I2C communication

This tutorial demonstrates: displaying content on a 0.91-inch OLED display driven by **hardware I2C**

1、software-hardware

- **STM32F103CubeIDE**
- **STM32 robot expansion board**

  I2C: chip internal peripheral

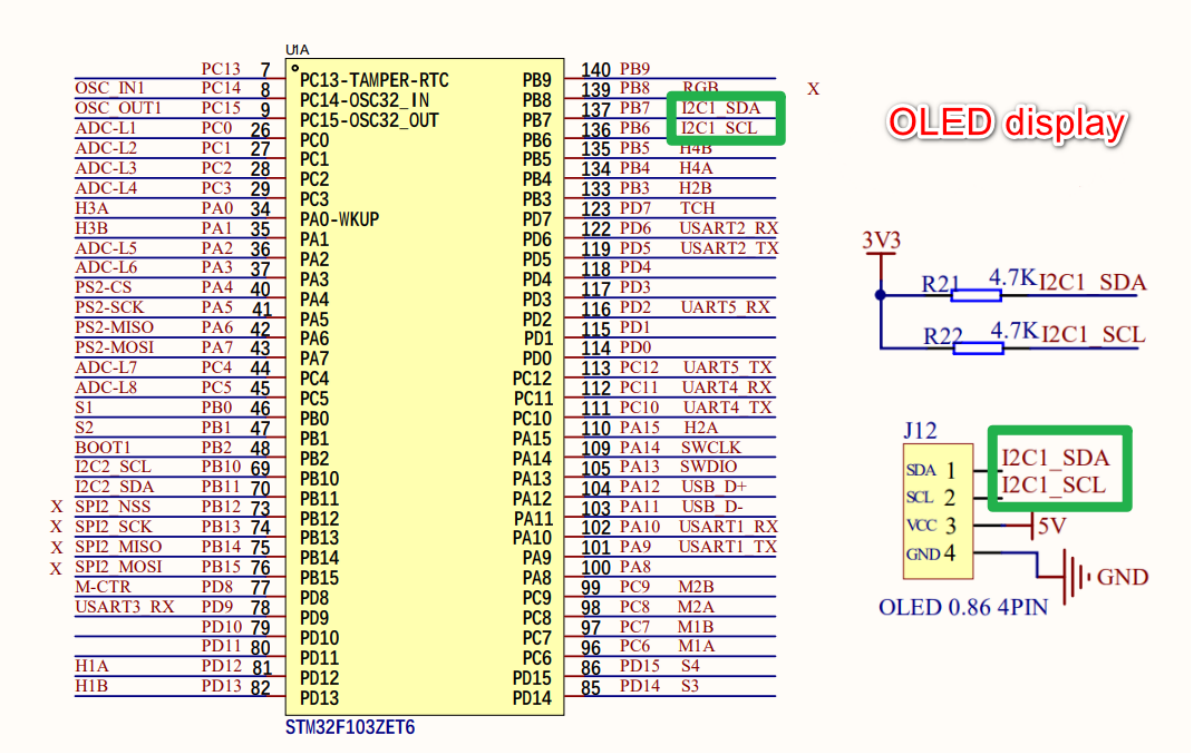
  OLED: External
- **Type-C cable or ST-Link**

