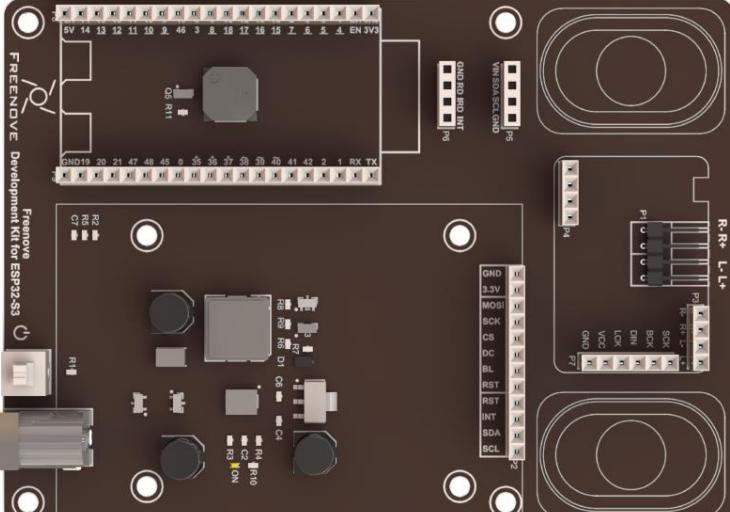
23     sprintf(tempString, "FT6336U TD Count %d / TD1 (%d, %4d, %4d) / TD2 (%d, %4d, %4d)\r\n",
24             tp.touch_count, tp.tp[0].status, tp.tp[0].x, tp.tp[0].y, tp.tp[1].status, tp.tp[1].x,
25             tp.tp[1].y);
26     Serial.print(tempString);
```

Chapter 9 LVGL

In this section, we will learn how to use the lvgl library.

Project 9.1 LVGL Test

Component List

ESP32-S3 WROOM x1	USB cable x1	2.8-inch Screen
		
ESP32-S3 WROOM Shield x1	9VBattery x1 (Not included in the kit, prepared by yourself)	
		
	9V battery cable x1	
		

Any concerns?  support@freenove.com



Component knowledge

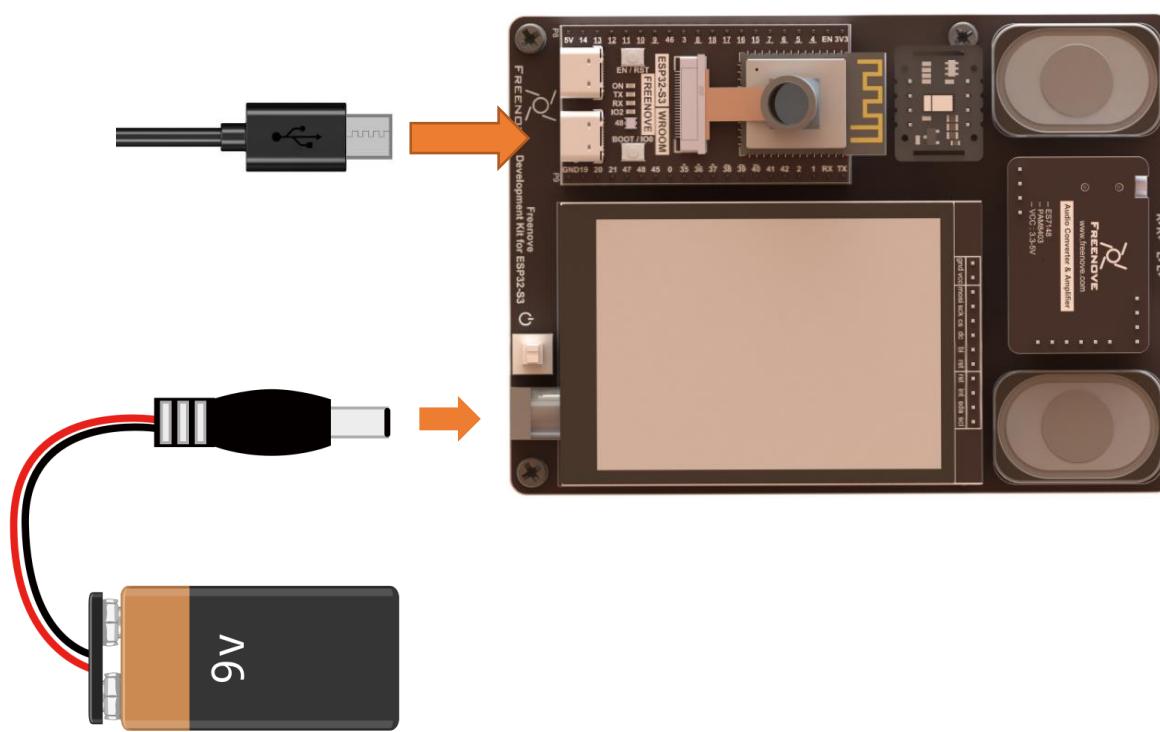
LVGL is a widely-used embedded GUI library that is implemented in pure C, making it highly portable and performant. It offers rich features and content, supporting both display and input devices such as touchscreens and keyboards.

	Features supported by LVGL
1	Powerful building blocks such as buttons, charts, lists, sliders, images, and more.
2	Advanced graphics with animation, anti-aliasing, opacity, and smooth scrolling.
3	Various input devices, such as touchpads, mice, keyboards, encoders, and more.
4	Multiple languages with UTF-8 encoding.
5	Multiple display types, including TFT and monochrome displays.
6	Fully customizable graphical elements.
7	LVGL can be used independently of any microcontroller or display hardware.
8	Highly extensible and can be configured to use very little memory (e.g. 64 kB of flash and 16 kB of RAM)
9	It can be used with or without an operating system, and supports external memory and GPUs as optional features.
10	Single-frame buffer operation, even with advanced graphics effects.
11	Written in C language to achieve maximum compatibility (compatible with C++ as well).
12	LVGL has a simulator that allows for embedded GUI design on a PC without any embedded hardware.
13	Resources to help developers quickly get started with the library, including tutorials, examples, and themes.
14	A wide range of resources.

Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.

Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com

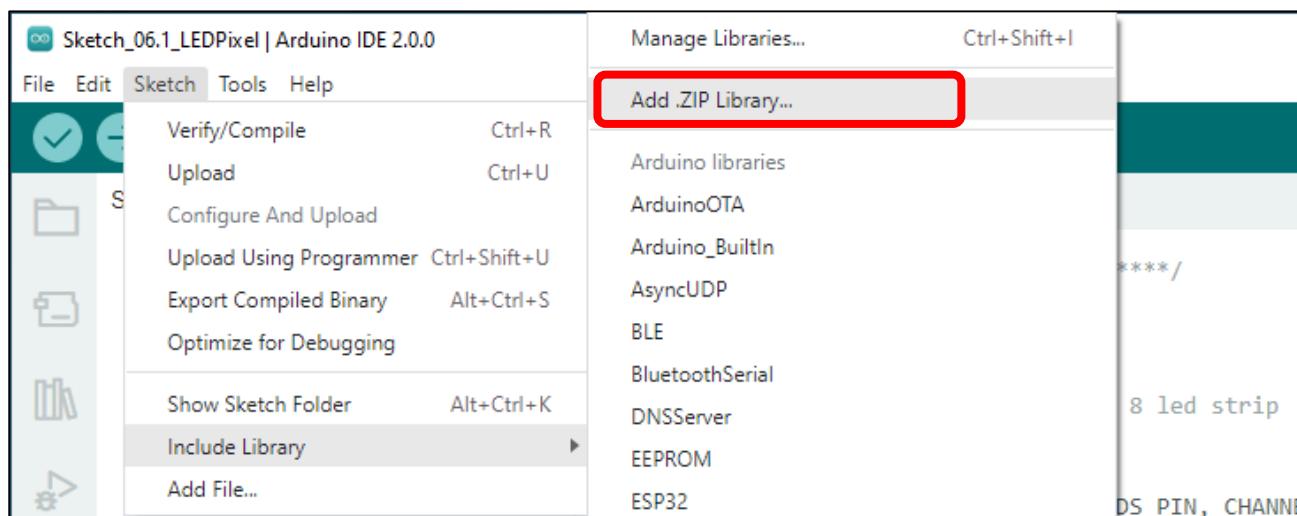


Sketch

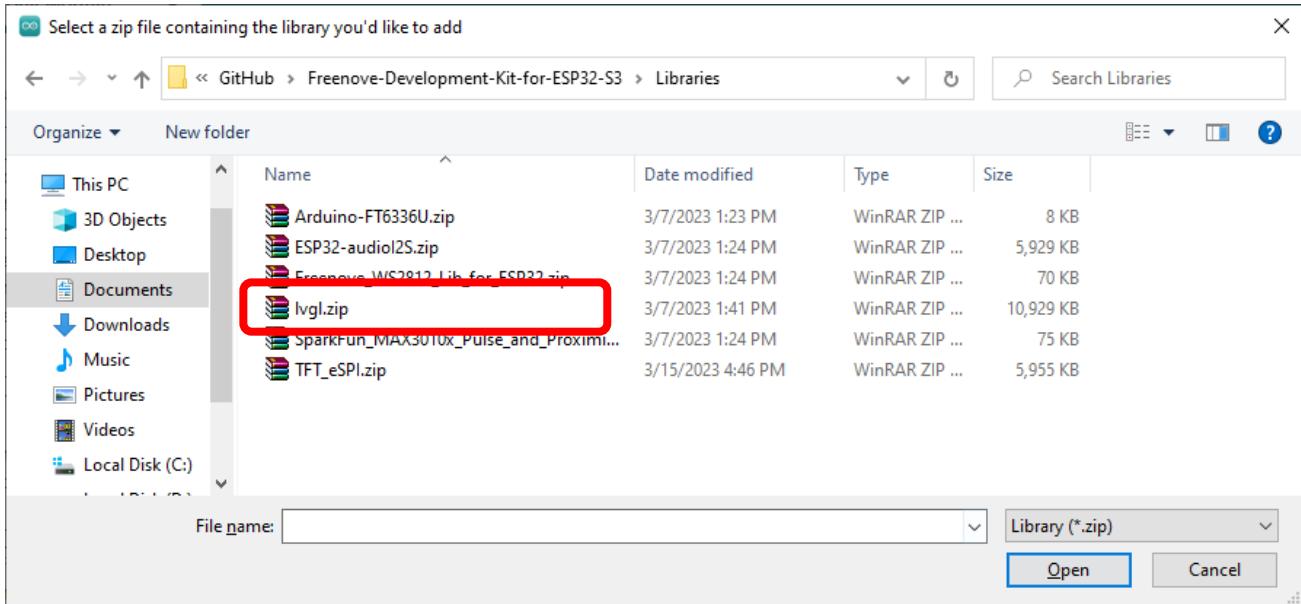
This code uses a library named "lvgl". If you have not installed it, please do so first.

How to install the library

Open Arduino IDE, click Sketch → Include Library → Add .ZIP Library. In the pop-up window, find the file named "**Freenove-Development-Kit-for-ESP32-S3\Libraries\lvgl.Zip**", which locates in this directory, and click OPEN.



Select lvgl.zip and click Open.



Please be aware that the lvgl.zip file is a pre-configured file library that is specifically designed for our product. Using the online "add library" function to add the lvgl library may cause compilation errors and render our product unusable.

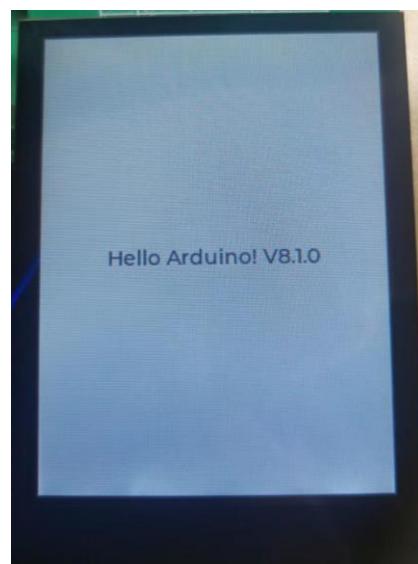
Sketch_09_LVGL

The screenshot shows the Arduino IDE interface with the following details:

- Title Bar:** Sketch_09_LVGL | Arduino IDE 2.0.4
- File Menu:** File Edit Sketch Tools Help
- Tool Selection:** ESP32S3 Dev Module
- Code Editor:** Displays the `Sketch_09_LVGL.ino` file content. The code initializes the display, sets up serial communication at 115200 baud, initializes the screen, prints the LVGL version, creates a simple label, and prints "Setup done".
- Output Window:** Shows the serial output:

```
Hash of data verified.  
Leaving...  
Hard resetting via RTS pin...
```
- Status Bar:** Ln 35, Col 1 ESP32S3 Dev Module on COM34 3

Click on Upload to upload the code to the ESP32-S3. Once the code has completed uploading, if you can see the screen displaying as shown below, it means that you have successfully configured the library and can now begin learning LVGL.



The following is the program code:

```

1 #include "display.h"
2 #include <lvgl.h>
3 #include <TFT_eSPI.h>
4 #include "FT6336U.h"
5
6 Display screen;
7 void setup() {
8     /* prepare for possible serial debug */
9     Serial.begin( 115200 );
10    /*** Init screen ***/
11    screen.init();
12    String LVGL_Arduino = "Hello Arduino! ";
13    LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
14    lv_version_patch();
15    Serial.println( LVGL_Arduino );
16    Serial.println( "I am LVGL_Arduino" );
17    /* Create simple label */
18    lv_obj_t *label = lv_label_create( lv_scr_act() );
19    lv_label_set_text( label, LVGL_Arduino.c_str() );
20    lv_obj_align( label, LV_ALIGN_CENTER, 0, 0 );
21    Serial.println( "Setup done" );
22 }
23
24 void loop() {
25     screen.routine(); /* let the GUI do its work */
26     delay( 5 );
27 }
```

To use some libraries, first you need to include their header files.

```

1 #include "display.h"
2 #include <lvgl.h>
3 #include <TFT_eSPI.h>
4 #include "FT6336U.h"
```

Request a screen operation object to operate the screen.

6	Display screen;
---	-----------------

Initialize and configure the screen.

11	screen.init();
----	----------------

Screen refresh function, by continuously calling this function, the interface can work properly.

21	screen.routine(); /* let the GUI do its work */
----	---

Place a label in the screen, centered and showing LVGL information.

16	/* Create simple label */ 17 lv_obj_t *label = lv_label_create(lv_scr_act()); 18 lv_label_set_text(label, LVGL_Arduino.c_str()); 19 lv_obj_align(label, LV_ALIGN_CENTER, 0, 0);
----	---

We placed the LVGL configuration code for the screen in the display file. Below is an introduction to the display file.

Add header files.

```
1 #include "display.h"
2 #include "TFT_eSPI.h"
3 #include "FT6336U.h"
```

Define two variables to record the resolution of the screen.

```
5 static const uint16_t screenWidth = 240;
6 static const uint16_t screenHeight = 320;
```

Create a screen display object tft, a touch screen object ft6336u, and a touch screen data type variable tp.

```
11 TFT_eSPI tft = TFT_eSPI(screenWidth, screenHeight); /* TFT instance */
12 FT6336U ft6336u(I2C_SDA, I2C_SCL, RST_N_PIN, INT_N_PIN);
13 FT6336U_TouchPointType tp;
```

Every once in a while, lvgl will check for any changes in the displayed content. If changes are detected, the function will be called to refresh the screen.

```
16 void my_disp_flush( lv_disp_drv_t *disp, const lv_area_t *area, lv_color_t *color_p ) {
17     uint32_t w = ( area->x2 - area->x1 + 1 );
18     uint32_t h = ( area->y2 - area->y1 + 1 );
19     tft.startWrite();
20     tft.setAddrWindow( area->x1, area->y1, w, h );
21     tft.pushColors((uint16_t*)&color_p->full, w * h, true );
22     tft.endWrite();
23     lv_disp_flush_ready( disp );
24 }
```

Every so often, LVGL will call this function to check if there have been any touch events on the screen.

```
27 void my_touchpad_read( lv_indev_drv_t * indev_driver, lv_indev_data_t * data ){
28     uint16_t touchX, touchY;
29     //bool touched = tft.getTouch( &touchX, &touchY, 600 );
30     tp = ft6336u.scan();
31     bool touched = tp.touch_count;
32     if( !touched ) {
33         data->state = LV_INDEV_STATE_REL;
34     }
35     else{
36         int x = tp.tp[0].x;
37         int y = tp.tp[0].y;
38         if(x >= 0 && x < screenWidth && y >= 0 && y < screenHeight) {
39             data->state = LV_INDEV_STATE_PR;
40             data->point.x = tp.tp[0].x;
41             data->point.y = tp.tp[0].y;
42         }
43     }
44 }
```



Configuration function of LVGL adapted to the screen. With the following function, we can write any content based on LVGL and display it on the screen. We can also execute corresponding events based on touch events.

```

46 void Display::init(void)
47 {
48     ft6336u.begin();
49     lv_init();
50     tft.begin();           /* TFT init */
51     tft.setRotation(TFT_DIRECTION); /* Landscape orientation, flipped */
52     lv_disp_draw_buf_init(&draw_buf, buf, NULL, screenWidth * 10);
53
54     /*Initialize the display*/
55     static lv_disp_drv_t disp_drv;
56     lv_disp_drv_init(&disp_drv);
57     /*Change the following line to your display resolution*/
58     disp_drv.hor_res = screenWidth;
59     disp_drv.ver_res = screenHeight;
60     disp_drv.flush_cb = my_disp_flush;
61     disp_drv.draw_buf = &draw_buf;
62     lv_disp_drv_register(&disp_drv);
63
64     /*Initialize the (dummy) input device driver*/
65     static lv_indev_drv_t indev_drv;
66     lv_indev_drv_init(&indev_drv);
67     indev_drv.type = LV_INDEV_TYPE_POINTER;
68     indev_drv.read_cb = my_touchpad_read;
69     lv_indev_drv_register(&indev_drv);
70 }
```

Call the following function to keep refreshing the screen, and to get the state and data of the touch screen.

```

72 void Display::routine(void)
73 {
74     lv_task_handler();
75 }
```

For more information about LVGL, you can click on the link below to check it out.

<https://docs.lvgl.io/8.1/>

<https://github.com/lvgl/lvgl/tree/release/v8.1>

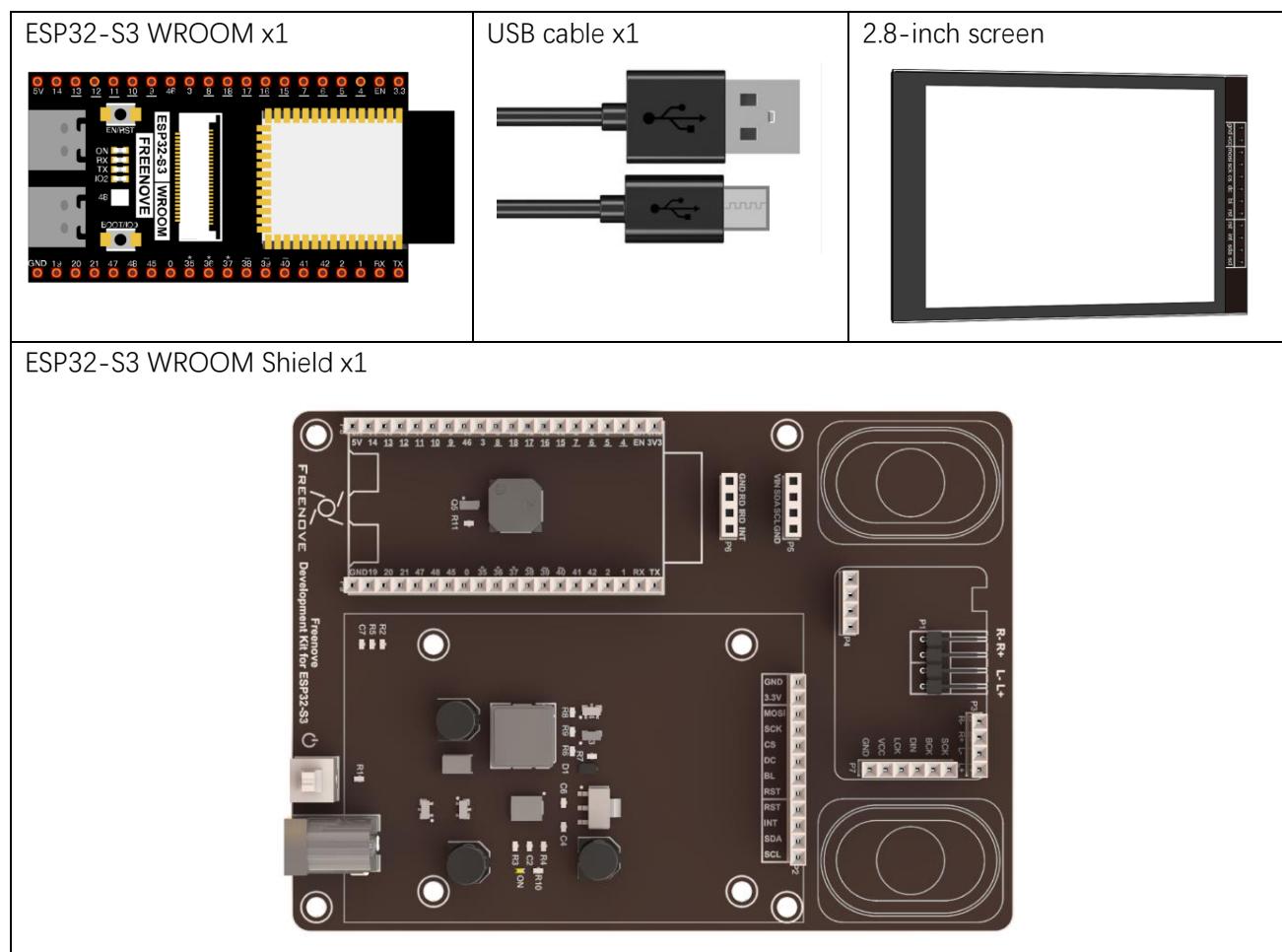
Chapter 10 LVGL Lable

In this chapter, we will learn how to use the label component on the screen.

Project 10.1 LVGL Lable

We have prepared two examples in the code, through which we will learn how to use the label component, how to display text in different colors, and how to add shadow effects to the text.

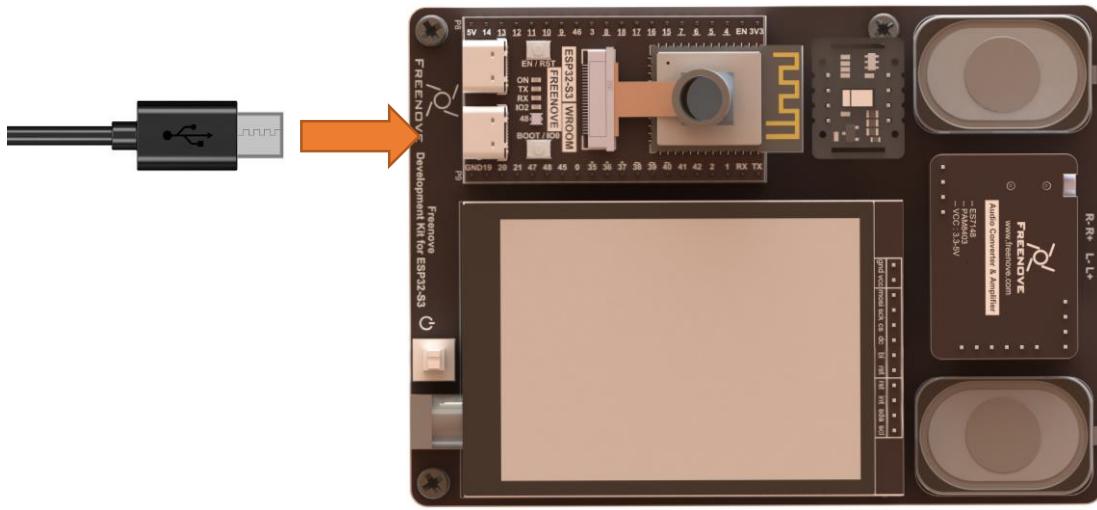
Component List



Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.

Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com



Sketch

Sketch_10_LVGL_Label

The screenshot shows the Arduino IDE interface with the title bar "Sketch_10_LVGL_Label | Arduino IDE 2.0.4". The toolbars include File, Edit, Sketch, Tools, Help, and a dropdown for "ESP32S3 Dev Module". The code editor displays "Sketch_10_LVGL_Label.ino" and several header files: "display.cpp", "display.h", "lv_example_label.cpp", and "lv_example_label.h". A red box highlights the "lv_example_label.h" tab. Another red box highlights the custom code section in the "Sketch_10_LVGL_Label.ino" code, which includes calls to "lv_example_label_1()" and "lv_example_label_2()".

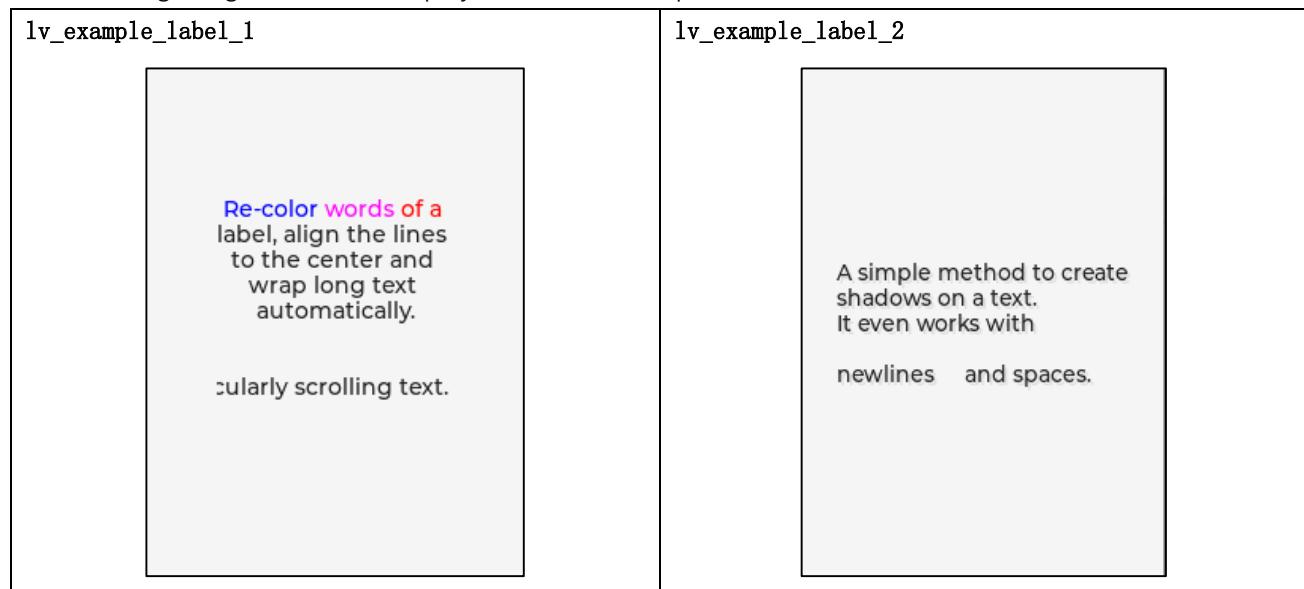
```

1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "lv_example_label.h"
5
6 Display screen;
7
8 void setup() {
9     Serial.begin(115200);
10
11     /*** Init screen ***/
12     screen.init();
13
14     /*** Print lvgl version ***/
15     String LVGL_Arduino = "Hello Arduino! ";
16     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
17     Serial.println(LVGL_Arduino);
18     Serial.println("I am LVGL_Arduino");
19     Serial.println("Setup done");
20
21     /*** The custom code ***/
22     lv_example_label_1(); //Recolor the text
23     //lv_example_label_2(); //Add a shadow to the text
24
25
26 void loop() {
27     screen.routine();
28     delay(5);
29 }

```

In the code, we have prepared two examples. After compiling and uploading the code with commented lines, the screen will display different content based on each example.

The following images show the display of the two examples.



The following is the program code:

Sketch_10_LVGL_Label.ino

```
1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "lv_example_label.h"
5 Display screen;
6 void setup() {
7     Serial.begin(115200);
8     /*** Init screen ***/
9     screen.init();
10    /*** Print lvgl version ***/
11    String LVGL_Arduino = "Hello Arduino! ";
12    LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
13    lv_version_patch();
14    Serial.println(LVGL_Arduino);
15    Serial.println("I am LVGL_Arduino");
16    Serial.println("Setup done");
17    /*** The custom code ***/
18    lv_example_label_1(); //Recolor the text
19    //lv_example_label_2(); //Add a shadow to the text
20 }
21 void loop() {
22     screen.routine();
23     delay(5);
24 }
```



To use some libraries, first you need to include their header files.

```
1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "lv_example_label.h"
```

Request a screen operation object to operate the screen.

```
5 Display screen;
```

Initialize and configure the screen.

```
9     screen.init();
```

Screen refresh function, by continuously calling this function, the interface can work properly.

```
21     screen.routine(); /* let the GUI do its work */
```

Here are two examples of labels. We can comment out one of them to display the other. For the specific code, please refer to lv_example_label.cpp and lv_example_label.h files.

```
16     /*** The custom code ***/
17     lv_example_label_1(); //Recolor the text
18     //lv_example_label_2(); //Add a shadow to the text
```

lv_example_label.h

Declare two example functions so that they can be called in the ino file.

```
1 #ifndef __LV_EXAMPLE_LABLE_H
2 #define __LV_EXAMPLE_LABLE_H
3 void lv_example_label_1(void);
4 void lv_example_label_2(void);
5 #endif
```

lv_example_label.cpp

Here is the complete code.

```
1 #include "lvgl.h"
2 #include "lv_example_label.h"

3
4 //Show line wrap, re-color, line align and text scrolling.
5 void lv_example_label_1(void)
6 {
7     lv_obj_t * label1 = lv_label_create(lv_scr_act());
8     /*
9         LV_LABEL_LONG_WRAP,           Keep the width of the object, wrap the line if the text is
10        too long, and enlarge the height of the object
11        LV_LABEL_LONG_DOT,          Keep the text size, and if it's too long, put dots at the
12        end
13        LV_LABEL_LONG_SCROLL,       Keep the text size and scroll back and forth
14        LV_LABEL_LONG_SCROLL_CIRCULAR, Keep the text size and scroll the text
15        LV_LABEL_LONG_CLIP,         Keep the size, and clip the text (keep only the front part
16        of the display)
17    */
```

```
18     /*Support long text, if the width is not enough to display, then continue to display the
19      newline*/
20     lv_label_set_long_mode(label1, LV_LABEL_LONG_WRAP);
21     lv_label_set_recolor(label1, true); /*Enable recolor through commands in the text*/
22     lv_label_set_text(label1, "#0000ff Re-color# #ff00ff words# #ff0000 of a # label, align
23      the lines to the center and wrap long text automatically.");
24     lv_obj_set_width(label1, 150); /*Set a small width to wrap lines automatically*/
25     lv_obj_set_style_text_align(label1, LV_TEXT_ALIGN_CENTER, 0); /*Set the label width to
26      center*/
27     lv_obj_align(label1, LV_ALIGN_CENTER, 0, -40); /*Set the label height to a distance of
28      between mid-40 pixels*/
29
30     lv_obj_t * label2 = lv_label_create(lv_scr_act());
31     lv_label_set_long_mode(label2, LV_LABEL_LONG_SCROLL); /*Circular scroll*/
32     lv_obj_set_width(label2, 150);
33     lv_label_set_text(label2, "It is a circularly scrolling text. ");
34     lv_obj_align(label2, LV_ALIGN_CENTER, 0, 40);
35 }
36
37 //Create a fake text shadow
38 void lv_example_label_2(void)
39 {
40     /*Create a style for the shadow*/
41     static lv_style_t style_shadow;//Apply for a style object
42     lv_style_init(&style_shadow); //Initialize the object
43     lv_style_set_text_opa(&style_shadow, LV_OPA_30);//Set the opacity to 30
44     lv_style_set_text_color(&style_shadow, lv_color_black());//Set the text color to black
45
46     /*Create a label for the shadow first (it's in the background)*/
47     lv_obj_t * shadow_label = lv_label_create(lv_scr_act());
48     lv_obj_add_style(shadow_label, &style_shadow, 0);
49     /*Create the main label*/
50     lv_obj_t * main_label = lv_label_create(lv_scr_act());
51     lv_label_set_text(main_label, "A simple method to create\n"
52                     "shadows on a text.\n"
53                     "It even works with\n\n"
54                     "newlines      and spaces.");
55     /*Set the same text for the shadow label*/
56     lv_label_set_text(shadow_label, lv_label_get_text(main_label));
57     /*Position the main label*/
58     lv_obj_align(main_label, LV_ALIGN_CENTER, 0, 0);
59     /*Shift the second label down and to the right by 2 pixel*/
60     lv_obj_align_to(shadow_label, main_label, LV_ALIGN_TOP_LEFT, 2, 2);
61 }
```

Create a label component in the current interface and assign it to a component type pointer variable label1.

```
7   lv_obj_t * label1 = lv_label_create(lv_scr_act());
```

Sets the mode of this label component.

```
20  lv_label_set_long_mode(label1, LV_LABEL_LONG_WRAP);
```

To re-customize the color of the font, please refer to the following two sentences.

```
21  lv_label_set_recolor(label1, true); /*Enable recolor through commands in the text*/
22  lv_label_set_text(label1, "#0000ff Re-color# #ff00ff words# #ff0000 of a # label, align
    the lines to the center and wrap long text automatically.");
```

Set the display width of the label component. If the content to be displayed exceeds this length, the remaining text will be displayed according to the default settings of the label component.

```
24  lv_obj_set_width(label1, 150); /*Set a small width to wrap lines automatically*/
```

Set the text content of the label component to be displayed in the center.

```
25  lv_obj_set_style_text_align(label1, LV_TEXT_ALIGN_CENTER, 0);
```

Set the label component to be located 40 pixels down from the center of the screen as a reference point.

```
27  lv_obj_align(label1, LV_ALIGN_CENTER, 0, -40);
```

Declare a variable of type "style" and name it "style_shadow", then initialize this variable.

```
41  static lv_style_t style_shadow;//Apply for a style object
42  lv_style_init(&style_shadow); //Initialize the object
```

Set the opacity of style_shadow to 30% and the color to black.

```
43  lv_style_set_text_opa(&style_shadow, LV_OPA_30); //Set the opacity to 30
44  lv_style_set_text_color(&style_shadow, lv_color_black()); //Set the text color to black
```

Create a label component to serve as the shadow effect with the style set to style_shadow.

```
47  lv_obj_t * shadow_label = lv_label_create(lv_scr_act());
48  lv_obj_add_style(shadow_label, &style_shadow, 0);
```

Define a label component to display the main text and set its content.

```
50  lv_obj_t * main_label = lv_label_create(lv_scr_act());
51  lv_label_set_text(main_label, "A simple method to create\n"
52  "shadows on a text.\n"
53  "It even works with\n"
54  "newlines and spaces.");
```

Read the content of the main_label component and copy the content to the shadow_label component

```
56  lv_label_set_text(shadow_label, lv_label_get_text(main_label));
```

Display the content of the main_label component in the center of the screen, and use main_label as a reference to display the content of shadow_label 2 pixels below and 2 pixels to the right of main_label, creating a shadow effect.

```
57  /*Position the main label*/
58  lv_obj_align(main_label, LV_ALIGN_CENTER, 0, 0);
59  /*Shift the second label down and to the right by 2 pixel*/
60  lv_obj_align_to(shadow_label, main_label, LV_ALIGN_TOP_LEFT, 2, 2);
```

To learn more about LVGL, please refer to the link below:

<https://docs.lvgl.io/8.1/widgets/core/label.html>

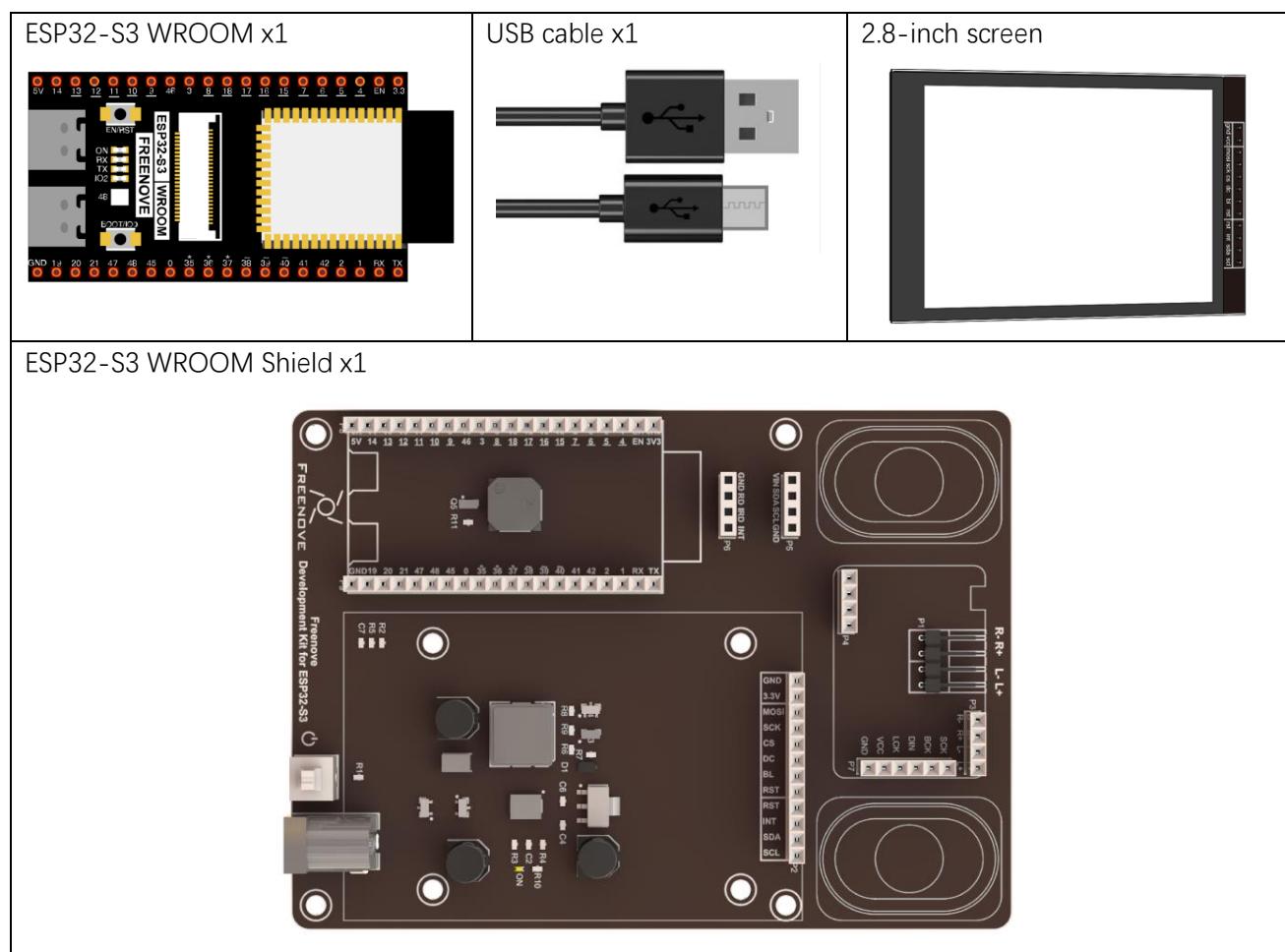
Chapter 11 LVGL Button

In this Chapter, we will learn how to use the button component on the screen

Project 11.1 LVGL Button

We have prepared three examples in the code to learn how to use the button component.

Component List

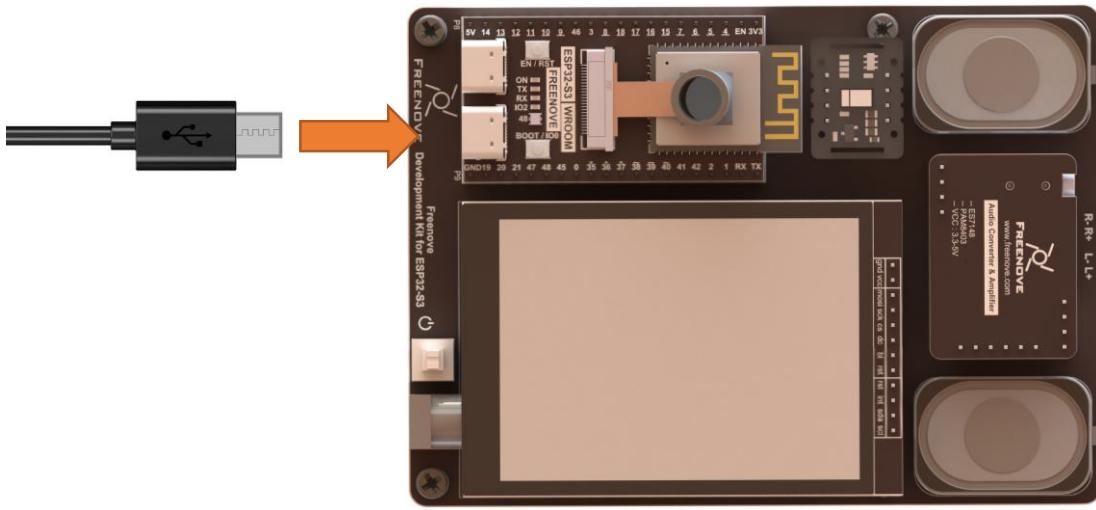




Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.

Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com



Sketch

Sketch_11_LVGL.Btn

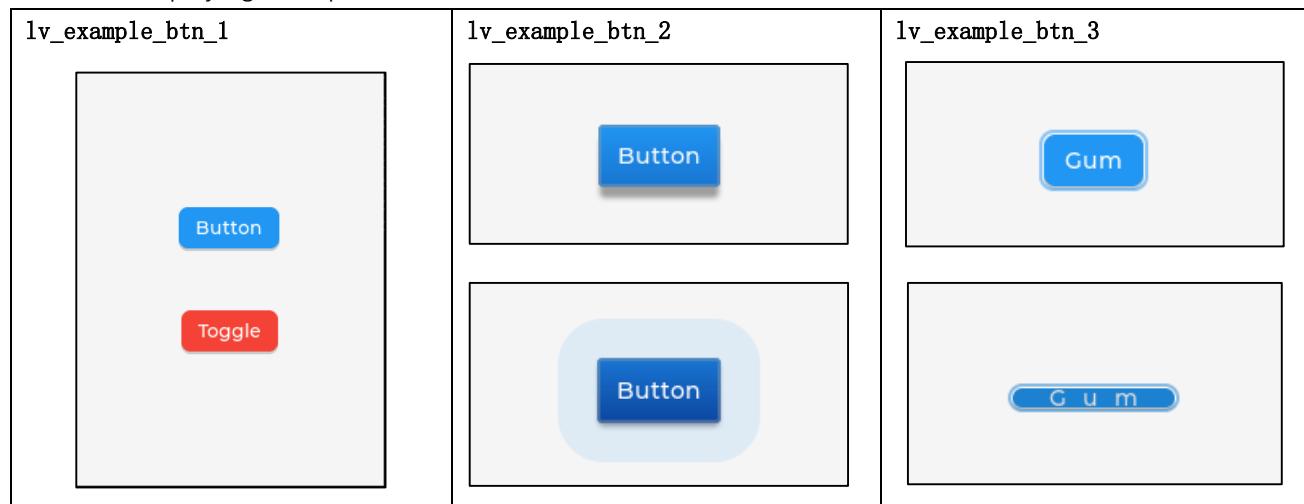
```

Sketch_11_LVGL.Btn | Arduino IDE 2.0.4
File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_11_LVGL.Btn.ino display.cpp display.h lv_example_btn.cpp lv_example_btn.h ...
1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "lv_example_btn.h"
5
6 Display screen;
7
8 void setup() {
9     Serial.begin(115200);
10
11     /*** Init screen ***/
12     screen.init();
13
14     /*** Print lvgl version ***/
15     String LVGL_Arduino = "Hello Arduino! ";
16     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
17     Serial.println(LVGL_Arduino);
18     Serial.println("I am LVGL_Arduino");
19     Serial.println("Setup done");
20
21     /*** The custom code ***/
22     lv_example_btn_1(); //Two types of button trigger events
23     //lv_example_btn_2(); //Style a button from scratch
24     //lv_example_btn_3(); //Create a style transition on a button to act like a gum when clicked
25
26 }

```

After commenting out the code, compiling and uploading it, different content can be displayed on the screen.

Below are displaying examples



The following is the program code:

Sketch_11_LVGL.Btn.ino

```

1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "lv_example_label.h"
5
6 Display screen;
7 void setup() {
8     Serial.begin(115200);
9     /*** Init screen ***/
10    screen.init();
11    /*** Print lvgl version ***/
12    String LVGL_Arduino = "Hello Arduino! ";
13    LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
14    lv_version_patch();
15    Serial.println(LVGL_Arduino);
16    Serial.println("I am LVGL_Arduino");
17    Serial.println("Setup done");
18    /*** The custom code ***/
19    lv_example_btn_1(); //Two types of button trigger events
20    //lv_example_btn_2(); //Style a button from scratch
21    //lv_example_btn_3(); //Create a style transition on a button to act like a gum when clicked
22 }
23 void loop() {
24     screen.routine();
25     delay(5);
26 }
```

There are three examples of button components. We can comment out two of them and remain one to display on the screen. The specific code can be found in the lv_example_btn.cpp and lv_example_btn.h files.

