Button control

This tutorial demonstrates: triggering an external interrupt through **GPIO input**, and controlling the LED and buzzer according to the key that triggers the interrupt.

1. Software-Hardware

- **STM32F103CubeIDE**
- **STM32 Robot Development Board**

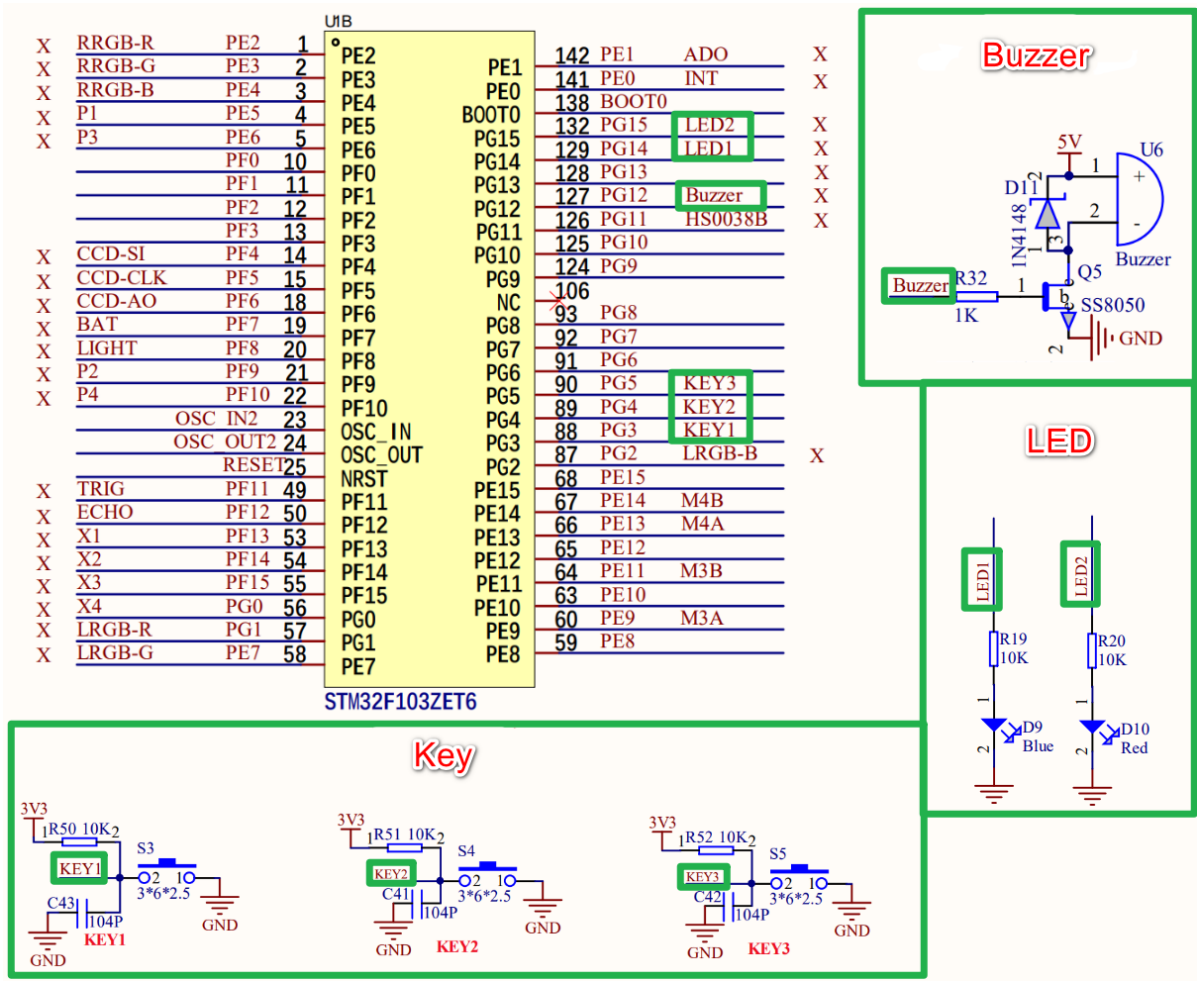
  GPIO: chip internal peripherals

  Buttons, LEDs and active buzzer: onboard
- **Type-C data cable or ST-Link**

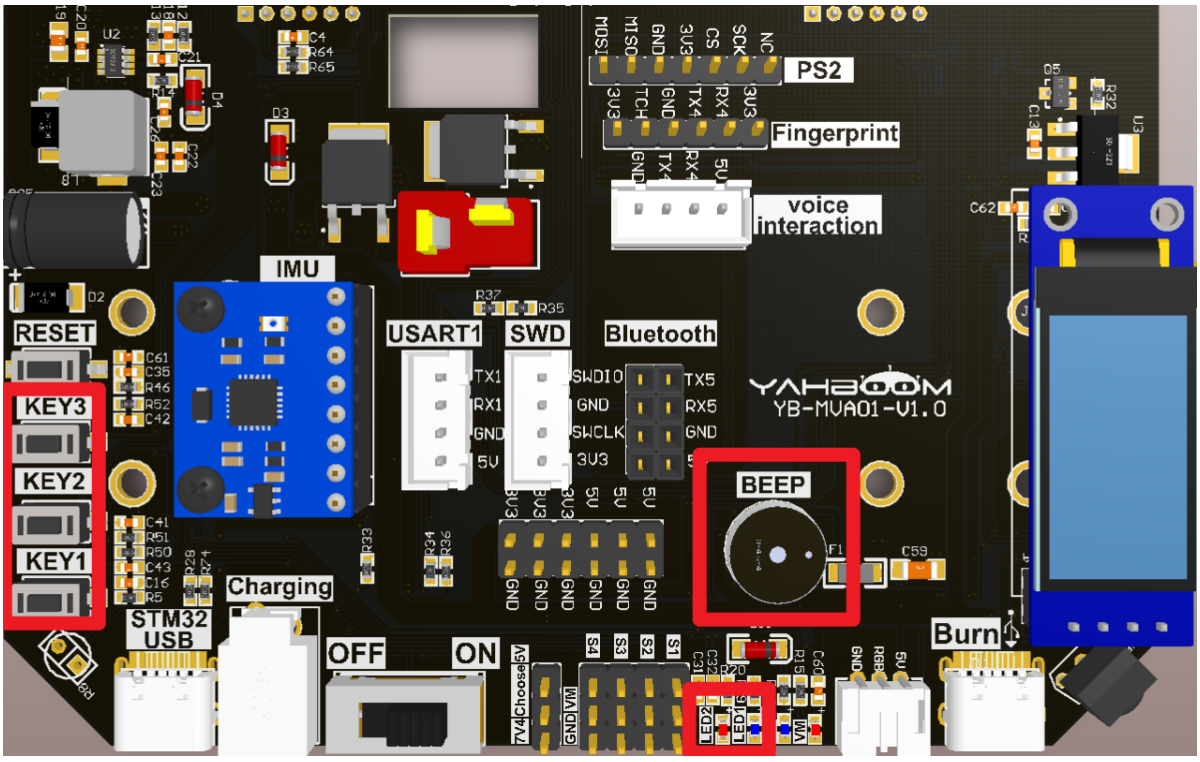
  Download programs or simulate the development board

2. Brief principle

1. Hardware schematic diagram



2. Physical connection diagram



3. Control principle

Trigger an external interrupt by pressing a button, and control the LED to turn on and off and the buzzer to sound according to the triggered button.

LED: High level lights up, low level turns off

LED(schematic name)	control pin	Function
LED1	PG14	Control LED1 to turn on and off
LED2	PG15	Control LED2 to turn on and off

KEY: High level by default, low level when the button is pressed

KEY(schematic name)	control pin	Function
KEY1	PG3	Change the KEY1 pin level state
KEY2	PG4	Change the KEY2 pin level state
KEY3	PG5	Change the KEY3 pin level state

Buzzer: High level sounds, low level does not sound

Buzzer(schematic name)	control pin	Function
Buzzer	PG12	Control the buzzer sound

- **NVIC (Nested Vectored Interrupt Controller)**

NVIC controls the interrupt-related functions of the entire chip and provides a reliable interrupt handling mechanism for the system.