  Download or simulate the program of the development board

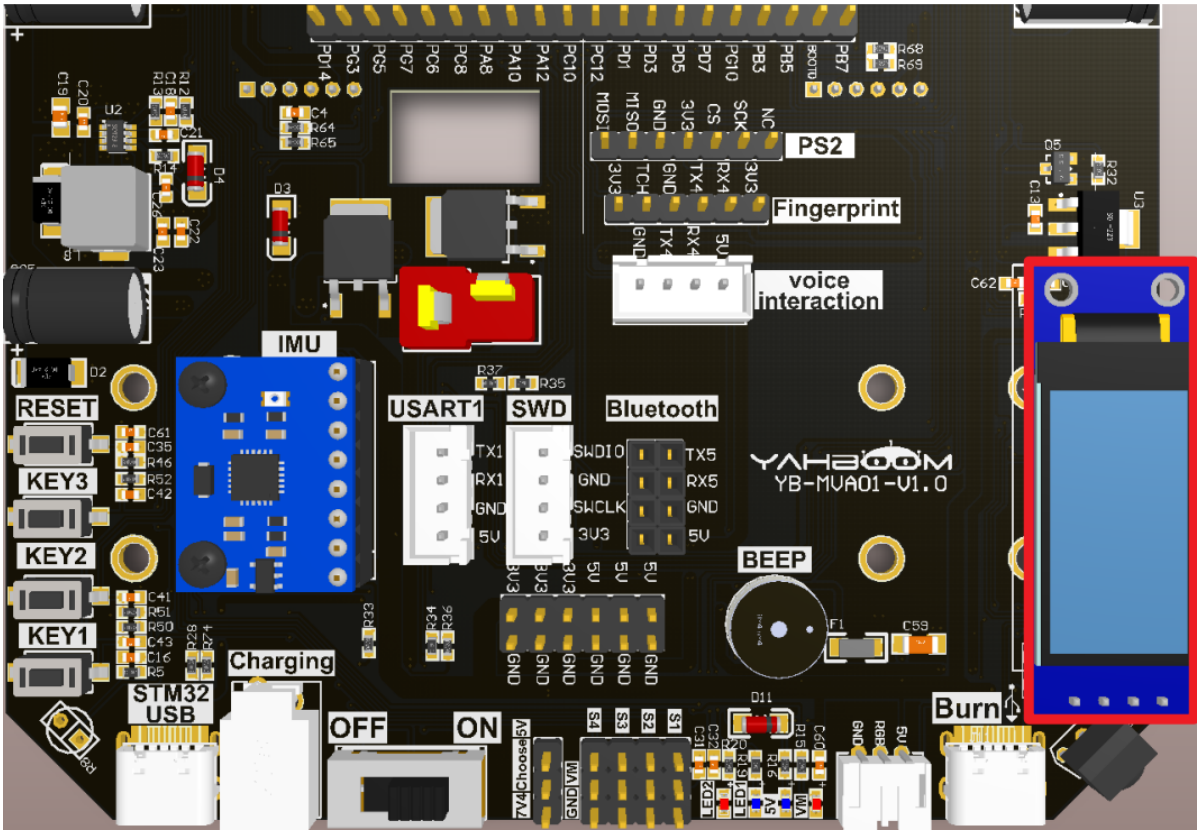
2、Brief principle

2.1、Hardware schematic diagram

The schematic shows only the I2C (I2C1) interface used in the tutorial



2.2、Physical connection diagram



OLED	STM32 expansion board
VCC	VCC
SCL	SCL
SDA	SDA
GND	GND

2.3、Principle of control

- **I2C**

I2C (Inter-Integrated Circuit) bus is a serial communication protocol, which is composed of serial data line (SDA) and serial clock line (SCL).

Serial data line（SDA）：Use to transfer data

```
All devices use the same data line and communicate by transmitting data in binary form.
```

Serial clock line（SCL）：Use for synchronous data transfer

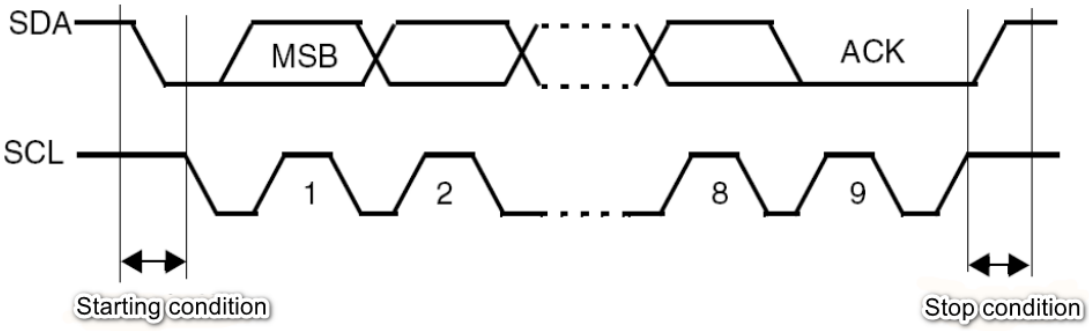
```
The clock line generates pulses at a specific frequency to ensure that both the sending and receiving devices can transmit data in the same timing sequence.
```