```

17  /**
18   * @brief The custom code
19   */
20  lv_example_btn_1(); //Two types of button trigger events
//lv_example_btn_2(); //Style a button from scratch
//lv_example_btn_3(); //Create a style transition on a button to act like a gum when clicked

```

lv_example_btn.h

Declare threee functions so that they can be called in the ino file.

```

1 #ifndef __LV_EXAMPLE_BTN_H
2 #define __LV_EXAMPLE_BTN_H
3 void lv_example_btn_1(void);
4 void lv_example_btn_2(void);
5 void lv_example_btn_3(void);
6#endif

```

lv_example_btn.cpp

Here is the complete code.

```

1 #include "lvgl.h"
2 #include "lv_example_btn.h"
3
4 /***** Example 1 *****/
5 static void event_handler(lv_event_t * e) {
6     lv_event_code_t code = lv_event_get_code(e);
7     if (code == LV_EVENT_CLICKED) {
8         LV_LOG_USER("Clicked");
9     }
10    else if (code == LV_EVENT_VALUE_CHANGED) {
11        LV_LOG_USER("Toggled");
12    }
13}
14 //Two types of button trigger events
15 void lv_example_btn_1(void) {
16     lv_obj_t * label;
17     lv_obj_t * btn1 = lv_btn_create(lv_scr_act());
18     lv_obj_add_event_cb(btn1, event_handler, LV_EVENT_ALL, NULL);
19     lv_obj_align(btn1, LV_ALIGN_CENTER, 0, -40);
20     label = lv_label_create(btn1);
21     lv_label_set_text(label, "Button");
22     lv_obj_center(label);
23
24     lv_obj_t * btn2 = lv_btn_create(lv_scr_act());
25     lv_obj_add_event_cb(btn2, event_handler, LV_EVENT_ALL, NULL);
26     lv_obj_align(btn2, LV_ALIGN_CENTER, 0, 40);

```

```
27 lv_obj_add_flag(btn2, LV_OBJ_FLAG_CHECKABLE);
28 lv_obj_set_height(btn2, LV_SIZE_CONTENT);
29 label = lv_label_create(btn2);
30 lv_label_set_text(label, "Toggle");
31 lv_obj_center(label);
32 }

33
34 /***** Example 2 *****/
35 //Style a button from scratch
36 void lv_example_btn_2(void) {
37 /*Init the style for the default state*/
38 static lv_style_t style;
39 lv_style_init(&style);
40 lv_style_set_radius(&style, 3);
41 lv_style_set_bg_opa(&style, LV_OPA_100);
42 lv_style_set_bg_color(&style, lv_palette_main(LV_PALETTE_BLUE));
43 lv_style_set_bg_grad_color(&style, lv_palette_darken(LV_PALETTE_BLUE, 2));
44 lv_style_set_bg_grad_dir(&style, LV_GRAD_DIR_VER);
45 lv_style_set_border_opa(&style, LV_OPA_40);
46 lv_style_set_border_width(&style, 2);
47 lv_style_set_border_color(&style, lv_palette_main(LV_PALETTE_GREY));
48 lv_style_set_shadow_width(&style, 8);
49 lv_style_set_shadow_color(&style, lv_palette_main(LV_PALETTE_GREY));
50 lv_style_set_shadow_ofs_y(&style, 8);
51 lv_style_set_outline_opa(&style, LV_OPA_COVER);
52 lv_style_set_outline_color(&style, lv_palette_main(LV_PALETTE_BLUE));
53 lv_style_set_text_color(&style, lv_color_white());
54 lv_style_set_pad_all(&style, 10);

55
56 /*Init the pressed style*/
57 static lv_style_t style_pr;
58 lv_style_init(&style_pr);
59 /*Add a large outline when pressed*/
60 lv_style_set_outline_width(&style_pr, 30);
61 lv_style_set_outline_opa(&style_pr, LV_OPA_TRANSP);
62 lv_style_set_translate_y(&style_pr, 5);
63 lv_style_set_shadow_ofs_y(&style_pr, 3);
64 lv_style_set_bg_color(&style_pr, lv_palette_darken(LV_PALETTE_BLUE, 2));
65 lv_style_set_bg_grad_color(&style_pr, lv_palette_darken(LV_PALETTE_BLUE, 4));

66
67 /*Add a transition to the outline*/
68 static lv_style_transition_dsc_t trans;
69 static lv_style_prop_t props[] = {LV_STYLE_OUTLINE_WIDTH, LV_STYLE_OUTLINE_OPA,
70 (lv_style_prop_t)0};
```

```

71 lv_style_transition_dsc_init(&trans, props, lv_anim_path_linear, 300, 0, NULL);
72 lv_style_set_transition(&style_pr, &trans);
73
74 lv_obj_t * btn1 = lv_btn_create(lv_scr_act());
75 lv_obj_remove_style_all(btn1); /*Remove the style coming from the theme*/
76 lv_obj_add_style(btn1, &style, LV_STATE_DEFAULT);
77 lv_obj_add_style(btn1, &style_pr, LV_STATE_PRESSED);
78 lv_obj_set_size(btn1, LV_SIZE_CONTENT, LV_SIZE_CONTENT);
79 lv_obj_center(btn1);
80
81 lv_obj_t * label = lv_label_create(btn1);
82 lv_label_set_text(label, "Button");
83 lv_obj_center(label);
84 }
85
86 /***** Example 3 *****/
87 //Create a style transition on a button to act like a gum when clicked
88 void lv_example_btn_3(void) {
89     /*Properties to transition/
90     static lv_style_prop_t props[] = {LV_STYLE_TRANSFORM_WIDTH, LV_STYLE_TRANSFORM_HEIGHT,
91     LV_STYLE_TEXT_LETTER_SPACE, (lv_style_prop_t)0};
92     /*Transition descriptor when going back to the default state.
93     Add some delay to be sure the press transition is visible even if the press was very
94     short*/
95     static lv_style_transition_dsc_t transition_dsc_def;
96     lv_style_transition_dsc_init(&transition_dsc_def, props, lv_anim_path_overshoot, 250, 100,
97     NULL);
98     /*Transition descriptor when going to pressed state.
99     No delay, go to presses state immediately*/
100    static lv_style_transition_dsc_t transition_dsc_pr;
101    lv_style_transition_dsc_init(&transition_dsc_pr, props, lv_anim_path_ease_in_out, 250, 0,
102    NULL);
103    /*Add only the new transition to he default state*/
104    static lv_style_t style_def;
105    lv_style_init(&style_def);
106    lv_style_set_transition(&style_def, &transition_dsc_def);
107
108    /*Add the transition and some transformation to the presses state.*/
109    static lv_style_t style_pr;
110    lv_style_init(&style_pr);
111    lv_style_set_transform_width(&style_pr, 10);
112    lv_style_set_transform_height(&style_pr, -10);
113    lv_style_set_text_letter_space(&style_pr, 10);
114    lv_style_set_transition(&style_pr, &transition_dsc_pr);

```

```

115
116 lv_obj_t * btn1 = lv_btn_create(lv_scr_act());
117 lv_obj_align(btn1, LV_ALIGN_CENTER, 0, -20);
118 lv_obj_add_style(btn1, &style_pr, LV_STATE_PRESSED);
119 lv_obj_add_style(btn1, &style_def, 0);
120
121 lv_obj_t * label = lv_label_create(btn1);
122 lv_label_set_text(label, "Gum");
123 }
```

Create a button component in the current interface and assign it to a component type pointer variable btn1.

```
17 lv_obj_t * btn1 = lv_btn_create(lv_scr_act());
```

Associate the button btn1 with a callback function event_handler to be triggered when the button is pressed.

```
18 lv_obj_add_event_cb(btn1, event_handler, LV_EVENT_ALL, NULL);
```

Display the button btn1 40 pixels above the center of the screen.

```
19 lv_obj_align(btn1, LV_ALIGN_CENTER, 0, -40);
```

Add a label component to button btn1 with the text "Button" displayed at the center of the button btn1.

```

20 label = lv_label_create(btn1);
21 lv_label_set_text(label, "Button");
22 lv_obj_center(label);
```

Set the button btn2 to have a selected toggle state effect, and set it to default height and width.

```

27 lv_obj_add_flag(btn2, LV_OBJ_FLAG_CHECKABLE);
28 lv_obj_set_height(btn2, LV_SIZE_CONTENT);
```

Create a style object and use it to set the component to have a background color gradient from blue to dark blue, with a 3-pixel rounded corner and 100% opacity.

```

37 /*Init the style for the default state*/
38 static lv_style_t style;
39 lv_style_init(&style);
40 lv_style_set_radius(&style, 3);
41 lv_style_set_bg_opa(&style, LV_OPA_100);
42 lv_style_set_bg_color(&style, lv_palette_main(LV_PALETTE_BLUE));
43 lv_style_set_bg_grad_color(&style, lv_palette_darken(LV_PALETTE_BLUE, 2));
44 lv_style_set_bg_grad_dir(&style, LV_GRAD_DIR_VER);
```

Apply a style to the component with 40% non-transparent border opacity, 2-pixel border width, and gray border color.

```

45 lv_style_set_border_opa(&style, LV_OPA_40);
46 lv_style_set_border_width(&style, 2);
47 lv_style_set_border_color(&style, lv_palette_main(LV_PALETTE_GREY));
```

Set the shadow of the component style to occupy 8 pixel rows, with the color gray, and the shadow offset relative to the main body is 8 pixel rows downward.

```

48 lv_style_set_shadow_width(&style, 8);
49 lv_style_set_shadow_color(&style, lv_palette_main(LV_PALETTE_GREY));
50 lv_style_set_shadow_ofs_y(&style, 8);
```



Set the outline of the component style to be fully opaque, and set the outline color to blue.

```
51   lv_style_set_outline_opa(&style, LV_OPA_COVER);
52   lv_style_set_outline_color(&style, lv_palette_main(LV_PALETTE_BLUE));
```

Set the component style font color to white and set the font distance from the component's border to 10 pixels.

```
53   lv_style_set_text_color(&style, lv_color_white());
54   lv_style_set_pad_all(&style, 10);
```

Set the outline of component style_pr to 30 pixels and the outline opacity to fully transparent.

```
60   lv_style_set_outline_width(&style_pr, 30);
61   lv_style_set_outline_opa(&style_pr, LV_OPA_TRANSP);
```

Set the component style_pr to have a downward offset of 5 pixels for the main body and 3 pixels for the shadow.

```
62   lv_style_set_translate_y(&style_pr, 5);
63   lv_style_set_shadow_ofs_y(&style_pr, 3);
```

Set the background color to be 2 shades darker than the normal blue color. Set the background gradient color to be 4 shades darker than the normal blue color.

```
64   lv_style_set_bg_color(&style_pr, lv_palette_darken(LV_PALETTE_BLUE, 2));
65   lv_style_set_bg_grad_color(&style_pr, lv_palette_darken(LV_PALETTE_BLUE, 4));
```

Apply for a transition object, set the transition time to 300ms, and associate it with the style_pr component.

```
68   static lv_style_transition_dsc_t trans;
69   static lv_style_prop_t props[] = {LV_STYLE_OUTLINE_WIDTH, LV_STYLE_OUTLINE_OPA,
70   (lv_style_prop_t)0};
71   lv_style_transition_dsc_init(&trans, props, lv_anim_path_linear, 300, 0, NULL);
    lv_style_set_transition(&style_pr, &trans);
```

Create a button object btn1 and remove all default styles. Set the style of the button in its normal state to style. When the button is pressed, trigger a transition effect from style to style_pr. Set the button to default width and height, and display it in the center of the screen.

```
73   lv_obj_t * btn1 = lv_btn_create(lv_scr_act());
74   lv_obj_remove_style_all(btn1); /*Remove the style coming from the theme*/
75   lv_obj_add_style(btn1, &style, LV_STATE_DEFAULT);
76   lv_obj_add_style(btn1, &style_pr, LV_STATE_PRESSED);
77   lv_obj_set_size(btn1, LV_SIZE_CONTENT, LV_SIZE_CONTENT);
78   lv_obj_center(btn1);
```

Set the width of the style_pr component to double its original size, decrease its height to half of its original size, and increase the font spacing by double.

```
106  lv_style_set_transform_width(&style_pr, 10);
107  lv_style_set_transform_height(&style_pr, -10);
108  lv_style_set_text_letter_space(&style_pr, 10);
```

To learn more about LVGL, please refer to

[https://docs.lvgl.io/8.1/widgets/core btn.html](https://docs.lvgl.io/8.1/widgets/core	btn.html)

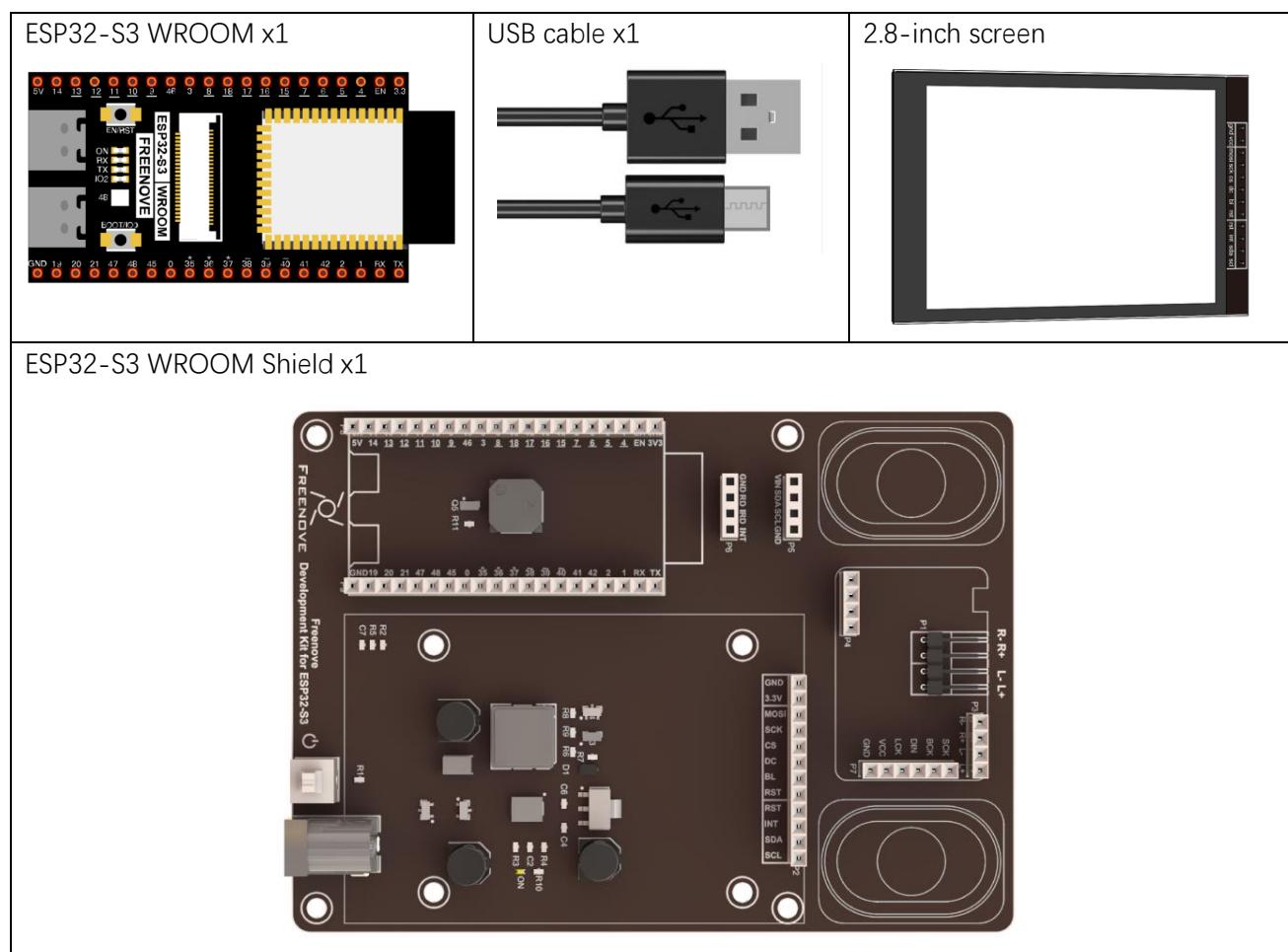
Chapter 12 LVGL Slider

In this Chapter, we will learn how to use the Slider component on the screen.

Project 12.1 LVGL Slider

We have prepared three examples in the code, through which we will learn how to use the Slider component.

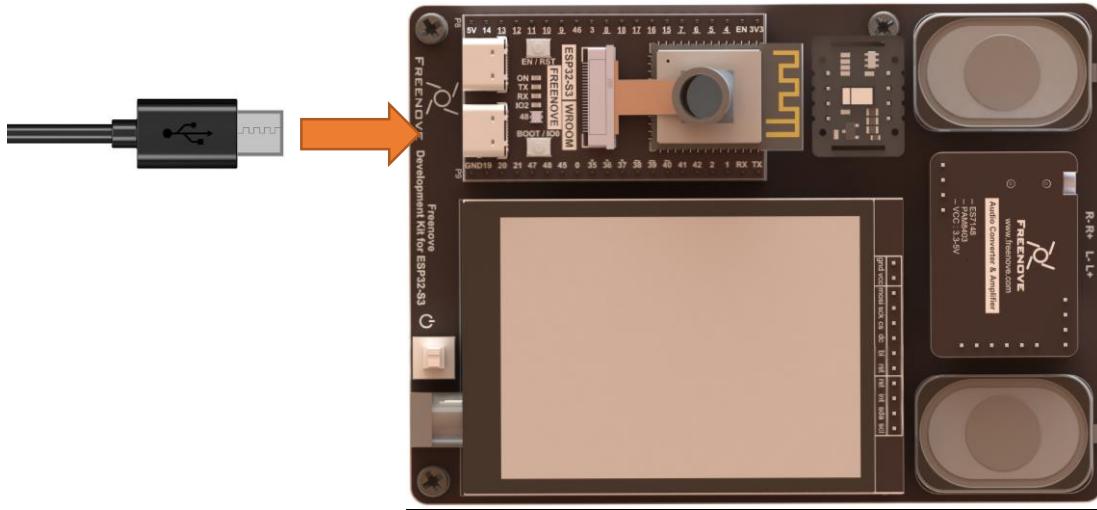
Component List



Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.

Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com



Sketch

Sketch_12_LVGL_Slider

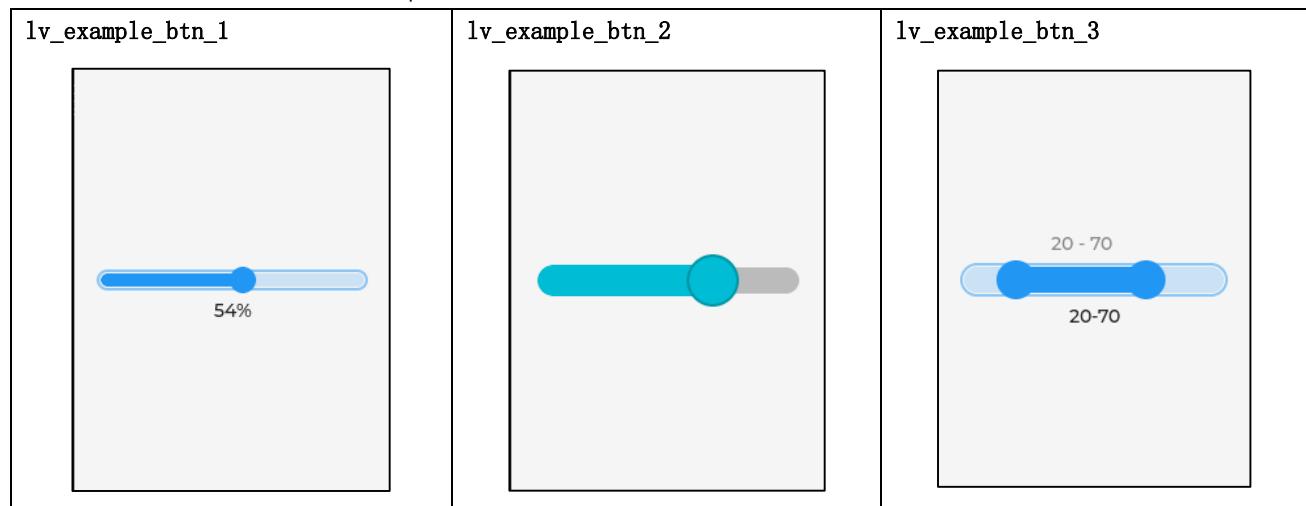
```

Sketch_12_Lvgl_Slider | Arduino IDE 2.0.4
File Edit Sketch Tools Help
Select Board
Sketch_12_Lvgl_Slider.ino display.cpp display.h lv_example_slider.cpp lv_example_slider.h ...
1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "lv_example_slider.h"
5
6 Display screen;
7
8 void setup() {
9   Serial.begin(115200);
10
11   /** Init screen **/
12   screen.init();
13
14   /** Print lvgl version **/
15   String LVGL_Arduino = "Hello Arduino!";
16   LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
17   Serial.println(LVGL_Arduino);
18   Serial.println("I am LVGL_Arduino");
19   Serial.println("Setup done");
20
21   /** The custom code ***/
22   lv_example_slider_1(); //A default slider with a label displaying the current value
23   //lv_example_slider_2(); //Show how to style a slider.
24   //lv_example_slider_3(); //Show the current value when the slider is pressed by extending the drawer
25 }
```

Ln 31, Col 1 X No board selected 1

After commenting out the code, compiling and uploading, the screen will display different contents depending on which example is uncommented.

Here are illustrations of the examples.



The following is the program code:

Sketch_12_LVGL_Slider.ino

```

1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "lv_example_label.h"
5 Display screen;
6 void setup() {
7     Serial.begin(115200);
8     /*** Init screen ***/
9     screen.init();
10    /*** Print lvgl version ***/
11    String LVGL_Arduino = "Hello Arduino! ";
12    LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
13    lv_version_patch();
14    Serial.println(LVGL_Arduino);
15    Serial.println("I am LVGL_Arduino");
16    Serial.println("Setup done");
17    /*** The custom code ***/
18    lv_example_slider_1(); //A default slider with a label displaying the current value
19    //lv_example_slider_2(); //Show how to style a slider.
20    //lv_example_slider_3(); //Show the current value when the slider is pressed by extending the
21    //drawer
22 }
23 void loop() {
24     screen.routine();
25     delay(5);
26 }
```



Here are three examples of Slider. We can comment out two of them to display the remaining one. You can refer to the lv_example_slider.cpp and lv_example_slider.h files for the specific code.

```

17  lv_example_slider_1() //A default slider with a label displaying the current value
18  //lv_example_slider_2() //Show how to style a slider.
19  //lv_example_slider_3() //Show the current value when the slider is pressed by extending the
20  drawer

```

lv_example_slider.h

Declare three functions so that they can be called in the ino file.

```

1 #ifndef __LV_EXAMPLE_SLIDER_H
2 #define __LV_EXAMPLE_SLIDER_H
3 void lv_example_slider_1(void);
4 void lv_example_slider_2(void);
5 void lv_example_slider_3(void);
6#endif

```

lv_example_slider.cpp

Here is the complete code.

```

1 #include "lvgl.h"
2 #include "lv_example_slider.h"
3
4 /***** Example 1 *****/
5 static lv_obj_t * slider_label;
6 static void slider_event_cb_1(lv_event_t * e) {
7     lv_obj_t * slider = lv_event_get_target(e);
8     char buf[8];
9     lv_snprintf(buf, sizeof(buf), "%d%%", (int)lv_slider_get_value(slider));
10    lv_label_set_text(slider_label, buf);
11    lv_obj_align_to(slider_label, slider, LV_ALIGN_OUT_BOTTOM_MID, 0, 10);
12 }
13
14 //A default slider with a label displaying the current value
15 void lv_example_slider_1(void) {
16     /*Create a slider in the center of the display*/
17     lv_obj_t * slider = lv_slider_create(lv_scr_act());
18     lv_obj_center(slider);
19     lv_obj_set_size(slider, 200, 10);
20     lv_obj_add_event_cb(slider, slider_event_cb_1, LV_EVENT_VALUE_CHANGED, NULL);
21
22     /*Create a label below the slider*/
23     slider_label = lv_label_create(lv_scr_act());
24     lv_label_set_text(slider_label, "0%");
25
26     lv_obj_align_to(slider_label, slider, LV_ALIGN_OUT_BOTTOM_MID, 0, 10);

```

```
27 }
28
29 //Show how to style a slider.
30 void lv_example_slider_2(void) {
31     /*Create a transition*/
32     static const lv_style_prop_t props[] = {LV_STYLE_BG_COLOR, (lv_style_prop_t)0};
33     static lv_style_transition_dsc_t transition_dsc;
34     lv_style_transition_dsc_init(&transition_dsc, props, lv_anim_path_linear, 300, 0, NULL);
35
36     static lv_style_t style_main;
37     static lv_style_t style_indicator;
38     static lv_style_t style_knob;
39     static lv_style_t style_pressed_color;
40     lv_style_init(&style_main);
41     lv_style_set_bg_opa(&style_main, LV_OPA_COVER);
42     lv_style_set_bg_color(&style_main, lv_color_hex3(0xbbb));
43     lv_style_set_radius(&style_main, LV_RADIUS_CIRCLE);
44     lv_style_set_pad_ver(&style_main, -2); /*Makes the indicator larger*/
45
46     lv_style_init(&style_indicator);
47     lv_style_set_bg_opa(&style_indicator, LV_OPA_COVER);
48     lv_style_set_bg_color(&style_indicator, lv_palette_main(LV_PALETTE_BLUE));
49     lv_style_set_radius(&style_indicator, LV_RADIUS_CIRCLE);
50     lv_style_set_transition(&style_indicator, &transition_dsc);
51
52     lv_style_init(&style_knob);
53     lv_style_set_bg_opa(&style_knob, LV_OPA_COVER);
54     lv_style_set_bg_color(&style_knob, lv_palette_main(LV_PALETTE_CYAN));
55     lv_style_set_border_color(&style_knob, lv_palette_darken(LV_PALETTE_CYAN, 2));
56     lv_style_set_border_width(&style_knob, 2);
57     lv_style_set_radius(&style_knob, LV_RADIUS_CIRCLE);
58     lv_style_set_pad_all(&style_knob, 10); /*Makes the knob larger*/
59     lv_style_set_transition(&style_knob, &transition_dsc);
60
61     lv_style_init(&style_pressed_color);
62     lv_style_set_bg_color(&style_pressed_color, lv_palette_darken(LV_PALETTE_CYAN, 2));
63     /*Create a slider and add the style*/
64     lv_obj_t * slider = lv_slider_create(lv_scr_act());
65     lv_obj_remove_style_all(slider); /*Remove the styles coming from the theme*/
66     lv_obj_add_style(slider, &style_main, LV_PART_MAIN); //Set the slider base color to gray
67     lv_obj_add_style(slider, &style_indicator, LV_PART_INDICATOR); //Set the slider color to
ciano
68     lv_obj_add_style(slider, &style_knob, LV_PART_KNOB); //Set the slider ball handle larger
and more prominent
```

```

69     lv_obj_add_style(slider, &style_pressed_color, LV_PART_INDICATOR | LV_PART_KNOB |
70     LV_STATE_PRESSED); // When pressed, the slider color is 2 color numbers darker
71
72     lv_obj_set_size(slider, 200, 20);
73     lv_obj_center(slider);
74 }
75
76 /**
77 * Example 3
78 */
79 static void slider_event_cb_3(lv_event_t * e) {
80     lv_event_code_t code = lv_event_get_code(e);
81     lv_obj_t *slider = lv_event_get_target(e);
82
83     /*Provide some extra space for the value*/
84     if(code == LV_EVENT_REFR_EXT_DRAW_SIZE) {
85         lv_event_set_ext_draw_size(e, 50);
86     }
87     else if(code == LV_EVENT_DRAW_PART_END) {
88         lv_obj_draw_part_dsc_t * dsc = lv_event_get_draw_part_dsc(e);
89         if(dsc->part == LV_PART_INDICATOR) {
90             char buf[16];
91             lv_snprintf(buf, sizeof(buf), "%d - %d", (int)lv_slider_get_left_value(slider),
92             (int)lv_slider_get_value(slider));
93             LV_LOG_USER("Slider Value Range: %s", buf);
94             lv_label_set_text(slider_label, buf);
95             lv_obj_align_to(slider_label, slider, LV_ALIGN_OUT_BOTTOM_MID, 0, 10);
96         }
97     }
98 }
99
100 //Show the current value when the slider is pressed by extending the drawer
101 void lv_example_slider_3(void) {
102     /*Create a slider in the center of the display*/
103     lv_obj_t * slider;
104     slider = lv_slider_create(lv_scr_act());
105
106     lv_obj_set_size(slider, 200, 20);
107     lv_obj_center(slider);
108
109     lv_slider_set_mode(slider, LV_SLIDER_MODE_RANGE);
110     lv_slider_set_value(slider, 70, LV_ANIM_OFF);
111     lv_slider_set_left_value(slider, 20, LV_ANIM_OFF);
112
113     lv_obj_add_event_cb(slider, slider_event_cb_3, LV_EVENT_ALL, NULL);
114     lv_obj_refresh_ext_draw_size(slider);

```

```

112
113     slider_label = lv_label_create(lv_scr_act());
114     lv_label_set_text(slider_label, "20-70");
115
116     lv_obj_align_to(slider_label, slider, LV_ALIGN_OUT_BOTTOM_MID, 0, 10);
117 }
```

Create a slider component with a width of 200 pixels and a height of 10 pixels, center it on the screen, and associate it with the callback function slider_event_cb_1.

```

14 //A default slider with a label displaying the current value
15 void lv_example_slider_1(void) {
16     /*Create a slider in the center of the display*/
17     lv_obj_t * slider = lv_slider_create(lv_scr_act());
18     lv_obj_center(slider);
19     lv_obj_set_size(slider, 200, 10);
20     lv_obj_add_event_cb(slider, slider_event_cb_1, LV_EVENT_VALUE_CHANGED, NULL);
21
22     /*Create a label below the slider*/
23     slider_label = lv_label_create(lv_scr_act());
24     lv_label_set_text(slider_label, "0%");
25
26     lv_obj_align_to(slider_label, slider, LV_ALIGN_OUT_BOTTOM_MID, 0, 10);
27 }
```

Get the object responsible for triggering the slider event and assign it to the variable "slider".

```
7     lv_obj_t * slider = lv_event_get_target(e);
```

Get the value of the slider, use the lv_snprintf() function to concatenate the data together, and display the content on a label.

```

8     char buf[8];
9     lv_snprintf(buf, sizeof(buf), "%d%%", (int)lv_slider_get_value(slider));
10    lv_label_set_text(slider_label, buf);
11    lv_obj_align_to(slider_label, slider, LV_ALIGN_OUT_BOTTOM_MID, 0, 10);
```

Create a background color transition object with a transition time of 300ms.

```

32     static const lv_style_prop_t props[] = {LV_STYLE_BG_COLOR, (lv_style_prop_t)0};
33     static lv_style_transition_dsc_t transition_dsc;
34     lv_style_transition_dsc_init(&transition_dsc, props, lv_anim_path_linear, 300, 0, NULL);
```

Set the "style_main" component's background to fully opaque, the background color to gray, and to rounded cornered. Also, make the indicator two pixels larger than the slider on the top and bottom.

```

40     lv_style_init(&style_main);
41     lv_style_set_bg_opa(&style_main, LV_OPA_COVER);
42     lv_style_set_bg_color(&style_main, lv_color_hex3(0xbbb));
43     lv_style_set_radius(&style_main, LV_RADIUS_CIRCLE);
44     lv_style_set_pad_ver(&style_main, -2); /*Makes the indicator larger*/
```



Set the background opacity of style_indicator component to fully opaque, set the background color to blue, set the component to rounded corner, and add a transition display for background color.

```
46     lv_style_init(&style_indicator);
47     lv_style_set_bg_opa(&style_indicator, LV_OPA_COVER);
48     lv_style_set_bg_color(&style_indicator, lv_palette_main(LV_PALETTE_BLUE));
49     lv_style_set_radius(&style_indicator, LV_RADIUS_CIRCLE);
50     lv_style_set_transition(&style_indicator, &transition_dsc);
```

Set the background opacity of the style_knob component to be completely opaque, set the background color to cyan, set the edge color to 2 shades darker than cyan. Set the edge width of the component to 2 pixels, set the component as rounded, and set the knob 10 pixels larger than the slider.

```
52     lv_style_init(&style_knob);
53     lv_style_set_bg_opa(&style_knob, LV_OPA_COVER);
54     lv_style_set_bg_color(&style_knob, lv_palette_main(LV_PALETTE_CYAN));
55     lv_style_set_border_color(&style_knob, lv_palette_darken(LV_PALETTE_CYAN, 2));
56     lv_style_set_border_width(&style_knob, 2);
57     lv_style_set_radius(&style_knob, LV_RADIUS_CIRCLE);
58     lv_style_set_pad_all(&style_knob, 10); /*Makes the knob larger*/
59     lv_style_set_transition(&style_knob, &transition_dsc);
```

Set the background color of the style_pressed_color component to 2 shades darker than cyan.

```
61     lv_style_init(&style_pressed_color);
62     lv_style_set_bg_color(&style_pressed_color, lv_palette_darken(LV_PALETTE_CYAN, 2));
```

Create a slider component, remove the default style attribute, add new attributes to the slider, and set the slider width to 200 pixels, height to 20 pixels, and display it in the center of the screen.

```
64     /*Create a slider and add the style*/
65     lv_obj_t * slider = lv_slider_create(lv_scr_act());
66     lv_obj_remove_style_all(slider);      /*Remove the styles coming from the theme*/
67     lv_obj_add_style(slider, &style_main, LV_PART_MAIN); //Set the slider base color to gray
68     lv_obj_add_style(slider, &style_indicator, LV_PART_INDICATOR); //Set the slider color to
   cyan
69     lv_obj_add_style(slider, &style_knob, LV_PART_KNOB); //Set the slider ball handle larger
   and more prominent
70     lv_obj_add_style(slider, &style_pressed_color, LV_PART_INDICATOR | LV_PART_KNOB |
   LV_STATE_PRESSED); // When pressed, the slider color is 2 color numbers darker
71
72     lv_obj_set_size(slider, 200, 20);
73     lv_obj_center(slider);
```

Provide some extra space to draw the slider.

```
81     /*Provide some extra space for the value*/
82     if(code == LV_EVENT_REFR_EXT_DRAW_SIZE) {
83         lv_event_set_ext_draw_size(e, 50);
84     }
```

If the drawing area of the indicator part changes, get the value of the slider and display it.

```

86     lv_obj_draw_part_dsc_t * dsc = lv_event_get_draw_part_dsc(e);
87     if(dsc->part == LV_PART_INDICATOR) {
88         char buf[16];
89         lv_snprintf(buf, sizeof(buf), "%d - %d", (int)lv_slider_get_left_value(slider),
90                     (int)lv_slider_get_value(slider));
91         LV_LOG_USER("Slider Value Range: %s", buf);
92         lv_label_set_text(slider_label, buf);
93         lv_obj_align_to(slider_label, slider, LV_ALIGN_OUT_BOTTOM_MID, 0, 10);
94     }

```

Create a slider component with a width of 200 pixels, a height of 20 pixels, and display it in the center of the screen.

```

99     /*Create a slider in the center of the display*/
100    lv_obj_t * slider;
101    slider = lv_slider_create(lv_scr_act());
102
103    lv_obj_set_size(slider, 200, 20);
104    lv_obj_center(slider);

```

Change the slider mode from normal mode to range mode. Set the starting value of the slider to 20 and the ending value to 70.

```

106    lv_slider_set_mode(slider, LV_SLIDER_MODE_RANGE);
107    lv_slider_set_value(slider, 70, LV_ANIM_OFF);
108    lv_slider_set_left_value(slider, 20, LV_ANIM_OFF);

```

Associate the slider with the callback function slider_event_cb_3. Refresh the drawing size.

```

110    lv_obj_add_event_cb(slider, slider_event_cb_3, LV_EVENT_ALL, NULL);
111    lv_obj_refresh_ext_draw_size(slider);

```

Create a label component, which displays the content of the slider 10 pixels below the slider.

```

113    slider_label = lv_label_create(lv_scr_act());
114    lv_label_set_text(slider_label, "20-70");
115
116    lv_obj_align_to(slider_label, slider, LV_ALIGN_OUT_BOTTOM_MID, 0, 10);

```

For more information about LVGL, please refer to the link below:

<https://docs.lvgl.io/8.1/widgets/core/slider.html>

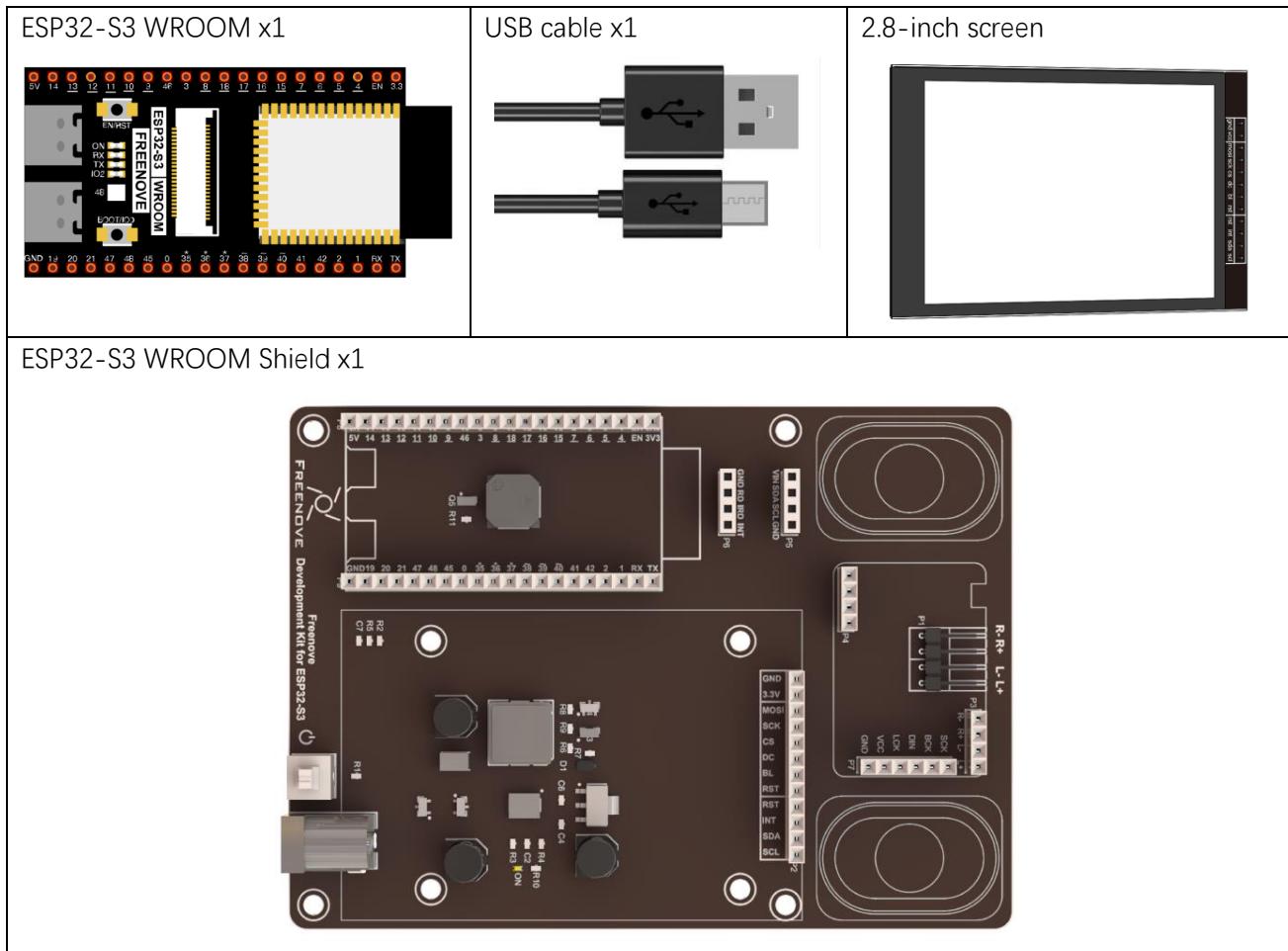
Chapter 13 LVGL Img

In this chapter, we will explore how to use the img component to display images on the screen in LVGL.

Project 13.1 LVGL Img

In this section, we will cover three examples that demonstrate how to use the img component in LVGL. Through these examples, you will learn how to effectively display images on the screen using the img component.

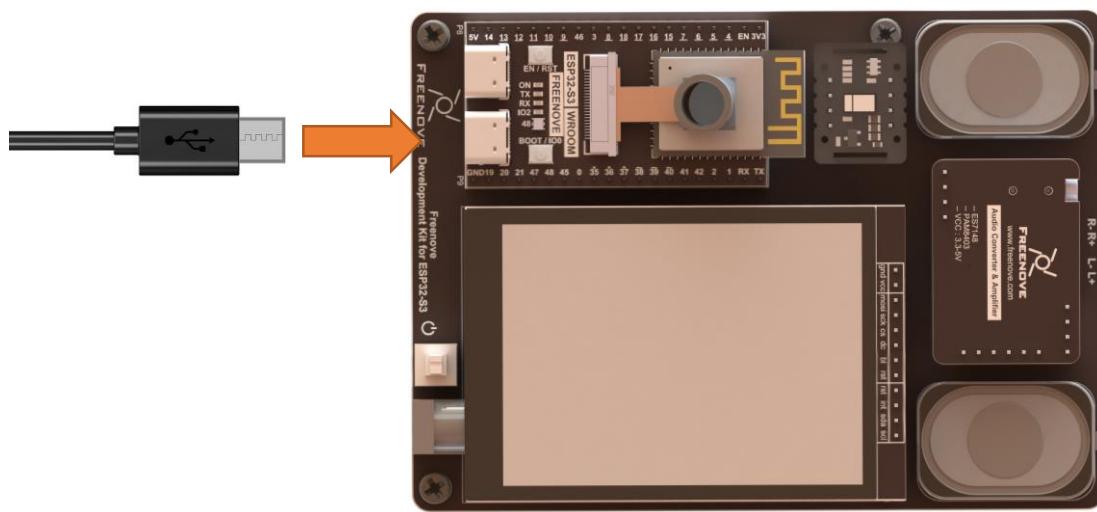
Component List



Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.

Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com



Sketch

Sketch_13_Lvgl_Img

The screenshot shows the Arduino IDE interface with the title bar "Sketch_13_Lvgl_Img | Arduino IDE 2.0.4". The menu bar includes File, Edit, Sketch, Tools, Help, and a toolbar with icons for file operations. The central workspace shows a list of files: Sketch_13_Lvgl_Img.ino, display.cpp, display.h, lv_example_img.cpp, lv_example_img.h (which is currently selected and highlighted with a red border), and lv_version.h. The code editor displays the following sketch:

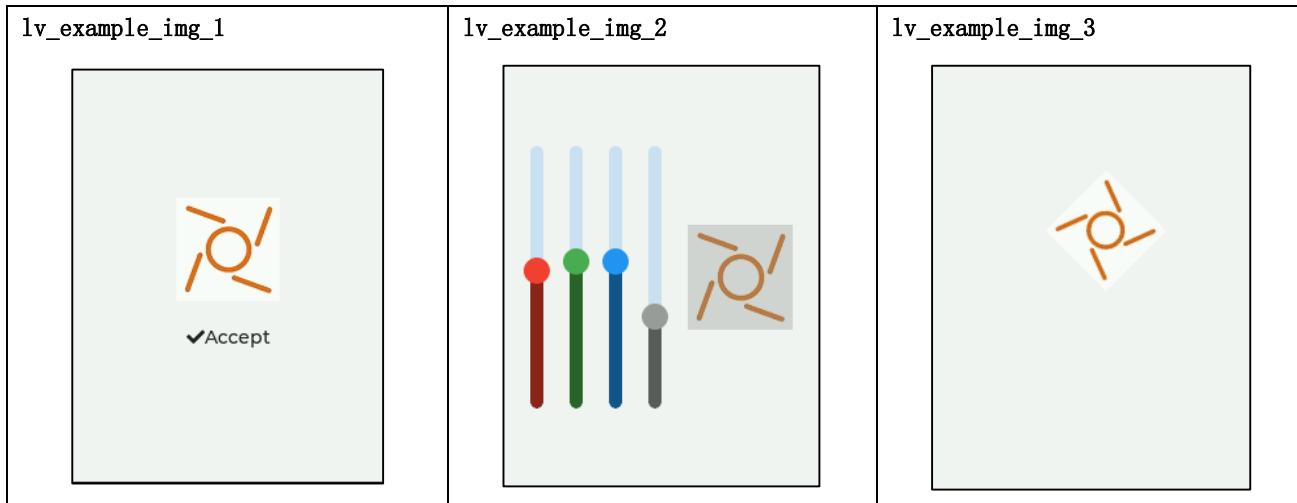
```
3 #include "display.h"
4 #include "lv_example_img.h"
5
6 Display screen;
7
8 void setup() {
9     Serial.begin(115200);
10
11     /*** Init screen ***/
12     screen.init();
13
14     /*** Print lvgl version ***/
15     String LVGL_Arduino = "Hello Arduino! ";
16     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
17     Serial.println(LVGL_Arduino);
18     Serial.println("I am LVGL_Arduino");
19     Serial.println("Setup done");
20
21     /*** The custom code ***/
22     lv_example_img_1(); //Basic use method.
23     //lv_example_img_2(); //Demonstrate runtime image re-coloring
24     //lv_example_img_3(); //Show transformations (zoom and rotation) using a pivot point.
25 }
```

A red box highlights the section of the code starting with "lv_example_img_1();".



By commenting out different sections of the code, compiling and uploading, you can display different content on the screen.

Below are the illustrations of the examples.



The following is the program code:

Sketch_13_LVGL_Img.ino

```

1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "lv_example_label.h"
5
6 Display screen;
7 void setup() {
8     Serial.begin(115200);
9     /*** Init screen ***/
10    screen.init();
11    /*** Print lvgl version ***/
12    String LVGL_Arduino = "Hello Arduino! ";
13    LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
14        lv_version_patch();
15    Serial.println(LVGL_Arduino);
16    Serial.println("I am LVGL_Arduino");
17    Serial.println("Setup done");
18
19    /*** The custom code ***/
20    lv_example_img_1(); //Basic use method.
21    //lv_example_img_2(); //Demonstrate runtime image re-coloring
22    //lv_example_img_3(); //Show transformations (zoom and rotation) using a pivot point.
23 }
24 void loop() {
25     screen.routine();
26     delay(5);
27 }
```

Here are three examples. We can comment out two of them to display the remaining one. Please refer to the lv_example_img.cpp and lv_example_img.h files for the specific code.