- **Interrupt Priority**

Preemption priority: The preemption priority is used to determine the relative priority between interrupts. When an interrupt with a high preemption priority occurs, it can interrupt the executing interrupt with a low preemption priority;

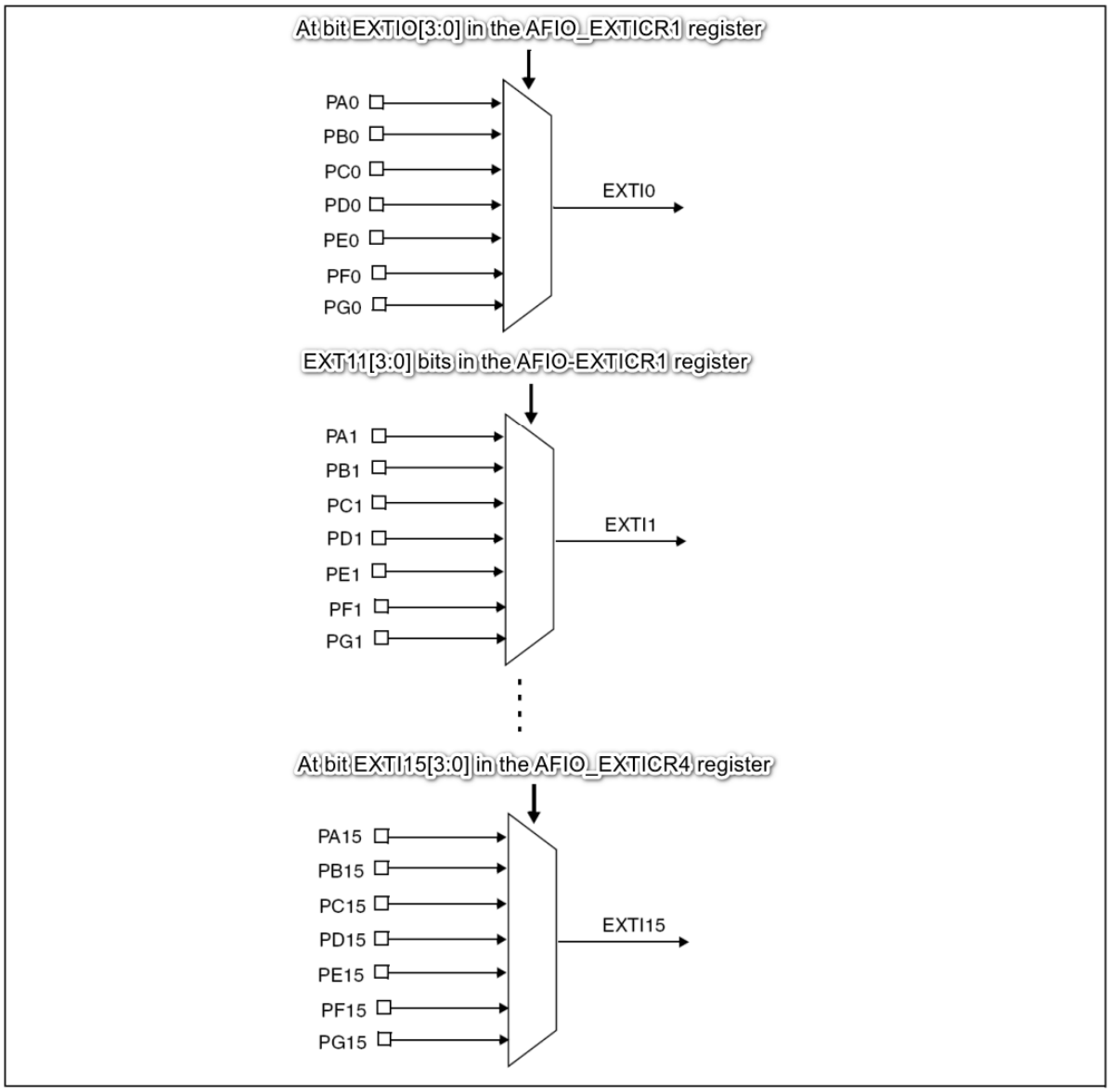
Response priority: When multiple interrupt sources have the same preemption priority, the interrupt with high response priority will be processed first and will not be interrupted by interrupts with the same preemption priority but low response priority.