Multi-device communication：The e I2C interface uses an addresse-based device identification mechanism to select the specific device to communicate with.

```
Each I2C device has a unique address that identifies the device; The master selects the specific device to communicate with by sending the device address
```

- **I2C communication**

  IIC bus timing diagram



Idle state

SCL high level, SDA high level;

Starting condition

SCL high level, SDA falling edge;

Stop condition

SCL high level, SDA rising edge;

Data transfer

SCL low, SDA rising edge or falling edge;

Signal of reply

When the slave receives the data, it sends a low level to the master to indicate successful reception.

Data validity

When the clock line is high, the data line must be stable; When the clock line is low, the data line is allowed to change.

```
SCL：The high level → is used for the beginning and end of the communication
SCL：The low level → is used to send and terminate data
```

3、Engineering configuration

Project Configuration: Prompt for configuration options during STM32CubeIDE project configuration

3.1、Notes

Omitted project configuration: **New project, chip selection, project configuration, SYS for pin configuration, RCC configuration, clock configuration, and project configuration** content

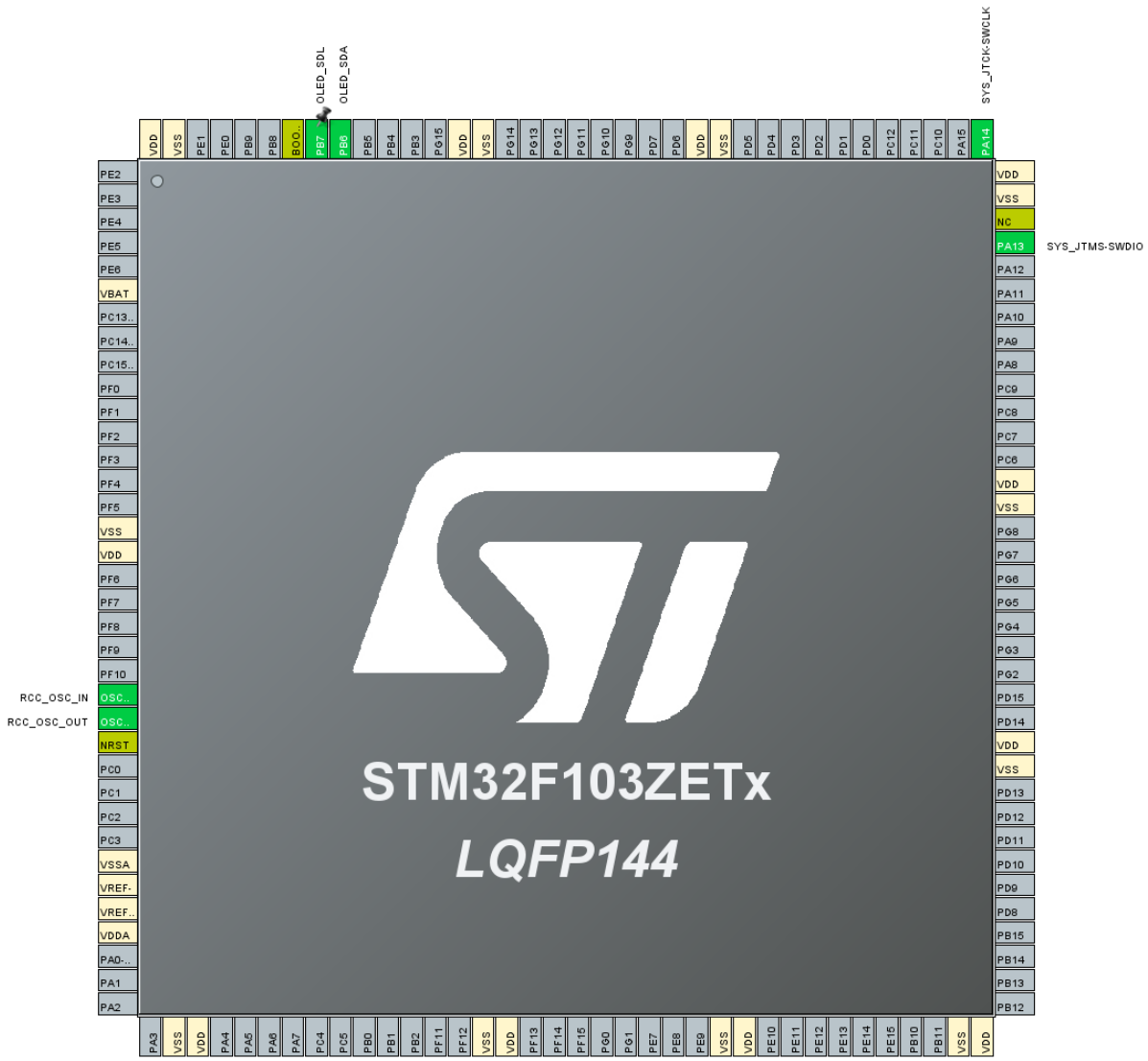
The project configuration part, which is not omitted, is the key point to configure in this tutorial.

```
Please refer to [2. Development environment construction and use: STM32CubeIDE
installation and use] to understand how to configure the omitted parts of the
project.
```