```
18 lv_example_img_1(); //Basic use method.
19 //lv_example_img_2(); //Demonstrate runtime image re-coloring
20 //lv_example_img_3(); //Show transformations (zoom and rotation) using a pivot point.
```

lv_example_img.h

Declare three functions so that they can be called in the ino file.

```
1 #ifndef __LV_EXAMPLE_IMG_H
2 #define __LV_EXAMPLE_IMG_H
3 void lv_example_img_1(void);
4 void lv_example_img_2(void);
5 void lv_example_img_3(void);
6#endif
```

Here is the complete code.

lv_example_img.cpp

```
1 #include "lvgl.h"
2 #include "lv_example_img.h"
3
4 const uint8_t img_freenove_map[] = {...}
85 }
86
87 /***** Example 1 *****/
88 lv_img_dsc_t img_freenove;
89 void lv_img_freenove_init(void) {
90     lv_img_header_t header;
91     header.always_zero = 0;
92     header.w = 80;
93     header.h = 80;
94     header.cf = LV_IMG_CF_TRUE_COLOR;
95     img_freenove.header = header;
96     img_freenove.data_size = 6400 * LV_IMG_PX_SIZE_ALPHA_BYTE;
97     img_freenove.data = img_freenove_map;
98 }
99
100 void lv_example_img_1(void) {
101     lv_img_freenove_init();
102     lv_obj_t * img1 = lv_img_create(lv_scr_act()); //Apply for an img variable
103     lv_img_set_src(img1, &img_freenove); //Add image information to img
104     lv_obj_align(img1, LV_ALIGN_CENTER, 0, -20); //It is displayed 20 pixels above the middle
of the screen
105     lv_obj_set_size(img1, 80, 80); //Set the size of the image
106 }
```

```

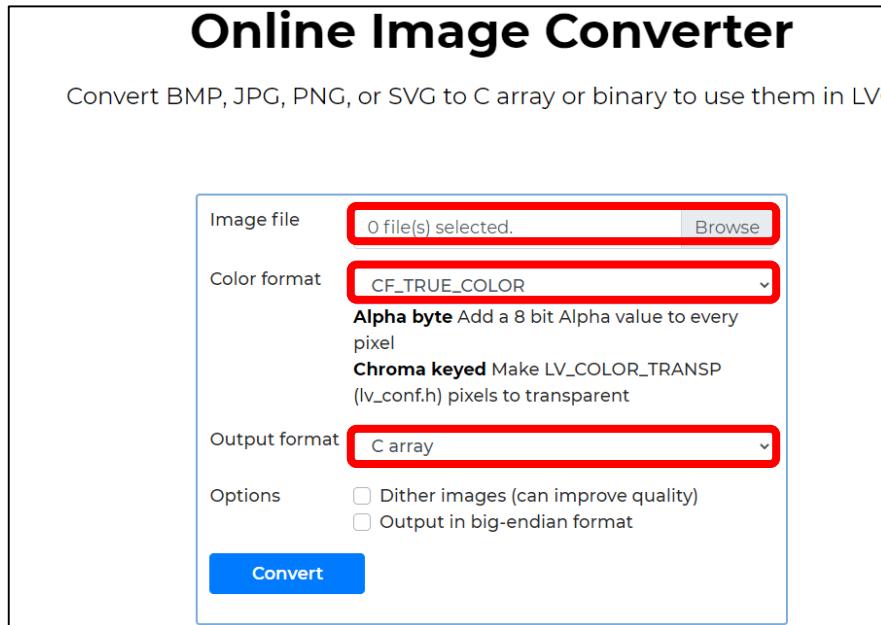
107 lv_obj_t * img2 = lv_img_create(lv_scr_act());
108 lv_img_set_src(img2, LV_SYMBOL_OK "Accept");
109 lv_obj_align_to(img2, img1, LV_ALIGN_OUT_BOTTOM_MID, 0, 20); //img2 is displayed 20 pixels
below img1
110 }
111
112 /***** Example 2 *****/
113 static lv_obj_t * red_slider, * green_slider, * blue_slider, * intense_slider;
114 static lv_obj_t * img1;
115
116 static void slider_event_cb(lv_event_t * e){
117     LV_UNUSED(e);
118     /*Recolor the image based on the sliders' values*/
119     lv_color_t color = lv_color_make(lv_slider_get_value(red_slider),
120                                     lv_slider_get_value(green_slider), lv_slider_get_value(blue_slider));
121     lv_opa_t intense = lv_slider_get_value(intense_slider);
122     lv_obj_set_style_img_recolor_opa(img1, intense, 0);
123     lv_obj_set_style_img_recolor(img1, color, 0);
124 }
125
126 static lv_obj_t * create_slider(lv_color_t color){
127     lv_obj_t * slider = lv_slider_create(lv_scr_act());
128     lv_slider_set_range(slider, 0, 255);
129     lv_obj_set_size(slider, 10, 200);
130     lv_obj_set_style_bg_color(slider, color, LV_PART_KNOB);
131     lv_obj_set_style_bg_color(slider, lv_color_darken(color, LV_OPA_40), LV_PART_INDICATOR);
132     lv_obj_add_event_cb(slider, slider_event_cb, LV_EVENT_VALUE_CHANGED, NULL);
133     return slider;
134 }
135
136 //Demonstrate runtime image re-coloring
137 void lv_example_img_2(void){
138     /*Create 4 sliders to adjust RGB color and re-color intensity*/
139     red_slider = create_slider(lv_palette_main(LV_PALETTE_RED));
140     green_slider = create_slider(lv_palette_main(LV_PALETTE_GREEN));
141     blue_slider = create_slider(lv_palette_main(LV_PALETTE_BLUE));
142     intense_slider = create_slider(lv_palette_main(LV_PALETTE_GREY));
143
144     lv_slider_set_value(red_slider, LV_OPA_20, LV_ANIM_OFF);
145     lv_slider_set_value(green_slider, LV_OPA_90, LV_ANIM_OFF);
146     lv_slider_set_value(blue_slider, LV_OPA_60, LV_ANIM_OFF);
147     lv_slider_set_value(intense_slider, LV_OPA_50, LV_ANIM_OFF);
148
149     lv_obj_align(red_slider, LV_ALIGN_LEFT_MID, 20, 0);

```

```
149 lv_obj_align_to(green_slider, red_slider, LV_ALIGN_OUT_RIGHT_MID, 20, 0);  
150 lv_obj_align_to(blue_slider, green_slider, LV_ALIGN_OUT_RIGHT_MID, 20, 0);  
151 lv_obj_align_to(intense_slider, blue_slider, LV_ALIGN_OUT_RIGHT_MID, 20, 0);  
152  
153 /*Now create the actual image*/  
154 lv_img_freenove_init();  
155 img1 = lv_img_create(lv_scr_act());  
156 lv_img_set_src(img1, &img_freenove);  
157 lv_obj_align_to(img1, intense_slider, LV_ALIGN_OUT_RIGHT_MID, 20, 0);  
158 lv_event_send(intense_slider, LV_EVENT_VALUE_CHANGED, NULL);  
159 }  
160  
161 /***** Example 3 *****/  
162 static void set_angle(void * img, int32_t v){  
163     lv_img_set_angle((lv_obj_t*)img, v);  
164 }  
165 static void set_zoom(void * img, int32_t v){  
166     lv_img_set_zoom((lv_obj_t*)img, v);  
167 }  
168  
169 //Show transformations (zoom and rotation) using a pivot point.  
170 void lv_example_img_3(void){  
171     lv_img_freenove_init();  
172     /*Now create the actual image*/  
173     lv_obj_t * img = lv_img_create(lv_scr_act());  
174     lv_img_set_src(img, &img_freenove);  
175     lv_obj_align(img, LV_ALIGN_CENTER, 0, 0);  
176     lv_img_set_pivot(img, 0, 0); /*Rotate around the top left corner*/  
177  
178     lv_anim_t a;  
179     lv_anim_init(&a);  
180     lv_anim_set_var(&a, img);  
181     lv_anim_set_time(&a, 3000); //Animation execution time  
182     lv_anim_set_playback_time(&a, 3000); //Animation playback time  
183     lv_anim_set_repeat_count(&a, LV_ANIM_REPEAT_INFINITE); //Repetitive animation  
184  
185     lv_anim_set_exec_cb(&a, set_angle); //Sets the animation callback function  
186     lv_anim_set_values(&a, 0, 3600); //Sets the parameter range of the callback function  
187     lv_anim_start(&a); //Start animation  
188  
189     lv_anim_set_exec_cb(&a, set_zoom); //Sets the animation callback function  
190     lv_anim_set_values(&a, 128, 512); //Sets the parameter range of the callback function  
191     lv_anim_start(&a); //Start animation  
192 }
```

Here we provide a website: <https://lvgl.io/tools/imageconverter>

It is an official website that allows you to convert images into arrays. You can click on the "Browse" button to select an image and convert it into an array file using the following configuration. Here we take the Freenove logo as an example.



Click "Convert" and the website will generate and download the corresponding array file. Open this file and find the definition shown below.

```

freenove.c
20 ifndef LV_ATTRIBUTE_IMG_FREENOVE
21 define LV_ATTRIBUTE_IMG_FREENOVE
22 endif
23
24 const LV_ATTRIBUTE_MEM_ALIGN LV_ATTRIBUTE_LARGE_CONST LV_ATTRIBUTE_IMG_FREENOVE uint8_t freenove_map[] = {
25 #if LV_COLOR_DEPTH == 1 || LV_COLOR_DEPTH == 2
26
27 #if LV_COLOR_DEPTH == 16 && LV_COLOR_SWAP == 0
28     /*Pixel format: Red: 5 bit, Green: 6 bit, Blue: 5 bit*/
29     0xff, 0xff,
30     0xff, 0xff,
31     0xff, 0xff,
32     0xff, 0xff,
33     0xff, 0xff,
34     0xff, 0xff,
35     0xff, 0xff,
36     0xff, 0xff,
37     0xff, 0xff,
38     0xff, 0xff,
39     0xff, 0xff,
40     0xff, 0xff,
41     0xff, 0xff,
42     0xff, 0xff,
43     0xff, 0xff,
44     0xff, 0xff,
45     0xff, 0xff,
46     0xff, 0xff,
47     0xff, 0xff,
48     0xff, 0xff,
49     0xff, 0xff,
50     0xff, 0xff,
51     0xff, 0xff,
52     0xff, 0xff,
53     0xff, 0xff,
54     0xff, 0xff,
55     0xff, 0xff,
56     0xff, 0xff,
57     0xff, 0xff,
58     0xff, 0xff,
59     0xff, 0xff,
60     0xff, 0xff,
61     0xff, 0xff,
62     0xff, 0xff,
63     0xff, 0xff,
64     0xff, 0xff,
65     0xff, 0xff,
66     0xff, 0xff,
67     0xff, 0xff,
68     0xff, 0xff,
69     0xff, 0xff,
70     0xff, 0xff,
71     0xff, 0xff,
72     0xff, 0xff,
73     0xff, 0xff,
74     0xff, 0xff,
75     0xff, 0xff,
76     0xff, 0xff,
77     0xff, 0xff,
78     0xff, 0xff,
79     0xff, 0xff,
80     0xff, 0xff,
81     0xff, 0xff,
82     0xff, 0xff,
83     0xff, 0xff,
84     0xff, 0xff,
85     0xff, 0xff
}

```

Define an array img_freenove_map and copy the content of the previously generated array to it.

4	const uint8_t img_freenove_map[] = {
...	...
85	};

Define an image type variable img_freenove and write a function lv_img_freenove_init() to initialize it.

Please note that the resolution of the original image must be filled in correctly. "w" and "h" represent the width and height of the original image resolution, respectively. "data_size" represents the size of the image, while "data" represents the actual image data. It is recommended not to modify other options.

```
88 lv_img_dsc_t img_freenove;
89 void lv_img_freenove_init(void) {
90     lv_img_header_t header;
91     header.always_zero = 0;
92     header.w = 80;
93     header.h = 80;
94     header.cf = LV_IMG_CF_TRUE_COLOR;
95     img_freenove.header = header;
96     img_freenove.data_size = 6400 * LV_IMG_PX_SIZE_ALPHA_BYTE;
97     img_freenove.data = img_freenove_map;
98 }
```

Call the lv_img_freenove_init() function to configure img_freenove.

```
101 lv_img_freenove_init();
```

Create a new image component and assign it to img1, set the image content to img_freenove, and display the image 20 pixels above the center of the screen. Set the size of the component to 80 pixels wide and 80 pixels high.

```
102 lv_obj_t * img1 = lv_img_create(lv_scr_act()); //Apply for an img variable
103 lv_img_set_src(img1, &img_freenove); //Add image information to img
104 lv_obj_align(img1, LV_ALIGN_CENTER, 0, -20); //It is displayed 20 pixels above the middle
105 of the screen
106 lv_obj_set_size(img1, 80, 80); //Set the size of the image
```

Create a new image component and assign it to img2. Display an internal symbol and text on img2. Set img2 to be positioned 20 pixels below img1.

```
107 lv_obj_t * img2 = lv_img_create(lv_scr_act());
108 lv_img_set_src(img2, LV_SYMBOL_OK "Accept");
109 lv_obj_align_to(img2, img1, LV_ALIGN_OUT_BOTTOM_MID, 0, 20); //img2 is displayed 20 pixels
below img1
```

Write a slider creation function, set the range, size, background color, and associated function of the slider.

```
126 static lv_obj_t * create_slider(lv_color_t color) {
127     lv_obj_t * slider = lv_slider_create(lv_scr_act());
128     lv_slider_set_range(slider, 0, 255);
129     lv_obj_set_size(slider, 10, 200);
130     lv_obj_set_style_bg_color(slider, color, LV_PART_KNOB);
131     lv_obj_set_style_bg_color(slider, lv_color_darken(color, LV_OPA_40), LV_PART_INDICATOR);
132     lv_obj_add_event_cb(slider, slider_event_cb, LV_EVENT_VALUE_CHANGED, NULL);
133     return slider;
134 }
```

Create 4 sliders, and set them to different colors.

```
139 red_slider = create_slider(lv_palette_main(LV_PALETTE_RED));
140 green_slider = create_slider(lv_palette_main(LV_PALETTE_GREEN));
```

Any concerns? ✉ support@freenove.com

```

141     blue_slider = create_slider(lv_palette_main(LV_PALETTE_BLUE));
142     intense_slider = create_slider(lv_palette_main(LV_PALETTE_GREY));

```

Use the values of three sliders to redefine the color of the image, and use the value of one slider to modify the opacity of the image background.

```

116     static void slider_event_cb(lv_event_t * e){
117         LV_UNUSED(e);
118         /*Recolor the image based on the sliders' values*/
119         lv_color_t color = lv_color_make(lv_slider_get_value(red_slider),
120                                         lv_slider_get_value(green_slider), lv_slider_get_value(blue_slider));
121         lv_opa_t intense = lv_slider_get_value(intense_slider);
122         lv_obj_set_style_img_recolor_opa(img1, intense, 0);
123         lv_obj_set_style_img_recolor(img1, color, 0);
124     }

```

Trigger a slider event manually.

```

158     lv_event_send(intense_slider, LV_EVENT_VALUE_CHANGED, NULL);

```

Image rotation function.

```

163     lv_img_set_angle((lv_obj_t*) img, v);

```

Image scaling function.

```

167     lv_img_set_zoom((lv_obj_t*) img, v);

```

Create an image component, set the display content and display position. Set the origin position of the image.

```

172     lv_img_freenove_init();
173     /*Now create the actual image*/
174     lv_obj_t * img = lv_img_create(lv_scr_act());
175     lv_img_set_src(img, &img_freenove);
176     lv_obj_align(img, LV_ALIGN_CENTER, 0, 0);
177     lv_img_set_pivot(img, 0, 0); /*Rotate around the top left corner*/

```

Create an animation object, associate the animation object with the img component, set the animation time to 3000ms, and the animation playback time to 3000ms, and play the animation repeatedly.

```

179     lv_anim_t a;
180     lv_anim_init(&a);
181     lv_anim_set_var(&a, img);
182     lv_anim_set_time(&a, 3000); //Animation execution time
183     lv_anim_set_playback_time(&a, 3000); //Animation playback time
184     lv_anim_set_repeat_count(&a, LV_ANIM_REPEAT_INFINITE); //Repetitive animation

```

Set the animation object associated with the set_angle function, with a precision of 0.1 degrees and 360 degrees corresponding to 3600. Start the animation.

```

186     lv_anim_set_exec_cb(&a, set_angle); //Sets the animation callback function
187     lv_anim_set_values(&a, 0, 3600); //Sets the parameter range of the callback function
188     lv_anim_start(&a); //Start animation

```

Associate the animation object with the set_zoom function, with 256 as the original image size, 128 representing the image being reduced to half its size, and 512 representing the image being enlarged to twice its size. Start the animation.

```

190     lv_anim_set_exec_cb(&a, set_zoom); //Sets the animation callback function

```

```
191     lv_anim_set_values(&a, 128, 512);    //Sets the parameter range of the callback function  
192     lv_anim_start(&a);                //Start animation
```

For more information about LVGL, please refer to the link below:

<https://docs.lvgl.io/8.1/widgets/core/img.html>

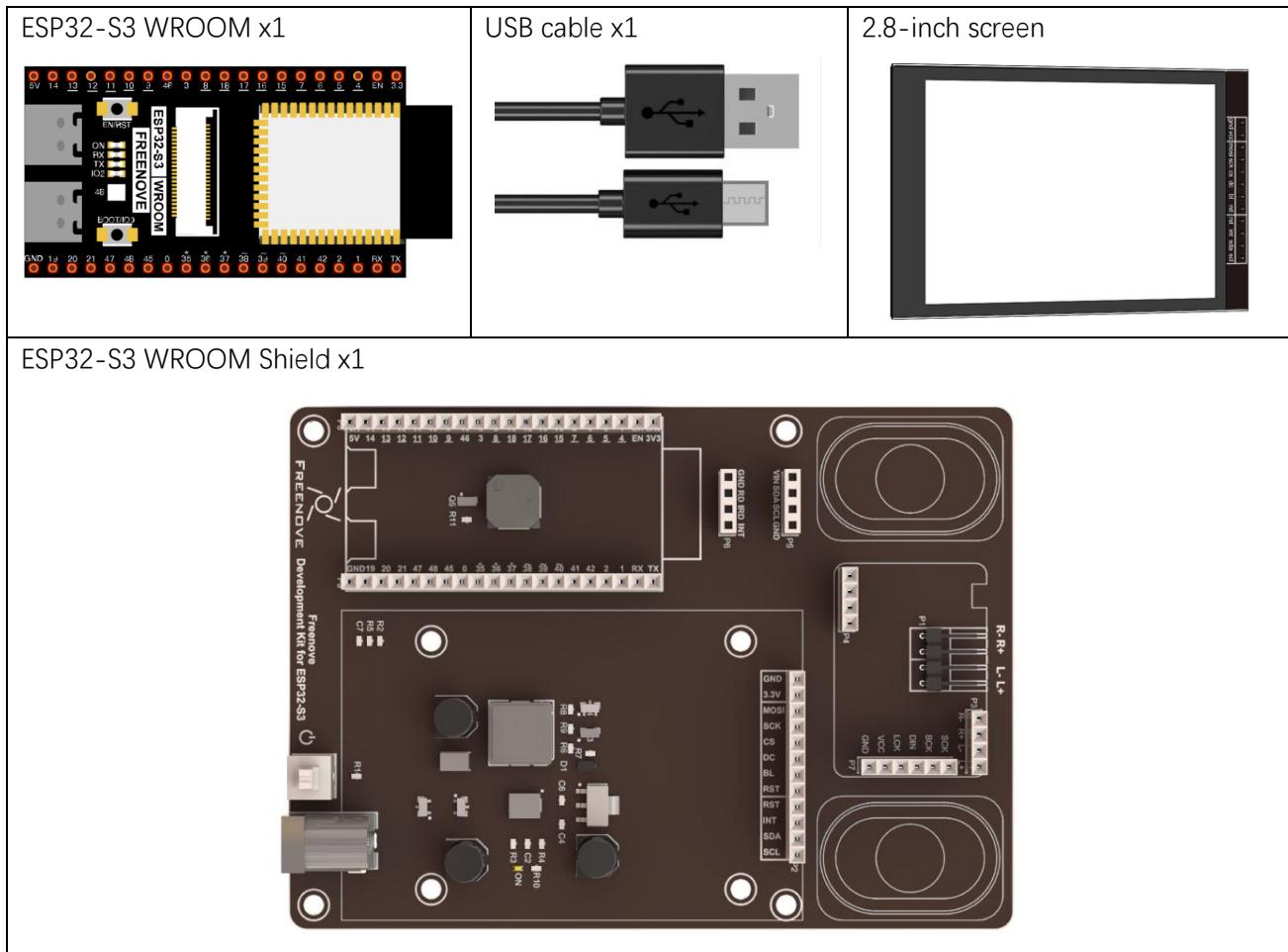
Chapter 14 LVGL Imgbtn

In this chapter, we will learn the usage of imgbtn component on the screen.

Project 14.1 LVGL Imgbtn

We have provided an example in the code. With the example, we will learn how to use the imgbtn component.

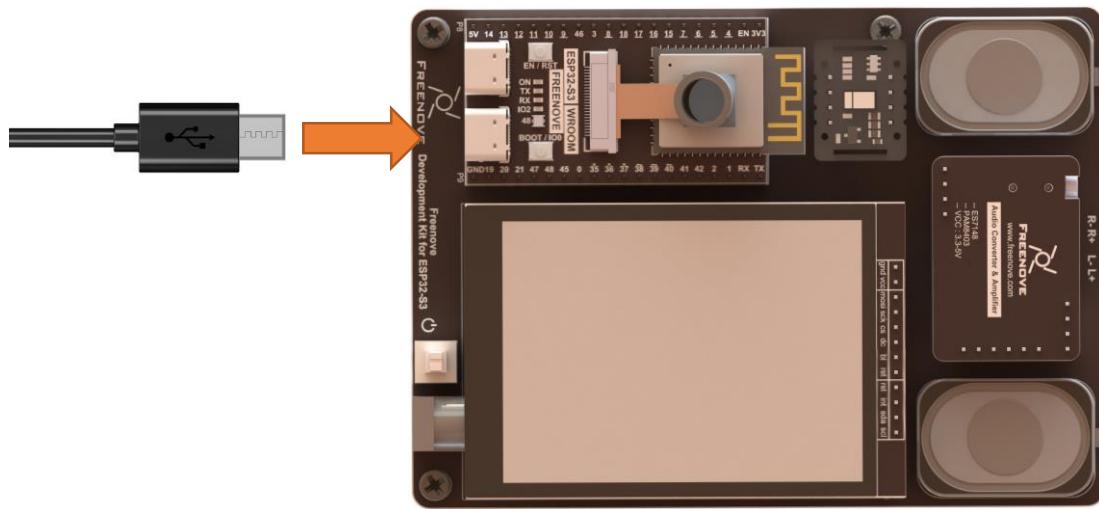
Component List



Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.

Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com



Sketch

Sketch_14_LVGL_Imgbtn

```

Sketch_14_Lvgl_Imgbtn | Arduino IDE 2.0.4
File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_14_Lvgl_Imgbtn.ino display.cpp display.h lv_example_imgbtn.h ...
1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4
5 #include "lv_example_imgbtn.h"
6
7 Display screen;
8
9 void setup() {
10   Serial.begin(115200);
11   /** Init screen ***/
12   screen.init();
13
14   /** Print lvgl version ***/
15   String LVGL_Arduino = "Hello Arduino! ";
16   LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
17   Serial.println(LVGL_Arduino);
18   Serial.println("I am LVGL_Arduino");
19   Serial.println("Setup done");
20
21   /** The custom code ***/
22   lv_example_imgbtn_1();
23 }
24
25 void loop() {
26   screen.routine();
27   delay(5);
28 }
```



Here is an illustration of the example:

`lv_example_imgbtn_1`



The following is the program code:

`Sketch_14_LVGL_Imgbtn.ino`

```

1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "lv_example_label.h"
5 Display screen;
6 void setup() {
7     Serial.begin(115200);
8     /*** Init screen ***/
9     screen.init();
10    /*** Print lvgl version ***/
11    String LVGL_Arduino = "Hello Arduino! ";
12    LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
13    lv_version_patch();
14    Serial.println(LVGL_Arduino);
15    Serial.println("I am LVGL_Arduino");
16    Serial.println("Setup done");
17
18    /*** The custom code ***/
19    lv_example_imgbtn_1(); //Basic use method.
20 }
21 void loop() {
22     screen.routine();
23     delay(5);
}

```

lv_example_imgbtn.h

We can define the three example functions and call them in the ino file.

```

1 #ifndef __LV_EXAMPLE_IMGBTN_H
2 #define __LV_EXAMPLE_IMGBTN_H
3 void lv_example_imgbtn_1(void);
4 #endif

```

Here is the complete code:

lv_example_imgbtn.cpp

```

1 #include "lvgl.h"
2 #include "lv_example_imgbtn.h"
3
4 const uint8_t img_freenove_map[] = {...}
5 ;
6
7 /***** Example 1 *****/
8 lv_img_dsc_t img_freenove;
9 void lv_img_freenove_init(void) {
10     lv_img_header_t header;
11     header.always_zero = 0;
12     header.w = 80;
13     header.h = 80;
14     header.cf = LV_IMG_CF_TRUE_COLOR;
15     img_freenove.header = header;
16     img_freenove.data_size = 6400 * LV_IMG_PX_SIZE_ALPHA_BYTE;
17     img_freenove.data = img_freenove_map;
18 }
19
20 void lv_example_imgbtn_1(void) {
21     lv_img_freenove_init();
22     /*Init the pressed style*/
23     static lv_style_t style_pr;//Apply for a style
24     lv_style_init(&style_pr); //Initialize it
25     lv_style_set_translate_y(&style_pr, 5);//Style: Every time you trigger, move down 5 pixels
26
27     /*Create an image button*/
28     lv_obj_t *imgbtn1 = lv_imgbtn_create(lv_scr_act()); //Apply for a picture button
29     lv_obj_add_style(imgbtn1, &style_pr, LV_STATE_PRESSED);//Triggered when the button is
30     pressed
31
32     lv_obj_set_size(imgbtn1, 80, 80); //Sets the size of the picture button
33     lv_obj_align(imgbtn1, LV_ALIGN_CENTER, 0, 0); //Set the position of the picture button
34     lv_imgbtn_set_src(imgbtn1, LV_IMGBTN_STATE_RELEASED, NULL, &img_freenove, NULL);
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
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86
87
88
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90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114

```

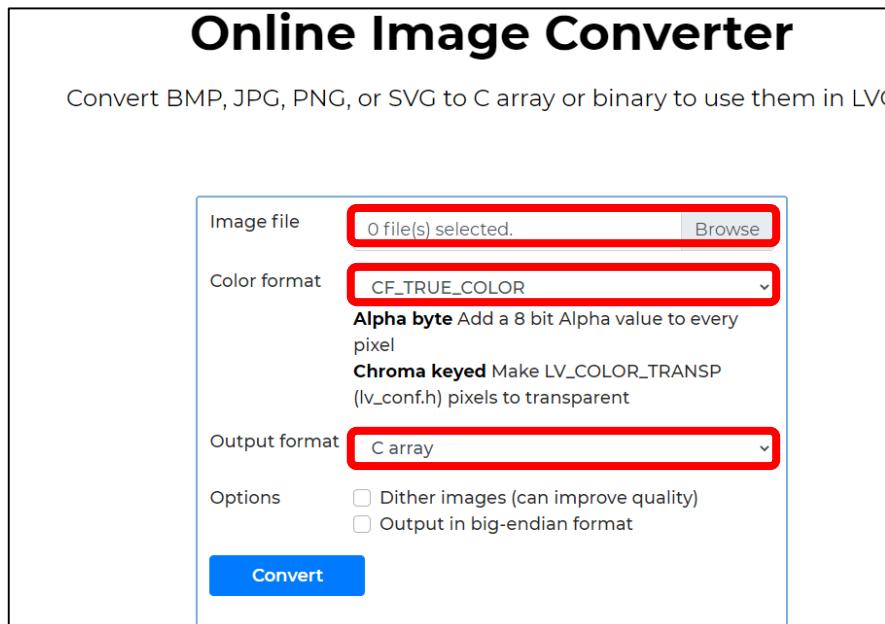
```

115 /*Create a label on the image button*/
116 lv_obj_t *label = lv_label_create(lv_scr_act());
117 lv_label_set_text(label, "Freenove");
118 lv_obj_align_to(label, imgbtn1, LV_ALIGN_OUT_BOTTOM_MID, 0, 20);
119 }

```

Here we provide a website: <https://lvgl.io/tools/imageconverter>

You can use the official website to convert an image to an array. Click "Browse" to select an image and convert it to an array file with the following configuration. Here we take the Freenove logo as an example.



Click "Convert" and the website will generate and download the corresponding array file. Open this file and find the definition shown below.

```

20 #ifndef LV_ATTRIBUTE_IMG_FREENOVE
21 #define LV_ATTRIBUTE_IMG_FREENOVE
22 #endif
23
24 const LV_ATTRIBUTE_MEM_ALIGN LV_ATTRIBUTE_LARGE_CONST LV_ATTRIBUTE_IMG_FREENOVE uint8_t freenove_map[] = {
25 #if LV_COLOR_DEPTH == 1 || LV_COLOR_DEPTH == 3
26 /*Pixel format: Red: 5 bit, Green: 6 bit, Blue: 5 bit*/
27 0xff, 0xff,
28 0xff, 0xff,
29 0xff, 0xff,
30 0xff, 0xff,
31 0xff, 0xff,
32 0xff, 0xff,
33 0xff, 0xff,
34 0xff, 0xff,
35 0xff, 0xff,
36 0xff, 0xff,
37 0xff, 0xff,
38 0xff, 0xff,
39 0xff, 0xff,
40 0xff, 0xff,
41 0xff, 0xff,
42 0xff, 0xff,
43 0xff, 0xff,
44 0xff, 0xff,
45 0xff, 0xff,
46 0xff, 0xff,
47 0xff, 0xff,
48 0xff, 0xff,
49 0xff, 0xff,
50 0xff, 0xff,
51 0xff, 0xff,
52 0xff, 0xff,
53 0xff, 0xff,
54 0xff, 0xff,
55 0xff, 0xff,
56 0xff, 0xff,
57 0xff, 0xff,
58 0xff, 0xff,
59 0xff, 0xff,
60 0xff, 0xff,
61 0xff, 0xff,
62 0xff, 0xff,
63 0xff, 0xff,
64 0xff, 0xff,
65 0xff, 0xff,
66 0xff, 0xff,
67 0xff, 0xff,
68 0xff, 0xff,
69 0xff, 0xff,
70 0xff, 0xff,
71 0xff, 0xff,
72 0xff, 0xff,
73 0xff, 0xff,
74 0xff, 0xff,
75 0xff, 0xff,
76 0xff, 0xff,
77 0xff, 0xff,
78 0xff, 0xff,
79 0xff, 0xff,
80 0xff, 0xff,
81 0xff, 0xff,
82 0xff, 0xff,
83 0xff, 0xff,
84 0xff, 0xff,
85 0xff, 0xff

```

Define an array img_freenove_map and copy the content of the previously generated array to it..

```

4 const uint8_t img_freenove_map[] = {
...
85 };

```

Define a variable img_freenove of type lv_img_dsc_t and write a function lv_img_freenove_init() to initialize it.

Please note that the original image resolution must be correctly filled in. "w" and "h" represent the width and height of the original image resolution, respectively. "data_size" represents the size of the image, while "data" represents the actual image data. It is recommended not to modify other options.

```

88 lv_img_dsc_t img_freenove;
89 void lv_img_freenove_init(void) {
90     lv_img_header_t header;
91     header.always_zero = 0;
92     header.w = 80;
93     header.h = 80;
94     header.cf = LV_IMG_CF_TRUE_COLOR;
95     img_freenove.header = header;
96     img_freenove.data_size = 6400 * LV_IMG_PX_SIZE_ALPHA_BYTE;
97     img_freenove.data = img_freenove_map;
98 }
```

Call the lv_img_freenove_init() function to configure img_freenove.

```
101 lv_img_freenove_init();
```

Create a style component, when this component is triggered, move the component down 5 pixels.

```

102 /*Init the pressed style*/
103 static lv_style_t style_pr;//Apply for a style
104 lv_style_init(&style_pr); //Initialize it
105 lv_style_set_translate_y(&style_pr, 5);//Style: Every time you trigger, move down 5 pixels
```

Create an image button component. Trigger the effect of the style when the component is pressed.

```

107 /*Create an image button*/
108 lv_obj_t *imgbtn1 = lv_imgbtn_create(lv_scr_act()); //Apply for a picture button
109 lv_obj_add_style(imgbtn1, &style_pr, LV_STATE_PRESSED);//Triggered when the button is
pressed
```

Set the size and position of the image button component, and display a picture on it.

```

111 lv_obj_set_size(imgbtn1, 80, 80); //Sets the size of the picture button
112 lv_obj_align(imgbtn1, LV_ALIGN_CENTER, 0, 0); //Set the position of the picture button
113 lv_imgbtn_set_src(imgbtn1, LV_IMGBTN_STATE_RELEASED, NULL, &img_freenove, NULL);
```

Create a label and display the content of the label 20 pixels below the image button component.

```

115 /*Create a label on the image button*/
116 lv_obj_t *label = lv_label_create(lv_scr_act());
117 lv_label_set_text(label, "Freenove");
118 lv_obj_align_to(label, imgbtn1, LV_ALIGN_OUT_BOTTOM_MID, 0, 20);
```

For more information about LVGL, please refer to the link below:

<https://docs.lvgl.io/8.1/widgets/extra/imbtn.html>

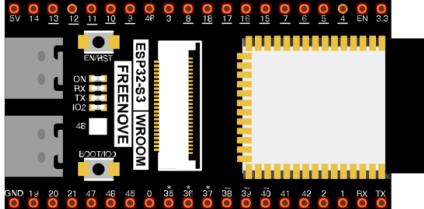
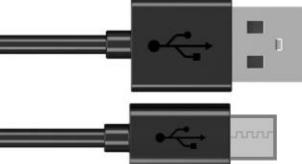
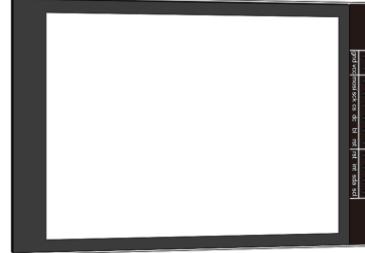
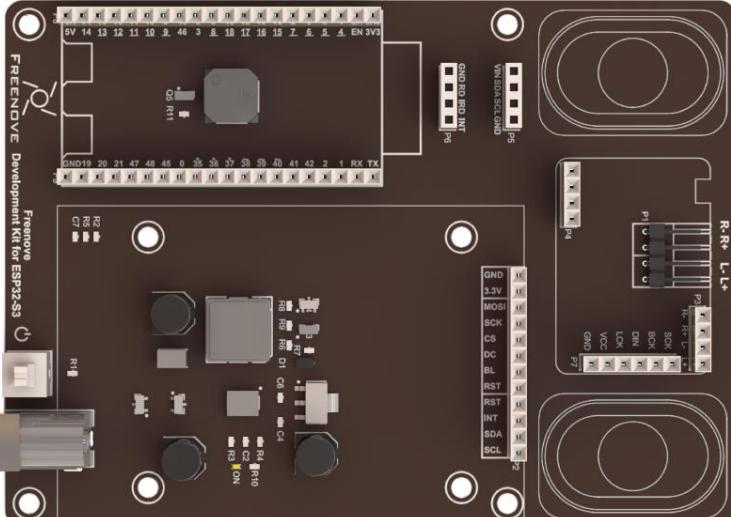
Chapter 15 LVGL Camera

In this chapter, we will learn how to create a camera example.

Project 15.1 LVGL Camera

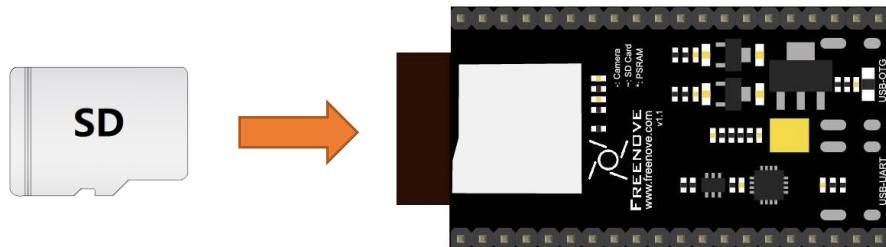
In this project, we will learn how to display the images captured by the camera on the screen.

Component List

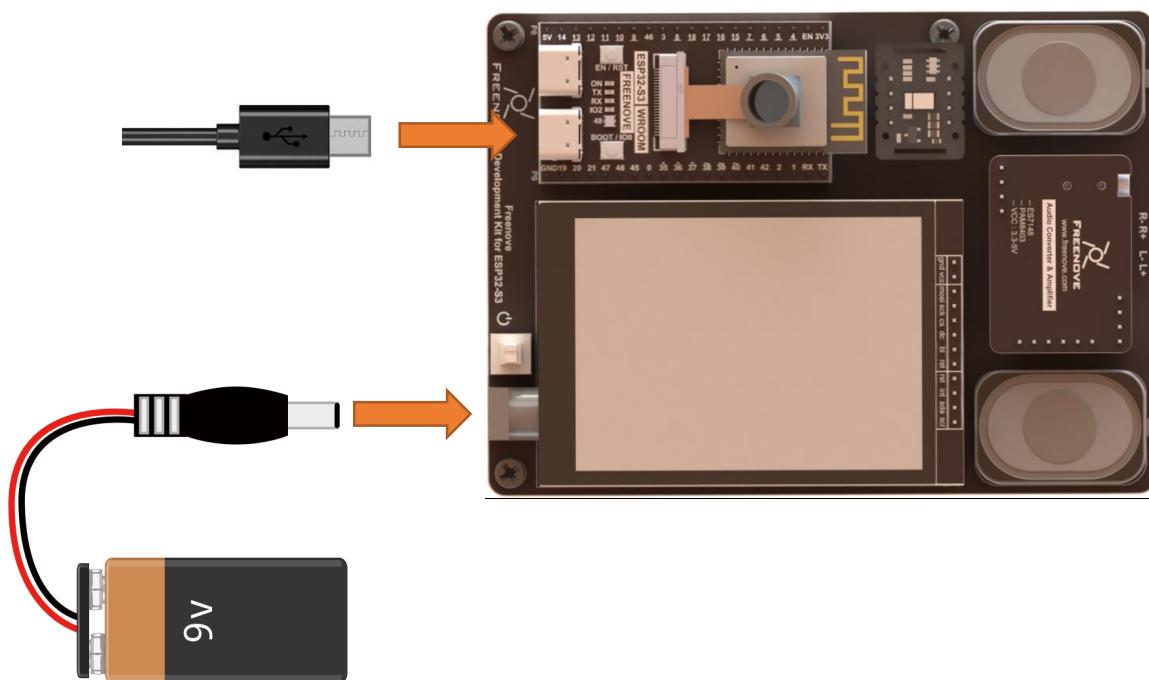
ESP32-S3 WROOM x1	USB cable x1	2.8-inch screen
		
ESP32-S3 WROOM Shield x1		Card reader x1 (random color)
		
9V battery cable x1	9V battery x1 <i>(Not included, prepared by yourself)</i>	SD card x1
		

Circuit

If you have not yet used the SD card, please refer to Chapter 4. Click [here](#) to navigate back to Chapter 4. Before connecting the USB cable, insert the SD card into the SD card slot on the back of the ESP32-S3.



Connect Freenove ESP32-S3 to the computer using the USB cable.

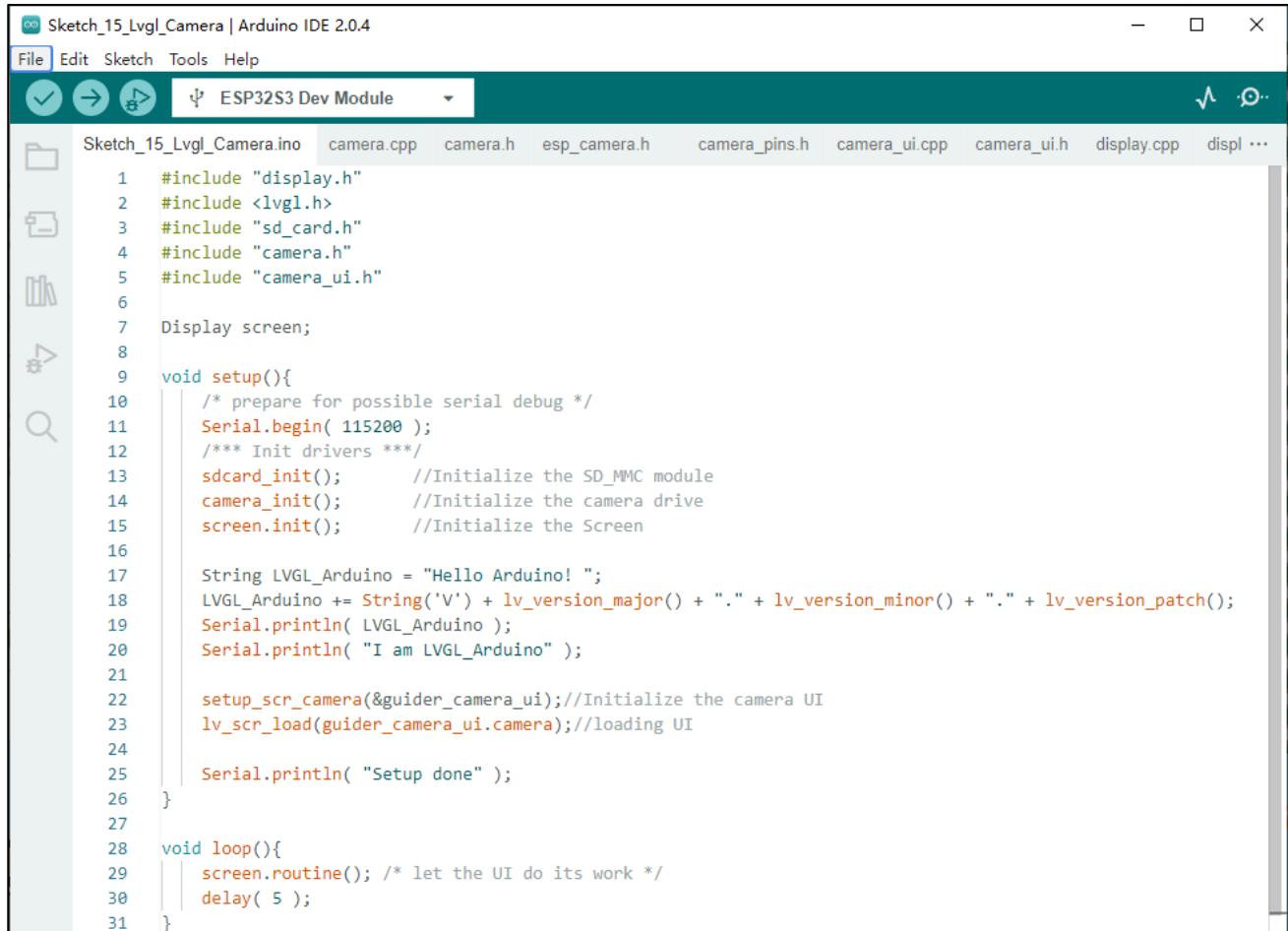


Sketch

Note: If you press the button to take a picture in the project, the picture will be saved to the picture folder of the sd card. You can use a card reader to access these pictures.

If you want to flip the image of the display, just swipe the screen slightly from left to right.

Sketch_15_LVGL_Camera



```

Sketch_15_Lvgl_Camera | Arduino IDE 2.0.4
File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_15_Lvgl_Camera.ino camera.cpp camera.h esp_camera.h camera_pins.h camera_ui.cpp camera_ui.h display.cpp disp ...
1 #include "display.h"
2 #include <lvgl.h>
3 #include "sd_card.h"
4 #include "camera.h"
5 #include "camera_ui.h"
6
7 Display screen;
8
9 void setup(){
10     /* prepare for possible serial debug */
11     Serial.begin( 115200 );
12     /*** Init drivers ***/
13     sdcard_init();          //Initialize the SD_MMC module
14     camera_init();          //Initialize the camera drive
15     screen.init();          //Initialize the Screen
16
17     String LVGL_Arduino = "Hello Arduino! ";
18     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
19     Serial.println( LVGL_Arduino );
20     Serial.println( "I am LVGL_Arduino" );
21
22     setup_scr_camera(&guider_camera_ui); //Initialize the camera UI
23     lv_scr_load(guider_camera_ui.camera); //loading UI
24
25     Serial.println( "Setup done" );
26 }
27
28 void loop(){
29     screen.routine(); /* let the UI do its work */
30     delay( 5 );
31 }

```

The following is the program code:

```

1 #include "display.h"
2 #include <lvgl.h>
3 #include "sd_card.h"
4 #include "camera.h"
5 #include "camera_ui.h"
6
7 Display screen;
8
9 void setup() {
10     /* prepare for possible serial debug */
11     Serial.begin( 115200 );
12     /*** Init drivers ***/
13     sdcard_init();          //Initialize the SD_MMC module

```

```

14     camera_init();           //Initialize the camera drive
15     screen.init();          //Initialize the Screen
16
17     String LVGL_Arduino = "Hello Arduino! ";
18     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
19     lv_version_patch();
20     Serial.println( LVGL_Arduino );
21     Serial.println( "I am LVGL_Arduino" );
22
23     setup_scr_camera(&guider_camera_ui);
24     lv_scr_load(guider_camera_ui.camera);
25
26     Serial.println( "Setup done" );
27 }
28
29 void loop() {
30     screen.routine(); /* let the GUI do its work */
31     delay( 5 );
32 }
```

Initialize the SD card, camera, and screen. Note that the LVGL library file system has already been configured to include the SD card by default. Therefore, in order to use the file system to manipulate the SD card in LVGL, SD card initialization must be performed before screen initialization.