- **EXTI (External Interrupt)**

The external interrupt/event controller consists of 19 edge detectors that generate event/interrupt requests.

Each input line can be independently configured with input type (pulse or suspend) and corresponding trigger event (rising edge, falling edge, or both edges), and each input line can be independently shielded.

External Interrupt/Event Line Image




```
EXTI0~EXIT4 each have independent interrupt channels
EXTI5~EXIT9 share the same interrupt channel: EXTI9_5_IRQ
EXTI10~EXIT15 share the same interrupt channel: EXTI15_10_IRQ
```

KEY(schematic name)	control pin	External interrupt service function
KEY1	PG3	EXTI3_IRQHandler function
KEY2	PG4	EXTI4_IRQHandler function
KEY3	PG5	EXTI9_5_IRQHandler function

This section tutorial external interrupt trigger mode: rising edge trigger.

3. Project configuration

Project configuration: Prompt configuration options during STM32CubeIDE project configuration

1. Description

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

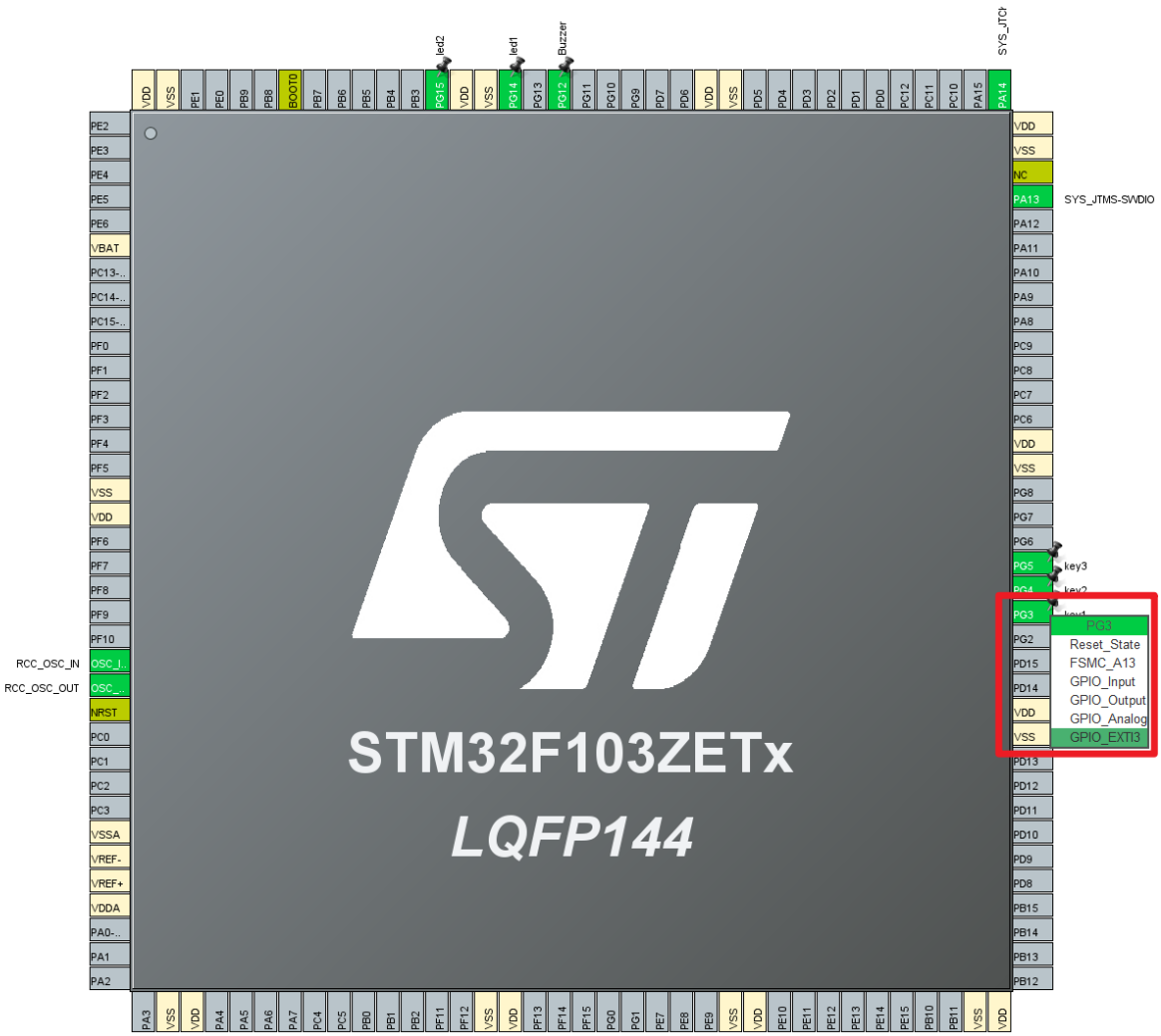
The project configuration part that is not omitted is the key point that needs to be configured in this tutorial.