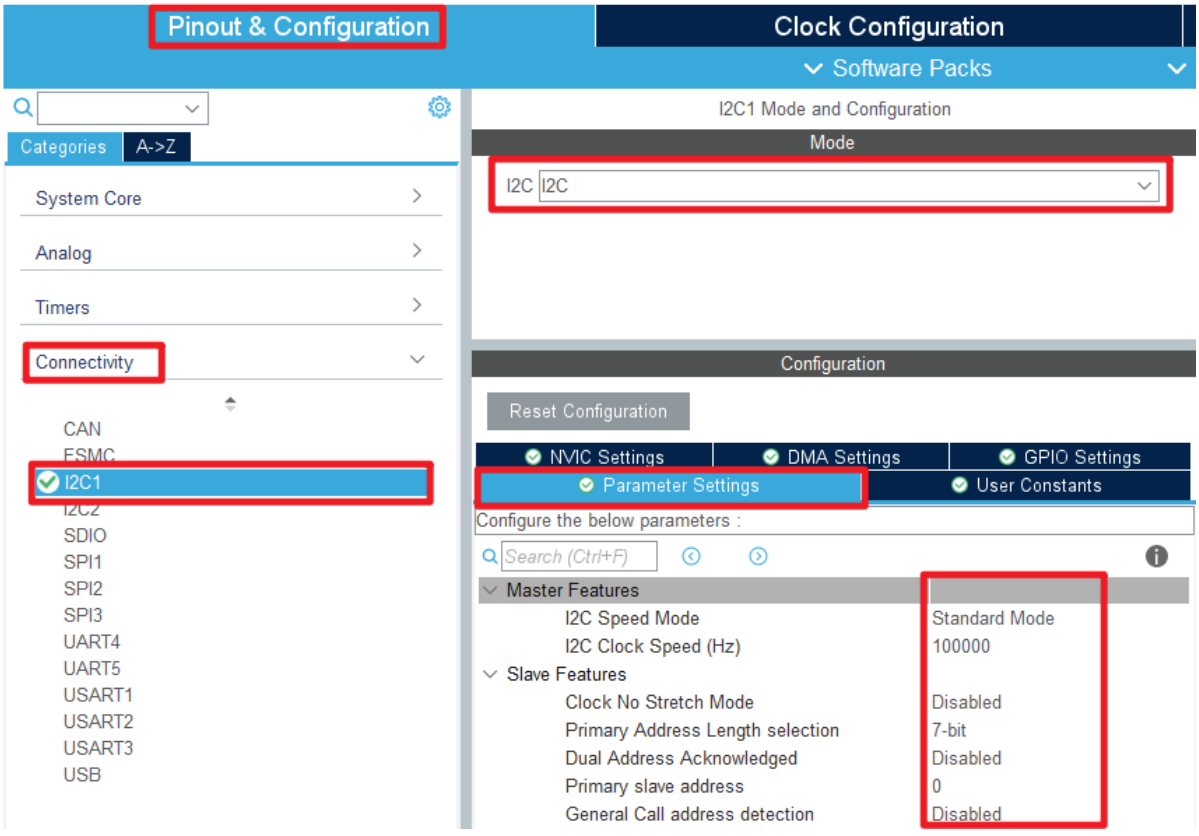
3.2、Pin configuration