```

13     sdcards_init();          //Initialize the SD_MMC module
14     camera_init();           //Initialize the camera drive
15     screen.init();          //Initialize the Screen
```

Configure the camera interface and load this interface.

```

22     setup_scr_camera(&guider_camera_ui);
23     lv_scr_load(guider_camera_ui.camera);
```

camera_ui.h

Declare the functions so that they can be called in the INO file.

```

1 #ifndef __CAMERA_UI_H
2 #define __CAMERA_UI_H
3
4 #include "lvgl.h"
5 #include "Arduino.h"
6 #include "esp_camera.h"
7 #include "lv_img.h"
8
9 extern camera_fb_t *fb;
10
11 typedef struct lvgl_camera{
12     lv_obj_t *camera;
13     lv_obj_t *camera_video;
14     lv_obj_t *camera_imgbttn_photo;
```

```

15    lv_obj_t *camera_imgbtn_home;
16 }lvgl_camera_ui;
17
18 extern lv_img_dsc_t photo_show;           //Apply an lvgl image variable
19 extern lvgl_camera_ui guider_camera_ui;  //Camera ui structure
20
21 void ui_set_photo_show(void);            //Initialize an lvgl image variable
22 void setup_scr_camera(lvgl_camera_ui *ui); //Parameter configuration function on the camera
screen
23
24 void create_camera_task(void);           //Create camera task thread
25 void stop_camera_task(void);             //Close the camera thread
26 void loopTask_camera(void *pvParameters); //Camera task thread
27
28 #endif

```

camera_ui.cpp

```

1 #include "camera_ui.h"
2 #include "camera.h"
3 #include "sd_card.h"
4
5 lv_img_dsc_t photo_show;           //apply an lvgl image variable
6 lvgl_camera_ui guider_camera_ui; //camera ui structure
7 camera_fb_t *fb = NULL;          //data structure of camera frame buffer
8 camera_fb_t *fb_buf = NULL;
9 TaskHandle_t cameraTaskHandle;    //camera thread task handle
10 static int camera_task_flag=0;    //camera thread running flag
11
12 //Create camera task thread
13 void create_camera_task(void) {
14     if(camera_task_flag==0) {
15         camera_task_flag=1;
16         ui_set_photo_show();
17         xTaskCreate(loopTask_camera, "loopTask_camera", 8192, NULL, 1, &cameraTaskHandle);
18     }
19     else{
20         Serial.println("loopTask_camera is running...");
21     }
22 }
23
24 //Close the camera thread
25 void stop_camera_task(void) {
26     if(camera_task_flag==1) {
27         camera_task_flag=0;
28         while(1) {

```

```
29         if (eTaskGetState(cameraTaskHandle) == eDeleted) {
30             break;
31         }
32         vTaskDelay(10);
33     }
34     Serial.println("loopTask_camera deleted!");
35 }
36 }
37
38 //camera thread
39 void loopTask_camera(void *pvParameters) {
40     Serial.println("loopTask_camera start...");
41     while (camera_task_flag) {
42         fb = esp_camera_fb_get();
43         fb_buf = fb;
44         esp_camera_fb_return(fb);
45         if (fb_buf!=NULL) {
46             for (int i=0;i<fb_buf->len;i+=2) {
47                 uint8_t temp=0;
48                 temp=fb_buf->buf[i];
49                 fb_buf->buf[i]=fb_buf->buf[i+1];
50                 fb_buf->buf[i+1]=temp;
51             }
52             photo_show.data = fb_buf->buf;
53             lv_img_set_src(guider_camera_ui.camera_video,&photo_show);
54         }
55     }
56     vTaskDelete(cameraTaskHandle);
57 }
58
59 //Initialize an lvgl image variable
60 void ui_set_photo_show(void) {
61     lv_img_header_t header;
62     header.always_zero = 0;
63     header.w = 240;
64     header.h = 240;
65     header.cf = LV_IMG_CF_TRUE_COLOR;
66     photo_show.header = header;
67     photo_show.data_size = 240 * 240 * 2;
68     photo_show.data = NULL;
69 }
70
71 //Click the photo icon, callback function: goes to the main ui interface
72 static void camera_imgbtn_photo_event_handler(lv_event_t *e) {
```

```

73 lv_event_code_t code = lv_event_get_code(e);
74 if (code == LV_EVENT_CLICKED) {
75     Serial.println("Clicked the camera button.");
76     if(camera_task_flag==1) {
77         stop_camera_task();
78         fb = esp_camera_fb_get();
79         if (fb != NULL) {
80             for (int i = 0; i < fb->len; i += 2) {
81                 uint8_t temp = 0;
82                 temp = fb->buf[i];
83                 fb->buf[i] = fb->buf[i + 1];
84                 fb->buf[i + 1] = temp;
85             }
86             int photo_index = list_count_number(list_picture);
87             Serial.printf("photo_index: %d\r\n",photo_index);
88             if(photo_index!=-1) {
89                 String path = String(PICTURE_FOLDER) + "/" + String(++photo_index) + ".bmp";//You can
view it directly from your computer
90                 write_rgb565_to_bmp((char *)path.c_str(), fb->buf, fb->len, fb->height, fb->width);
91                 list_insert_tail(list_picture, (char *)path.c_str());
92             }
93         }
94     } else {
95         Serial.println("Camera capture failed.");
96     }
97     esp_camera_fb_return(fb);
98 }
99 create_camera_task();
100 }
101 }
102 //Click the home icon, callback function: goes to the main ui interface
103 static void camera_imgbtn_home_event_handler(lv_event_t *e) {
104     lv_event_code_t code = lv_event_get_code(e);
105
106     switch (code) {
107     case LV_EVENT_CLICKED:
108     {
109         Serial.println("Clicked the home button.");
110     }
111     break;
112     case LV_EVENT_RELEASED:
113     {
114         /*

```

```
116     stop_camera_task();
117     if (!lv_obj_is_valid(guider_main_ui.main))
118         setup_scr_main(&guider_main_ui);
119     lv_disp_t *d = lv_obj_get_disp(lv_scr_act());
120     if (d->prev_scr == NULL && d->scr_to_load == NULL)
121         lv_scr_load(guider_main_ui.main);
122     lv_obj_del(guider_camera_ui.camera);
123     */
124 }
125 break;
126 default:
127     break;
128 }
129 }

130 //Slide the screen to flip the screen
131 static void camera_screen_gesture_event_handler(lv_event_t *e) {
132     lv_event_code_t code = lv_event_get_code(e);
133     if (code == LV_EVENT_GESTURE) {
134         lv_dir_t dir = lv_indev_get_gesture_dir(lv_indev_get_act());
135         bool state=0;
136         switch (dir) {
137             case LV_DIR_LEFT:
138             case LV_DIR_RIGHT:
139                 state = camera_get_mirror_horizontal();
140                 state = !state;
141                 camera_set_mirror_horizontal(state);
142                 break;
143             case LV_DIR_TOP:
144             case LV_DIR_BOTTOM:
145                 state = camera_get_flip_vertical();
146                 state = !state;
147                 camera_set_flip_vertical(state);
148                 break;
149         }
150     }
151 }
152 }

153 //Parameter configuration function on the camera screen
154 void setup_scr_camera(lvgl_camera_ui *ui) {
155     //Write the camera interface
156     ui->camera = lv_obj_create(NULL);
157     setup_list_head_picture();    //Generate a linked list based on the SD card's picture folder
158     lv_img_home_init();
```

```

160 lv_img_camera_init();
161
162 /*Init the pressed style*/
163 static lv_style_t style_pr;//Apply for a style
164 lv_style_init(&style_pr); //Initialize it
165 lv_style_set_translate_y(&style_pr, 5);//Style: Every time you trigger, move down 5 pixels
166
167 //Write codes for camera_video
168 ui->camera_video = lv_img_create(ui->camera);
169 lv_obj_set_pos(ui->camera_video, 0, 0);
170 lv_obj_set_size(ui->camera_video, 240, 240);
171
172 //Write codes for camera_photo
173 ui->camera_imgbtn_photo = lv_imgbtn_create(ui->camera);
174 lv_obj_set_pos(ui->camera_imgbtn_photo, 20, 240);
175 lv_obj_set_size(ui->camera_imgbtn_photo, 80, 80);
176 lv_img_set_src(ui->camera_imgbtn_photo, &img_camera);
177 lv_obj_add_style(ui->camera_imgbtn_photo, &style_pr, LV_STATE_PRESSED);
178 //Write codes for camera_return
179 ui->camera_imgbtn_home = lv_imgbtn_create(ui->camera);
180 lv_obj_set_pos(ui->camera_imgbtn_home, 140, 240);
181 lv_obj_set_size(ui->camera_imgbtn_home, 80, 80);
182 lv_img_set_src(ui->camera_imgbtn_home, &img_home);
183 lv_obj_add_style(ui->camera_imgbtn_home, &style_pr, LV_STATE_PRESSED);//Triggered when the
184 button is pressed
185
186 lv_obj_add_event_cb(ui->camera_imgbtn_photo, camera_imgbtn_photo_event_handler,
187 LV_EVENT_ALL, NULL);
188 lv_obj_add_event_cb(ui->camera_imgbtn_home, camera_imgbtn_home_event_handler, LV_EVENT_ALL,
189 NULL);
190 lv_obj_add_event_cb(ui->camera, camera_screen_gesture_event_handler, LV_EVENT_ALL, NULL);
191 create_camera_task();
192 }

```

Obtain the raw data of the camera through esp_camera_fb_get(), store the data in fb_buf, and release the camera for the next acquisition of camera data.

```

42     fb = esp_camera_fb_get();
43     fb_buf = fb;
44     esp_camera_fb_return(fb);

```

Obtain the raw data from the camera using esp_camera_fb_get() function, store the data in fb_buf, and release the camera for the next data acquisition.

```

46     for (int i=0;i<fb_buf->len;i+=2) {
47         uint8_t temp=0;
48         temp=fb_buf->buf[i];
49         fb_buf->buf[i]=fb_buf->buf[i+1];

```

```

50     fb_buf->buf[i+1]=temp;
51 }
```

Assign the processed data to the lvgl img component and display it on the screen.

```

52     photo_show.data = fb_buf->buf;
53     lv_img_set_src(guider_camera_ui.camera_video, &photo_show);
```

Create a video streaming thread to have the ESP32-S3 collect camera data and display it on the screen.

```

12 //Create camera task thread
13 void create_camera_task(void) {
14     if(camera_task_flag==0) {
15         camera_task_flag=1;
16         ui_set_photo_show();
17         xTaskCreate(loopTask_camera, "loopTask_camera", 8192, NULL, 1, &cameraTaskHandle);
18     }
19     else{
20         Serial.println("loopTask_camera is running...");
```

When camera_task_flag is set to 0, the video thread will exit and delete the handle cameraTaskHandle.

Therefore, when calling the stop_camera_task() function, just set camera_task_flag to 0, and then determine whether cameraTaskHandle has been deleted.

```

24 //Close the camera thread
25 void stop_camera_task(void) {
26     if(camera_task_flag==1) {
27         camera_task_flag=0;
28         while(1) {
29             if (eTaskGetState(cameraTaskHandle) == eDeleted) {
30                 break;
31             }
32             vTaskDelay(10);
33         }
34         Serial.println("loopTask_camera deleted!");
35     }
36 }
```

Call the function to calculate the number of members in the current linked list,

```

86     int photo_index = list_count_number(list_picture);
87     Serial.printf("photo_index: %d\r\n", photo_index);
```

Save the obtained camera raw image data as a 16-bit deep bmp file.

```

90     write_rgb565_to_bmp((char *)path.c_str(), fb->buf, fb->len, fb->height, fb->width);
```

Call the tail insertion method to add the file name to the linked list.

```

91     list_insert_tail(list_picture, (char *)path.c_str());
```

Picture button home, nothing is executed here, only the button trigger information is printed.

```

103 //Click the home icon, callback function: goes to the main ui interface
104 static void camera_imgbtn_home_event_handler(lv_event_t *e)
```

Create an operation object and assign it to the camera member in the ui structure.

Any concerns? ✉ support@freenove.com

```

133 //Write the camera interface
134 ui->camera = lv_obj_create(NULL);

```

Generate a linked list according to the picture folder in the sd card.

```
135 setup_list_head_picture(); //Generate a linked list based on the SD card's picture folder
```

Configure the image data for the two image buttons used in the camera interface.

```

136 lv_img_home_init();
137 lv_img_camera_init();

```

Apply a style to the image button to make it move down 5 pixels every time it is pressed.

```

139 /*Init the pressed style*/
140 static lv_style_t style_pr;//Apply for a style
141 lv_style_init(&style_pr); //Initialize it
142 lv_style_set_translate_y(&style_pr, 5);//Style: Every time you trigger, move down 5 pixels

```

Add an img component to the ui structure's camera member to display the image.

```

167 //Write codes for camera_video
168 ui->camera_video = lv_img_create(ui->camera);
169 lv_obj_set_pos(ui->camera_video, 0, 0);
170 lv_obj_set_size(ui->camera_video, 240, 240);

```

Add an image button with the camera icon as its image content. Set the position and size of the image. Add a downshift effect to the button when it is pressed.

```

172 //Write codes for camera_photo
173 ui->camera_imgbtn_photo = lv_imgbtn_create(ui->camera);
174 lv_obj_set_pos(ui->camera_imgbtn_photo, 20, 240);
175 lv_obj_set_size(ui->camera_imgbtn_photo, 80, 80);
176 lv_img_set_src(ui->camera_imgbtn_photo, &img_camera);
177 lv_obj_add_style(ui->camera_imgbtn_photo, &style_pr, LV_STATE_PRESSED);//Triggered when the
button is pressed

```

Add a picture button, and set the picture content as home. Set the picture position and size, and add a pressed effect that moves the button down.

```

178 //Write codes for camera_return
179 ui->camera_imgbtn_home = lv_imgbtn_create(ui->camera);
180 lv_obj_set_pos(ui->camera_imgbtn_home, 140, 240);
181 lv_obj_set_size(ui->camera_imgbtn_home, 80, 80);
182 lv_img_set_src(ui->camera_imgbtn_home, &img_home);
183 lv_obj_add_style(ui->camera_imgbtn_home, &style_pr, LV_STATE_PRESSED);//Triggered when the
button is pressed

```

Associate each of the two image buttons with their respective callback functions.

```

186 lv_obj_add_event_cb(ui->camera_imgbtn_photo, camera_imgbtn_photo_event_handler,
LV_EVENT_ALL, NULL);
187 lv_obj_add_event_cb(ui->camera_imgbtn_home, camera_imgbtn_home_event_handler, LV_EVENT_ALL,
NULL);
188 lv_obj_add_event_cb(ui->camera, camera_screen_gesture_event_handler, LV_EVENT_ALL, NULL);

```

Call the function to create a camera thread to display the camera image on the screen.

```
189 create_camera_task();
```

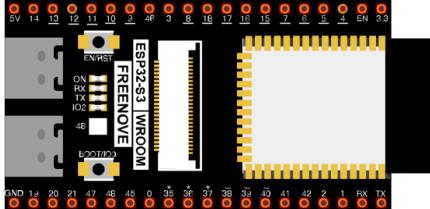
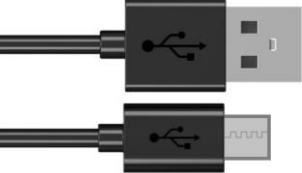
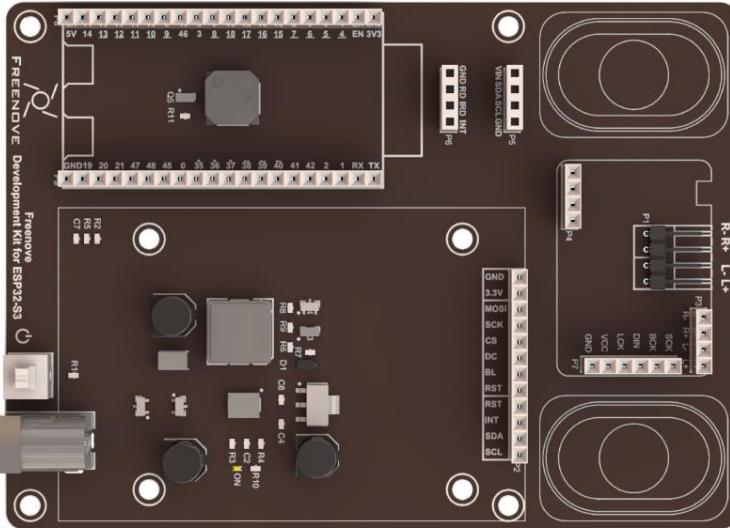
Chapter 16 LVGL Picture

In this chapter, we will learn how to create an image viewer.

Project 16.1 LVGL Picture

In this project, we will learn how to view pictures saved in SD card.

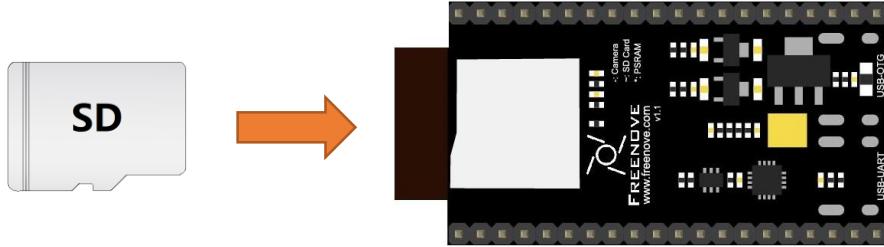
Component List

ESP32-S3 WROOM x1	USB cable x1	2.8-inch screen
		
ESP32-S3 WROOM Shield x1		Card reader x1 (random color)
		
9V battery cable x1	9V battery x1 <i>(Not included, prepared by yourself)</i>	SD card x1
		

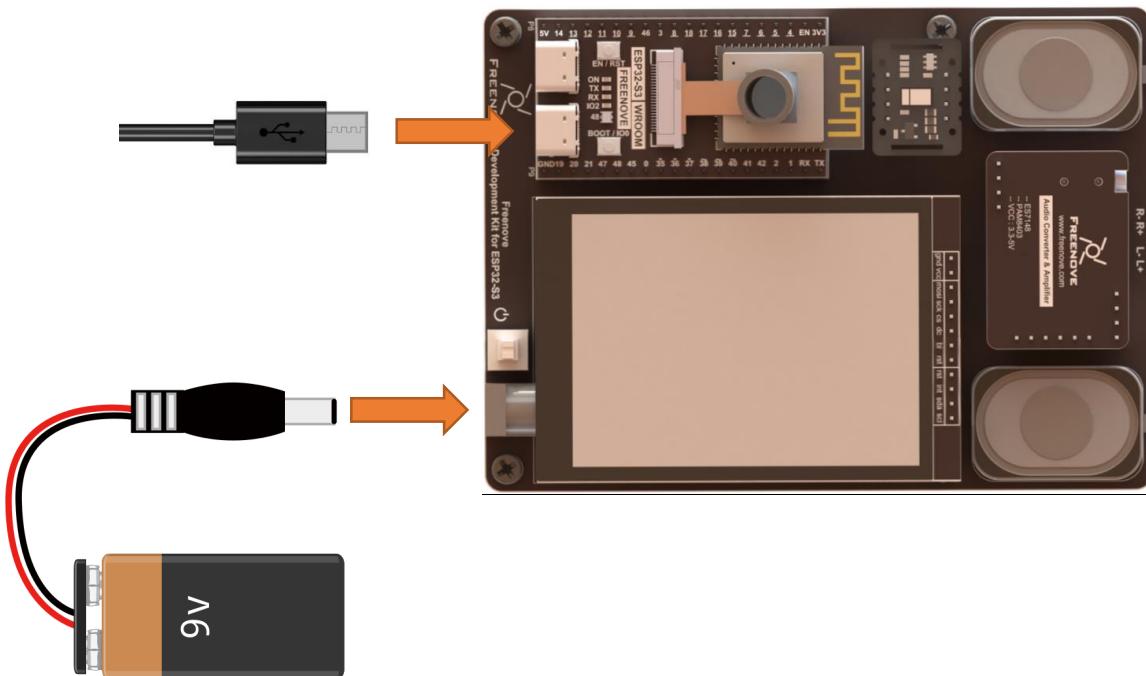
Any concerns? ✉ support@freenove.com

Circuit

If you have not yet used the SD card, please refer to Chapter 4. Click [here](#) to navigate back to Chapter 4. Before connecting the USB cable, insert the SD card into the SD card slot on the back of the ESP32-S3.



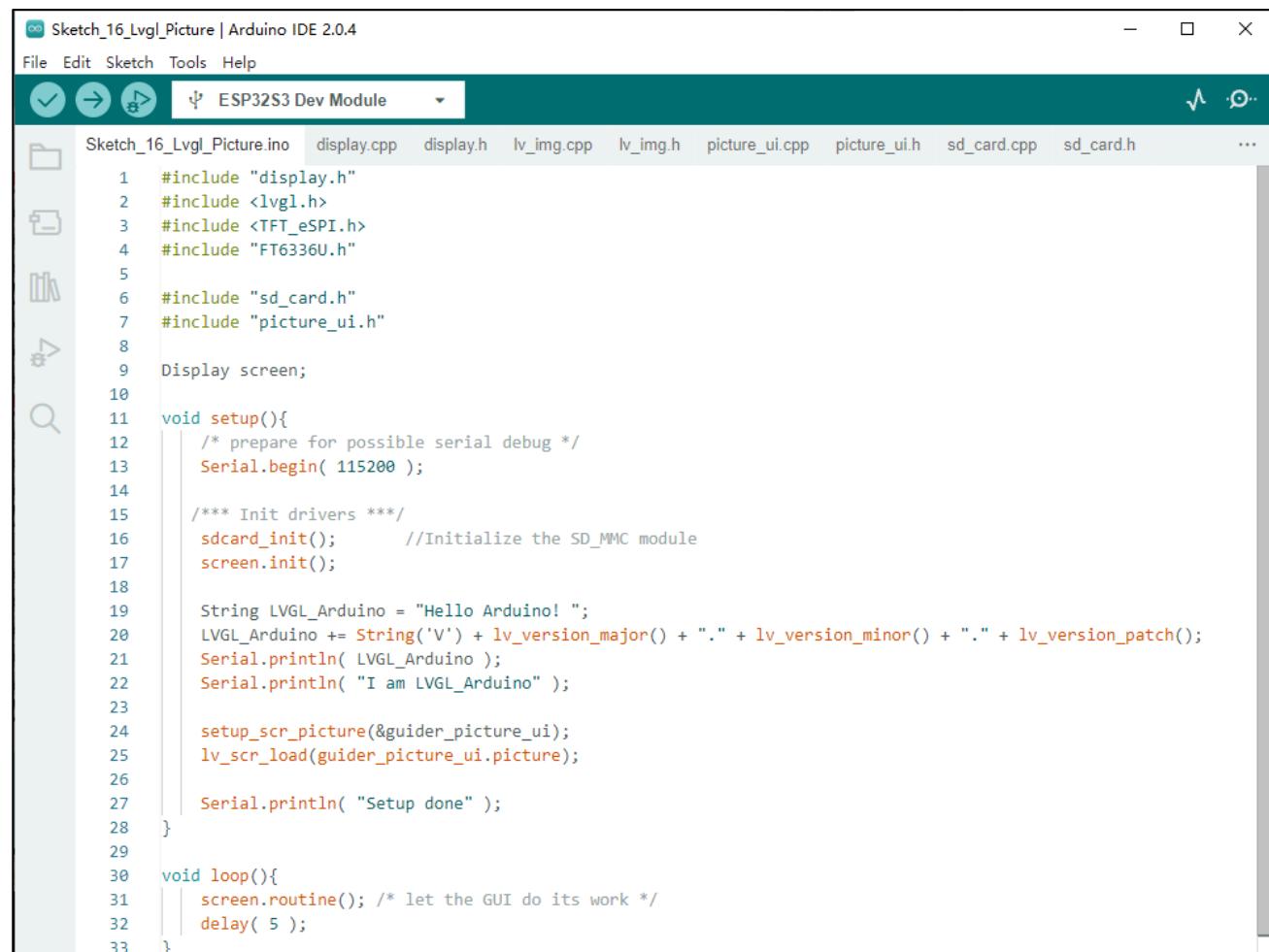
Connect Freenove ESP32-S3 to the computer using the USB cable.



Sketch

Before starting the project, please make sure that there is a folder named picture in your sd card, and the pictures inside are of bmp format, and their resolution is 240*240.

Sketch_16_LVGL_Picture



```
Sketch_16_Lvgl_Picture | Arduino IDE 2.0.4
File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_16_Lvgl_Picture.ino display.cpp display.h lv_img.cpp lv_img.h picture_ui.cpp picture_ui.h sd_card.cpp sd_card.h ...
1 #include "display.h"
2 #include <lvgl.h>
3 #include <TFT_eSPI.h>
4 #include "FT6336U.h"
5
6 #include "sd_card.h"
7 #include "picture_ui.h"
8
9 Display screen;
10
11 void setup(){
12     /* prepare for possible serial debug */
13     Serial.begin( 115200 );
14
15     /*** Init drivers ***/
16     sdcard_init();      //Initialize the SD_MMC module
17     screen.init();
18
19     String LVGL_Arduino = "Hello Arduino! ";
20     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
21     Serial.println( LVGL_Arduino );
22     Serial.println( "I am LVGL_Arduino" );
23
24     setup_scr_picture(&guider_picture_ui);
25     lv_scr_load(guider_picture_ui.picture);
26
27     Serial.println( "Setup done" );
28 }
29
30 void loop(){
31     screen.routine(); /* let the GUI do its work */
32     delay( 5 );
33 }
```

The following is the program code:

```
1 #include "display.h"
2 #include <lvgl.h>
3 #include <TFT_eSPI.h>
4 #include "FT6336U.h"
5
6 #include "sd_card.h"
7 #include "picture_ui.h"
8
9 Display screen;
10
11 void setup() {
12     /* prepare for possible serial debug */
13     Serial.begin( 115200 );
```

```

14
15     /*** Init drivers ***/
16     sdcard_init();          //Initialize the SD_MMC module
17     screen.init();          //Initialize the Screen
18
19     String LVGL_Arduino = "Hello Arduino! ";
20     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
21     lv_version_patch();
22     Serial.println( LVGL_Arduino );
23     Serial.println( "I am LVGL_Arduino" );
24
25     setup_scr_picture(&guider_picture_ui);
26     lv_scr_load(guider_picture_ui.picture);
27
28     Serial.println( "Setup done" );
29 }
30
31 void loop() {
32     screen.routine(); /* let the GUI do its work */
33     delay( 5 );
34 }
```

Configure the image viewing interface and load this interface.

```

22     setup_scr_picture(&guider_picture_ui);
23     lv_scr_load(guider_picture_ui.picture);
```

picture_ui.h

Declare the functions so that they can be called in the ino file.

```

1 #ifndef __PICTURE_UI_H
2 #define __PICTURE_UI_H
3
4 #include "lvgl.h"
5 #include "Arduino.h"
6
7 typedef struct lvgl_picture{
8     lv_obj_t *picture;
9     lv_obj_t *picture_left;
10    lv_obj_t *picture_right;
11    lv_obj_t *picture_show;
12    lv_obj_t *picture_home;
13 }lvgl_picture;
14
15 extern lvgl_picture ui;      //picture ui structure
16 void setup_scr_picture(lvgl_picture *ui); //Parameter configuration function on the picture
screen
17 void picture_imgbtn_display(char *name);    //Read the image file and display it
```

18

19 #endif

picture_ui.cpp

```
1 #include "picture_ui.h"
2 #include "sd_card.h"
3 #include "lv_img.h"
4
5 lv_img_dsc_t pic_show;           //apply an lvgl image variable
6 lvgl_picture_ui guider_picture_ui; //picture ui structure
7 static int picture_index_num=1;   //index number of the picture
8
9 //Initialize an lvgl image variable
10 void ui_set_pic_show(void) {
11     lv_img_header_t header;
12     header.always_zero = 0;
13     header.w = 240;
14     header.h = 240;
15     header.cf = LV_IMG_CF_TRUE_COLOR;
16     pic_show.header = header;
17     pic_show.data_size = 240 * 240 * 2;
18     pic_show.data = NULL;
19 }
20
21 //Click the left icon, callback function: show the last picture
22 static void picture_imgbtn_left_event_handler(lv_event_t *e) {
23     lv_event_code_t code = lv_event_get_code(e);
24     if (code == LV_EVENT_CLICKED) {
25         Serial.println("Clicked the left button.");
26         picture_index_num--;
27         if(picture_index_num < 1)
28             picture_index_num=list_count_number(list_picture);
29         picture_imgbtn_display(list_find_node(list_picture, picture_index_num));
30     }
31 }
32
33 //Click the right icon, callback function: show the next picture
34 static void picture_imgbtn_right_event_handler(lv_event_t *e) {
35     lv_event_code_t code = lv_event_get_code(e);
36     if (code == LV_EVENT_CLICKED) {
37         Serial.println("Clicked the right button.");
38         picture_index_num++;
39         if(picture_index_num > list_count_number(list_picture))
40             picture_index_num=1;
41         picture_imgbtn_display(list_find_node(list_picture, picture_index_num));
42 }
```

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```
42    }
43 }
44
45 //Click the home icon, callback function: goes to the main ui interface
46 static void picture_imgbtn_home_event_handler(lv_event_t *e) {
47     lv_event_code_t code = lv_event_get_code(e);
48     switch (code) {
49         case LV_EVENT_CLICKED:
50             {
51                 Serial.println("Clicked the return button.");
52             }
53             break;
54         case LV_EVENT_RELEASED:
55             {
56                 /*
57                 if (!lv_obj_is_valid(guider_main_ui.main))
58                     setup_scr_main(&guider_main_ui);
59                 lv_disp_t *d = lv_obj_get_disp(lv_scr_act());
60                 if (d->prev_scr == NULL && d->scr_to_load == NULL)
61                     lv_scr_load(guider_main_ui.main);
62                 lv_obj_del(guider_picture_ui.picture);
63                 */
64             }
65             break;
66         default:
67             break;
68     }
69 }
70
71 //Parameter configuration function on the picture screen
72 void setup_scr_picture(lvgl_picture_ui *ui){
73     //Write codes picture
74     ui->picture = lv_obj_create(NULL);
75     lv_img_home_init();
76     lv_img_left_init();
77     lv_img_right_init();
78
79     /*Init the pressed style*/
80     static lv_style_t style_pr;//Apply for a style
81     lv_style_init(&style_pr); //Initialize it
82     lv_style_set_translate_y(&style_pr, 5);//Style: Every time you trigger, move down 5 pixels
83
84     //Write codes picture_left
85     ui->picture_left = lv_imgbtn_create(ui->picture);
```

```
86 lv_obj_set_pos(ui->picture_left, 10, 250);
87 lv_obj_set_size(ui->picture_left, 60, 60);
88 lv_img_set_src(ui->picture_left, &img_left);
89 lv_obj_add_style(ui->picture_left, &style_pr, LV_STATE_PRESSED);

90
91 //Write codes picture_right
92 ui->picture_right = lv_imgbtn_create(ui->picture);
93 lv_obj_set_pos(ui->picture_right, 170, 250);
94 lv_obj_set_size(ui->picture_right, 60, 60);
95 lv_img_set_src(ui->picture_right, &img_right);
96 lv_obj_add_style(ui->picture_right, &style_pr, LV_STATE_PRESSED);

97
98 //Write codes picture_home
99 ui->picture_home = lv_imgbtn_create(ui->picture);
100 lv_obj_remove_style_all(ui->picture_home);
101 lv_obj_set_pos(ui->picture_home, 80, 240);
102 lv_obj_set_size(ui->picture_home, 80, 80);
103 lv_img_set_src(ui->picture_home, &img_home);
104 lv_obj_add_style(ui->picture_home, &style_pr, LV_STATE_PRESSED);

105
106 //Write codes picture_show
107 ui->picture_show = lv_img_create(ui->picture);
108 lv_obj_set_pos(ui->picture_show, 0, 0);
109 lv_obj_set_size(ui->picture_show, 240, 240);

110
111 ui_set_pic_show();
112 setup_list_head_picture();
113 picture_index_num = list_count_number(list_picture);
114 picture_imgbtn_display(list_find_node(list_picture, picture_index_num));

115
116 lv_obj_add_event_cb(ui->picture_left, picture_imgbtn_left_event_handler, LV_EVENT_ALL,
117 NULL);
118 lv_obj_add_event_cb(ui->picture_right, picture_imgbtn_right_event_handler, LV_EVENT_ALL,
119 NULL);
120
121 //Read the image file and display it
122 void picture_imgbtn_display(char *name) {
123     if(name!=NULL) {
124         char buf_picture_name[100]={"S:"};
125         strcat(buf_picture_name, PICTURE_FOLDER);
126         strcat(buf_picture_name, "/");
```

```

127     strcat(buf_picture_name, name);
128     lv_img_set_src(guider_picture_ui.picture_show, buf_picture_name);
129 }
130 else{
131     lv_img_set_src(guider_picture_ui.picture_show, LV_SYMBOL_DUMMY "The picture folder has no
132 files.");
133 }

```

Declare the header files.

```

1 #include "picture_ui.h"
2 #include "sd_card.h"
3 #include "lv_img.h"

```

"pic_show" is used to store image data. "guider_picture_ui" is used to configure the interface.

"picture_index_num" is used to record the position of the picture.

```

5 lv_img_dsc_t pic_show;           //apply an lvgl image variable
6 lvgl_picture_ui guider_picture_ui; //picture ui structure
7 static int picture_index_num=1;   //index number of the picture

```

Configure the parameters of the variable pic_show.

```

9 //Initialize an lvgl image variable
10 void ui_set_pic_show(void) {
11     lv_img_header_t header;
12     header.always_zero = 0;
13     header.w = 240;
14     header.h = 240;
15     header.cf = LV_IMG_CF_TRUE_COLOR;
16     pic_show.header = header;
17     pic_show.data_size = 240 * 240 * 2;
18     pic_show.data = NULL;
19 }

```

In the image display interface, we will use 3 image buttons. Here, we need to configure the image data.

```

75 lv_img_home_init();
76 lv_img_left_init();
77 lv_img_right_init();

```

Set a style to configure the image button so that it moves down 5 pixels each time it is pressed.

```

80 static lv_style_t style_pr;//Apply for a style
81 lv_style_init(&style_pr); //Initialize it
82 lv_style_set_translate_y(&style_pr, 5);//Style: Every time you trigger, move down 5 pixels

```

Apply for a picture button component, set its position, size, displayed picture content, and add the effect of the button being pressed.

```

84 //Write codes picture_left
85 ui->picture_left = lv_imgbtn_create(ui->picture);
86 lv_obj_set_pos(ui->picture_left, 10, 250);
87 lv_obj_set_size(ui->picture_left, 60, 60);
88 lv_img_set_src(ui->picture_left, &img_left);

```

```
89    lv_obj_add_style(ui->picture_left, &style_pr, LV_STATE_PRESSED);
```

Call the ui_set_pic_show() function to configure pic_show.

```
111    ui_set_pic_show();
```

Search the "picture" folder on the SD card and add all the BMP file names to the linked list "list_picture".

Please note that you can directly put custom pictures in the SD card and display them on the screen, but the resolution of the pictures must be 240x240. Resolutions that are too large or too small may not be displayed well.

```
112    setup_list_head_picture();
```

Calculate the number of members in the linked list list_picture, and assign the value back to picture_index_num.

```
113    picture_index_num = list_count_number(list_picture);
```

Call the list_find_node() function to obtain the file name of the node specified in the linked list list_picture. Call the picture_imgbtn_display() function to load and display the picture on the screen.

```
114    picture_imgbtn_display(list_find_node(list_picture, picture_index_num));
```

Associate the three picture buttons with their respective callback functions.

```
116    lv_obj_add_event_cb(ui->picture_left, picture_imgbtn_left_event_handler, LV_EVENT_ALL,
117                         NULL);
117    lv_obj_add_event_cb(ui->picture_right, picture_imgbtn_right_event_handler, LV_EVENT_ALL,
118                         NULL);
118    lv_obj_add_event_cb(ui->picture_home, picture_imgbtn_home_event_handler, LV_EVENT_ALL,
                         NULL);
```

Image button display function. When the file name is empty, print a prompt message. When the file name is not empty, generate the correct image path according to the file name, and load this file to the image component.

```
121 //Read the image file and display it
122 void picture_imgbtn_display(char *name) {
123     if(name!=NULL) {
124         char buf_picture_name[100]={"$:"};
125         strcat(buf_picture_name, PICTURE_FOLDER);
126         strcat(buf_picture_name, "/");
127         strcat(buf_picture_name, name);
128         lv_img_set_src(guiders_picture_ui.picture_show, buf_picture_name);
129     }
130     else{
131         lv_img_set_src(guiders_picture_ui.picture_show, LV_SYMBOL_DUMMY "The picture folder has no
files.");
132     }
133 }
```



Chapter 17 LVGL Music

In this chapter, we will learn how to create a simple music player.

Project 17.1 LVGL Music

In this project, we will learn how to make a simple mp3 player and play the music of mp3 format in the SD card through the speaker.

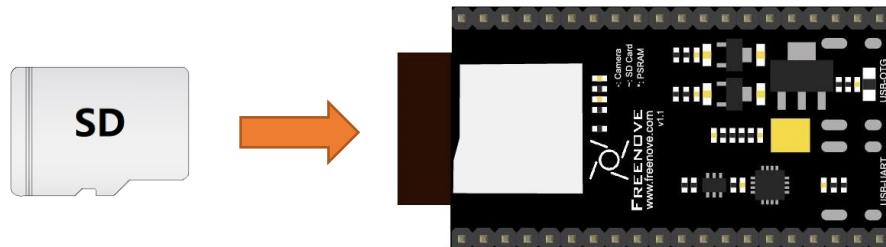
Component List

ESP32-S3 WROOM x1	USB cable x1	2.8-inch screen
ESP32-S3 WROOM Shield x1		Card reader x1 (random color)
9V battery cable x1	9V battery x1 (Not included, prepared by yourself)	SD card x1

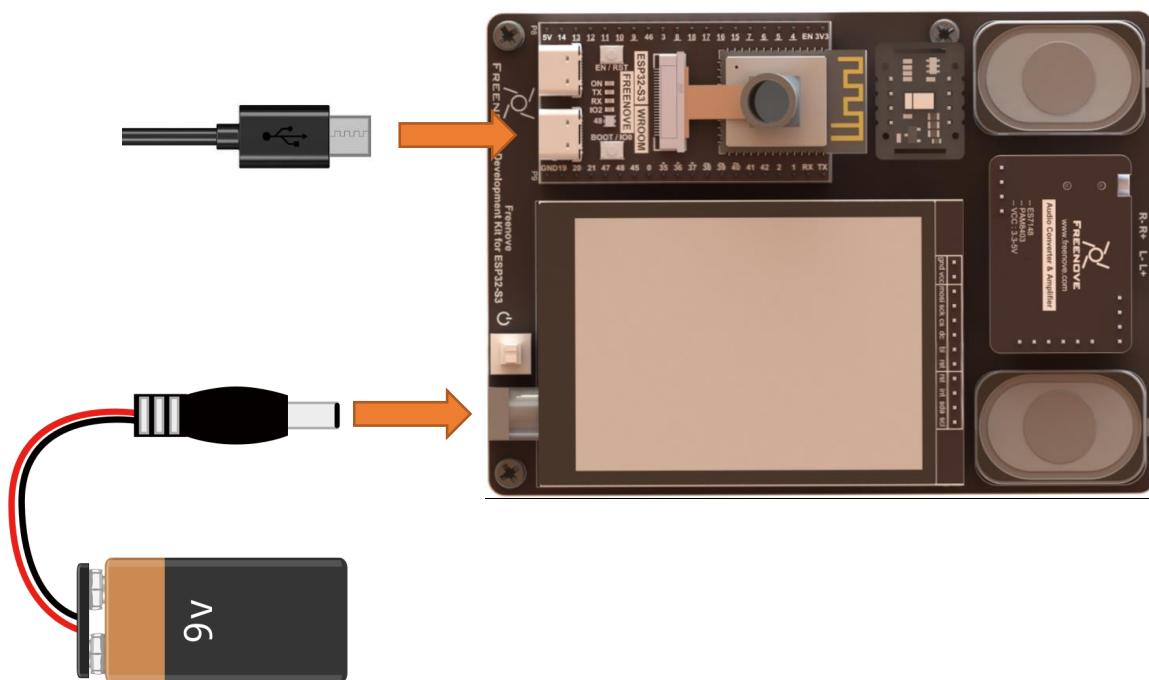
Any concerns? [✉ support@freenove.com](mailto:support@freenove.com)

Circuit

If you have not yet used the SD card, please refer to Chapter 4. Click [here](#) to navigate back to Chapter 4. Before connecting the USB cable, insert the SD card into the SD card slot on the back of the ESP32-S3.



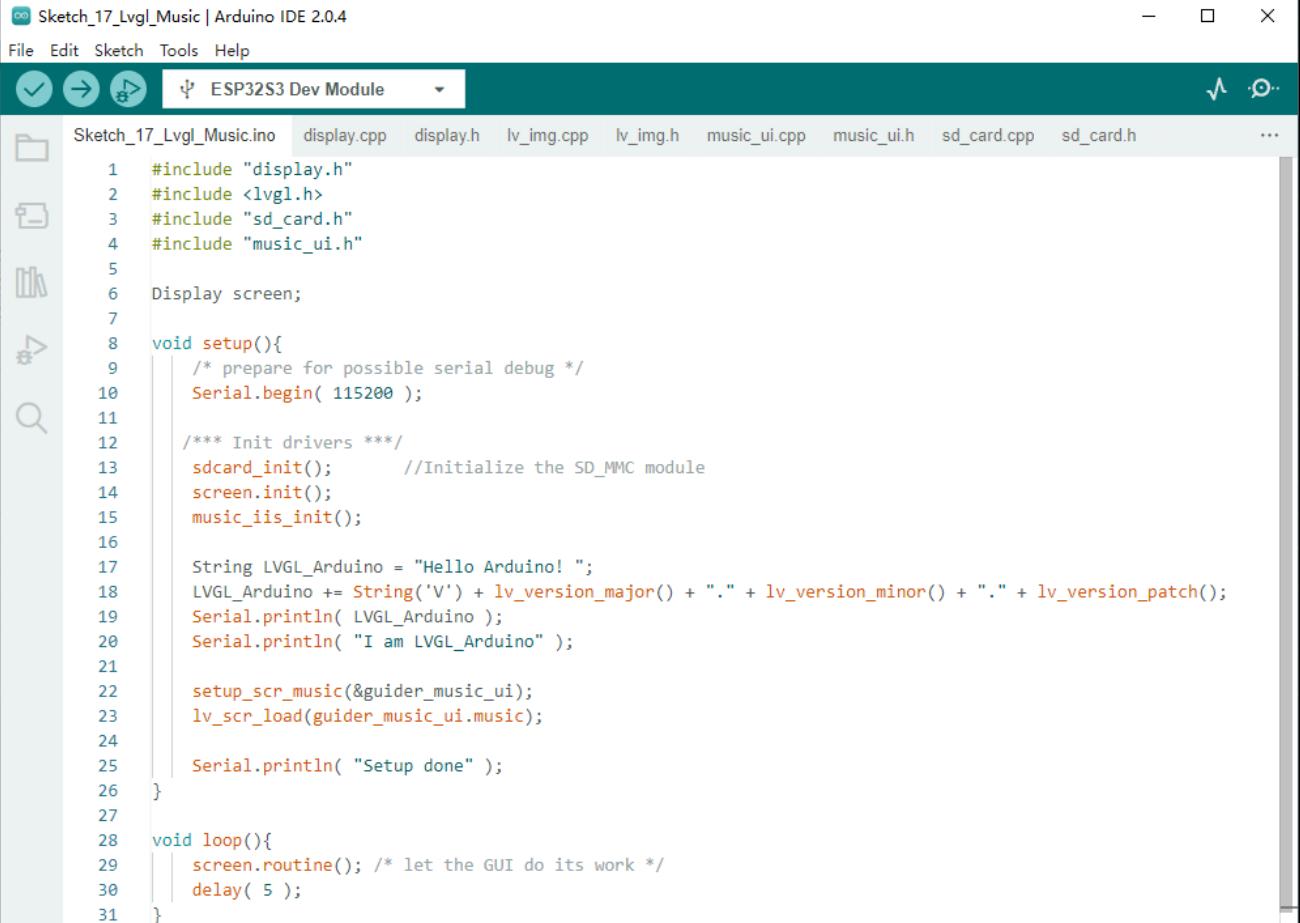
Connect Freenove ESP32-S3 to the computer using the USB cable.