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

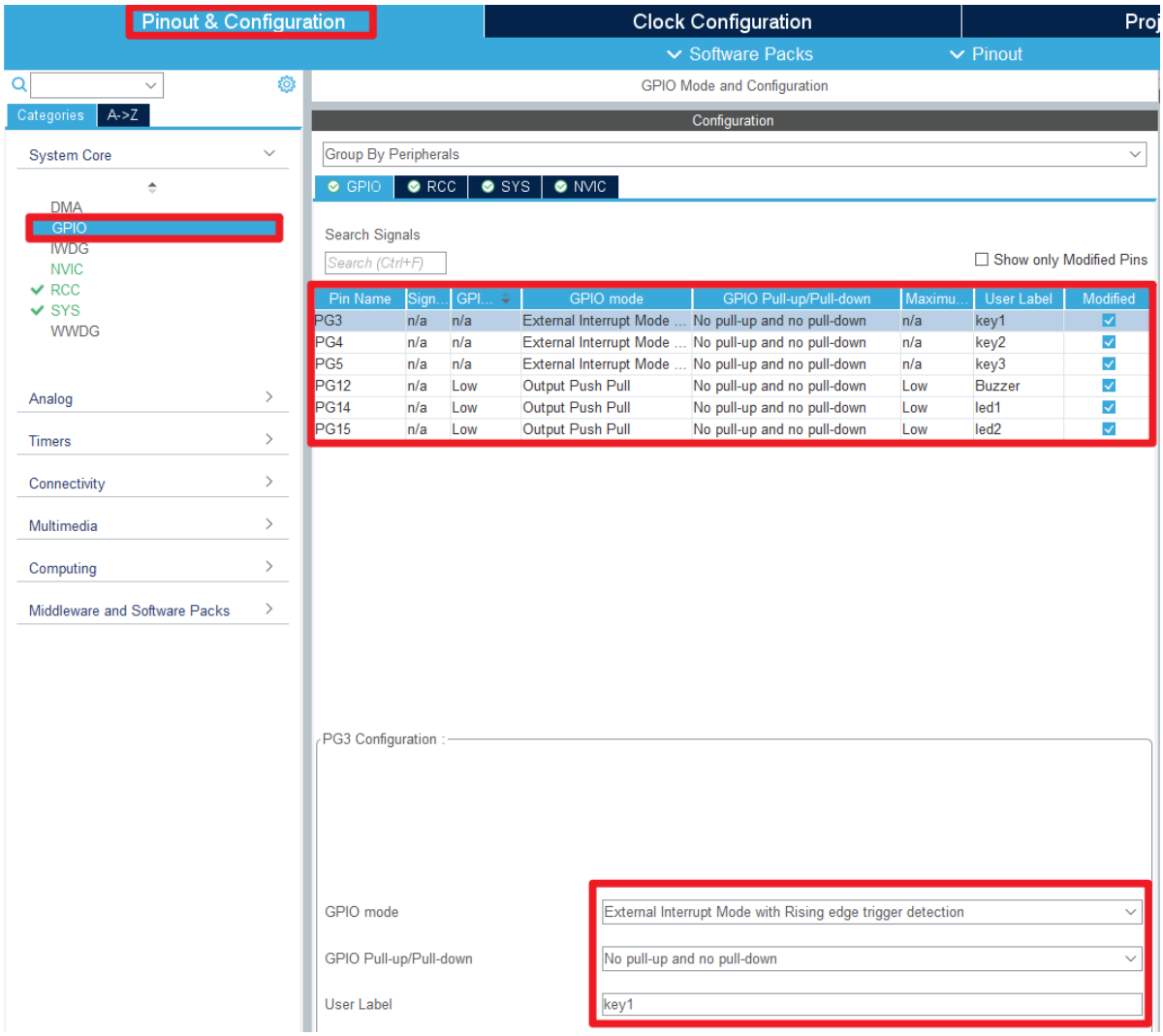
2. Pin configuration

- **Configure specified pin function**