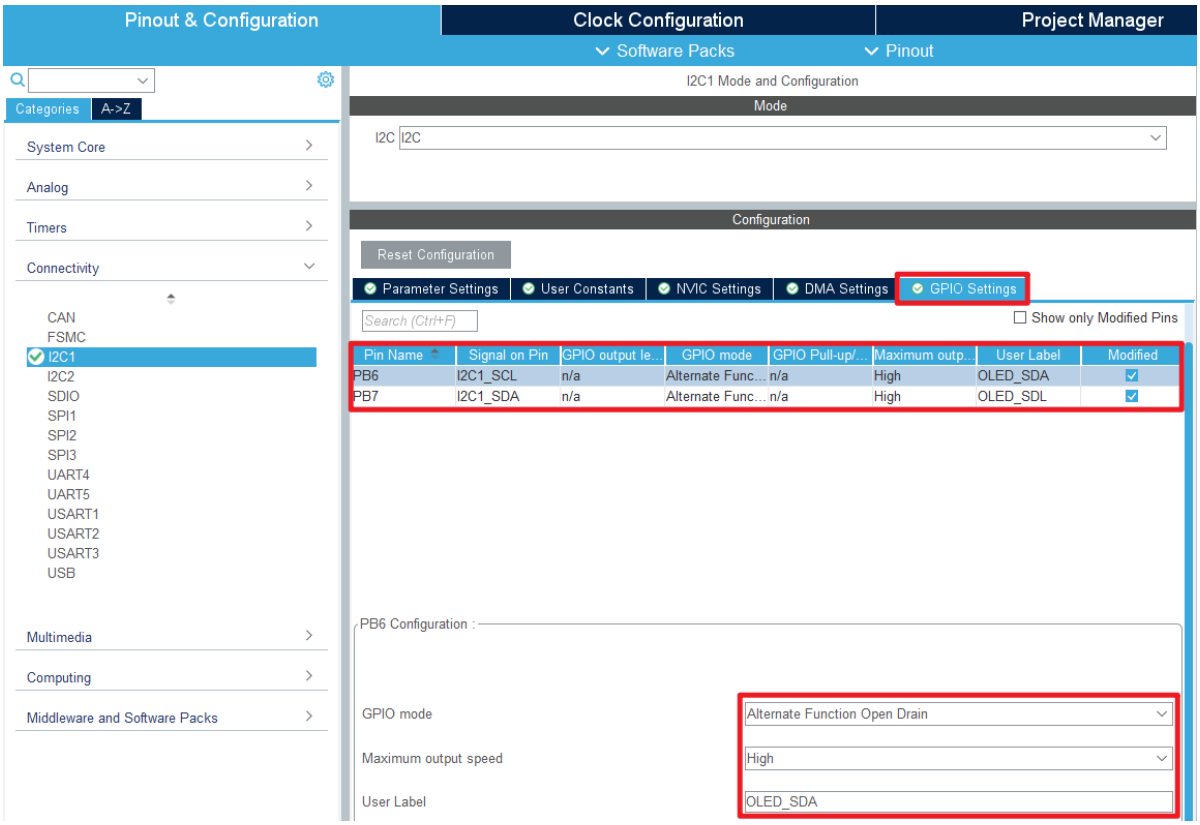
- **Configure the specified pin function**