Sketch

Before starting the project, please make sure that there is a folder named music in your sd card, and the songs inside are in mp3 format.

Sketch_17_LVGL_Music



```

Sketch_17_Lvgl_Music | Arduino IDE 2.0.4
File Edit Sketch Tools Help
ESP32S3 Dev Module
Sketch_17_Lvgl_Music.ino display.cpp display.h lv_img.cpp lv_img.h music_ui.cpp music_ui.h sd_card.cpp sd_card.h ...
1 #include "display.h"
2 #include <lvgl.h>
3 #include "sd_card.h"
4 #include "music_ui.h"
5
6 Display screen;
7
8 void setup(){
9     /* prepare for possible serial debug */
10    Serial.begin( 115200 );
11
12    /*** Init drivers ***/
13    sdcard_init();      //Initialize the SD_MMC module
14    screen.init();
15    music_iis_init();
16
17    String LVGL_Arduino = "Hello Arduino! ";
18    LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
19    Serial.println( LVGL_Arduino );
20    Serial.println( "I am LVGL_Arduino" );
21
22    setup_scr_music(&guider_music_ui);
23    lv_scr_load(guider_music_ui.music);
24
25    Serial.println( "Setup done" );
26 }
27
28 void loop(){
29     screen.routine(); /* let the GUI do its work */
30     delay( 5 );
31 }

```

The following is the program code:

```

1 #include "display.h"
2 #include <lvgl.h>
3 #include "sd_card.h"
4 #include "music_ui.h"
5
6 Display screen;
7
8 void setup() {
9     /* prepare for possible serial debug */
10    Serial.begin( 115200 );
11
12    /*** Init drivers ***/
13    sdcard_init();      //Initialize the SD_MMC module
14    screen.init();

```

```

15     music_iis_init();
16
17     String LVGL_Arduino = "Hello Arduino! ";
18     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
19     lv_version_patch();
20     Serial.println( LVGL_Arduino );
21     Serial.println( "I am LVGL_Arduino" );
22
23     setup_scr_music(&guider_music_ui);
24     lv_scr_load(guider_music_ui.music);
25
26     Serial.println( "Setup done" );
27 }
28
29 void loop() {
30     screen.routine(); /* let the GUI do its work */
31     delay( 5 );
32 }
```

Configure the music player interface and load this interface.

```

22     setup_scr_music(&guider_music_ui);
23     lv_scr_load(guider_music_ui.music);
```

music_ui.h

Declare the functions so that they can be called in the ino file.

```

1 #ifndef __MUSIC_H
2 #define __MUSIC_H
3
4 #include "lvgl.h"
5 #include "Arduino.h"
6
7 #define I2S_BCLK 42
8 #define I2S_DOUT 41
9 #define I2S_LRC 14
10
11 typedef struct lvgl_music{
12     lv_obj_t *music;
13     lv_obj_t *music_imgbtn_home;
14     lv_obj_t *music_imgbtn_left;
15     lv_obj_t *music_imgbtn_play;
16     lv_obj_t *music_imgbtn_stop;
17     lv_obj_t *music_imgbtn_right;
18     lv_obj_t *music_label;
19     lv_obj_t *music_slider_valume;
20     lv_obj_t *music_slider_label;
21     lv_obj_t *music_bar_time;
```

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```

22 }lvgl_music_ui;
23
24 extern lvgl_music_ui guider_music_ui;//music ui structure
25 void setup_scr_music(lvgl_music_ui *ui); //Parameter configuration function on the music screen
26
27 void music_set_label_text(char *text); //Set the label display content
28 void music_iis_init(void); //Initialize the audio interface
29 void music_set_volume(int volume); //Set the volume: 0-21
30 int music_read_volume(void); //Query volume
31 void music_load_mp3(char* name); //load the mp3
32 void music_pause_resume(void); //Pause/play the music
33 void music_stop(void); //Stop the music
34 bool music_is_running(void); //Whether the music is running
35 long music_get_total_playing_time(void); //Gets how long the music player has been playing
36 long music_get_file_duration(void); //Obtain the playing time of the music file
37 bool music_set_play_position(int second); //Set play position
38 long music_read_play_position(void); //Gets the current playing time of the music
39 void music_loop(void); //Non-blocking audio execution function
40 void loopTask_music(void *pvParameters); //music player task thread
41 void start_music_task(void); //Create music task thread
42 void stop_music_task(void); //Close the music thread
43 int music_task_is_running(void); //Check whether the thread is running
44 //optional
45 void audio_info(const char *info);
46 void audio_eof_mp3(const char *info);
47
48 #endif

```

music_ui.cpp

```

1 #include "music_ui.h"
2 #include "sd_card.h"
3 #include "stdlib.h"
4 #include "string.h"
5 #include "Audio.h"
6 #include "FS.h"
7 #include "SD_MMC.h"
8 #include "lv_img.h"
9
10 lvgl_music_ui guider_music_ui;//music ui structure
11 int music_button_state = 0; //UI Button status
12 int music_index_num = 1; //index number of the music
13
14 Audio audio;
15 int music_task_flag = 0; //music thread running flag
16 TaskHandle_t musicTaskHandle; //music thread task handle

```

```
17 //Click the home icon, callback function: goes to the main ui interface
18 static void music_imbtn_home_event_handler(lv_event_t *e) {
19     lv_event_code_t code = lv_event_get_code(e);
20     switch (code) {
21         case LV_EVENT_CLICKED:
22             {
23                 Serial.println("Clicked the home button.");
24             }
25             break;
26         case LV_EVENT_RELEASED:
27             {
28                 /*
29                     stop_music_task(); //Close the thread when exiting the music ui interface
30                     if (!lv_obj_is_valid(guider_main_ui.main))
31                         setup_scr_main(&guider_main_ui);
32                     lv_disp_t *d = lv_obj_get_disp(lv_scr_act());
33                     if (d->prev_scr == NULL && d->scr_to_load == NULL)
34                         lv_scr_load(guider_main_ui.main);
35                     //After exiting the interface, delete the interface to ensure that the next time you
36                     enter the initial interface
37                     lv_obj_del(guider_music_ui.music);
38                     */
39             }
40             break;
41         default:
42             break;
43     }
44 }
45
46 //Click the left icon, callback function: play the last song
47 static void music_imbtn_left_event_handler(lv_event_t *e) {
48     lv_event_code_t code = lv_event_get_code(e);
49     switch (code) {
50         case LV_EVENT_CLICKED:
51             {
52                 Serial.println("Clicked the left button.");
53             }
54             break;
55         case LV_EVENT_RELEASED:
56             {
57                 Serial.println("Play the last song.");
58                 music_index_num--;
59                 if (music_index_num < 1)
```

```
60         music_index_num = list_count_number(list_music);
61         stop_music_task();
62         lv_img_set_src(guider_music_ui.music_imgbtn_play, &img_pause);
63         music_button_state = 0;
64         char *buf_music_name = list_find_node(list_music, music_index_num);
65         music_set_label_text(buf_music_name);
66         if(buf_music_name!=NULL) {
67             char buf_music_path[255] = {MUSIC_FOLDER};
68             strcat(buf_music_path, "/");
69             strcat(buf_music_path, buf_music_name);
70             Serial.println(buf_music_path);
71             music_load_mp3(buf_music_path);
72             start_music_task();
73             lv_img_set_src(guider_music_ui.music_imgbtn_play, &img_playing);
74             music_button_state = 1;
75         }
76     }
77     break;
78 default:
79     break;
80 }
81 }
82
83 //Click the right icon, callback function: play the next song
84 static void music_imgbtn_right_event_handler(lv_event_t *e) {
85     lv_event_code_t code = lv_event_get_code(e);
86     switch (code) {
87     case LV_EVENT_CLICKED:
88     {
89         Serial.println("Clicked the right button.");
90     }
91     break;
92     case LV_EVENT_RELEASED:
93     {
94         Serial.println("Play the next song.");
95         music_index_num++;
96         if (music_index_num > list_count_number(list_music))
97             music_index_num = 1;
98
99         stop_music_task();
100        lv_img_set_src(guider_music_ui.music_imgbtn_play, &img_pause);
101        music_button_state = 0;
102        char *buf_music_name = list_find_node(list_music, music_index_num);
103        music_set_label_text(buf_music_name);
```

```
104     if(buf_music_name!=NULL) {
105         char buf_music_path[255] = {MUSIC_FOLDER};
106         strcat(buf_music_path, "/");
107         strcat(buf_music_path, buf_music_name);
108         Serial.println(buf_music_path);
109         music_load_mp3(buf_music_path);
110         start_music_task();
111         lv_img_set_src(guider_music_ui.music_imgbtn_play, &img_playing);
112         music_button_state = 1;
113     }
114 }
115 break;
116 default:
117     break;
118 }
119 }
120
121 //Click the play icon, callback function: play or pause the music
122 static void music_imgbtn_play_event_handler(lv_event_t *e) {
123     lv_event_code_t code = lv_event_get_code(e);
124     switch (code) {
125     case LV_EVENT_CLICKED:
126     {
127         Serial.println("Clicked the play button.");
128     }
129     break;
130     case LV_EVENT_RELEASED:
131     {
132         music_button_state = !music_button_state;
133         if (music_button_state == 1)
134             lv_img_set_src(guider_music_ui.music_imgbtn_play, &img_playing);
135         else
136             lv_img_set_src(guider_music_ui.music_imgbtn_play, &img_pause);
137
138     //Gets whether a music task currently exists
139     int is_task_running = music_task_is_running();
140     if (is_task_running == 1) { //If so, pause or play it
141         music_pause_resume();
142     } else {
143         /*If there is no music thread currently, load the music name first, and then create
the audio thread*/
144         char *buf_music_name = list_find_node(list_music, music_index_num);
145         if(buf_music_name!=NULL){
146             char buf_music_path[255] = {MUSIC_FOLDER};
```

```
147     strcat(buf_music_path, "/");
148     strcat(buf_music_path, buf_music_name);
149     Serial.println(buf_music_path);
150     music_load_mp3(buf_music_path);
151     start_music_task();
152   }
153 }
154 }
155 break;
156 default:
157   break;
158 }
159 }
160
//Click the stop icon, callback function: stop the music
162 static void music_imgbtn_stop_event_handler(lv_event_t *e) {
163   lv_event_code_t code = lv_event_get_code(e);
164   switch (code) {
165     case LV_EVENT_CLICKED:
166     {
167       Serial.println("Clicked the stop button.");
168     }
169     break;
170     case LV_EVENT_RELEASED:
171     {
172       lv_img_set_src(guider_music_ui.music_imgbtn_play, &img_pause);
173       stop_music_task();
174       lv_bar_set_value(guider_music_ui.music_bar_time, 0, LV_ANIM_OFF);
175       music_button_state = 0;
176       Serial.println("The music has stop.");
177     }
178     break;
179   default:
180     break;
181 }
182 }
183
184 static void music_slider_change_event_handler(lv_event_t * e) {
185   lv_obj_t *slider = lv_event_get_target(e);
186   char buf[16];
187   int volume = (int)lv_slider_get_value(slider);
188   lv_snprintf(buf, sizeof(buf), "Volume:%d", volume);
189   lv_label_set_text(guider_music_ui.music_slider_label, buf);
190   int last_volume = music_read_volume();
```

```
191     if(volume != last_volume)
192         music_set_volume(volume);
193 }
194
195 //Parameter configuration function on the music screen
196 void setup_scr_music(lvgl_music_ui *ui) {
197     ui->music = lv_obj_create(NULL);
198     lv_img_home_init();
199     lv_img_left_init();
200     lv_img_right_init();
201     lv_img_pause_init();
202     lv_img_playing_init();
203     lv_img_stop_init();
204     setup_list_head_music();
205
206     /*Init the pressed style*/
207     static lv_style_t style_pr;//Apply for a style
208     lv_style_init(&style_pr); //Initialize it
209     lv_style_set_translate_y(&style_pr, 5);//Style: Every time you trigger, move down 5 pixels
210
211     ui->music_imgbtn_home = lv_imgbtn_create(ui->music);
212     lv_obj_set_pos(ui->music_imgbtn_home, 80, 20);
213     lv_obj_set_size(ui->music_imgbtn_home, 80, 80);
214     lv_img_set_src(ui->music_imgbtn_home, &img_home);
215     lv_obj_add_style(ui->music_imgbtn_home, &style_pr, LV_STATE_PRESSED);//Triggered when the
button is pressed
216
217     ui->music_slider_label = lv_label_create(ui->music);
218     lv_obj_set_size(ui->music_slider_label, 160, 20);
219     lv_obj_align(ui->music_slider_label, LV_ALIGN_CENTER, 40, -30);
220
221     ui->music_slider_valume = lv_slider_create(ui->music);
222     lv_obj_set_size(ui->music_slider_valume, 180, 10);
223     lv_obj_set_pos(ui->music_slider_valume, 30, 150);
224     lv_slider_set_mode(ui->music_slider_valume, LV_SLIDER_MODE_NORMAL);
225     lv_slider_set_range(ui->music_slider_valume, 0, 21);
226     lv_slider_set_value(ui->music_slider_valume, 10, LV_ANIM_OFF);
227
228     ui->music_label = lv_label_create(ui->music);
229     lv_obj_set_pos(ui->music_label, 40, 180);
230     lv_obj_set_size(ui->music_label, 160, 20);
231     music_set_label_text(list_find_node(list_music, music_index_num));
232     lv_label_set_long_mode(ui->music_label, LV_LABEL_LONG_SCROLL_CIRCULAR );
```

```
234     lv_obj_set_style_text_align(ui->music_label, LV_TEXT_ALIGN_CENTER, 0);  
235  
236     ui->music_imgbtn_left = lv_imgbtn_create(ui->music);  
237     lv_obj_set_pos(ui->music_imgbtn_left, 0, 220);  
238     lv_obj_set_size(ui->music_imgbtn_left, 60, 60);  
239     lv_img_set_src(ui->music_imgbtn_left, &img_left);  
240     lv_obj_add_style(ui->music_imgbtn_left, &style_pr, LV_STATE_PRESSED);  
241  
242     ui->music_imgbtn_play = lv_imgbtn_create(ui->music);  
243     lv_obj_set_pos(ui->music_imgbtn_play, 60, 220);  
244     lv_obj_set_size(ui->music_imgbtn_play, 60, 60);  
245     lv_img_set_src(ui->music_imgbtn_play, &img_pause);  
246     lv_obj_add_style(ui->music_imgbtn_play, &style_pr, LV_STATE_PRESSED);  
247  
248     ui->music_imgbtn_stop = lv_imgbtn_create(ui->music);  
249     lv_obj_set_pos(ui->music_imgbtn_stop, 120, 220);  
250     lv_obj_set_size(ui->music_imgbtn_stop, 60, 60);  
251     lv_img_set_src(ui->music_imgbtn_stop, &img_stop);  
252     lv_obj_add_style(ui->music_imgbtn_stop, &style_pr, LV_STATE_PRESSED);  
253  
254     ui->music_imgbtn_right = lv_imgbtn_create(ui->music);  
255     lv_obj_set_pos(ui->music_imgbtn_right, 180, 220);  
256     lv_obj_set_size(ui->music_imgbtn_right, 60, 60);  
257     lv_img_set_src(ui->music_imgbtn_right, &img_right);  
258     lv_obj_add_style(ui->music_imgbtn_right, &style_pr, LV_STATE_PRESSED);  
259  
260     ui->music_bar_time = lv_bar_create(ui->music);  
261     lv_obj_set_size(ui->music_bar_time, 240, 5);  
262     lv_obj_set_pos(ui->music_bar_time, 0, 290);  
263     lv_slider_set_mode(ui->music_bar_time, LV_SLIDER_MODE_NORMAL);  
264     lv_bar_set_range(ui->music_bar_time, 0, 100);  
265     lv_bar_set_value(ui->music_bar_time, 0, LV_ANIM_OFF);  
266  
267     lv_obj_add_event_cb(ui->music_imgbtn_home, music_imgbtn_home_event_handler, LV_EVENT_ALL,  
NULL);  
268     lv_obj_add_event_cb(ui->music_imgbtn_left, music_imgbtn_left_event_handler, LV_EVENT_ALL,  
NULL);  
269     lv_obj_add_event_cb(ui->music_imgbtn_right, music_imgbtn_right_event_handler, LV_EVENT_ALL,  
NULL);  
270     lv_obj_add_event_cb(ui->music_imgbtn_play, music_imgbtn_play_event_handler, LV_EVENT_ALL,  
NULL);  
271     lv_obj_add_event_cb(ui->music_imgbtn_stop, music_imgbtn_stop_event_handler, LV_EVENT_ALL,  
NULL);  
272
```

```
273     lv_obj_add_event_cb(ui->music_slider_valume, music_slider_change_event_handler,
274     LV_EVENT_ALL, NULL);
275 }
276
277 //Set the label display content
278 void music_set_label_text(char *text) {
279     if(text!=NULL) {
280         lv_label_set_text(guider_music_ui.music_label, text);
281     }
282     else{
283         lv_label_set_text(guider_music_ui.music_label, "The music folder has no files.");
284     }
285 }
286
287 //Initialize the audio interface
288 void music_iis_init(void) {
289     audio.setPinout(I2S_BCLK, I2S_LRC, I2S_DOUT);
290 }
291
292 //Set the volume: 0-21
293 void music_set_volume(int volume) {
294     audio.setVolume(volume);
295 }
296
297 //Query volume
298 int music_read_volume(void) {
299     return audio.getVolume();
300 }
301
302 //load the mp3
303 void music_load_mp3(char *name) {
304     audio.connecttoFS(SD_MMC, name);
305 }
306
307 //Pause/play the music
308 void music_pause_resume(void) {
309     audio.pauseResume();
310 }
311
312 //Stop the music
313 void music_stop(void) {
314     audio.stopSong();
315 }
316
317 //Whether the music is running
318 bool music_is_running(void) {
319     return audio.isRunning();
320 }
321
322 //Gets how long the music player has been playing
323 long music_get_total_playing_time(void) {
```

```
315     return (long)audio.getTotalPlayingTime() / 1000;
316 }
317 //Obtain the playing time of the music file
318 long music_get_file_duration(void) {
319     return (long)audio.getAudioFileDuration();
320 }
321 //Set play position
322 bool music_set_play_position(int second) {
323     return audio.setAudioPlayPosition((uint16_t)second);
324 }
325 //Gets the current playing time of the music
326 long music_read_play_position(void) {
327     return audio.getAudioCurrentTime();
328 }
329 //Non-blocking music execution function
330 void music_loop(void) {
331     audio.loop();
332 }
333
334 //music player thread
335 void loopTask_music(void *pvParameters) {
336     Serial.println("loopTask_music start...");
337     int temp = 0;
338     while (music_task_flag == 1) {
339         music_loop();
340         int t1 = music_get_total_playing_time(); //Gets how long the music player has been playing
341         int t2 = music_get_file_duration(); //Gets the playing time of the music file
342         int t3 = music_read_play_position(); //Gets the current playing time of the music
343         if(temp==1) {
344             int t4 = map(t3, 0, t2, 0, 100);
345             lv_bar_set_value(guider_music_ui.music_bar_time, t4, LV_ANIM_OFF);
346             //Serial.printf("t1: %d\t t2: %d\t t3: %d\t t4: %d\r\n", t1, t2, t3, t4);
347         }
348         if ((t1 < t2) && (t2 > 0) && (temp == 0)) { //The music starts to play
349             lv_bar_set_value(guider_music_ui.music_bar_time, 0, LV_ANIM_OFF);
350             temp = 1;
351         } else if ((t2 == 0) && (temp == 1)) { //The music stop to play
352             temp = 0;
353             music_task_flag = 0;
354             lv_img_set_src(guider_music_ui.music_imgbtn_play, &img_pause);
355             music_button_state = 0;
356             break;
357         }
358 }
```

```
359     music_stop();
360     Serial.println("loopTask_music stop...");
361     vTaskDelete(musicTaskHandle);
362 }
363
364 //Create music task thread
365 void start_music_task(void) {
366     if (music_task_flag == 0) {
367         music_task_flag = 1;
368         xTaskCreate(loopTask_music, "loopTask_music", 8192, NULL, 1, &musicTaskHandle);
369     } else {
370         Serial.println("loopTask_music is running...");
371     }
372 }
373
374 //Close the music thread
375 void stop_music_task(void) {
376     if (music_task_flag == 1) {
377         music_task_flag = 0;
378         while (1) {
379             if (eTaskGetState(musicTaskHandle) == eDeleted) {
380                 break;
381             }
382             vTaskDelay(10);
383         }
384         Serial.println("loopTask_music deleted!");
385     }
386 }
387
388 //Check whether the thread is running
389 int music_task_is_running(void) {
390     return music_task_flag;
391 }
392
393 // optional
394 void audio_info(const char *info) {
395     Serial.print("info      ");
396     Serial.println(info);
397 }
398 void audio_eof_mp3(const char *info) {
399     Serial.print("eof_mp3      ");
400     Serial.println(info);
401 }
```



Callback functions, which are called when the corresponding screen events are triggered.

```

19 static void music_imgbtn_home_event_handler(lv_event_t *e)
47 static void music_imgbtn_left_event_handler(lv_event_t *e)
84 static void music_imgbtn_right_event_handler(lv_event_t *e)
122 static void music_imgbtn_play_event_handler(lv_event_t *e)
162 static void music_imgbtn_stop_event_handler(lv_event_t *e)
184 static void music_slider_change_event_handler(lv_event_t * e)

```

Music player interface setting function.

```
196 void setup_scr_music(lvgl_music_ui *ui)
```

The display function of the label component. If the text is empty, the prompt information will be printed. If not empty, the content is displayed.

```

275 void music_set_label_text(char *text) {
276     if(text!=NULL) {
277         lv_label_set_text(guider_music_ui.music_label, text);
278     }
279     else{
280         lv_label_set_text(guider_music_ui.music_label, "The music folder has no files.");
281     }
282 }
```

Some audio driver functions, which can be used to control music playback, pause, playback position view, etc.

```

285 void music_iis_init(void)
289 void music_set_volume(int volume)
293 int music_read_volume(void)
297 void music_load_mp3(char *name)
301 void music_pause_resume(void)
305 void music_stop(void)
309 bool music_is_running(void)
313 long music_get_total_playing_time(void)
317 long music_get_file_duration(void)
321 bool music_set_play_position(int second)
325 long music_read_play_position(void)

```

When the music parameters are properly configured, the audio task execution function should continuously call the music_loop() function to enable uninterrupted music playback. Failure to call this function in a timely manner can lead to issues such as frozen or failed mp3 playback.

```
329 void music_loop(void)
```

Music playback thread. When music_task_flag is 1, the thread content is executed, the music_loop() function is continuously called to play music, and the music playback time is obtained and set on the progress bar. If the music has finished playing, close the music playback thread.

```

333 //music player thread
334 void loopTask_music(void *pvParameters) {
335     Serial.println("loopTask_music start...");
336     int temp = 0;
337     while (music_task_flag == 1) {

```

```

338     music_loop();
339     int t1 = music_get_total_playing_time(); //Gets how long the music player has been playing
340     int t2 = music_get_file_duration();      //Gets the playing time of the music file
341     int t3 = music_read_play_position();    //Gets the current playing time of the music
342     if(temp==1) {
343         int t4 = map(t3, 0, t2, 0, 100);
344         lv_bar_set_value(guider_music_ui.music_bar_time, t4, LV_ANIM_OFF);
345         //Serial.printf("t1: %d\nt2: %d\nt3: %d\nt4: %d\r\n", t1, t2, t3, t4);
346     }
347     if ((t1 < t2) && (t2 > 0) && (temp == 0)) { //The music starts to play
348         lv_bar_set_value(guider_music_ui.music_bar_time, 0, LV_ANIM_OFF);
349         temp = 1;
350     } else if ((t2 == 0) && (temp == 1)) {      //The music stop to play
351         temp = 0;
352         music_task_flag = 0;
353         lv_img_set_src(guider_music_ui.music_imgbtn_play, &img_pause);
354         music_button_state = 0;
355         break;
356     }
357 }
358 music_stop();
359 Serial.println("loopTask_music stop... ");
360 vTaskDelete(musicTaskHandle);
361 }
```

Thread creation function. Determine whether the thread flag music_task_flag has been configured to 1. If the value is 1, the thread already exists and there is no need to create a thread again. If the value is 0, a thread needs to be created.

```

363 //Create music task thread
364 void start_music_task(void) {
365     if (music_task_flag == 0) {
366         music_task_flag = 1;
367         xTaskCreate(loopTask_music, "loopTask_music", 8192, NULL, 1, &musicTaskHandle);
368     } else {
369         Serial.println("loopTask_music is running... ");
370     }
371 }
```

Thread shutdown function. Set the thread flag music_task_flag to zero, the thread will end and delete the handle musicTaskHandle. Use the eTaskGetState() function to determine whether the handle musicTaskHandle has been deleted. If it has been deleted, the thread has been closed; Otherwise, wait until the thread is deleted.

```

373 //Close the music thread
374 void stop_music_task(void) {
375     if (music_task_flag == 1) {
376         music_task_flag = 0;
```

```

377 while (1) {
378     if (eTaskGetState(musicTaskHandle) == eDeleted) {
379         break;
380     }
381     vTaskDelay(10);
382 }
383 Serial.println("loopTask_music deleted!");
384 }
385 }
```

If music_task_flag is 1, it means that the thread already exists. If it is 0, it means that the thread has been closed.

```

387 //Check whether the thread is running
388 int music_task_is_running(void) {
389     return music_task_flag;
390 }
```

Every time the music information is loaded, the basic information of the music will be printed out.

```

393 void audio_info(const char *info) {
394     Serial.print("info      ");
395     Serial.println(info);
396 }
```

Every time when playing music ends, print the end prompt message.

```

397 void audio_eof_mp3(const char *info) {
398     Serial.print("eof_mp3      ");
399     Serial.println(info);
400 }
```

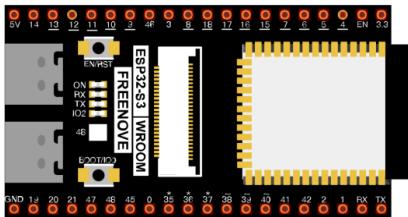
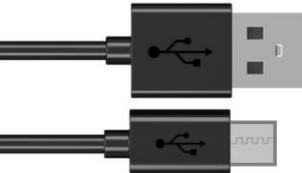
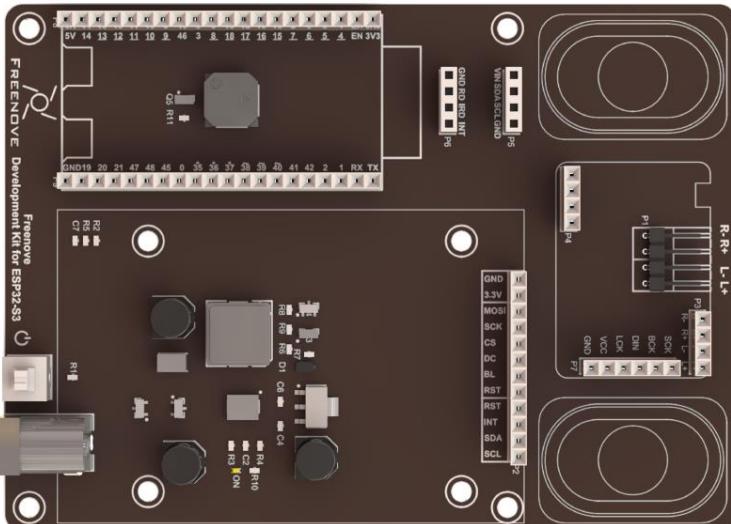
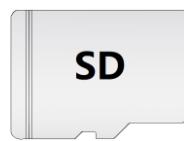
Chapter 18 LVGL Heartrate

In this chapter, we will learn how to create a heartrate monitor.

Project 18.1 LVGL Heartrate

In this project, we will learn how to obtain the raw data and heartrate data of the MAX30102 module and display them on the screen.

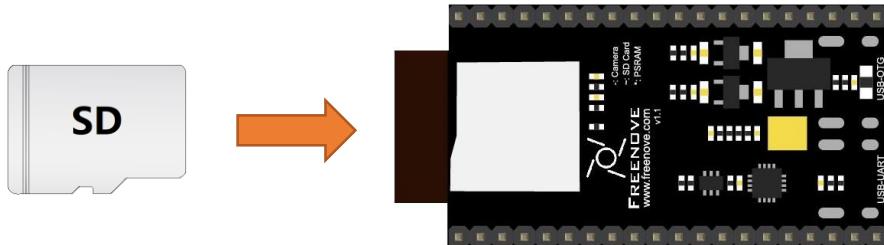
Component List

ESP32-S3 WROOM x1	USB cable x1	2.8-inch screen
		
ESP32-S3 WROOM Shield x1		Card reader x1 (random color)
		
9V battery cable x1	9V battery x1 (Not included, prepared by yourself)	SD card x1
		

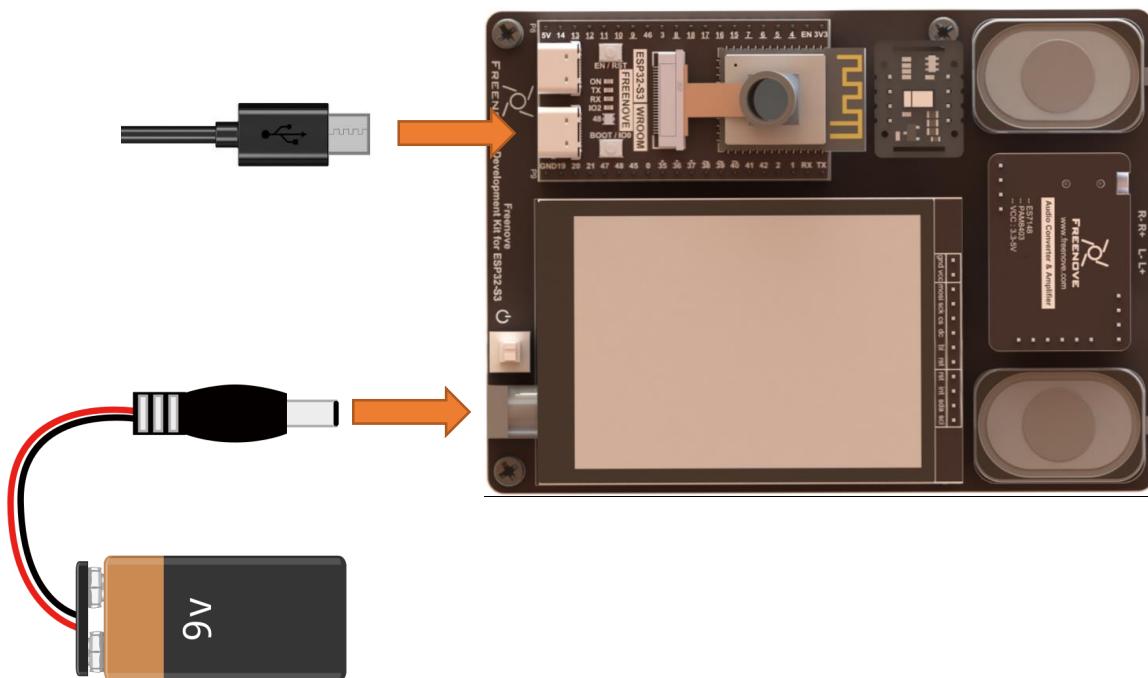
Any concerns? [✉ support@freenove.com](mailto:support@freenove.com)

Circuit

If you have not yet used the SD card, please refer to Chapter 4. Click [here](#) to navigate back to Chapter 4. Before connecting the USB cable, insert the SD card into the SD card slot on the back of the ESP32-S3.

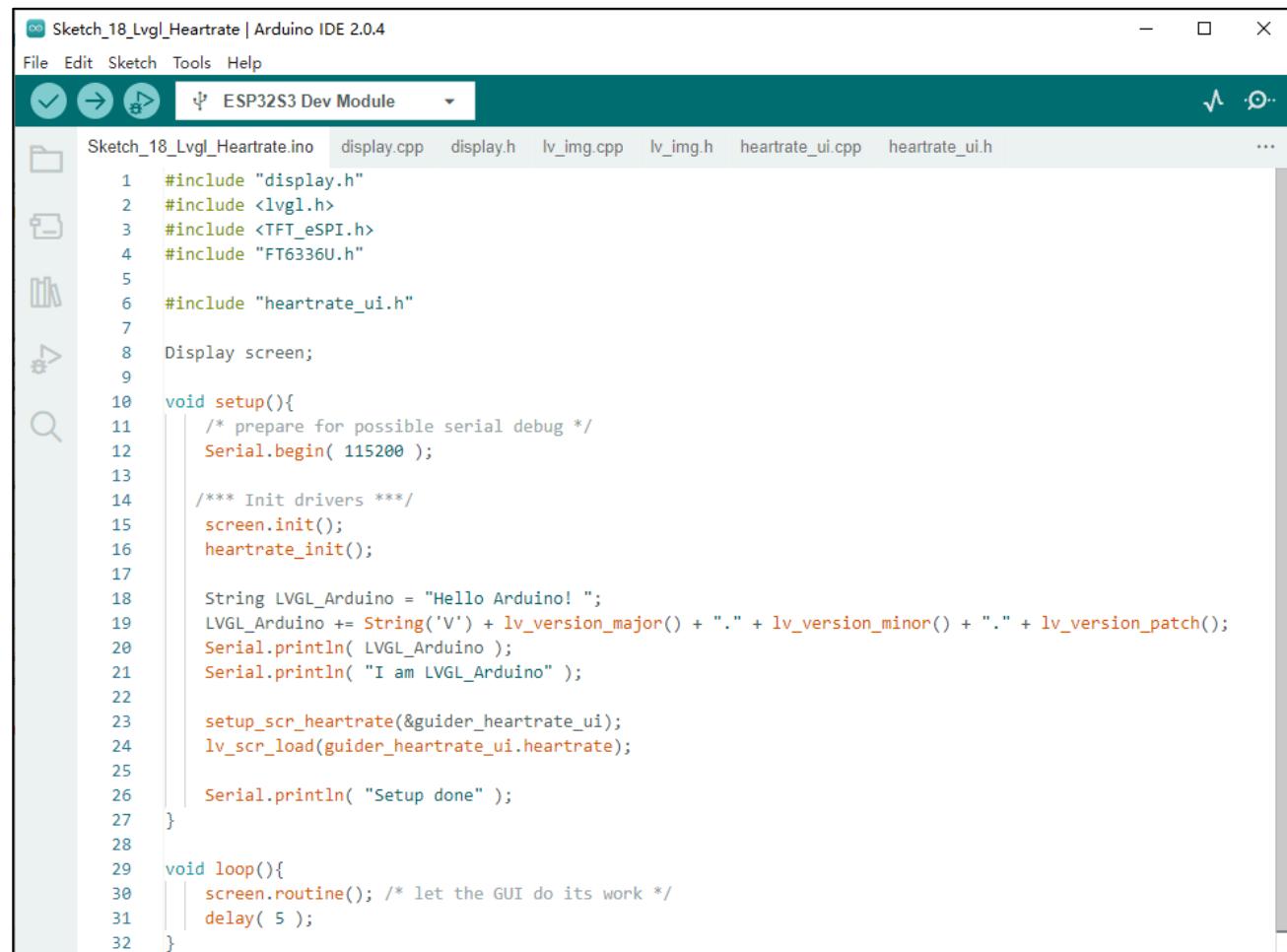


Connect Freenove ESP32-S3 to the computer using the USB cable.



Sketch

Sketch_18_LVGL_Heartrate



The screenshot shows the Arduino IDE interface with the following details:

- Title Bar:** Sketch_18_Lvgl_Heartrate | Arduino IDE 2.0.4
- Menu Bar:** File Edit Sketch Tools Help
- Toolbar:** Includes icons for Save, Run, Stop, and others.
- Sketch Selection:** ESP32S3 Dev Module
- Code Area:** Displays the C++ code for the sketch. The code includes headers for display, lvgl, TFT_eSPI, FT6336U, and heartrate_ui, along with setup and loop functions for initializing serial communication, drivers, and the LVGL GUI.

The following is the program code:

```
1 #include "display.h"
2 #include <lvgl.h>
3 #include <TFT_eSPI.h>
4 #include "FT6336U.h"
5 #include "heartrate_ui.h"
6
7 Display screen;
8
9 void setup() {
10     /* prepare for possible serial debug */
11     Serial.begin( 115200 );
12
13     /*** Init drivers ***/
14     screen.init();
15     heartrate_init();
16
17     String LVGL_Arduino = "Hello Arduino! ";
18     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
19     Serial.println( LVGL_Arduino );
20     Serial.println( "I am LVGL_Arduino" );
21
22     setup_scr_heartrate(&guider_heartrate_ui);
23     lv_scr_load(guider_heartrate_ui.heartrate);
24
25     Serial.println( "Setup done" );
26 }
27
28 void loop(){
29     screen.routine(); /* let the GUI do its work */
30     delay( 5 );
31 }
```

```

16
17     String LVGL_Arduino = "Hello Arduino! ";
18     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
19     lv_version_patch();
20     Serial.println( LVGL_Arduino );
21     Serial.println( "I am LVGL_Arduino" );
22
23     setup_scr_heartrate(&guider_heartrate_ui);
24     lv_scr_load(guider_heartrate_ui.heartrate);
25
26     Serial.println( "Setup done" );
27 }
28
29 void loop() {
30     screen.routine(); /* let the GUI do its work */
31     delay( 5 );
32 }
```

Configure the heart rate monitor interface and load this interface.

```

22     setup_scr_heartrate(&guider_heartrate_ui);
23     lv_scr_load(guider_heartrate_ui.heartrate);
```

heartrate_ui.h

Declare the functions so that they can be called in the ino file.

```

1 #ifndef __HEARTRATE_UI_H
2 #define __HEARTRATE_UI_H
3
4 #include "Arduino.h"
5 #include "lvgl.h"
6
7 #define I2C_SDA 2
8 #define I2C_SCL 1
9
10 #define HEARTRATE_SERIAL 0      //Serial print the original ir value, average value and dynamic
11 data.
12 #define CHART_LOW_LIMIT 0      //Lower limit of Chart
13 #define CHART_HIGH_LIMIT 2000 //Upper limit of Chart
14
15 typedef struct lvgl_heartrate
16 {
17     lv_obj_t *heartrate;
18     lv_obj_t *heartrate_chart;
19     lv_obj_t *heartrate_label_heart_rate;
20     lv_obj_t *heartrate_home;
21 }lvgl_heartrate_ui;
```

```

23 extern lvgl_heartrate_ui guider_heartrate_ui;      //music ui structure
24
25 int heartrate_init(void);           //Initialization heartrate module
26 void heartrate_shutdown(void);     //The heartrate module is enabled to enter low power mode
27 void heartrate_wake_up(void);      //Wake up the heartrate module
28
29 void loopTask_heartrate(void *pvParameters);    //heartrate task thread
30 void create_heartrate_task(void);                //Create heartrate task thread
31 void stop_heartrate_task(void);                  //Close the heartrate thread
32
33 void setup_scr_heartrate(lvgl_heartrate_ui *ui); //Parameter configuration function on the
heartrate screen
34
35 #endif

```

heartrate_ui.cpp

```

1 #include "heartrate_ui.h"
2 #include "lv_img.h"
3 #include <Wire.h>
4 #include "MAX30105.h"
5 #include "heartRate.h"
6
7 MAX30105 heartrate;           //apply a module object
8 static lv_chart_series_t *series; //apply an lvgl chart variable
9 lvgl_heartrate_ui guider_heartrate_ui; //heartrate ui structure
10 int heartrate_task_flag = 0;    //heartrate thread running flag
11 TaskHandle_t heartrateTaskHandle; //heartrate thread task handle
12
13 const byte RATE_SIZE = 4;      //Increase this for more averaging. 4 is good.
14 byte rates[RATE_SIZE];        //Array of heart rates
15 byte rateSpot = 0;            //Record the number of bits in the heart rate array
16 long lastBeat = 0;             //Time at which the last beat occurred
17 float beatsPerMinute;         //store the heartbeat value per minute
18 int beatAvg = 0;              //Heart rate average
19 int beatAvgLast = 0;           //Average heart rate from last time
20 byte irvalueSpot = 0;          //Record the number of bits in the heartrate irvalue array
21 const byte AVERAGE_NUM = 10;    //Increase this for more averaging. 10 is good.
22 long heartrate_irvalue[AVERAGE_NUM]; //Array of heartrate irvalue
23 long show_value = 0;           //The data values of the points in the heart rate line plot
24
25 //Initialization heartrate module
26 int heartrate_init(void) {
27     if (!heartrate.begin(Wire, I2C_SPEED_FAST)) {
28         Serial.println("MAX30105 was not found. Please check wiring/power. ");
29         return -1;

```

```

30 }
31 hearrate.setup(); //Configure sensor with these settings
32 hearrate.shutdown();
33 }
34
35 //The heartrate module is enabled to enter low power mode
36 void hearrate_shutdown(void) {
37   hearrate.shutDown();
38 }
39
40 //Wake up the heartrate module
41 void hearrate_wake_up(void) {
42   hearrate.wakeUp();
43 }
44
45 //Calculate the average value of the array
46 long hearrate_average(long array[], int num) {
47   long average = 0;
48   for (int i = 0; i < num; i++) {
49     average += array[i];
50   }
51   average = average / num;
52   return average;
53 }
54
55 //heartrate task thread
56 void loopTask_heartrate(void *pvParameters) {
57   Serial.println("loopTask_heartrate start...");
58
59   while (heartrate_task_flag) {
60     long irValue = hearrate.getIR(); //Get the raw data
61     if (irValue < 50000) {
62       //heartrate.setup();
63       delay(100);
64     }
65     else{
66       if (checkForBeat(irValue) == true) {
67         //We sensed a beat!
68         long delta = millis() - lastBeat;
69         lastBeat = millis();
70         beatsPerMinute = 60.0 / (delta / 1000.0);
71
72         if (beatsPerMinute < 255 && beatsPerMinute > 50) {
73           rates[rateSpot++] = (byte)beatsPerMinute; //Store this reading in the array

```

```
74     rateSpot %= RATE_SIZE; //Wrap variable
75     //Take average of readings
76     beatAvg = 0;
77     for (byte x = 0; x < RATE_SIZE; x++)
78         beatAvg += rates[x];
79     beatAvg /= RATE_SIZE;
80 }
81 }
82 heartrate_irvalue[irvalueSpot++] = irValue; //Put the raw data into an array
83 irvalueSpot %= AVERAGE_NUM;
84 long average = heartrate_average(heartrate_irvalue, AVERAGE_NUM);
85 show_value = irValue - average + (CHART_HIGH_LIMIT / 2);
86
87 #if HEARTRATE_SERIAL
88     Serial.printf("%ld %ld %ld\r\n", irValue, average, show_value);
89 #endif
90
91 if (irValue > 50000 && show_value > CHART_LOW_LIMIT && show_value < CHART_HIGH_LIMIT)
92     lv_chart_set_next_value(guider_heartrate_ui.heartrate_chart, series, show_value);
93 if (beatAvg != beatAvgLast) {
94     beatAvgLast = beatAvg;
95     lv_label_set_text_fmt(guider_heartrate_ui.heartrate_label_heart_rate, "HeartRate: %d",
beatAvg);
96 }
97 }
98 }
99 heartrate_shutdown();
100 vTaskDelete(heartrateTaskHandle);
101 }
102
103 //Create heartrate task thread
104 void create_heartrate_task(void) {
105     if (heartrate_task_flag == 0) {
106         heartrate_task_flag = 1;
107         xTaskCreate(loopTask_heartrate, "loopTask_heartrate", 8192, NULL, 1,
&heartrateTaskHandle);
108     } else {
109         Serial.println("loopTask_heartrate is running...");
110     }
111 }
112
113 //Close the heartrate thread
114 void stop_heartrate_task(void) {
115     if (heartrate_task_flag == 1) {
```

```
116    heartrate_task_flag = 0;
117    while (1) {
118        if (eTaskGetState(heartrateTaskHandle) == eDeleted) {
119            break;
120        }
121        vTaskDelay(10);
122    }
123    Serial.println("loopTask_heartrate deleted!");
124 }
125 }
126
127 //Click the home icon, callback function: goes to the main ui interface
128 static void heartrate_home_event_handler(lv_event_t *e) {
129     lv_event_code_t code = lv_event_get_code(e);
130     switch (code) {
131         case LV_EVENT_CLICKED:
132         {
133             Serial.println("Clicked the home button.");
134         }
135         break;
136         case LV_EVENT_RELEASED:
137         {
138             /*
139             stop_heartrate_task();
140             delay(100);
141             if (!lv_obj_is_valid(guider_main_ui.main))
142                 setup_scr_main(&guider_main_ui);
143             lv_disp_t *d = lv_obj_get_disp(lv_scr_act());
144             if (d->prev_scr == NULL && d->scr_to_load == NULL)
145                 lv_scr_load(guider_main_ui.main);
146             lv_obj_del(guider_heartrate_ui.heartrate);
147             */
148         }
149         break;
150     default:
151         break;
152     }
153 }
154
155 //Parameter configuration function on the heartrate screen
156 void setup_scr_heartrate(lvgl_heartrate_ui *ui) {
157     ui->heartrate = lv_obj_create(NULL);
158     lv_img_home_init();
159 }
```

```
160 /*Init the pressed style*/
161 static lv_style_t style_pr;//Apply for a style
162 lv_style_init(&style_pr); //Initialize it
163 lv_style_set_translate_y(&style_pr, 5);//Style: Every time you trigger, move down 5 pixels
164
165 /*Create a chart*/
166 ui->heartrate_chart = lv_chart_create(ui->heartrate);
167
168 lv_obj_set_size(ui->heartrate_chart, 180, 200);
169 lv_obj_set_pos(ui->heartrate_chart, 60, 120);
170 lv_chart_set_type(ui->heartrate_chart, LV_CHART_TYPE_LINE); /*Show lines and points too*/
171 lv_chart_set_div_line_count(ui->heartrate_chart, 5, 10); //Set chart to 5 rows and
10 columns
172 lv_chart_set_point_count(ui->heartrate_chart, 100); //chart shows the data for
100 points
173 lv_obj_set_style_size(ui->heartrate_chart, 0, LV_PART_INDICATOR); //Make each data point
unsalient
174
175 lv_chart_set_update_mode(ui->heartrate_chart, LV_CHART_UPDATE_MODE_SHIFT); //Move chart to
update data
176 /*Add two data series*/
177 series = lv_chart_add_series(ui->heartrate_chart, lv_palette_main(LV_PALETTE_BLUE),
LV_CHART_AXIS_SECONDARY_Y); //Let the data be on the right y axis
178 lv_chart_set_range(ui->heartrate_chart, LV_CHART_AXIS_SECONDARY_Y, CHART_LOW_LIMIT,
CHART_HIGH_LIMIT); //Set the value range of right y axis
179
180 lv_chart_set_axis_tick(ui->heartrate_chart, LV_CHART_AXIS_PRIMARY_Y, 3, 1, 11, 2, true, 60);
//Let the axis be on the left y axis
181 lv_chart_set_range(ui->heartrate_chart, LV_CHART_AXIS_PRIMARY_Y, CHART_LOW_LIMIT,
CHART_HIGH_LIMIT); //Set the value range of left y axis
182
183 ui->heartrate_label_heart_rate = lv_label_create(ui->heartrate);
184 lv_obj_set_pos(ui->heartrate_label_heart_rate, 0, 50);
185 lv_obj_set_size(ui->heartrate_label_heart_rate, 140, 40);
186 lv_label_set_text(ui->heartrate_label_heart_rate, "HeartRate:0");
187 lv_label_set_long_mode(ui->heartrate_label_heart_rate, LV_LABEL_LONG_WRAP);
188 lv_obj_set_style_text_align(ui->heartrate_label_heart_rate, LV_TEXT_ALIGN_CENTER, 0);
189
190 ui->heartrate_home = lv_imgbtn_create(ui->heartrate);
191 lv_obj_set_pos(ui->heartrate_home, 150, 20);
192 lv_obj_set_size(ui->heartrate_home, 80, 80);
193 lv_img_set_src(ui->heartrate_home, &img_home);
194 lv_obj_add_style(ui->heartrate_home, &style_pr, LV_STATE_PRESSED); //Triggered when the
button is pressed
```

```

195 lv_obj_add_event_cb(ui->heartrate_home, heartrate_home_event_handler, LV_EVENT_ALL, NULL);
196 create_heartrate_task();
197 heartrate_wake_up();
198 }
199 }
```

Initialize the heart rate module and configure it to sleep mode.

```

25 //Initialization heartrate module
26 int heartrate_init(void) {
27     if (!heartrate.begin(Wire, I2C_SPEED_FAST)) {
28         Serial.println("MAX30105 was not found. Please check wiring/power. ");
29         return -1;
30     }
31     heartrate.setup(); //Configure sensor with these settings
32     heartrate_shutdown();
33 }
```

Heartrate module sleep function and module wake-up function.

```

35 //The heartrate module is enabled to enter low power mode
36 void heartrate_shutdown(void) {
37     heartrate.shutDown();
38 }
39
40 //Wake up the heartrate module
41 void heartrate_wake_up(void) {
42     heartrate.wakeUp();
43 }
```

Average the heartrate values obtained multiple times.

```

45 //Calculate the average value of the array
46 long heartrate_average(long array[], int num) {
47     long average = 0;
48     for (int i = 0; i < num; i++) {
49         average += array[i];
50     }
51     average = average / num;
52     return average;
53 }
```

Acquire raw infrared data.

```

60 long irValue = heartrate.getIR(); //Get the raw data
```

Heartrate checking function. Returns true if a mentality spike is detected, otherwise returns false.

```

66 checkForBeat(irValue)
```

If the HEARTRATE_SERIAL macro definition is set to 1, the original data will be printed to the serial port, allowing you to view the heart rate waveform using a serial port drawing function. By default, serial port data is not printed.

```
87 #if HEARTRATE_SERIAL
88     Serial.printf("%ld %ld %ld\r\n", irValue, average, show_value);
89 #endif
```

Label component setup function, which can be used similarly like printf().

```
95 lv_label_set_text_fmt(guider_heartrate_ui.heartrate_label_heart_rate, "HeartRate: %d",
beatAvg);
```

Create a line chart with 100 data points to make the waveform more closely resemble real data. Set the chart to scroll continuously for optimal viewing.

```
165 /*Create a chart*/
166 ui->heartrate_chart = lv_chart_create(ui->heartrate);
167
168 lv_obj_set_size(ui->heartrate_chart, 180, 200);
169 lv_obj_set_pos(ui->heartrate_chart, 60, 120);
170 lv_chart_set_type(ui->heartrate_chart, LV_CHART_TYPE_LINE); /*Show lines and points too*/
171 lv_chart_set_div_line_count(ui->heartrate_chart, 5, 10); //Set chart to 5 rows and 10 columns
172 lv_chart_set_point_count(ui->heartrate_chart, 100); //chart shows the data for 100 points
173 lv_obj_set_style_size(ui->heartrate_chart, 0, LV_PART_INDICATOR); //Make each data point
unsalient
174
175 lv_chart_set_update_mode(ui->heartrate_chart, LV_CHART_UPDATE_MODE_SHIFT); //Move chart to
update data
176 /*Add two data series*/
177 series = lv_chart_add_series(ui->heartrate_chart, lv_palette_main(LV_PALETTE_BLUE),
LV_CHART_AXIS_SECONDARY_Y); //Let the data be on the right y axis
178 lv_chart_set_range(ui->heartrate_chart, LV_CHART_AXIS_SECONDARY_Y, CHART_LOW_LIMIT,
CHART_HIGH_LIMIT); //Set the value range of right y axis
179
180 lv_chart_set_axis_tick(ui->heartrate_chart, LV_CHART_AXIS_PRIMARY_Y, 3, 1, 11, 2, true, 60);
//Let the axis be on the left y axis
181 lv_chart_set_range(ui->heartrate_chart, LV_CHART_AXIS_PRIMARY_Y, CHART_LOW_LIMIT,
CHART_HIGH_LIMIT); //Set the value range of left y axis
```

Display heart rate data on a line chart.

```
92 lv_chart_set_next_value(guider_heartrate_ui.heartrate_chart, series, show_value);
```

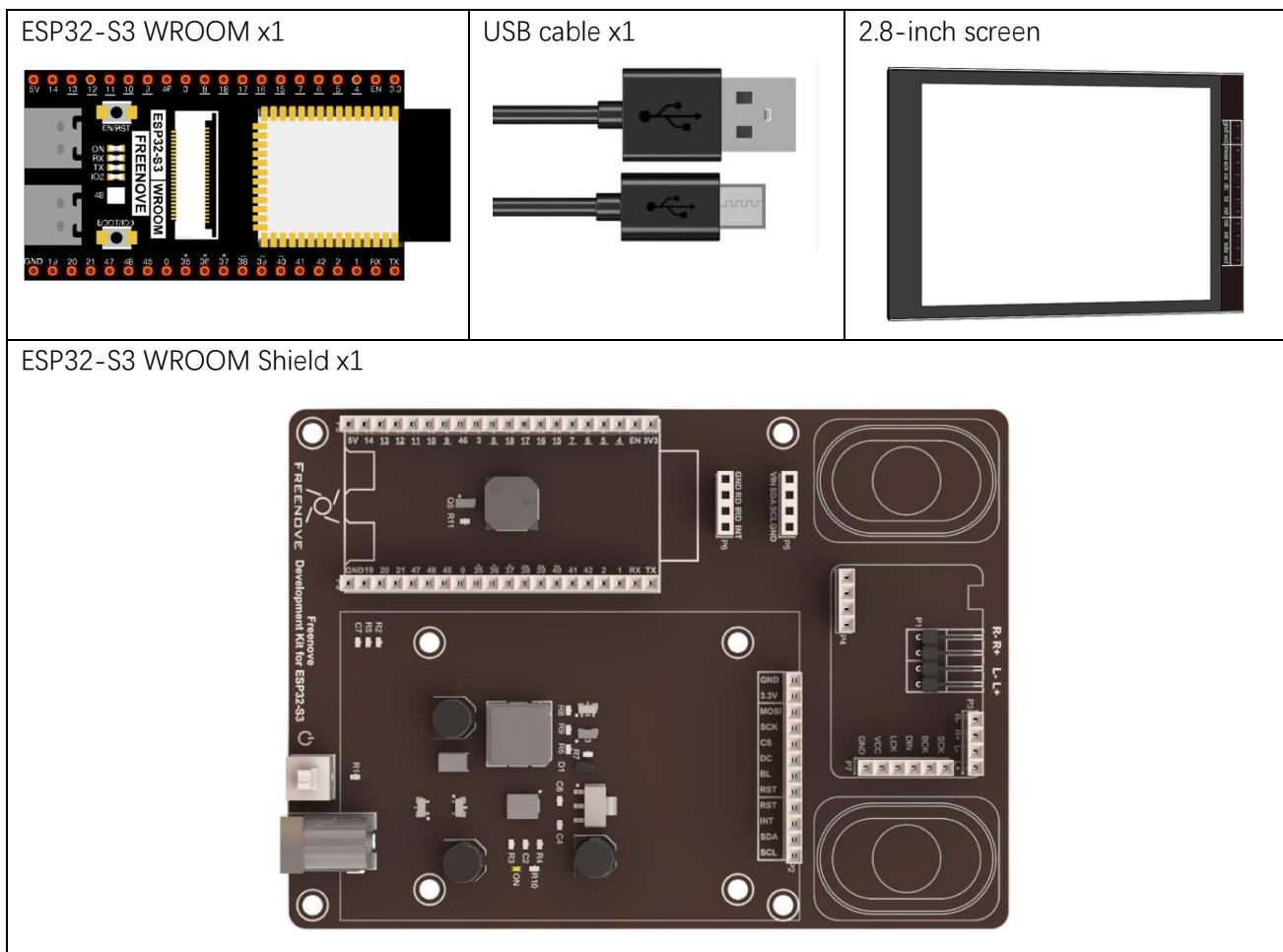
Chapter 19 LVGL WS2812

In this chapter, we learn to control the onboard WS2812 RGB LED with the touch screen.

Project 19.1 LVGL WS2812

In the code, we use four sliders to control the LED, three of which control the LED's red, green and blue colors, and one controls the brightness.

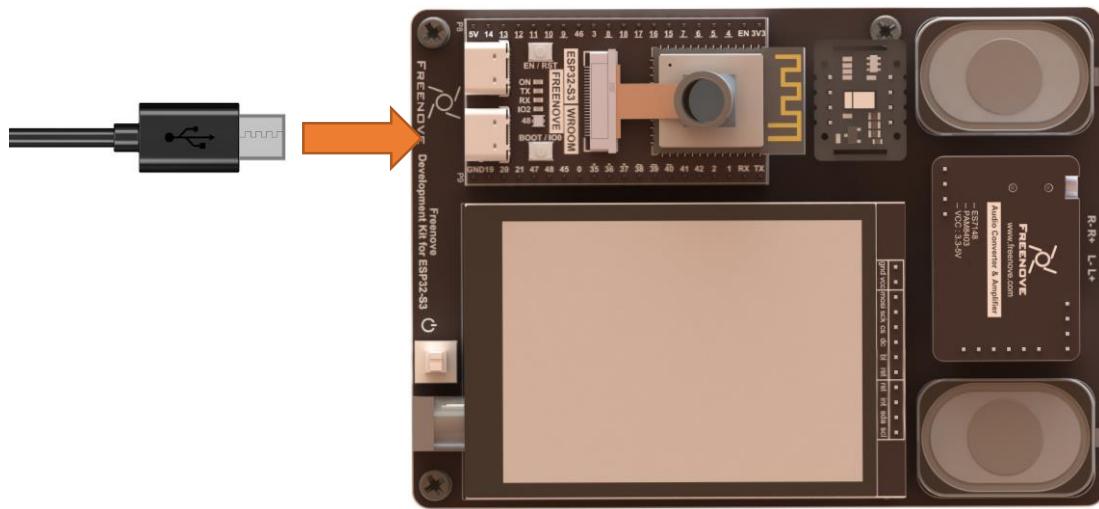
Component List



Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.

Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com



Sketch

```

Sketch_19_Lvgl_WS2812 | Arduino IDE 2.1.0
File Edit Sketch Tools Help
Sketch_19_Lvgl_WS2812.ino display.cpp display.h lv_img.cpp lv_img.h ws2812_ui.cpp ws2812_ui.h ...
4 #include "ws2812_ui.h"
5
6 Display screen;
7
8 void setup() {
9     Serial.begin(115200);
10
11     /** Init screen ***
12     screen.init();
13
14     /** Print lvgl version ***
15     String LVGL_Arduino = "Hello Arduino!";
16     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
17     Serial.println(LVGL_Arduino);
18     Serial.println("I am LVGL_Arduino");
19     Serial.println("Setup done");
20
21     /** The custom code ***
22     setup_scr_ws2812(&guider_ws2812_ui);
23     lv_scr_load(guider_ws2812_ui.ws2812);
24
25
26 void loop() {
27     screen.routine();
28     delay(5);
29 }

```

Output

```

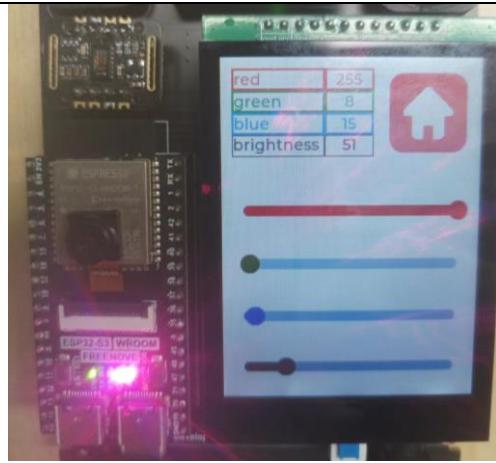
C:\Users\DESKTOP-LIN\AppData\Local\Arduino15\packages\esp32\tools\xtensa-esp32s3-elf-gcc\esp-2021r2-patch5-8
C:\Users\DESKTOP-LIN\AppData\Local\Arduino15\packages\esp32\tools\xtensa-esp32s3-elf-gcc\esp-2021r2-patch5-8
C:\Users\DESKTOP-LIN\AppData\Local\Arduino15\ Compiling sketch...

```

Ln 9, Col 24 ESP32S3 Dev Module on COM3 4 2



Here is an illustration of the example:



By sliding the slider of different colors, the ESP32S3's onboard LED will change color accordingly, and the values of color data are shown at the top of the screen.

The following is the program code:

[Sketch_19_Lvgl_WS2812.ino](#)

```

1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "ws2812_ui.h"
5 Display screen;
6 void setup() {
7   Serial.begin(115200);
8
9   /*** Init screen ***/
10  screen.init();
11
12  /*** Print lvgl version ***/
13  String LVGL_Arduino = "Hello Arduino! ";
14  LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
15    lv_version_patch();
16  Serial.println(LVGL_Arduino);
17  Serial.println("I am LVGL_Arduino");
18  Serial.println("Setup done");
19
20  /*** The custom code ***/
21  setup_scr_ws2812(&guider_ws2812_ui);
22  lv_scr_load(guider_ws2812_ui.ws2812);
23 }
24 void loop() {
25   screen.routine();
26   delay(5);
27 }
```

ws2812_ui.h

The declaration file about the LED's interface and driver is as below:

```
1 #ifndef __WS2812_UI_H
2 #define __WS2812_UI_H
3
4 #include "lvgl.h"
5 #include "Arduino.h"
6
7 #define LEDS_COUNT 1
8 #define LEDS_PIN 48
9 #define CHANNEL 0
10
11 typedef struct lvgl_ws2812
12 {
13     lv_obj_t *ws2812;
14     lv_obj_t *ws2812_home;
15     lv_obj_t *ws2812_slider_red;
16     lv_obj_t *ws2812_slider_green;
17     lv_obj_t *ws2812_slider_blue;
18     lv_obj_t *ws2812_slider_brightness;
19     lv_obj_t *ws2812_lable_red;
20     lv_obj_t *ws2812_lable_green;
21     lv_obj_t *ws2812_lable_blue;
22     lv_obj_t *ws2812_lable_brightness;
23     lv_obj_t *ws2812_text_red;
24     lv_obj_t *ws2812_text_green;
25     lv_obj_t *ws2812_text_blue;
26     lv_obj_t *ws2812_text_brightness;
27 }lvgl_ws2812_ui;
28
29 extern lvgl_ws2812_ui guider_ws2812_ui;      //ws2812 ui structure
30
31 bool ws2812_init(void);
32 void ws2812_set_color(int num, int red, int green, int blue, int brightness);
33
34 void setup_scr_ws2812(lvgl_ws2812_ui *ui); //Parameter configuration function on the ws2812
screen
35
36#endif
```

Here is the complete code:

ws2812_ui.cpp

```

1 // #include "main_ui.h"
2 #include "lvgl.h"
3 #include "ws2812_ui.h"
4 #include "lv_img.h"
5 #include "Freenove_WS2812_Lib_for_ESP32.h"
6
7 lvgl_ws2812_ui guider_ws2812_ui;
8 Freenove_ESP32_WS2812 strip = Freenove_ESP32_WS2812(LEDS_COUNT, LEDS_PIN, CHANNEL, TYPE_GRB);
9
10 bool ws2812_init(void) {
11     strip.begin();
12     strip.setBrightness(1);
13     return 1;
14 }
15
16 void ws2812_set_color(int num, int red, int green, int blue, int brightness) {
17     red = constrain(red, 0, 255);
18     green = constrain(green, 0, 255);
19     blue = constrain(blue, 0, 255);
20     brightness = constrain(brightness, 0, 255);
21     strip.setBrightness(brightness);
22     strip.setLedColorData(num, red, green, blue);
23     strip.show();
24 }
25
26 static void ws2812_imgbtn_home_event_handler(lv_event_t *e) {
27     lv_event_code_t code = lv_event_get_code(e);
28     switch (code) {
29         case LV_EVENT_CLICKED:
30         {
31             Serial.println("Clicked the logo button.");
32         }
33         break;
34         case LV_EVENT_RELEASED:
35         {
36             /*
37             if (!lv_obj_is_valid(guider_main_ui.main))
38                 setup_scr_main(&guider_main_ui);
39             lv_scr_load(guider_main_ui.main);
40             lv_obj_del(guider_music_ui.music);
41             */
42         }

```

```
43         break;
44     default:
45         break;
46     }
47 }
48
49 static void slider_event_cb(lv_event_t *e) {
50     LV_UNUSED(e);
51     int color_red = lv_slider_get_value(guider_ws2812_ui.ws2812_slider_red);
52     int color_green = lv_slider_get_value(guider_ws2812_ui.ws2812_slider_green);
53     int color_blue = lv_slider_get_value(guider_ws2812_ui.ws2812_slider_blue);
54     int color_brightness = lv_slider_get_value(guider_ws2812_ui.ws2812_slider_brightness);
55
56     lv_label_set_text_fmt(guider_ws2812_ui.ws2812_text_red, "%d", color_red);
57     lv_label_set_text_fmt(guider_ws2812_ui.ws2812_text_green, "%d", color_green);
58     lv_label_set_text_fmt(guider_ws2812_ui.ws2812_text_blue, "%d", color_blue);
59     lv_label_set_text_fmt(guider_ws2812_ui.ws2812_text_brightness, "%d", color_brightness);
60
61     ws2812_set_color(0, color_red, color_green, color_blue, color_brightness);
62 }
63
64 void create_lable(lvgl_ws2812_ui *ui, lv_obj_t **lable1, lv_obj_t **lable2) {
65     *lable1 = lv_label_create(ui->ws2812);
66     lv_obj_set_style_text_align(*lable1, LV_TEXT_ALIGN_LEFT, 0);
67     lv_obj_set_size(*lable1, 85, 20);
68
69     *lable2 = lv_label_create(ui->ws2812);
70     lv_obj_set_style_text_align(*lable2, LV_TEXT_ALIGN_CENTER, 0);
71     lv_obj_set_size(*lable2, 45, 20);
72 }
73
74 static lv_obj_t *create_slider(lvgl_ws2812_ui *ui, lv_color_t color) {
75     lv_obj_t *slider = lv_slider_create(ui->ws2812);
76     lv_slider_set_range(slider, 0, 255);
77     lv_obj_set_size(slider, 200, 10);
78     lv_obj_set_style_bg_color(slider, color, LV_PART_KNOB);
79     lv_obj_set_style_bg_color(slider, color, LV_PART_INDICATOR);
80     lv_obj_add_event_cb(slider, slider_event_cb, LV_EVENT_VALUE_CHANGED, NULL);
81     return slider;
82 }
83
84 //Parameter configuration function on the ws2812 screen
85 void setup_scr_ws2812(lvgl_ws2812_ui *ui) {
86     ws2812_init();
```

```
87 //Write codes picture
88 ui->ws2812 = lv_obj_create(NULL);
89 static lv_style_t bg_style;
90 lv_style_init(&bg_style);
91 lv_style_set_bg_color(&bg_style, lv_color_hex(0xffffffff));
92 lv_obj_add_style(ui->ws2812, &bg_style, LV_PART_MAIN);
93
94
95 lv_img_home_init();
96 //Write codes picture_home
97 ui->ws2812_home = lv_imgbtn_create(ui->ws2812);
98 lv_obj_remove_style_all(ui->ws2812_home);
99 lv_obj_set_pos(ui->ws2812_home, 150, 10);
100 lv_obj_set_size(ui->ws2812_home, 80, 80);
101 lv_img_set_src(ui->ws2812_home, &img_home);
102 static lv_style_t style_pr;           //Apply for a style
103 lv_style_init(&style_pr);           //Initialize it
104 lv_style_set_translate_y(&style_pr, 5); //Style: Every time you trigger, move down 5 pixels
105 lv_obj_add_style(ui->ws2812_home, &style_pr, LV_STATE_PRESSED);
106
107 create_lable(ui, &ui->ws2812_lable_red, &ui->ws2812_text_red);
108 lv_obj_set_pos(ui->ws2812_lable_red, 10, 10);
109 lv_obj_set_pos(ui->ws2812_text_red, 95, 10);
110 lv_label_set_text(ui->ws2812_lable_red, "red");
111 lv_label_set_text(ui->ws2812_text_red, "255");
112 static lv_style_t style_color_red;
113 lv_style_init(&style_color_red);
114 lv_style_set_border_width(&style_color_red, 2);
115 lv_style_set_border_color(&style_color_red, lv_palette_main(LV_PALETTE_RED));
116 lv_style_set_text_color(&style_color_red, lv_palette_main(LV_PALETTE_RED));
117 lv_obj_add_style(ui->ws2812_lable_red, &style_color_red, LV_PART_MAIN);
118 lv_obj_add_style(ui->ws2812_text_red, &style_color_red, LV_PART_MAIN);
119
120 create_lable(ui, &ui->ws2812_lable_green, &ui->ws2812_text_green);
121 lv_obj_set_pos(ui->ws2812_lable_green, 10, 30);
122 lv_obj_set_pos(ui->ws2812_text_green, 95, 30);
123 lv_label_set_text(ui->ws2812_lable_green, "green");
124 lv_label_set_text(ui->ws2812_text_green, "255");
125 static lv_style_t style_color_green;
126 lv_style_init(&style_color_green);
127 lv_style_set_border_width(&style_color_green, 2);
128 lv_style_set_border_color(&style_color_green, lv_palette_main(LV_PALETTE_GREEN));
129 lv_style_set_text_color(&style_color_green, lv_palette_main(LV_PALETTE_GREEN));
130 lv_obj_add_style(ui->ws2812_lable_green, &style_color_green, LV_PART_MAIN);
```

```
131 lv_obj_add_style(ui->ws2812_text_green, &style_color_green, LV_PART_MAIN);
132
133 create_lable(ui, &ui->ws2812_lable_blue, &ui->ws2812_text_blue);
134 lv_obj_set_pos(ui->ws2812_lable_blue, 10, 50);
135 lv_obj_set_pos(ui->ws2812_text_blue, 95, 50);
136 lv_label_set_text(ui->ws2812_lable_blue, "blue");
137 lv_label_set_text(ui->ws2812_text_blue, "255");
138 static lv_style_t style_color_blue;
139 lv_style_init(&style_color_blue);
140 lv_style_set_border_width(&style_color_blue, 2);
141 lv_style_set_border_color(&style_color_blue, lv_palette_main(LV_PALETTE_BLUE));
142 lv_style_set_text_color(&style_color_blue, lv_palette_main(LV_PALETTE_BLUE));
143 lv_obj_add_style(ui->ws2812_lable_blue, &style_color_blue, LV_PART_MAIN);
144 lv_obj_add_style(ui->ws2812_text_blue, &style_color_blue, LV_PART_MAIN);
145
146 create_lable(ui, &ui->ws2812_lable_brightness, &ui->ws2812_text_brightness);
147 lv_obj_set_pos(ui->ws2812_lable_brightness, 10, 70);
148 lv_obj_set_pos(ui->ws2812_text_brightness, 95, 70);
149 lv_label_set_text(ui->ws2812_lable_brightness, "brightness");
150 lv_label_set_text(ui->ws2812_text_brightness, "255");
151 static lv_style_t style_color_brightness;
152 lv_style_init(&style_color_brightness);
153 lv_style_set_border_width(&style_color_brightness, 1);
154 lv_style_set_border_color(&style_color_brightness, lv_palette_darken(LV_PALETTE_GREY, 2));
155 lv_style_set_text_color(&style_color_brightness, lv_palette_darken(LV_PALETTE_GREY, 2));
156 lv_obj_add_style(ui->ws2812_lable_brightness, &style_color_brightness, LV_PART_MAIN);
157 lv_obj_add_style(ui->ws2812_text_brightness, &style_color_brightness, LV_PART_MAIN);
158
159 ui->ws2812_slider_red = create_slider(ui, lv_palette_main(LV_PALETTE_RED));
160 ui->ws2812_slider_green = create_slider(ui, lv_palette_main(LV_PALETTE_GREEN));
161 ui->ws2812_slider_blue = create_slider(ui, lv_palette_main(LV_PALETTE_BLUE));
162 ui->ws2812_slider_brightness = create_slider(ui, lv_palette_main(LV_PALETTE_GREY));
163
164 lv_slider_set_value(ui->ws2812_slider_red, LV_OPA_10, LV_ANIM_OFF);
165 lv_slider_set_value(ui->ws2812_slider_green, LV_OPA_10, LV_ANIM_OFF);
166 lv_slider_set_value(ui->ws2812_slider_blue, LV_OPA_10, LV_ANIM_OFF);
167 lv_slider_set_value(ui->ws2812_slider_brightness, LV_OPA_10, LV_ANIM_OFF);
168
169 lv_obj_align(ui->ws2812_slider_red, LV_ALIGN_LEFT_MID, 20, -20);
170 lv_obj_align_to(ui->ws2812_slider_green, ui->ws2812_slider_red, LV_ALIGN_OUT_BOTTOM_MID, 0,
40);
171 lv_obj_align_to(ui->ws2812_slider_blue, ui->ws2812_slider_green, LV_ALIGN_OUT_BOTTOM_MID, 0,
40);
172 lv_obj_align_to(ui->ws2812_slider_brightness, ui->ws2812_slider_blue,
```

```

173     LV_ALIGN_OUT_BOTTOM_MID, 0, 40);
174     lv_event_send(ui->ws2812_slider_brightness, LV_EVENT_VALUE_CHANGED, NULL);
175     lv_obj_add_event_cb(ui->ws2812_home, ws2812_imgbtn_home_event_handler,
176     LV_EVENT_VALUE_CHANGED, NULL);
176 }

```

Call the WS2812 library file.

```
5 #include "Freenove_WS2812_Lib_for_ESP32.h"
```

Apply for a WS2812 interface object and configure its parameters.

```
8 Freenove_ESP32_WS2812 strip = Freenove_ESP32_WS2812(LEDS_COUNT, LEDS_PIN, CHANNEL, TYPE_GRB);
```

Initialize the WS2812 LED and set its brightness to 1.

```

10 bool ws2812_init(void) {
11     strip.begin();
12     strip.setBrightness(1);
13     return 1;
14 }

```

WS2812 color setting function, through which the color of the specified WS2812 LED can be set. Parameter num refers to the index number of the specified LED, and the remaining four parameters correspond to the red, green, blue and brightness values respectively.

```

16 void ws2812_set_color(int num, int red, int green, int blue, int brightness) {
17     red = constrain(red, 0, 255);
18     green = constrain(green, 0, 255);
19     blue = constrain(blue, 0, 255);
20     brightness = constrain(brightness, 0, 255);
21     strip.setBrightness(brightness);
22     strip.setLedColorData(num, red, green, blue);
23     strip.show();
24 }

```

Label creation function, which is used to create labels in batches, and the created objects are returned through formal parameters.

```

64 void create_lable(lvgl_ws2812_ui *ui, lv_obj_t **lable1, lv_obj_t **lable2) {
65     *lable1 = lv_label_create(ui->ws2812);
66     lv_obj_set_style_text_align(*lable1, LV_TEXT_ALIGN_LEFT, 0);
67     lv_obj_set_size(*lable1, 85, 20);
68
69     *lable2 = lv_label_create(ui->ws2812);
70     lv_obj_set_style_text_align(*lable2, LV_TEXT_ALIGN_CENTER, 0);
71     lv_obj_set_size(*lable2, 45, 20);
72 }

```

Use the label creation function to create two labels and assign values to the actual parameters corresponding to the two formal parameters of the function, and set the position and content of the labels.

```
107  create_label(ui, &ui->ws2812_label_red, &ui->ws2812_text_red);
108  lv_obj_set_pos(ui->ws2812_label_red, 10, 10);
109  lv_obj_set_pos(ui->ws2812_text_red, 95, 10);
110  lv_label_set_text(ui->ws2812_label_red, "red");
111  lv_label_set_text(ui->ws2812_text_red, "255");
```

The slider creation function specifies the color of the slider through the formal parameter, and returns the created slider through the return value. Each slider has a range of 0-255. The created sliders are associated with the slider_event_cb function.

```
74   static lv_obj_t *create_slider(lvgl_ws2812_ui *ui, lv_color_t color) {
75     lv_obj_t *slider = lv_slider_create(ui->ws2812);
76     lv_slider_set_range(slider, 0, 255);
77     lv_obj_set_size(slider, 200, 10);
78     lv_obj_set_style_bg_color(slider, color, LV_PART_KNOB);
79     lv_obj_set_style_bg_color(slider, color, LV_PART_INDICATOR);
80     lv_obj_add_event_cb(slider, slider_event_cb, LV_EVENT_VALUE_CHANGED, NULL);
81     return slider;
82 }
```

Call the slider creation function to create four sliders of different colors and assign them to the corresponding slider objects.

```
159  ui->ws2812_slider_red = create_slider(ui, lv_palette_main(LV_PALETTE_RED));
160  ui->ws2812_slider_green = create_slider(ui, lv_palette_main(LV_PALETTE_GREEN));
161  ui->ws2812_slider_blue = create_slider(ui, lv_palette_main(LV_PALETTE_BLUE));
162  ui->ws2812_slider_brightness = create_slider(ui, lv_palette_main(LV_PALETTE_GREY));
```

Sets the initial value of the slider. LV_OPA_10 means 10%, and the range of the slider is 0-255. Therefore, the value of LV_OPA_10 is 25.

```
164  lv_slider_set_value(ui->ws2812_slider_red, LV_OPA_10, LV_ANIM_OFF);
165  lv_slider_set_value(ui->ws2812_slider_green, LV_OPA_10, LV_ANIM_OFF);
166  lv_slider_set_value(ui->ws2812_slider_blue, LV_OPA_10, LV_ANIM_OFF);
167  lv_slider_set_value(ui->ws2812_slider_brightness, LV_OPA_10, LV_ANIM_OFF);
```

Trigger a slider event and set the callback function of the home button in the interface.

```
174  lv_event_send(ui->ws2812_slider_brightness, LV_EVENT_VALUE_CHANGED, NULL);
175  lv_obj_add_event_cb(ui->ws2812_home, ws2812_imgbtn_home_event_handler,
LV_EVENT_VALUE_CHANGED, NULL);
```

Slider event callback function. Every time this function is triggered, get the values of the four sliders and display them in the value area in the upper left corner, and set the corresponding color and brightness of the onboard WS2812 LED.

```
49   static void slider_event_cb(lv_event_t *e) {
50     LV_UNUSED(e);
51     int color_red = lv_slider_get_value(guiders_ws2812.ui.ws2812_slider_red);
52     int color_green = lv_slider_get_value(guiders_ws2812.ui.ws2812_slider_green);
53     int color_blue = lv_slider_get_value(guiders_ws2812.ui.ws2812_slider_blue);
54     int color_brightness = lv_slider_get_value(guiders_ws2812.ui.ws2812_slider_brightness);
```

```
55 lv_label_set_text_fmt(guider_ws2812_ui.ws2812_text_red, "%d", color_red);  
56 lv_label_set_text_fmt(guider_ws2812_ui.ws2812_text_green, "%d", color_green);  
57 lv_label_set_text_fmt(guider_ws2812_ui.ws2812_text_blue, "%d", color_blue);  
58 lv_label_set_text_fmt(guider_ws2812_ui.ws2812_text_brightness, "%d", color_brightness);  
59  
60 ws2812_set_color(0, color_red, color_green, color_blue, color_brightness);  
61  
62 }
```

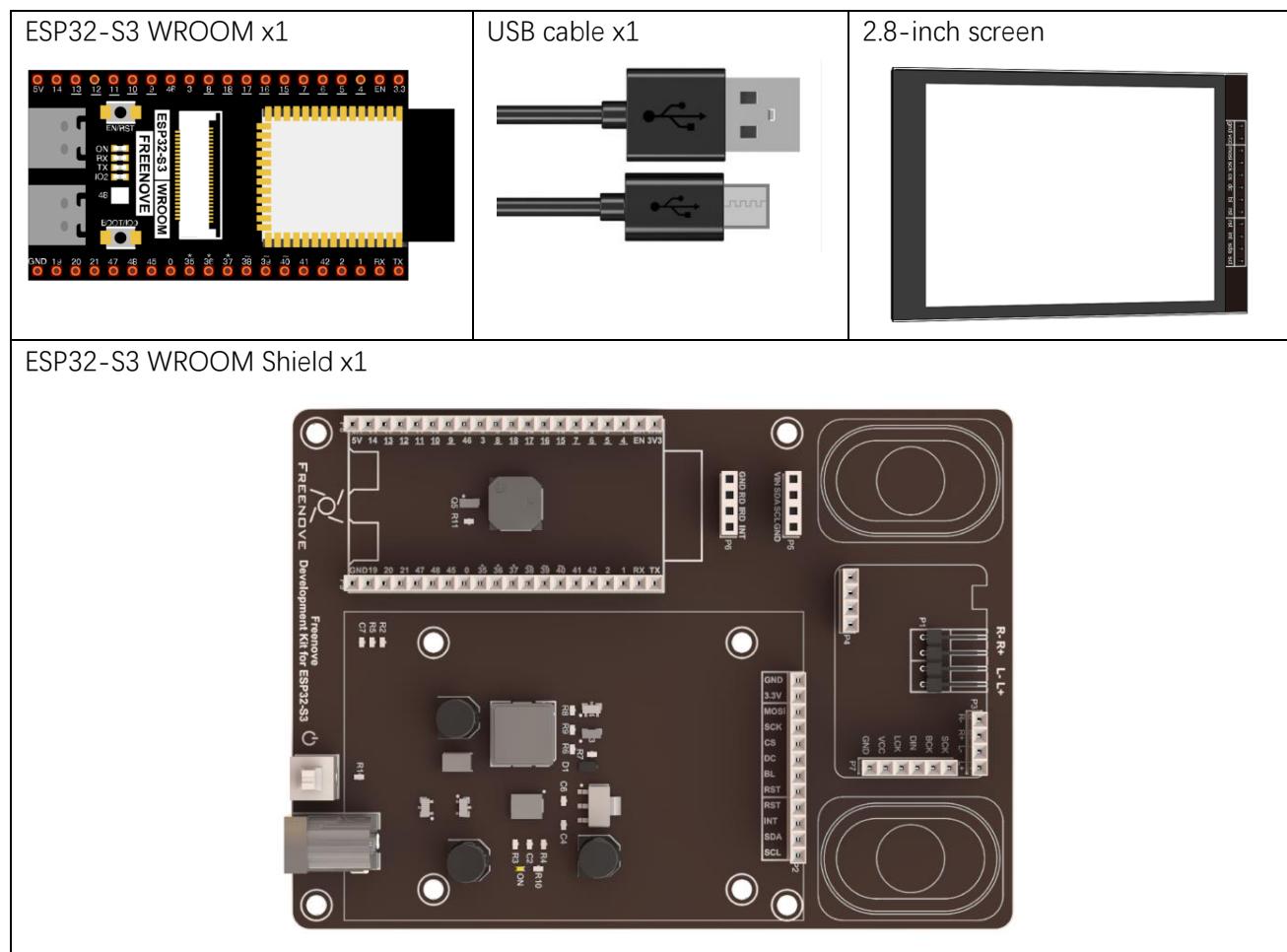
Chapter 20 LVGL Buzzer

In this chapter, we will control the buzzer to make different sounds with the touch screen.

Project 20.1 LVGL Buzzer

In the code, we use matrix buttons, spinners, and checkboxes to interact with the onboard buzzer.

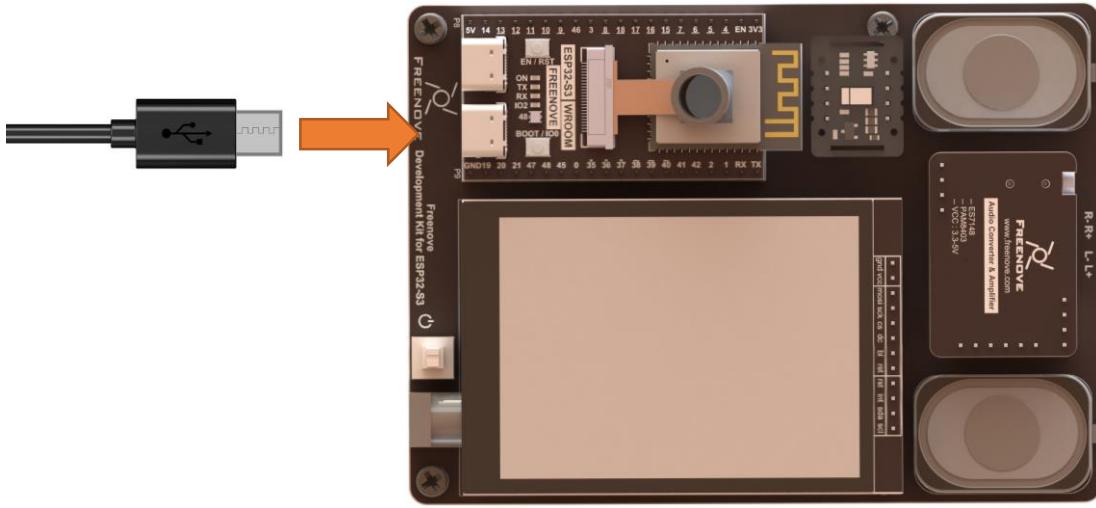
Component List



Circuit

Connect Freenove ESP32-S3 to the computer using the USB cable.

Hardware connection. If you need any support, please feel free to contact us via: support@freenove.com



Sketch

Sketch_20_Lvgl_Buzzer | Arduino IDE 2.1.0

```

File Edit Sketch Tools Help
File Sketch Tools Help
Sketch_20_Lvgl_Buzzer.ino display.cpp display.h lv_img.cpp lv_img.h sound_ui.cpp sound_ui.h ...
1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "sound_ui.h"
5
6 Display screen;
7
8 void setup() {
9     Serial.begin(115200);
10
11     /** Init screen ***
12     screen.init();
13
14     /** Print lvgl version ***
15     String LVGL_Arduino = "Hello Arduino! ";
16     LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
17     Serial.println(LVGL_Arduino);
18     Serial.println("I am LVGL_Arduino");
19     Serial.println("Setup done");
20
21     /** The custom code ***
22     setup_scr_sound(&guider_sound_ui);
23     lv_scr_load(guider_sound_ui.sound);
24
25
26 void loop() {
27     screen.route();
28     delay(5);
29 }

```

Output

```

"C:\Users\DESKTOP-LIN\AppData\Local\Arduino15\"
"C:\Users\DESKTOP-LIN\AppData\Local\Arduino15\" Compiling sketch...

```

Ln 30, Col 1 ESP32S3 Dev Module on COM3

Here is an illustration of the example:



The checkbox controls the buzzer to sound or off. The spinner controls the duration of each sound, in milliseconds. The matrix keyboard controls the buzzer to make different sounds.

The following is the program code:

Sketch_20_Lvgl_Buzzer.ino

```
1 #include <lvgl.h>
2 #include "Arduino.h"
3 #include "display.h"
4 #include "sound_ui.h"
5 Display screen;
6 void setup() {
7   Serial.begin(115200);
8
9   /*** Init screen ***/
10  screen.init();
11
12  /*** Print lvgl version ***/
13  String LVGL_Arduino = "Hello Arduino! ";
14  LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
15    lv_version_patch();
16  Serial.println(LVGL_Arduino);
17  Serial.println("I am LVGL_Arduino");
18  Serial.println("Setup done");
19
20  /*** The custom code ***/
21  setup_scr_sound(&guider_sound_ui);
22  lv_scr_load(guider_sound_ui.sound);
23 }
24 void loop() {
25   screen.routine();
26   delay(5);
27 }
```

Any concerns? ✉ support@freenove.com

sound_ui.h

The declaration file about the buzzer interface and driver is as beloww:

```
1 #ifndef __SOUND_UI_H
2 #define __SOUND_UI_H
3
4 #include "lvgl.h"
5 #include "Arduino.h"
6
7 #define NOTE_D0 0
8 #define NOTE_D1 174
9 #define NOTE_D2 200
10 #define NOTE_D3 226
11 #define NOTE_D4 252
12 #define NOTE_D5 276
13 #define NOTE_D6 302
14 #define NOTE_D7 328
15 #define NOTE_BUZZER_GRADE 3
16
17 #define PIN_BUZZER 45           //Define the pins for the ESP32 control buzzer
18 #define BUZZER_CHN 0            //Define the PWM channel for ESP32
19 #define BUZZER_FREQUENCY 1000   //Define the resonant frequency of the buzzer
20
21 typedef struct lvgl_sound{
22     lv_obj_t *sound;
23     lv_obj_t *sound_imgbtn_home;
24     lv_obj_t *sound_checkbox_buzzer;
25     lv_obj_t *sound_spinbox_buzzer;
26     lv_obj_t *sound_btn_decrement;
27     lv_obj_t *sound_btn_increment;
28     lv_obj_t *sound_btndmatrix;
29 }lvgl_sound;
30
31 extern lvgl_sound ui; //sound ui structure
32
33 void buzzer_init(void);
34 void buzzer_alert(int freq, int time);
35 void sound_set_buzzer(int tone);
36
37 int sound_checkbox_switch(int buzzer_state, int audio_state);
38 void setup_scr_sound(lvgl_sound *ui);
39#endif
```

Here is the complete code:

sound_ui.cpp