You can directly select the corresponding pin number in the pin view, and the corresponding option will appear when the mouse is left clicked

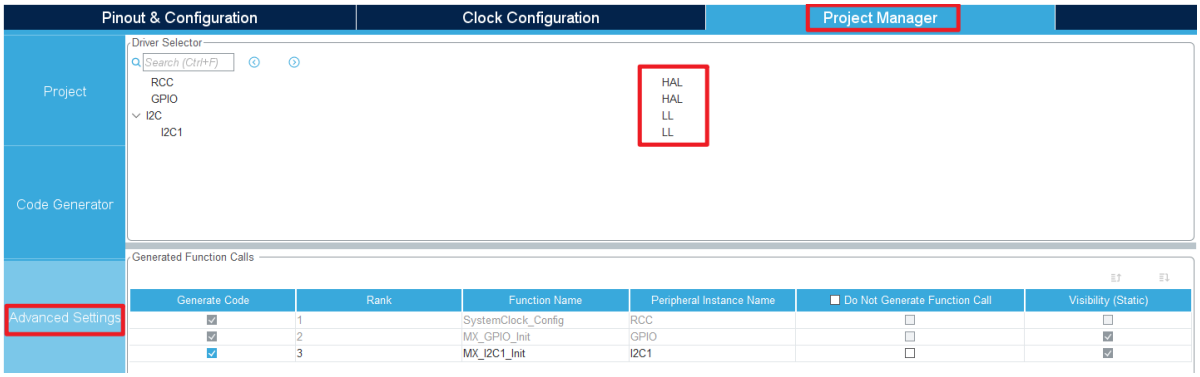

OLED_SDL
OLED_SDA
SYS_JTCK-SWCLK
SYS_JTMS-SWDIO
RCC_OSC_IN
RCC_OSC_OUT
STM32F103ZETx
LQFP144

- **I2C**

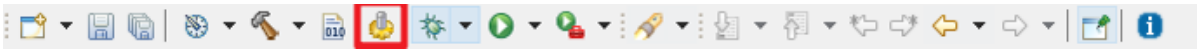

Pinout & Configuration
Clock Configuration
Software Packs
Categories
A->Z
System Core
Analog
Timers
Connectivity
CAN
FSMC
I2C1
I2C2
SDIO
SPI1
SPI2
SPI3
UART4
UART5
USART1
USART2
USART3
USB
I2C1 Mode and Configuration
Mode
I2C
Configuration
Reset Configuration
NVIC Settings
DMA Settings
GPIO Settings
Parameter Settings
User Constants
Configure the below parameters :
Search (Ctrl+F)
Master Features
I2C Speed Mode
Standard Mode
I2C Clock Speed (Hz)
100000
Slave Features
Clock No Stretch Mode
Disabled
Primary Address Length selection
7-bit
Dual Address Acknowledged
Disabled
Primary slave address
0
General Call address detection
Disabled



- **Advanced Settings**



- **Generating code**



4、Main function

This paper mainly introduces the functional code written by users. **Detailed code can be opened by yourself in the project file we provide, and enter the Bsp folder to view the source code.**

4.1、User function

> **function：I2C_Send7bitAddress**

Function prototypes	**void I2C_Send7bitAddress(I2C_TypeDef *I2Cx, uint8_t Address, uint8_t I2C_Direction)**
Functional Description	Send slave device address
Input parameters1	**I2Cx**：I2C handle address

Function prototypes	void I2C_Send7bitAddress(I2C_TypeDef *I2Cx, uint8_t Address, uint8_t I2C_Direction)
Input parameters2	**Address**：Slave device address
Input parameters3	**I2C_Direction**：Read or write
None	None