```
1 // #include "second_main_ui.h"
2 #include "sound_ui.h"
3 #include "lv_img.h"
4
5 lvgl_sound_ui guider_sound_ui; //sound ui structure
6 int buzzer_state = 0;
7 int buzzer_time = 100;
8
9 static void lv_spinbox_increment_event_cb(lv_event_t *e) {
10     lv_event_code_t code = lv_event_get_code(e);
11     if (code == LV_EVENT_SHORT_CLICKED || code == LV_EVENT_LONG_PRESSED_REPEAT) {
12         lv_spinbox_increment(guider_sound_ui.sound_spinbox_buzzer);
13         buzzer_time = lv_spinbox_get_value(guider_sound_ui.sound_spinbox_buzzer);
14         Serial.printf("data:%d\r\n", buzzer_time);
15     }
16 }
17
18 static void lv_spinbox_decrement_event_cb(lv_event_t *e) {
19     lv_event_code_t code = lv_event_get_code(e);
20     if (code == LV_EVENT_SHORT_CLICKED || code == LV_EVENT_LONG_PRESSED_REPEAT) {
21         lv_spinbox_decrement(guider_sound_ui.sound_spinbox_buzzer);
22         buzzer_time = lv_spinbox_get_value(guider_sound_ui.sound_spinbox_buzzer);
23         Serial.printf("data:%d\r\n", buzzer_time);
24     }
25 }
26
27 static void sound_btnmatrix_event_handler(lv_event_t *e) {
28     lv_event_code_t code = lv_event_get_code(e);
29     lv_obj_t *obj = lv_event_get_target(e);
30     if (code == LV_EVENT_VALUE_CHANGED) {
31         uint32_t id = lv_btnmatrix_get_selected_btn(obj);
32         if (buzzer_state == 1) {
33             sound_set_buzzer(id + 1);
34         } else {
35             sound_set_buzzer(0);
36         }
37     }
38 }
39
40 static void sound_checkbox_event_handler(lv_event_t *e) {
41     lv_event_code_t code = lv_event_get_code(e);
42     lv_obj_t *obj = lv_event_get_target(e);
```

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```
43     if (code == LV_EVENT_VALUE_CHANGED) {
44         buzzer_state = lv_obj_get_state(obj) & LV_STATE_CHECKED ? 1 : 0;
45     }
46 }
47
48 static void sound_home_event_handler(lv_event_t *e) {
49     lv_event_code_t code = lv_event_get_code(e);
50     switch (code) {
51     case LV_EVENT_CLICKED:
52     {
53         Serial.println("Clicked the home button.");
54     }
55     break;
56     case LV_EVENT_RELEASED:
57     {
58         /*
59         if (!lv_obj_is_valid(guider_second_main_ui.second_main))
60             setup_scr_second_main(&guider_second_main_ui);
61         lv_scr_load(guider_second_main_ui.second_main);
62         lv_obj_del(guider_sound_ui.sound);
63         */
64     }
65     break;
66     default:
67     break;
68 }
69 }
70 //Parameter configuration function on the sound screen
71 void setup_scr_sound(lvgl_sound_ui *ui) {
72     buzzer_init();
73
74     //Write codes picture
75     ui->sound = lv_obj_create(NULL);
76     static lv_style_t bg_style;
77     lv_style_init(&bg_style);
78     lv_style_set_bg_color(&bg_style, lv_color_hex(0xffffffff));
79     lv_obj_add_style(ui->sound, &bg_style, LV_PART_MAIN);
80
81     lv_img_home_init();
82     //Write codes sound_imgbtn_home
83     ui->sound_imgbtn_home = lv_imgbtn_create(ui->sound);
84     lv_obj_remove_style_all(ui->sound_imgbtn_home);
85     lv_obj_set_pos(ui->sound_imgbtn_home, 150, 10);
86     lv_obj_set_size(ui->sound_imgbtn_home, 80, 80);
```

```
87     lv_img_set_src(ui->sound_imgbtn_home, &img_home);
88
89     static lv_style_t style_pr;
90     lv_style_init(&style_pr);
91     lv_style_set_translate_y(&style_pr, 5);
92     lv_obj_add_style(ui->sound_imgbtn_home, &style_pr, LV_STATE_PRESSED);
93
94     ui->sound_checkbox_buzzer = lv_checkbox_create(ui->sound);
95     lv_checkbox_set_text(ui->sound_checkbox_buzzer, "Buzzer");
96     lv_obj_set_pos(ui->sound_checkbox_buzzer, 25, 15);
97
98     ui->sound_spinbox_buzzer = lv_spinbox_create(ui->sound);
99     lv_spinbox_set_range(ui->sound_spinbox_buzzer, 40, 1000);
100    lv_spinbox_set_digit_format(ui->sound_spinbox_buzzer, 4, 4);
101    lv_spinbox_step_prev(ui->sound_spinbox_buzzer);
102    lv_obj_set_width(ui->sound_spinbox_buzzer, 50);
103    lv_obj_set_pos(ui->sound_spinbox_buzzer, 50, 50);
104    lv_spinbox_set_value(ui->sound_spinbox_buzzer, buzzer_time);
105
106    ui->sound_btn_increment = lv_btn_create(ui->sound);
107    lv_obj_set_size(ui->sound_btn_increment, 25, 25);
108    lv_obj_align_to(ui->sound_btn_increment, ui->sound_spinbox_buzzer, LV_ALIGN_OUT_RIGHT_MID,
109                    2, 0);
110
111    ui->sound_btn_decrement = lv_btn_create(ui->sound);
112    lv_obj_set_size(ui->sound_btn_decrement, 25, 25);
113    lv_obj_align_to(ui->sound_btn_decrement, ui->sound_spinbox_buzzer, LV_ALIGN_OUT_LEFT_MID,
114                    -2, 0);
115
116    static const char *btnm_map[] = { "do", "re", "mi", "\n", "fa", "so", "la", "\n", "si",
117                                    "" };
118    ui->sound_btndmatrix = lv_btndmatrix_create(ui->sound);
119    lv_btndmatrix_set_map(ui->sound_btndmatrix, btm_map);
120    lv_obj_set_size(ui->sound_btndmatrix, 220, 200);
121    lv_obj_set_pos(ui->sound_btndmatrix, 10, 110);
122    lv_obj_add_event_cb(ui->sound_checkbox_buzzer, sound_checkbox_event_handler, LV_EVENT_ALL,
123                        NULL);
124    lv_obj_add_event_cb(ui->sound_btndmatrix, sound_btndmatrix_event_handler, LV_EVENT_ALL, NULL);
125    lv_obj_add_event_cb(ui->sound_imgbtn_home, sound_home_event_handler, LV_EVENT_ALL, NULL);
```



```
125 }
126
127 //Buzzer initialization
128 void buzzer_init(void) {
129     pinMode(PIN_BUZZER, OUTPUT);
130     ledcSetup(BUZZER_CHN, BUZZER_FREQUENCY, 10);
131     ledcAttachPin(PIN_BUZZER, BUZZER_CHN);
132     ledcWriteTone(BUZZER_CHN, 0);
133 }
134
135 void buzzer_alert(int freq, int time) {
136     ledcWriteTone(BUZZER_CHN, freq * NOTE_BUZZER_GRADE);
137     delay(time);
138     ledcWriteTone(BUZZER_CHN, 0);
139 }
140
141 void buzzer_repeat_alert(int beat, int rebeat) {
142     beat = constrain(beat, 1, 9);
143     rebeat = constrain(rebeat, 1, 255);
144     for (int j = 0; j < rebeat; j++) {
145         for (int i = 0; i < beat; i++) {
146             buzzer_alert(BUZZER_FREQUENCY, 100);
147             delay(100);
148         }
149         delay(500);
150     }
151 }
152
153 void sound_set_buzzer(int tone) {
154     int freq = 0;
155     switch (tone) {
156         case 1: freq = NOTE_D1; break;
157         case 2: freq = NOTE_D2; break;
158         case 3: freq = NOTE_D3; break;
159         case 4: freq = NOTE_D4; break;
160         case 5: freq = NOTE_D5; break;
161         case 6: freq = NOTE_D6; break;
162         case 7: freq = NOTE_D7; break;
163         default: freq = NOTE_D0; break;
164     }
165     buzzer_alert(freq, buzzer_time);
166 }
```

Buzzer initialization function.

```
127 //Buzzer initialization
128 void buzzer_init(void) {
129     pinMode(PIN_BUZZER, OUTPUT);
130     ledcSetup(BUZZER_CHN, BUZZER_FREQUENCY, 10);
131     ledcAttachPin(PIN_BUZZER, BUZZER_CHN);
132     ledcWriteTone(BUZZER_CHN, 0);
133 }
```

Control the buzzer to emit a sound at a specific frequency and last for “time” milliseconds.

```
135 void buzzer_alert(int freq, int time) {
136     ledcWriteTone(BUZZER_CHN, freq * NOTE_BUZZER_GRADE);
137     delay(time);
138     ledcWriteTone(BUZZER_CHN, 0);
139 }
```

Control the buzzer to emit sound of specific frequency regularly.

```
141 void buzzer_repeat_alert(int beat, int rebeat) {
142     beat = constrain(beat, 1, 9);
143     rebeat = constrain(rebeat, 1, 255);
144     for (int j = 0; j < rebeat; j++) {
145         for (int i = 0; i < beat; i++) {
146             buzzer_alert(BUZZER_FREQUENCY, 100);
147             delay(100);
148         }
149         delay(500);
150     }
151 }
```

Control the buzzer to emit sounds of different frequencies.

```
153 void sound_set_buzzer(int tone) {
154     int freq = 0;
155     switch (tone) {
156         case 1: freq = NOTE_D1; break;
157         case 2: freq = NOTE_D2; break;
158         case 3: freq = NOTE_D3; break;
159         case 4: freq = NOTE_D4; break;
160         case 5: freq = NOTE_D5; break;
161         case 6: freq = NOTE_D6; break;
162         case 7: freq = NOTE_D7; break;
163     default: freq = NOTE_D0; break;
164 }
165 buzzer_alert(freq, buzzer_time);
166 }
```



Create a checkbox and set its position as well as the displayed content.

```
93 ui->sound_checkbox_buzzer = lv_checkbox_create(ui->sound);
94 lv_checkbox_set_text(ui->sound_checkbox_buzzer, "Buzzer");
95 lv_obj_set_pos(ui->sound_checkbox_buzzer, 25, 15);
```

Create a spinner, set its range to 40-1000, and display in a 4-digit integer mode.

```
97 ui->sound_spinbox_buzzer = lv_spinbox_create(ui->sound);
98 lv_spinbox_set_range(ui->sound_spinbox_buzzer, 40, 1000);
99 lv_spinbox_set_digit_format(ui->sound_spinbox_buzzer, 4, 4);
100 lv_spinbox_step_prev(ui->sound_spinbox_buzzer);
101 lv_obj_set_width(ui->sound_spinbox_buzzer, 50);
102 lv_obj_set_pos(ui->sound_spinbox_buzzer, 50, 50);
103 lv_spinbox_set_value(ui->sound_spinbox_buzzer, buzzer_time);
```

Add 2 buttons on the left and right sides of the spinner to adjust the spinner's value, and associate it with the corresponding callback function.

```
105 ui->sound_btn_increment = lv_btn_create(ui->sound);
106 lv_obj_set_size(ui->sound_btn_increment, 25, 25);
107 lv_obj_align_to(ui->sound_btn_increment, ui->sound_spinbox_buzzer, LV_ALIGN_OUT_RIGHT_MID,
2, 0);
108 lv_obj_set_style_bg_img_src(ui->sound_btn_increment, LV_SYMBOL_PLUS, 0);
109 lv_obj_add_event_cb(ui->sound_btn_increment, lv_spinbox_increment_event_cb, LV_EVENT_ALL,
NULL);
110
111 ui->sound_btn_decrement = lv_btn_create(ui->sound);
112 lv_obj_set_size(ui->sound_btn_decrement, 25, 25);
113 lv_obj_align_to(ui->sound_btn_decrement, ui->sound_spinbox_buzzer, LV_ALIGN_OUT_LEFT_MID,
-2, 0);
114 lv_obj_set_style_bg_img_src(ui->sound_btn_decrement, LV_SYMBOL_MINUS, 0);
115 lv_obj_add_event_cb(ui->sound_btn_decrement, lv_spinbox_decrement_event_cb, LV_EVENT_ALL,
NULL);
```

Create a matrix keyboard and set its displayed content, size and position.

```
117 static const char *bttnm_map[] = { "do", "re", "mi", "\n", "fa", "so", "la", "\n", "si", "" };
118 ui->sound_bttnmatrix = lv_bttnmatrix_create(ui->sound);
119 lv_bttnmatrix_set_map(ui->sound_bttnmatrix, bttnm_map);
120 lv_obj_set_size(ui->sound_bttnmatrix, 220, 200);
121 lv_obj_set_pos(ui->sound_bttnmatrix, 10, 110);
```

Checkbox, matrix keyboard, and Home button callback associated functions, which associate these controls with corresponding callback functions.

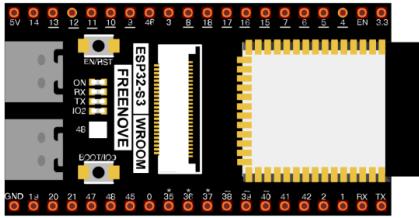
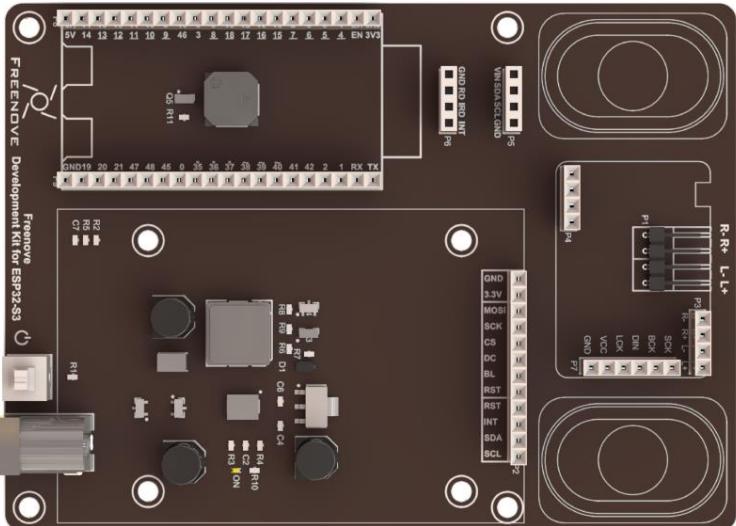
```
122 lv_obj_add_event_cb(ui->sound_checkbox_buzzer, sound_checkbox_event_handler, LV_EVENT_ALL,
NULL);
123 lv_obj_add_event_cb(ui->sound_bttnmatrix, sound_bttnmatrix_event_handler, LV_EVENT_ALL, NULL);
124 lv_obj_add_event_cb(ui->sound_imgbtn_home, sound_home_event_handler, LV_EVENT_ALL, NULL);
```

Chapter 21 LVGL Multifunctionality

In this chapter, we pull together several of the previous examples as a comprehensive routine.

Project 21.1 LVGL Multifunctionality

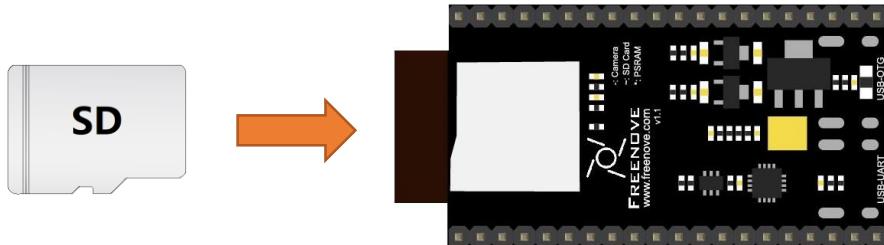
Component List

ESP32-S3 WROOM x1	USB cable x1	2.8-inch screen
		
ESP32-S3 WROOM Shield x1		Card reader x1 (random color)
		
9V battery cable x1	9V battery x1 <i>(Not included, prepared by yourself)</i>	SD card x1
		

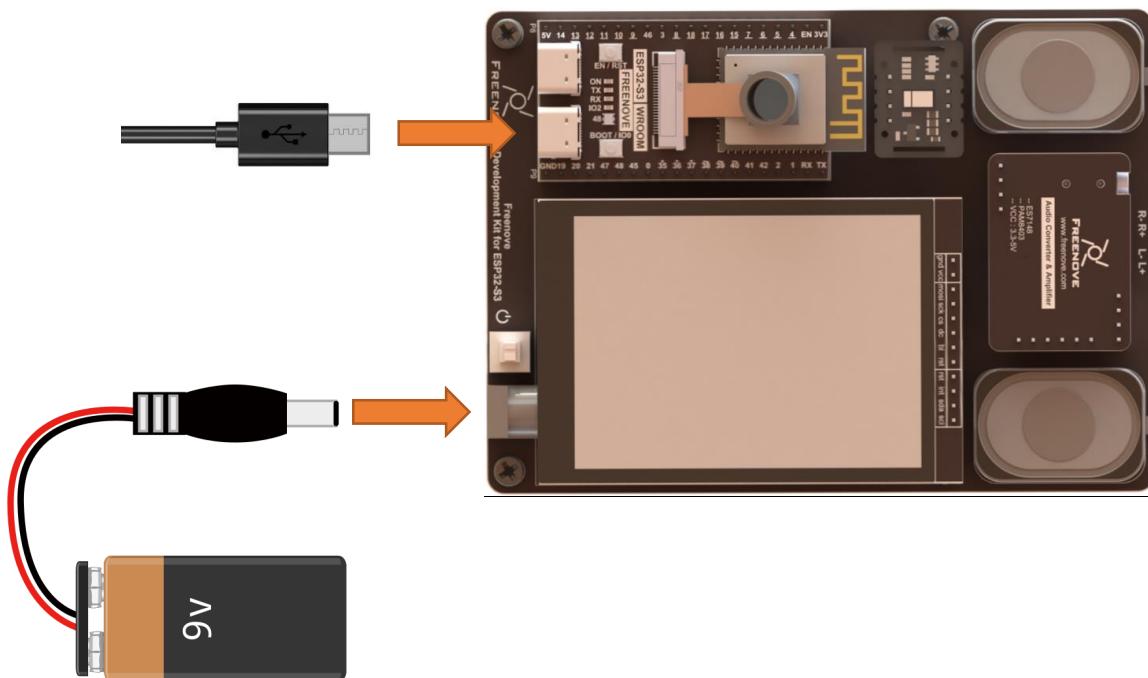
Any concerns? ✉ support@freenove.com

Circuit

If you have not yet used the SD card, please refer to Chapter 4. Click [here](#) to navigate back to Chapter 4. Before connecting the USB cable, insert the SD card into the SD card slot on the back of the ESP32-S3.



Connect Freenove ESP32-S3 to the computer using the USB cable.



Sketch

Sketch_21_LVGL_Multifunctionality

```

Sketch_19_Lvgl_Multifunctionality | Arduino IDE 2.0.4
File Edit Sketch Tools Help
Sketch_19_Lvgl_Multifunctionality.ino camera.cpp sensor.h camera.h camera_pins.h camera_ui.cpp camera_ui.h display.cpp disp ...
12 int setup_success = 1;
13 int count = 0;
14
15 void setup() {
16     /* prepare for possible serial debug */
17     Serial.begin(115200);
18     /*** Init drivers ***/
19     int iic_num = wire_scan();
20     int sd_init_state = sdcard_init();           //Initialize the SD_MMC module
21     int camera_init_state = camera_init();       //Initialize the camera drive
22     int music_init_state = music_iis_init();    //Initialize the audio interface
23     buzzer_init();                            //Test the buzzer
24     audio_init();                            //Test the audio module
25     setup_success = driver_check_show(iic_num, sd_init_state, camera_init_state, music_init_state);
26
27     if (setup_success != 0) {
28         screen.init();          //Initialize the TFT and Touch chip.
29         music_set_volume(10);
30         hearrate_init();      //Initialization hearrate module
31
32         String LVGL_Arduino = "Hello Arduino! ";
33         LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." + lv_version_patch();
34         Serial.println(LVGL_Arduino);
35         Serial.println("I am LVGL_Arduino");
36
37         setup_ui(&guider_main_ui); //Load Ui Screen function: guider_main_ui
38         Serial.println("Setup done"); //Print prompt message
39     }
40     while(audio_test_isRunning()); //Wait for the audio to end.
41 }
42
43 void loop() {
44     if (setup_success != 0) {
45         screen.routine(); /* let the GUI do its work */
46         delay(5);
47     }
48 }
49

```

The following is the program code:

```

1 #include <Arduino.h>
2 #include <lvgl.h>
3 #include <TFT_eSPI.h>
4 #include "display.h"
5 #include "FT6336U.h"
6 #include "sd_card.h"
7 #include "camera.h"
8 #include "main_ui.h"
9 #include "driver_test.h"
10
11 Display screen;
12 int setup_success = 1;

```

```

13
14 void setup() {
15     /* prepare for possible serial debug */
16     Serial.begin(115200);
17     /*** Init drivers ***/
18     int iic_num = wire_scan();
19     int sd_init_state = sdcard_init();           //Initialize the SD_MMC module
20     int camera_init_state = camera_init();       //Initialize the camera drive
21     int music_init_state = music_iis_init();     //Initialize the audio interface
22     buzzer_init();                            //Test the buzzer
23     audio_init();                            //Test the audio module
24     setup_success = driver_check_show(iic_num, sd_init_state, camera_init_state,
25     music_init_state);
26     if (setup_success != 0) {
27         screen.init();          //Initialize the TFT and Touch chip.
28         music_set_volume(10);
29         heartrate_init();    //Initialization heartrate module
30
31         String LVGL_Arduino = "Hello Arduino! ";
32         LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "."
33         lv_version_patch();
34         Serial.println(LVGL_Arduino);
35         Serial.println("I am LVGL_Arduino");
36
37         setup_ui(&guider_main_ui);      //Load Ui Screen function: guider_main_ui
38         Serial.println("Setup done");   //Print prompt message
39     }
40
41     while(audio_test_isRunning()); //Wait for the audio to end.
42 }
43
44 void loop() {
45     if (setup_success != 0) {
46         screen.routine(); /* let the GUI do its work */
47         delay(5);
48     }
49 }
```

Scan for I2C devices and initialize the SD card, camera, and I2S interface. Emit 3 beeps from the buzzer and play a test music on the speaker.

```

18     int iic_num = wire_scan();
19     int sd_init_state = sdcard_init();           //Initialize the SD_MMC module
20     int camera_init_state = camera_init();       //Initialize the camera drive
21     int music_init_state = music_iis_init();     //Initialize the audio interface
22     buzzer_init();                            //Test the buzzer
23     audio_init();                            //Test the audio module
```

Print the initialization information on the screen and return the setup_success value. If the value is 1, it indicates that the device has passed the test. If the value is 0, it means that some device initialization has failed.

```
24     setup_success = driver_check_show(iic_num, sd_init_state, camera_init_state,
25                                         music_init_state);
```

If all hardware initialization succeeds, load the lvgl system, set the music volume, initialize the heart rate module, print a prompt message, and then enter the main control interface.

```
25     if (setup_success != 0) {
26         screen.init();      //Initialize the TFT and Touch chip.
27         music_set_volume(10);
28         hearrate_init();  //Initialization hearrate module
29
30         String LVGL_Arduino = "Hello Arduino! ";
31         LVGL_Arduino += String('V') + lv_version_major() + "." + lv_version_minor() + "." +
32                         lv_version_patch();
33         Serial.println(LVGL_Arduino);
34         Serial.println("I am LVGL_Arduino");
35
36         setup_ui(&guider_main_ui);    //Load Ui Screen function: guider_main_ui
37         Serial.println("Setup done"); //Print prompt message
38     }
39     while(audio_test_isRunning()); //Wait for the audio to end.
```

main_ui.h

Declare the functions so that they can be called in the ino file.

```
1 #ifndef __MAIN_UI_H
2 #define __MAIN_UI_H
3
4 #include "lvgl.h"
5 #include "Arduino.h"
6
7 #include "camera_ui.h"
8 #include "picture_ui.h"
9 #include "music_ui.h"
10 #include "hearrate_ui.h"
11
12 typedef struct lvgl_main
13 {
14     lv_obj_t *main;
15     lv_obj_t *main_imgbtn_logo;
16     lv_obj_t *main_imgbtn_camera;
17     lv_obj_t *main_imgbtn_picture;
18     lv_obj_t *main_imgbtn_music;
19     lv_obj_t *main_imgbtn_hearrate;
20 }lvgl_main_ui;//main ui struct
```

```
21
22 extern lvgl_main_ui guider_main_ui; //main ui structure
23 void setup_scr_main(lvgl_main_ui *ui); //Parameter configuration function on the main screen
24 void setup_ui(lvgl_main_ui *ui); //Load Ui Screen function
25
26 #endif
```

main_ui.cpp

```
1 #include "main_ui.h"
2 #include "second_main_ui.h"
3 #include "lv_img.h"
4
5 lvgl_main_ui guider_main_ui; //main ui structure
6
7 //Click the main interface logo, callback function: do nothing
8 static void main_imgbtn_logo_event_handler(lv_event_t *e) {
9     lv_event_code_t code = lv_event_get_code(e);
10    switch (code) {
11        case LV_EVENT_CLICKED:
12            {
13                Serial.println("Clicked the logo button.");
14            }
15            break;
16        case LV_EVENT_RELEASED:
17            {
18                if (!lv_obj_is_valid(guider_second_main_ui.second_main))
19                    setup_scr_second_main(&guider_second_main_ui);
20                lv_scr_load(guider_second_main_ui.second_main);
21                lv_obj_del(guider_main_ui.main);
22            }
23            break;
24        default:
25            break;
26    }
27 }
28
29 //Click the camera icon, callback function: goes to the camera ui interface
30 static void main_imgbtn_camera_event_handler(lv_event_t *e) {
31     lv_event_code_t code = lv_event_get_code(e);
32     switch (code) {
33         case LV_EVENT_CLICKED:
34             {
35                 Serial.println("Clicked the camera button.");
36             }
37             break;
```

```
38     case LV_EVENT_RELEASED:
39     {
40         if (!lv_obj_is_valid(guider_camera_ui.camera))
41             setup_scr_camera(&guider_camera_ui);
42         lv_scr_load(guider_camera_ui.camera);
43         lv_obj_del(guider_main_ui.main);
44     }
45     break;
46     default:
47     break;
48 }
49 }

50 //Click the picture icon, callback function: goes to the picture ui interface
51 static void main_imgbtn_picture_event_handler(lv_event_t *e) {
52     lv_event_code_t code = lv_event_get_code(e);
53     switch (code) {
54     case LV_EVENT_CLICKED:
55     {
56         Serial.println("Clicked the picture button.");
57     }
58     break;
59     case LV_EVENT_RELEASED:
60     {
61         if (!lv_obj_is_valid(guider_picture_ui.picture))
62             setup_scr_picture(&guider_picture_ui);
63         lv_scr_load(guider_picture_ui.picture);
64         lv_obj_del(guider_main_ui.main);
65     }
66     break;
67     default:
68     break;
69 }
70 }
71 }

72 //Click the music icon, callback function: goes to the music ui interface
73 static void main_imgbtn_music_event_handler(lv_event_t *e) {
74     lv_event_code_t code = lv_event_get_code(e);
75     switch (code) {
76     case LV_EVENT_CLICKED:
77     {
78         Serial.println("Clicked the music button.");
79     }
80     break;
81 }
```

```
82     case LV_EVENT_RELEASED:
83     {
84         if (!lv_obj_is_valid(guider_music_ui.music))
85             setup_scr_music(&guider_music_ui);
86         lv_scr_load(guider_music_ui.music);
87         lv_obj_del(guider_main_ui.main);
88     }
89     break;
90 default:
91     break;
92 }
93 }

//Click the heartrate icon, callback function: goes to the heartrate ui interface
96 static void main_imgbtn_heartrate_event_handler(lv_event_t *e) {
97     lv_event_code_t code = lv_event_get_code(e);

98     switch (code) {
99
100     case LV_EVENT_CLICKED:
101     {
102         Serial.println("Clicked the heartrate button.");
103     }
104     break;
105     case LV_EVENT_RELEASED:
106     {
107         if (!lv_obj_is_valid(guider_heartrate_ui.heartrate))
108             setup_scr_heartrate(&guider_heartrate_ui);
109         lv_scr_load(guider_heartrate_ui.heartrate);
110         lv_obj_del(guider_main_ui.main);
111     }
112     break;
113     default:
114     break;
115 }
116 }

117
118 //Parameter configuration function on the main screen
119 void setup_scr_main(lvgl_main_ui *ui) {
120     //Write codes main
121     ui->main = lv_obj_create(NULL);

122     static lv_style_t bg_style;
123     lv_style_init(&bg_style);
124     lv_style_set_bg_color(&bg_style, lv_color_hex(0xffffffff));
125 }
```

```
126 lv_obj_add_style(ui->main, &bg_style, LV_PART_MAIN);  
127  
128 lv_img_freenove_init();  
129 lv_img_camera_init();  
130 lv_img_music_init();  
131 lv_img_heartrate_init();  
132 lv_img_picture_init();  
133  
134 /*Init the pressed style*/  
135 static lv_style_t style_pr;           //Apply for a style  
136 lv_style_init(&style_pr);           //Initialize it  
137 lv_style_set_translate_y(&style_pr, 5); //Style: Every time you trigger, move down 5 pixels  
138  
139 //Write codes main_imgbtn_logo  
140 ui->main_imgbtn_logo = lv_imgbtn_create(ui->main);  
141 lv_obj_set_pos(ui->main_imgbtn_logo, 40, 20);  
142 lv_obj_set_size(ui->main_imgbtn_logo, 160, 90);  
143 lv_img_set_src(ui->main_imgbtn_logo, &img_freenove);  
144 lv_obj_add_style(ui->main_imgbtn_logo, &style_pr, LV_STATE_PRESSED);  
145  
146 //Write codes main_imgbtn_camera  
147 ui->main_imgbtn_camera = lv_imgbtn_create(ui->main);  
148 lv_obj_set_pos(ui->main_imgbtn_camera, 20, 135);  
149 lv_obj_set_size(ui->main_imgbtn_camera, 80, 80);  
150 lv_img_set_src(ui->main_imgbtn_camera, &img_camera);  
151 lv_obj_add_style(ui->main_imgbtn_camera, &style_pr, LV_STATE_PRESSED);  
152  
153 //Write codes main_imgbtn_picture  
154 ui->main_imgbtn_picture = lv_imgbtn_create(ui->main);  
155 lv_obj_set_pos(ui->main_imgbtn_picture, 140, 135);  
156 lv_obj_set_size(ui->main_imgbtn_picture, 80, 80);  
157 lv_img_set_src(ui->main_imgbtn_picture, &img_picture);  
158 lv_obj_add_style(ui->main_imgbtn_picture, &style_pr, LV_STATE_PRESSED);  
159  
160 //Write codes main_imgbtn_music  
161 ui->main_imgbtn_music = lv_imgbtn_create(ui->main);  
162 lv_obj_set_pos(ui->main_imgbtn_music, 20, 225);  
163 lv_obj_set_size(ui->main_imgbtn_music, 80, 80);  
164 lv_img_set_src(ui->main_imgbtn_music, &img_music);  
165 lv_obj_add_style(ui->main_imgbtn_music, &style_pr, LV_STATE_PRESSED);  
166  
167 //Write codes main_imgbtn_heartrate  
168 ui->main_imgbtn_heartrate = lv_imgbtn_create(ui->main);  
169 lv_obj_set_pos(ui->main_imgbtn_heartrate, 140, 225);
```

```

170 lv_obj_set_size(ui->main_imgbtn_heartrate, 80, 80);
171 lv_img_set_src(ui->main_imgbtn_heartrate, &img_heartrate);
172 lv_obj_add_style(ui->main_imgbtn_heartrate, &style_pr, LV_STATE_PRESSED);
173
174 lv_obj_add_event_cb(ui->main_imgbtn_logo, main_imgbtn_logo_event_handler, LV_EVENT_ALL,
175 NULL);
176 lv_obj_add_event_cb(ui->main_imgbtn_camera, main_imgbtn_camera_event_handler, LV_EVENT_ALL,
177 NULL);
178 lv_obj_add_event_cb(ui->main_imgbtn_picture, main_imgbtn_picture_event_handler,
179 LV_EVENT_ALL, NULL);
180 lv_obj_add_event_cb(ui->main_imgbtn_music, main_imgbtn_music_event_handler, LV_EVENT_ALL,
181 NULL);
182 lv_obj_add_event_cb(ui->main_imgbtn_heartrate, main_imgbtn_heartrate_event_handler,
183 LV_EVENT_ALL, NULL);
184 }
185 //Load Ui Screen function
186 void setup_ui(lvgl_main_ui *ui) {
187     setup_scr_main(ui);
188     lv_scr_load(ui->main);
189 }
```

The callback function for the main interface image buttons, triggered when the corresponding button is clicked, causing the interface to switch to the sub-function interface.

```

8 static void main_imgbtn_logo_event_handler(lv_event_t *e)
30 static void main_imgbtn_camera_event_handler(lv_event_t *e)
52 static void main_imgbtn_picture_event_handler(lv_event_t *e)
74 static void main_imgbtn_music_event_handler(lv_event_t *e)
96 static void main_imgbtn_heartrate_event_handler(lv_event_t *e)
```

Create an interface component and set the background color of the component.

```

120 //Write codes main
121 ui->main = lv_obj_create(NULL);
122
123 static lv_style_t bg_style;
124 lv_style_init(&bg_style);
125 lv_style_set_bg_color(&bg_style, lv_color_hex(0xffffffff));
126 lv_obj_add_style(ui->main, &bg_style, LV_PART_MAIN);
```

Initialize image data.

```

128 lv_img_freenove_init();
129 lv_img_camera_init();
130 lv_img_music_init();
131 lv_img_heartrate_init();
132 lv_img_picture_init();
```

Define a component style. When the component is triggered, the component moves down by 5 pixels.

```

134 /*Init the pressed style*/
```

```
135 static lv_style_t style_pr;//Apply for a style  
136 lv_style_init(&style_pr); //Initialize it  
137 lv_style_set_translate_y(&style_pr, 5);//Style: Every time you trigger, move down 5 pixels
```

Set the position and size of the main_imgbtn_logo image button, and specify the image to be displayed.

Apply a component style that moves the button down by 5 pixels when it is pressed.

```
139 //Write codes main_imgbtn_logo  
140 ui->main_imgbtn_logo = lv_imgbtn_create(ui->main);  
141 lv_obj_set_pos(ui->main_imgbtn_logo, 40, 20);  
142 lv_obj_set_size(ui->main_imgbtn_logo, 160, 90);  
143 lv_img_set_src(ui->main_imgbtn_logo, &img_freenove);  
144 lv_obj_add_style(ui->main_imgbtn_logo, &style_pr, LV_STATE_PRESSED);
```

Set the callback function when the image button main_imgbtn_logo is pressed.

```
174 lv_obj_add_event_cb(ui->main_imgbtn_logo, main_imgbtn_logo_event_handler, LV_EVENT_ALL,  
NULL);
```

Configure and load the main interface.

```
179 //Load Ui Screen function  
180 void setup_ui(lvgl_main_ui *ui) {  
181     setup_scr_main(ui);  
182     lv_scr_load(ui->main);  
183 }
```



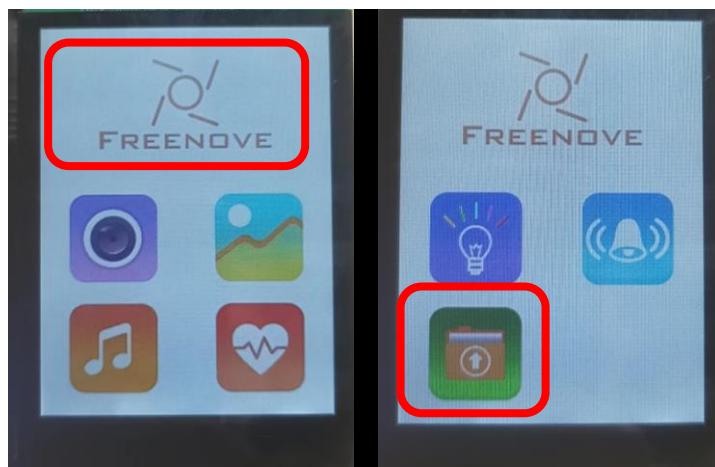
Project 22.1 Computer software

This chapter mainly introduces the operation of a PC-side interactive software.

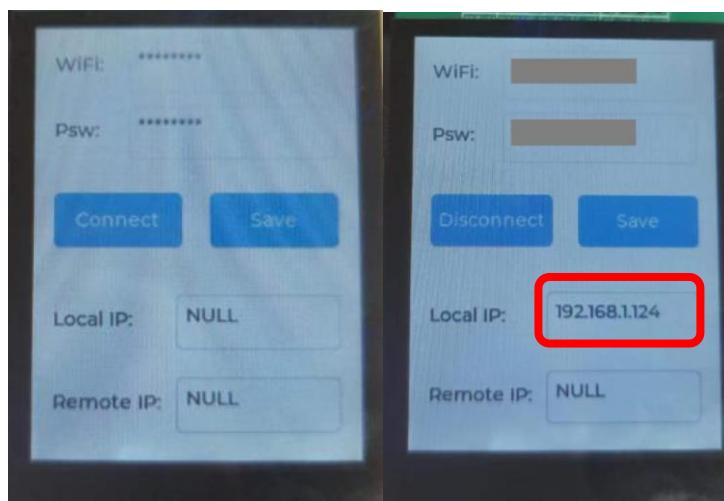
Hardware Preparation

Steps:

1. Tap the Freenove logo on the screen to switch the interface to the second page, and tap the folder icon.



2. Enter your WiFi name and password in the new interface. After making sure everything is correct, click save, and it will save your WiFi name and password in the SD card, and then click connect. Check the local IP address.



At this point, the hardware preparations are done. Please continue reading below.

Run software on Windows system

Install python3 and some related python libraries to run the software.

If you want to modify the client, please following this section.

Install python3

Download and install Python3 package.

<https://www.python.org/downloads/windows/>

The screenshot shows the Python website's 'Downloads' page specifically for Windows. At the top, there is a navigation bar with three tabs: 'About', 'Downloads', and 'Documentation'. The 'Downloads' tab is highlighted with a blue background. Below the navigation bar, the text 'Python »» Downloads »» Windows' is displayed. The main content area has a large title 'Python Releases for Windows'. Underneath the title, there is a list of two items:

- [Latest Python 3 Release - Python 3.8.1](#)
- [Latest Python 2 Release - Python 2.7.17](#)

Select Python3.8.1.

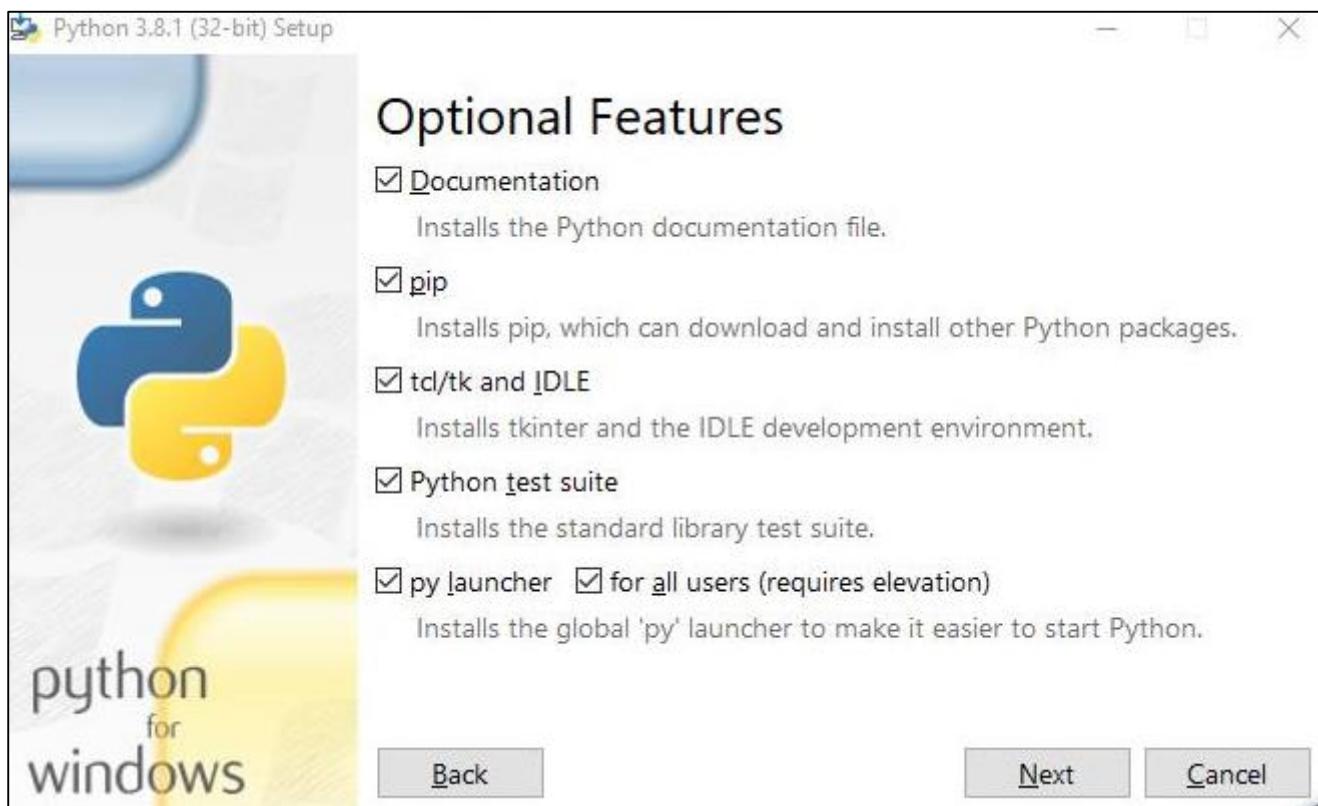
Version	Operating System	Description
Gzipped source tarball	Source release	
XZ compressed source tarball	Source release	
macOS 64-bit installer	Mac OS X	for OS X 10.9 and later
Windows help file	Windows	
Windows x86-64 embeddable zip file	Windows	for AMD64/EM64T/x64
Windows x86-64 executable installer	Windows	for AMD64/EM64T/x64
Windows x86-64 web-based installer	Windows	for AMD64/EM64T/x64
Windows x86 embeddable zip file	Windows	
Windows x86 executable installer	Windows	
Windows x86 web-based installer	Windows	

Click Windows x86 executable installerto download. After downloading, click to install.

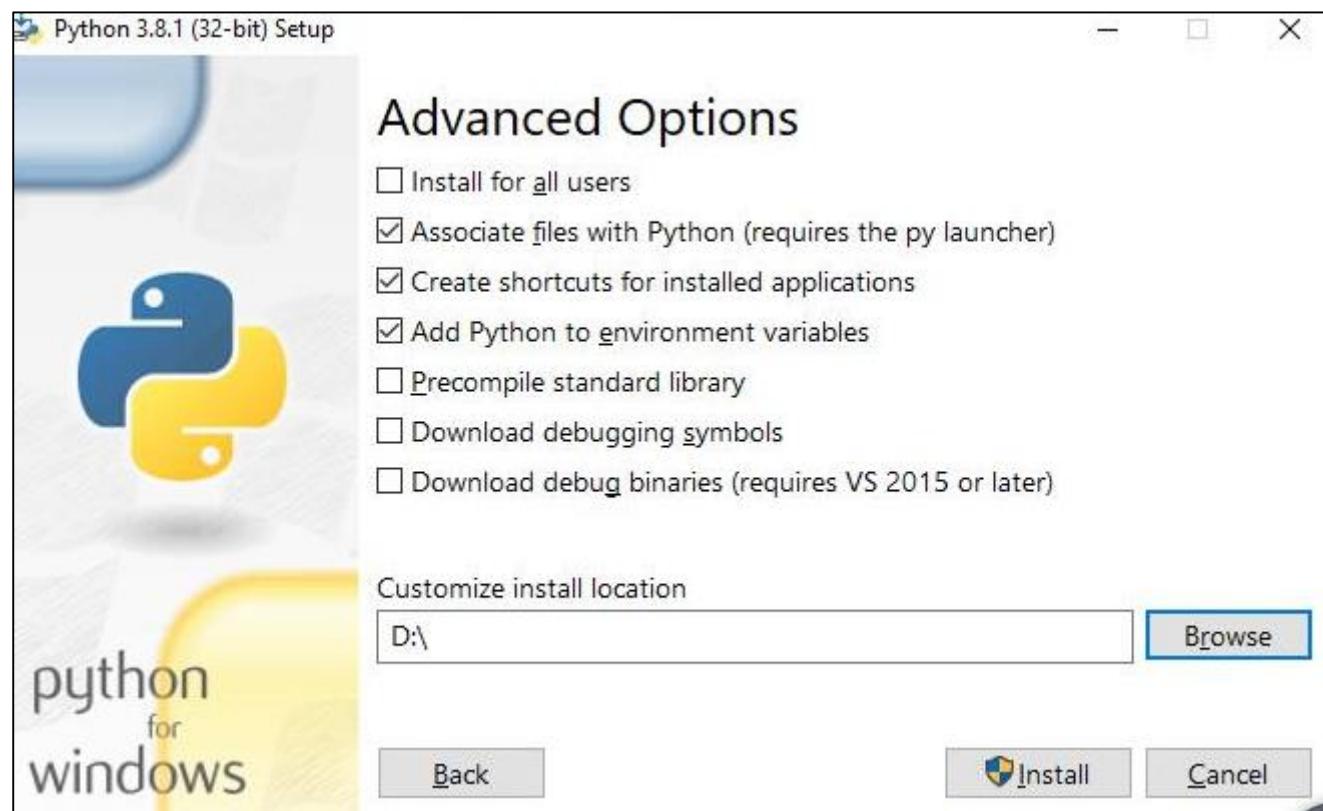
Please note that “Add Python 3.8 to PATH” MUST be checked.