> **function：OLED_Init**

Function prototypes	void OLED_Init(void)
Functional Description	OLED initialization
Input parameters	None
Return value	None

> **function：OLED_Draw_Line**

Function prototypes	void OLED_Draw_Line(char *data, uint8_t line, bool clear, bool refresh)
Functional Description	Write a single character
Input parameters1	**data**：Displaying data
Input parameters2	**line**：Number of rows
Input parameters3	**clear**：Clear or not
Input parameters4	**refresh**：refresh or not
Return value	None

> **function：SSD1306_UpdateScreen**

Function prototypes	void SSD1306_UpdateScreen(void)
Functional Description	oled screen update display
Input parameters	None
Return value	None

> **function：SSD1306_UpdateScreen**

Function prototypes	void SSD1306_Fill(SSD1306_COLOR_t color)
Functional Description	The oled screen cleared, but did not refresh the display
Input parameters	**color**：The color to display

Function prototypes	void SSD1306_Fill(SSD1306_COLOR_t color)
Return value	None

> **function：SSD1306_UpdateScreen**

Function prototypes	void SSD1306_GotoXY(uint16_t x, uint16_t y)
Functional Description	Sets the current cursor
Input parameters1	**x**：Horizontal coordinate
Input parameters2	**y**：Vertical coordinate
Return value	None

> **function：SSD1306_DrawPixel**

Function prototypes	void SSD1306_DrawPixel(uint16_t x, uint16_t y, SSD1306_COLOR_t color)
Functional Description	Drawing a pixel
Input parameters1	**x**：Horizontal coordinate
Input parameters2	**y**：Vertical coordinate
Input parameters3	**color**：The color to display
Return value	None

4.2、LL library function analysis

LL library functions that have been covered in the previous tutorial will not be covered in the tutorial

```
If you want to find the HAL library and LL library function analysis involved in the entire tutorial, you can view the documents in the folder [8. STM32 Manual: STM32F1_HAL Library and LL Library_User Manual]
```

> **function：LL_I2C_Init**

Function prototypes	uint32_t LL_I2C_Init(I2C_TypeDef *I2Cx, LL_I2C_InitTypeDef *I2C_InitStruct)
Functional Description	Initialize the I2C peripheral parameters
Input parameters1	**I2Cx**：I2C handle address
Input parameters2	**I2C_InitStruct**：I2C initialization structure that contains configuration information for specified I2C peripherals

Function prototypes	uint32_t LL_I2C_Init(I2C_TypeDef *I2Cx, LL_I2C_InitTypeDef *I2C_InitStruct)
Return value	None

> function：LL_I2C_Enable

Function prototypes	void LL_I2C_Enable(I2C_TypeDef *I2Cx)
Functional Description	Enable the I2C peripheral
Input parameters	**I2Cx**：I2C handle address
Return value	None

> function：LL_I2C_GenerateStartCondition

Function prototypes	void LL_I2C_GenerateStartCondition(I2C_TypeDef *I2Cx)
Functional Description	I2C communication start condition
Input parameters	**I2Cx**：I2C handle address
Return value	None

> function：LL_I2C_TransmitData8

Function prototypes	void LL_I2C_TransmitData8(I2C_TypeDef *I2Cx, uint8_t Data)
Functional Description	Sends 8 bits of data to the specified I2C peripheral
Input parameters1	**I2Cx**：I2C handle address
Input parameters2	**Data**：data
Return value	None

> function：LL_I2C_GenerateStopCondition

Function prototypes	void LL_I2C_GenerateStopCondition(I2C_TypeDef *I2Cx)
Functional Description	I2C communication end condition
Input parameters	**I2Cx**：I2C handle address
Return value	None

5、Experimental phenomenon

After downloading the program successfully, press the RESET button of the development board to observe the OLED display

```
For program download, please refer to [2. Development environment construction
and use: program download and simulation]
```

phenomenon:

OLED: The first line shows oled init success! , the second row shows oled + I2c class! The third row displays oled show success!