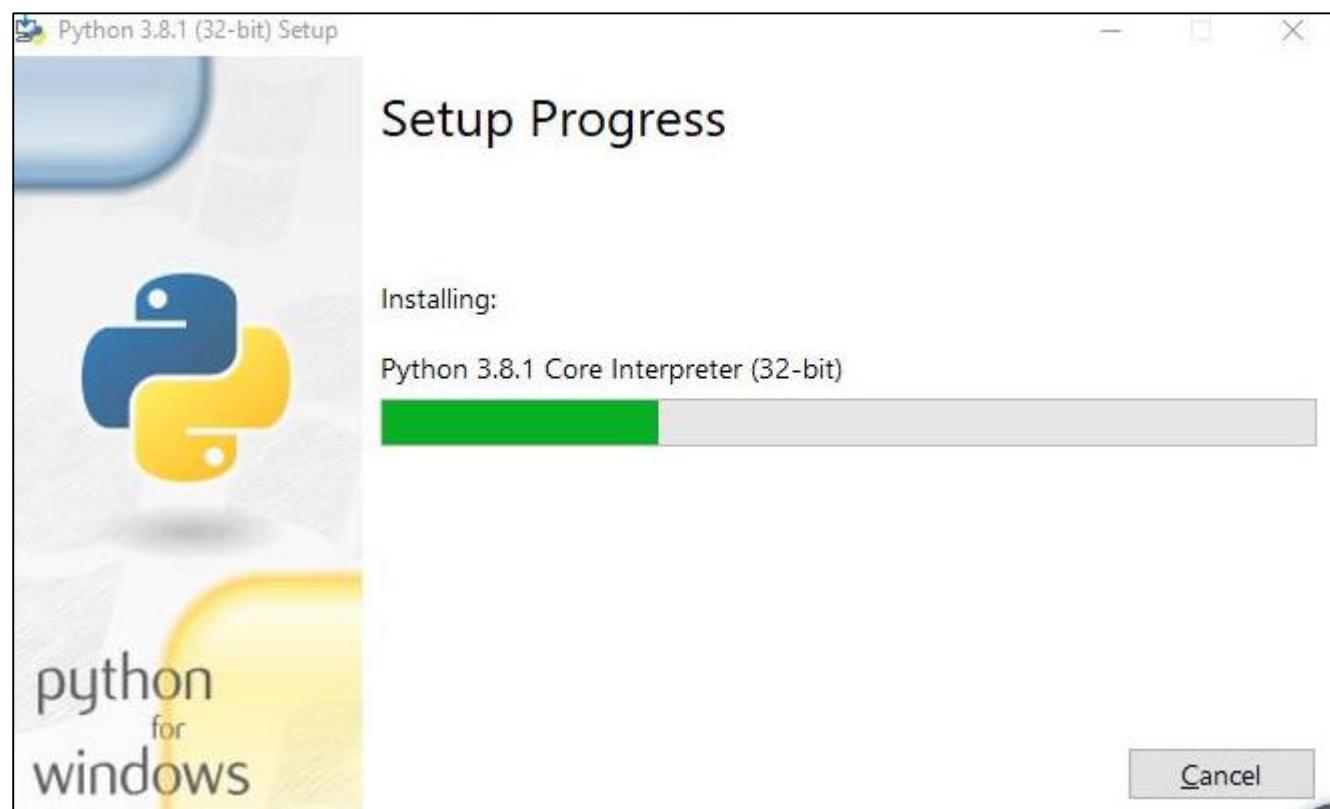
Check all the options and then click “Next”.



Here you can select the installation path of Python. We install it at D drive. If you are a novice, you can select the default path.



Wait for it to finish installing.





Now the installation is finished.



Install PyQt5、opencv、numpy and other libraries.

Open the folder Freenove_Development_Kit_for_ESP32_S3\Software\ESP32S3_lvgl_software_setup.

GitHub Freenove_Development_Kit_for_ESP32_S3 > Software > ESP32S3_lvgl_software_setup			
名称	修改日期	类型	大小
setup_linux.png	2022/6/16 10:48	PNG 文件	162 KB
setup_linux.py	2022/6/16 10:42	PY 文件	1 KB
setup_mac.png	2022/6/16 15:20	PNG 文件	79 KB
setup_mac.py	2022/6/16 15:22	PY 文件	1 KB
setup_window.png	2022/6/16 16:03	PNG 文件	79 KB
setup_window.py	2022/6/16 16:00	PY 文件	1 KB

The address depends on where you saved Freenove_Development_Kit_for_ESP32_S3.

Type "CMD" in the file bar and press Enter.

cmd			
名称	修改日期	类型	大小
setup_linux.png	2022/6/16 10:48	PNG 文件	162 KB
setup_linux.py	2022/6/16 10:42	PY 文件	1 KB
setup_mac.png	2022/6/16 15:20	PNG 文件	79 KB
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setup_window.png	2022/6/16 16:03	PNG 文件	79 KB
setup_window.py	2022/6/16 16:00	PY 文件	1 KB

In the Command Prompt window, type python setup_window.py and press the Enter key.

```
D:\Documents\GitHub\Freenove_Development_Kit_for_ESP32_S3\Software\ESP32S3_lvgl_software_setup>python
Python 3.8.1 (tags/v3.8.1:1b293b6, Dec 18 2019, 22:39:24) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> ^Z

D:\Documents\GitHub\Freenove_Development_Kit_for_ESP32_S3\Software\ESP32S3_lvgl_software_setup>python setup_window.py
```

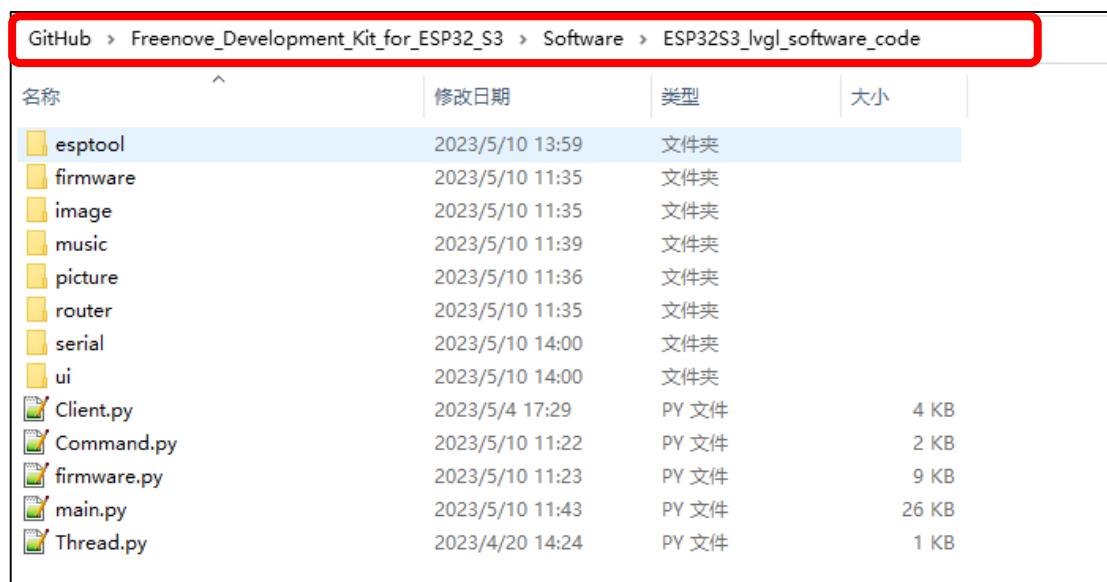
Wait for the installation to finish.

```
D:\Documents\GitHub\Freenove_Development_Kit_for_ESP32_S3\Software\ESP32S3_lvgl_software_setup>pip list
Package           Version
-----
altgraph          0.17.3
click             7.1.2
future            0.18.2
numpy             1.24.1
opencv-contrib-python 4.7.0.72
opencv-python     4.6.0.66
pefile            2022.5.30
Pillow            9.3.0
pip               23.1
pyinstaller       5.7.0
pyinstaller-hooks-contrib 2022.14
PyQt5             5.15.4
pyqt5-plugins    5.15.4.2.2
PyQt5-Qt5        5.15.2
PyQt5-sip         12.11.0
pyqt5-tools      5.15.4.3.2
pyserial          3.5
python-dotenv    0.21.0
pywin32-ctypes   0.2.0
qt5-applications 5.15.2.2.2
qt5-tools         5.15.2.1.2
setuptools        65.6.3
```

If not all libraries are installed successfully, it will prompt "Some libraries have not been installed. Please run Python3 setup_windows.py again", and then you need to enter and execute the command again. Most installation failures are caused by poor networks. You can check your network before installation.

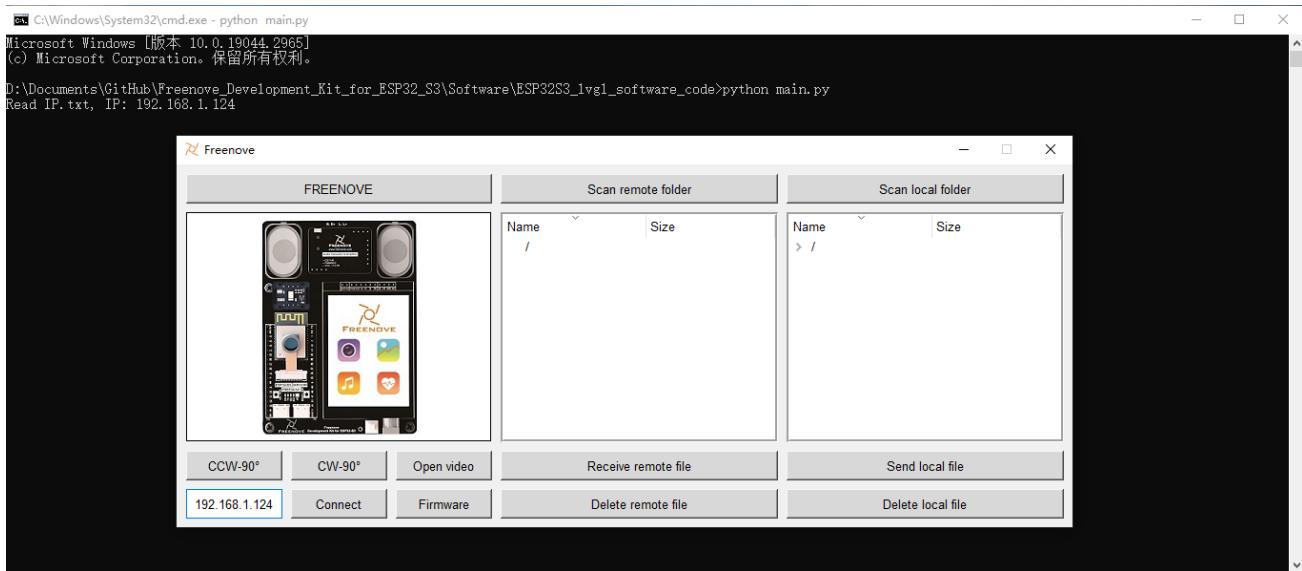
Run main.py

In the same way, open the Freenove_Development_Kit_for_ESP32_S3\Software\ESP32S3_lvgl_software_code folder, and enter CMD in the file bar and press the Enter key.



名称	修改日期	类型	大小
esptool	2023/5/10 13:59	文件夹	
firmware	2023/5/10 11:35	文件夹	
image	2023/5/10 11:35	文件夹	
music	2023/5/10 11:39	文件夹	
picture	2023/5/10 11:36	文件夹	
router	2023/5/10 11:35	文件夹	
serial	2023/5/10 14:00	文件夹	
ui	2023/5/10 14:00	文件夹	
Client.py	2023/5/4 17:29	PY 文件	4 KB
Command.py	2023/5/10 11:22	PY 文件	2 KB
firmware.py	2023/5/10 11:23	PY 文件	9 KB
main.py	2023/5/10 11:43	PY 文件	26 KB
Thread.py	2023/4/20 14:24	PY 文件	1 KB

Input “Python main.py” and press enter. If it fails, you can input “Python3 main.py” to try again.



If you want to modify the code, you can modify the files in ESP32S3_lvgl_software_code folder.

Run client on macOS system

Here we take MacOS 10.13 as an example. To run client on MacOS, you need to install some software and libraries. MacOS 10.13 comes with python2 but not python3. However, the projects in this program need to be run with python3, so you need to install it first.

Install python3

Download installation package, link: <https://www.python.org/downloads/>

Click Python 3.8.2.

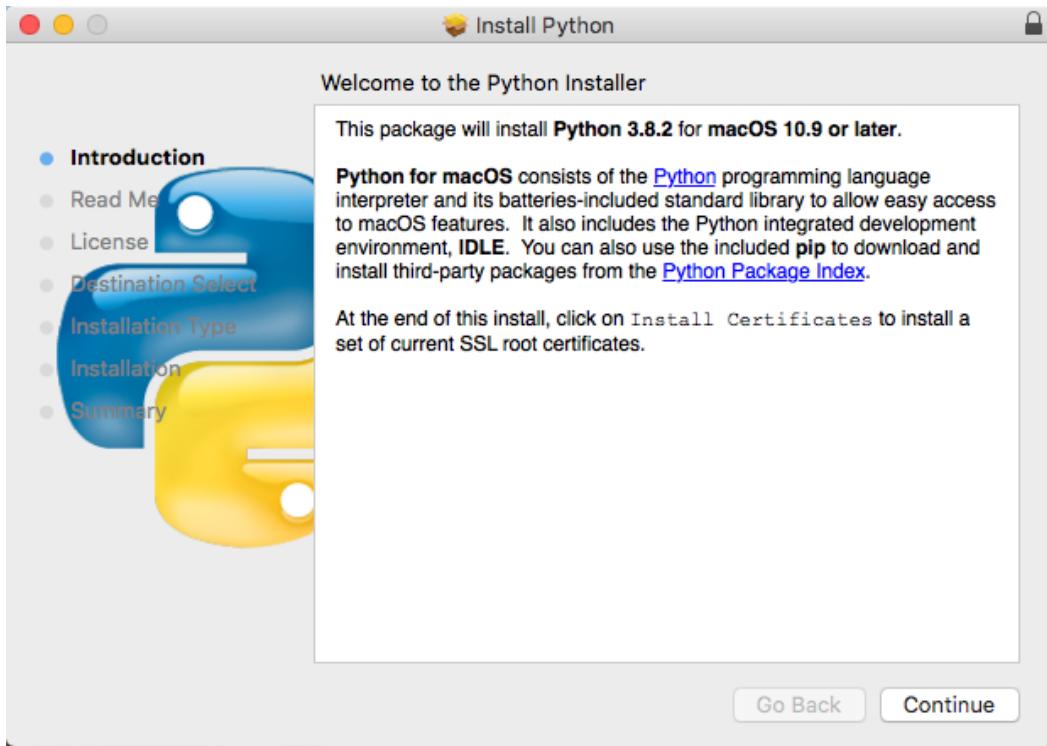
Release version	Release date	
Python 3.8.2	Feb. 24, 2020	Download
Python 3.8.1	Dec. 18, 2019	Download
Python 3.7.6	Dec. 18, 2019	Download
Python 3.6.10	Dec. 18, 2019	Download
Python 3.5.9	Nov. 2, 2019	Download
Python 3.5.8	Oct. 29, 2019	Download

At the bottom of the page, click macOS 64-bit installer and download installation package.

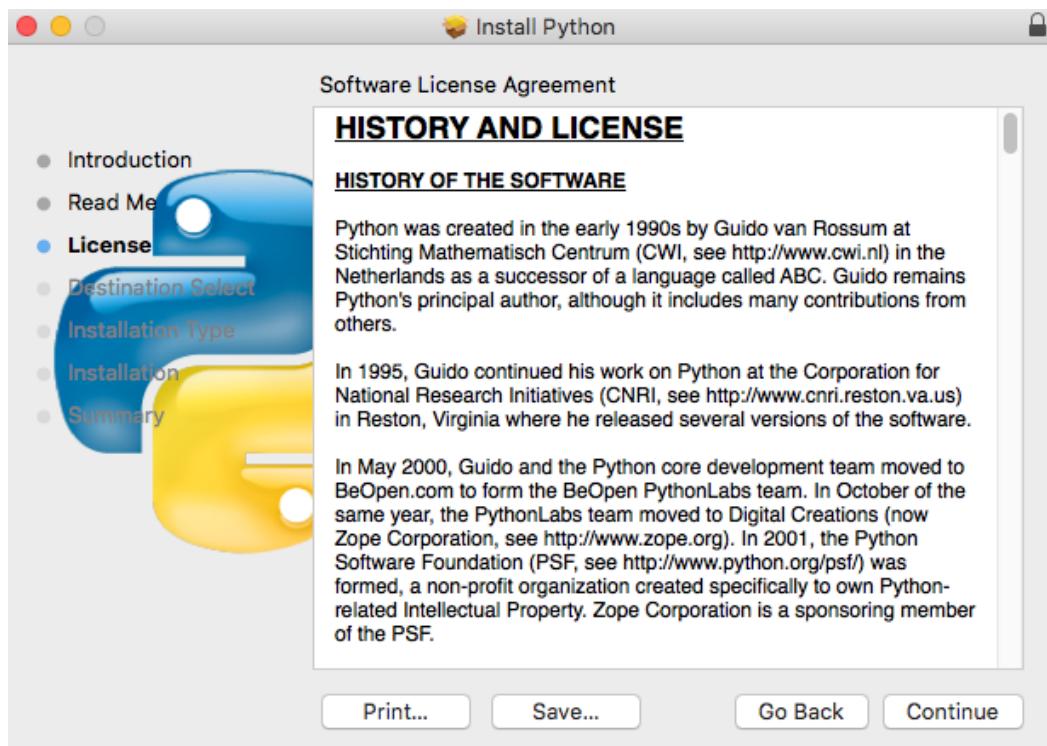
Version	Operating System	Description
Gzipped source tarball	Source release	
XZ compressed source tarball	Source release	
macOS 64-bit installer	Mac OS X	for OS X 10.9 and later
Windows help file	Windows	
Windows x86-64 embeddable zip file	Windows	for AMD64/EM64T/x64
Windows x86-64 executable installer	Windows	for AMD64/EM64T/x64
Windows x86-64 web-based installer	Windows	for AMD64/EM64T/x64
Windows x86 embeddable zip file	Windows	
Windows x86 executable installer	Windows	
Windows x86 web-based installer	Windows	



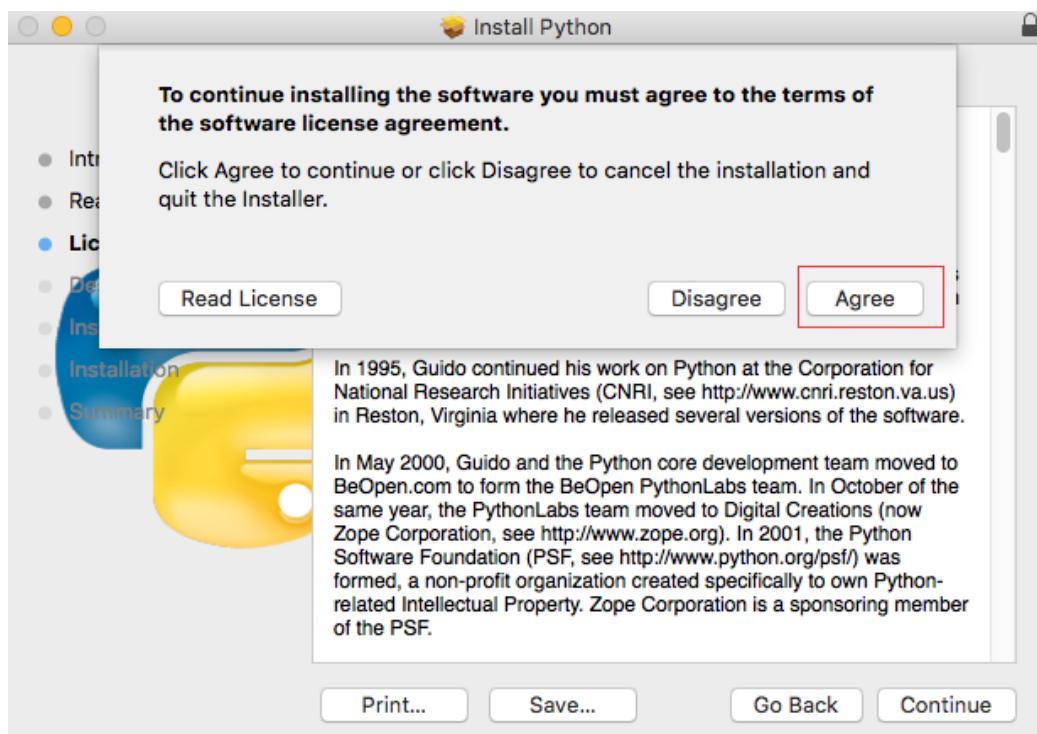
Click Continue.



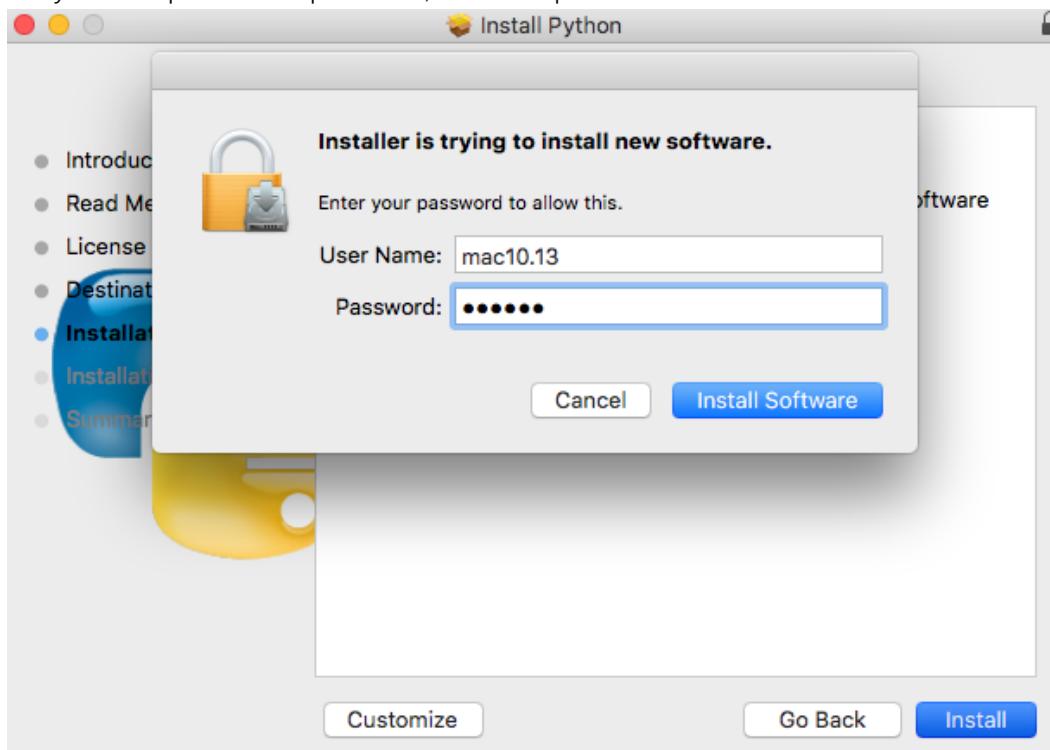
Click Continue



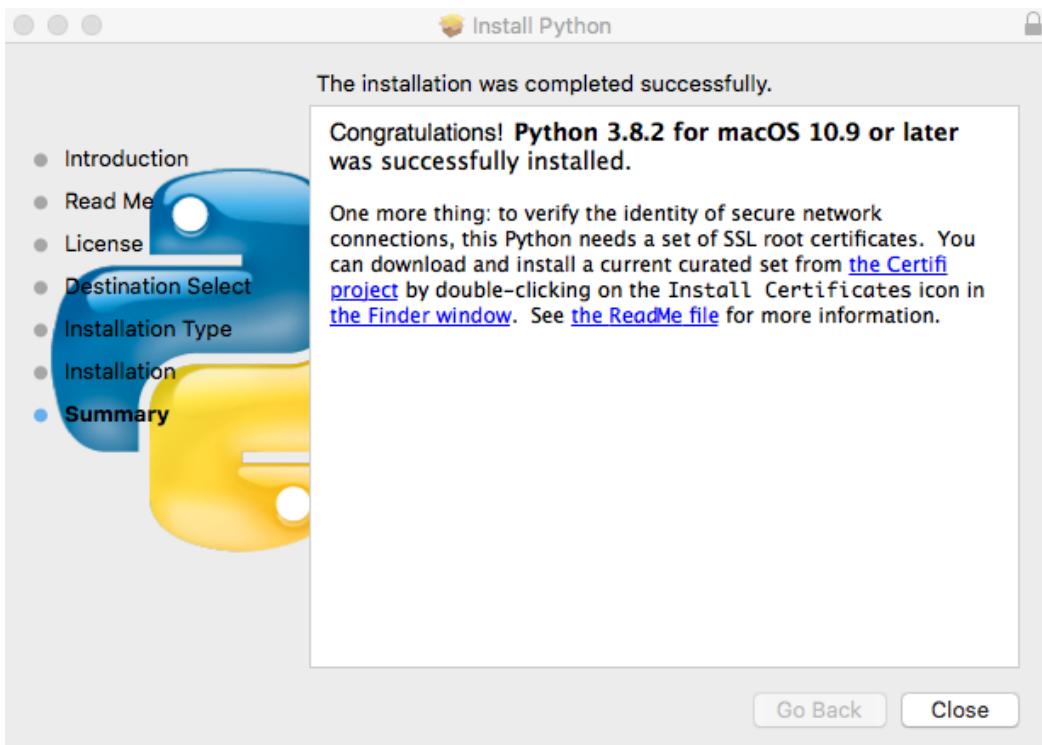
Click Agree.



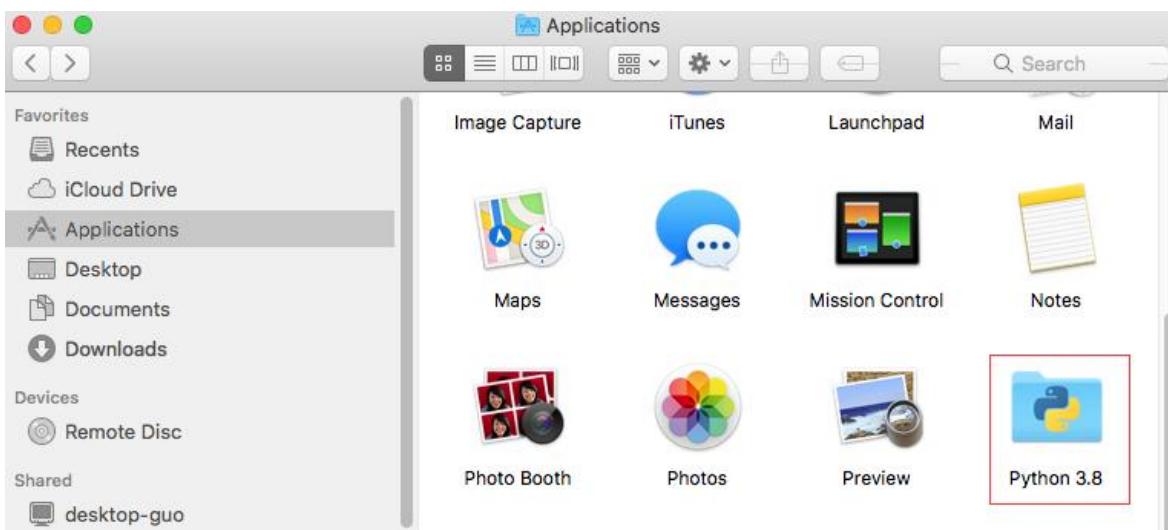
Click Install. If your computer has a password, enter the password and Install Software.



Now the installation succeeds.



You can find it in Applications.



Install PyQt5, opencv, numpy and other libraries

If you have not yet download the code of ESP32 car to your macOS, you can download it from the following link: https://github.com/Freenove/Freenove_Development_Kit_for_ESP32_S3.git

After downloading, you can find it in **Downloads** of Macintosh HD.

Open **Terminal**.



Enter the following commands in Terminal

1. Enter “**Downloads**”(where the code locates). If your code locates in a different path, you need to enter the location of your code.

```
cd Downloads
```

2. Enter the directory where setup_mac.py locates

```
cd Freenove_Development_Kit_for_ESP32_S3/Software/ESP32S3_lvgl_software_setup
```

3. Run setup_macos.py:

```
python3 setup_mac.py
```

The installation takes some time. Please wait with patience. When installs successfully, it will print "All libraries installed successfully":

Package	Version
altgraph	0.17
certifi	2020.12.5
macholib	1.14
modulegraph	0.18
numpy	1.19.0
opencv-contrib-python-headless	4.3.0.36
opencv-python-headless	4.3.0.36
Pillow	7.2.0
pip	20.3.3
py2app	0.22
pyinstaller	4.0
pyinstaller-hooks-contrib	2020.8
PyQt5	5.12
PyQt5-sip	4.19.19
pyserial	3.5
setuptools	47.1.0
wheel	0.34.2

All libraries installed successfully

Note: If not all libraries are installed successfully, it will prompt “Some libraries have not been installed”.

Please input and run Python3 setup_macos.py again. Most installation failures are caused by poor networks. You can Check your network before installation

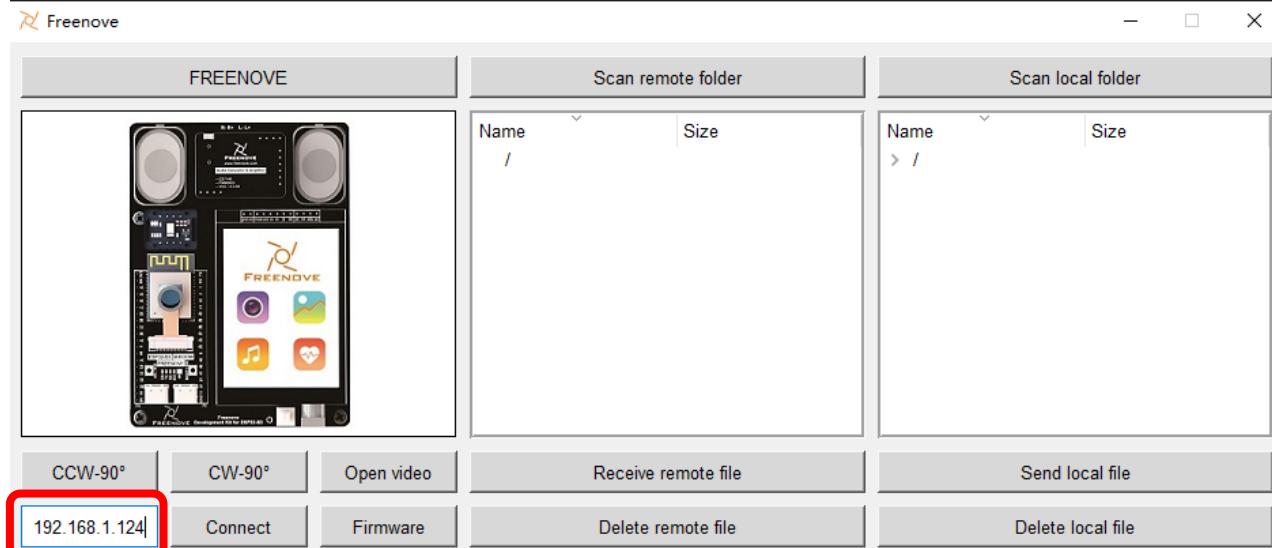
Run main.py

Following the previous steps, after the installation completes, you are now in the directory where setup_mac.py is located. (Freenove_Development_Kit_for_ESP32_S3/Software/ESP32S3_lvgl_software_code) Enter the following command to run main.py.

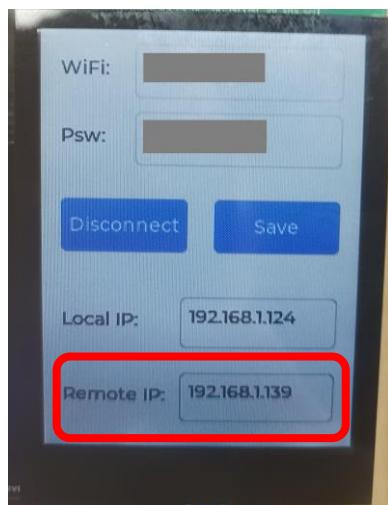
```
python3 main.py
```

Software Operation

1. Make sure the esp32s3 and your computer are at the same LAN, that is, they are connected to the same router.
2. Open the software, type in the IP address gained at the hardware preparation. For example, the IP address we got is 192.168.1.124.

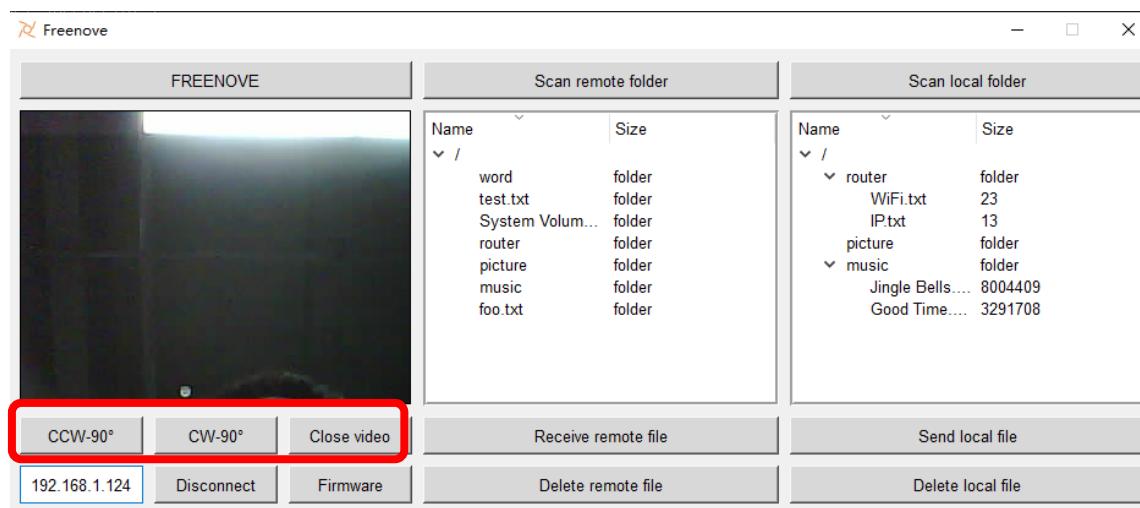


3. Click on “Connect”. If it connects to the hardware successfully, the computer’s IP address will also show in the hardware screen.

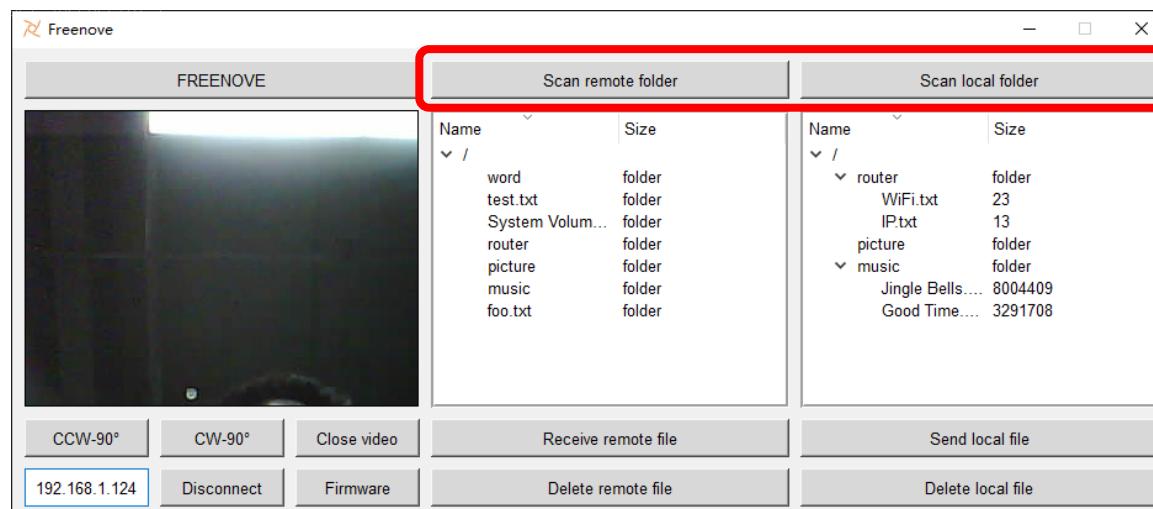


At this point, the computer has established a WiFi connection with the hardware.

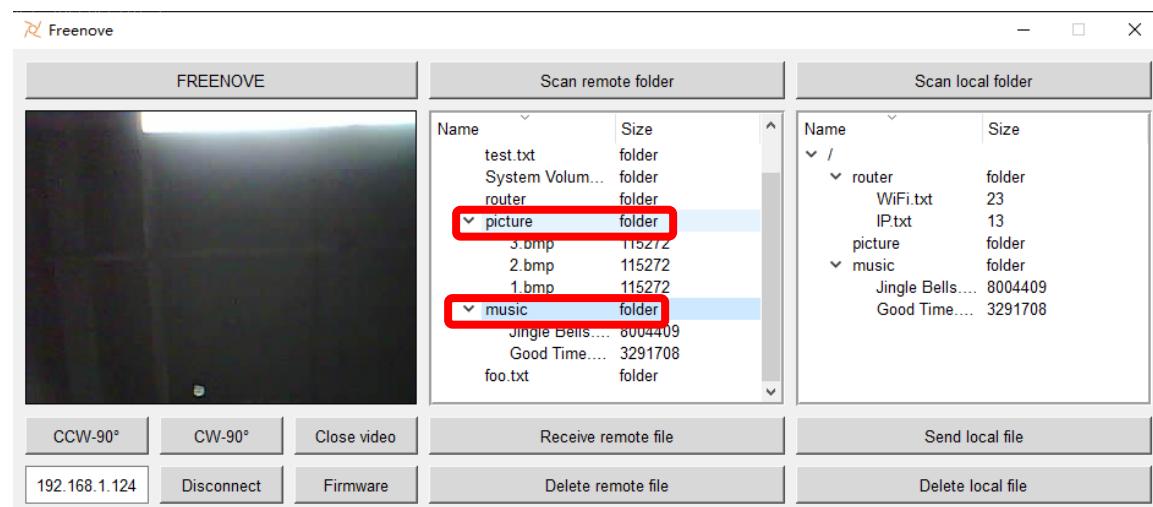
4. Click “Open Video” to view the video from the hardware camera in real time. You can also rotate the real-time transmission screen of the camera by pressing the button.



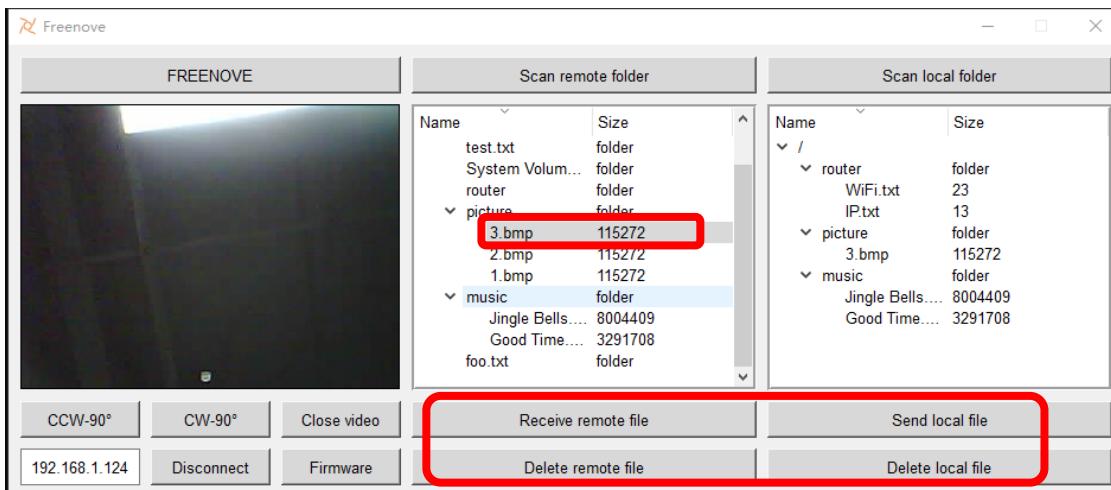
5. Click the Scan button to scan the local directory and the directory files of the SD card in the hardware, and display them in the tree list.



6. Click the file tree list under Scan Remote, and the files in this folder will be refreshed.

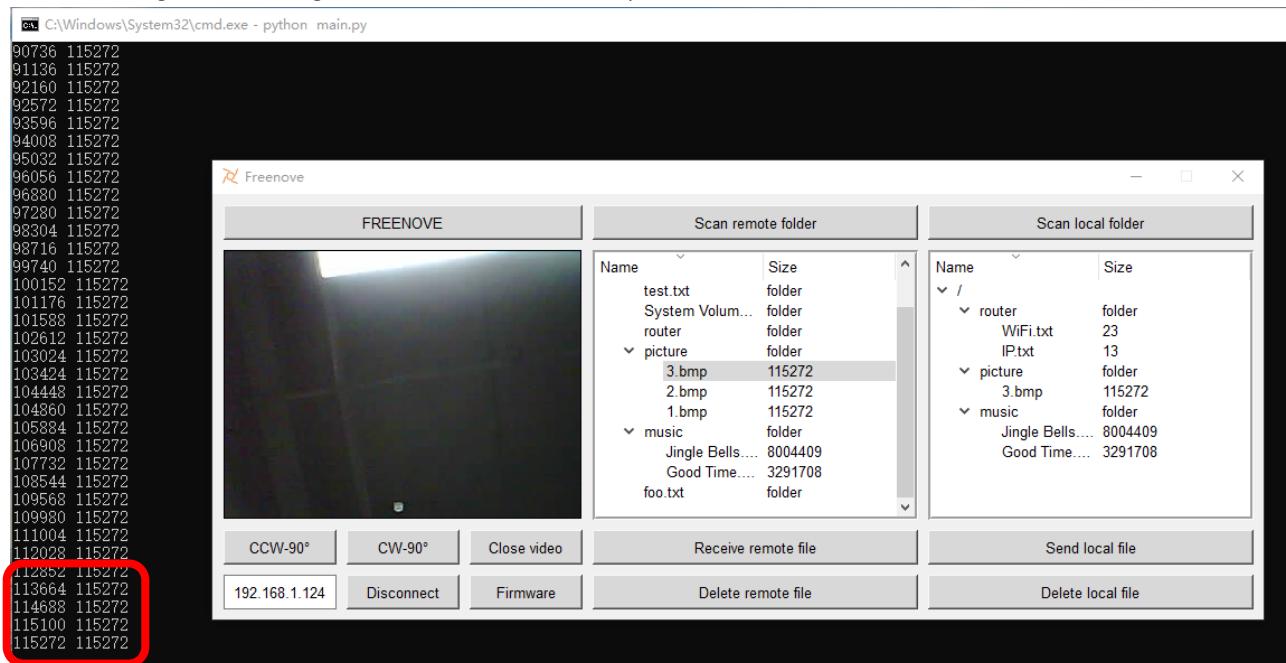


7. First, select the files in the directory, by clicking the “receive” or “send” button, you can transfer the files from the hardware to the computer through WiFi, or send the files from the computer to the hardware. Similarly, clicking the delete button will directly delete the corresponding file.



Note: Only files can be selected, not folders.

8. The receiving and sending information of the file is printed in the black interface.



Note: Sometimes due to the poor WiFi signal transmission, the file may receive missing bytes. Please delete the file and receive it again until the number of received bytes is normal.

What's next?

Thanks for reading! This tutorial has come to an end. If you notice any mistakes, omissions, or have any other questions or ideas related to the contents of this tutorial or the kit, please do not hesitate to contact us.

support@freenove.com

We will check and correct it as soon as possible.

If you want learn more about ESP32-S3, you view our ultimate tutorial:

https://github.com/Freenove/Freenove_Ultimate_Starter_Kit_for_ESP32_S3/archive/master.zip

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.

Any concerns? ✉ support@freenove.com