You can directly select the corresponding pin number in the pin view, and the corresponding options will appear when you left-click the mouse.

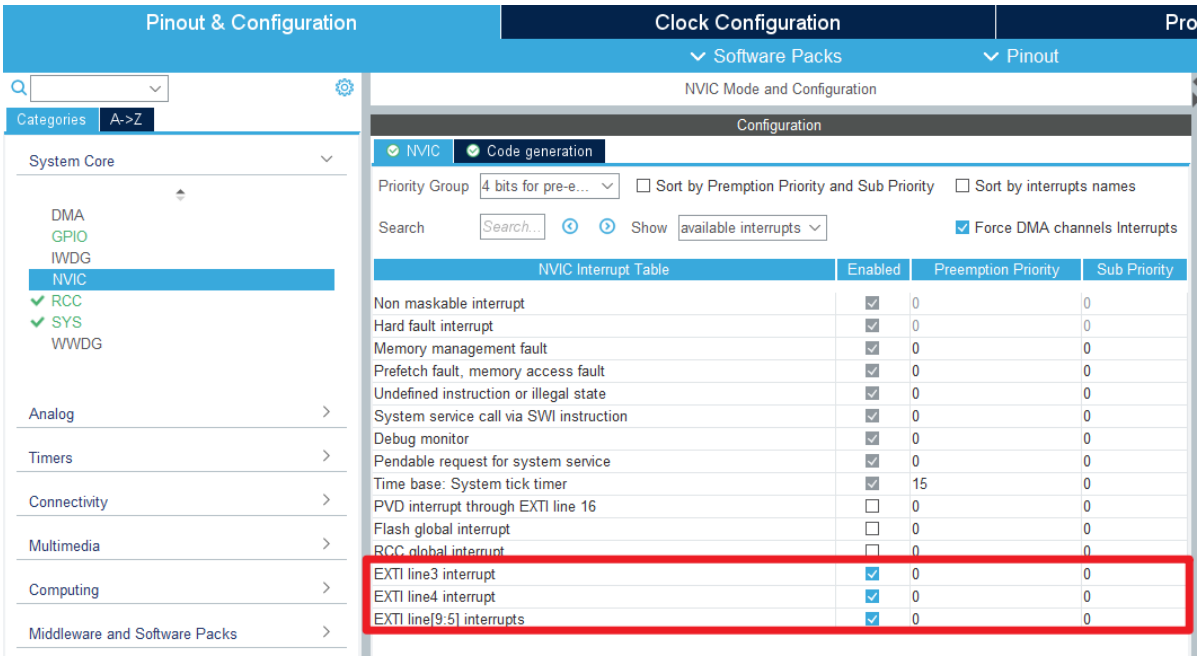


- **GPIO**

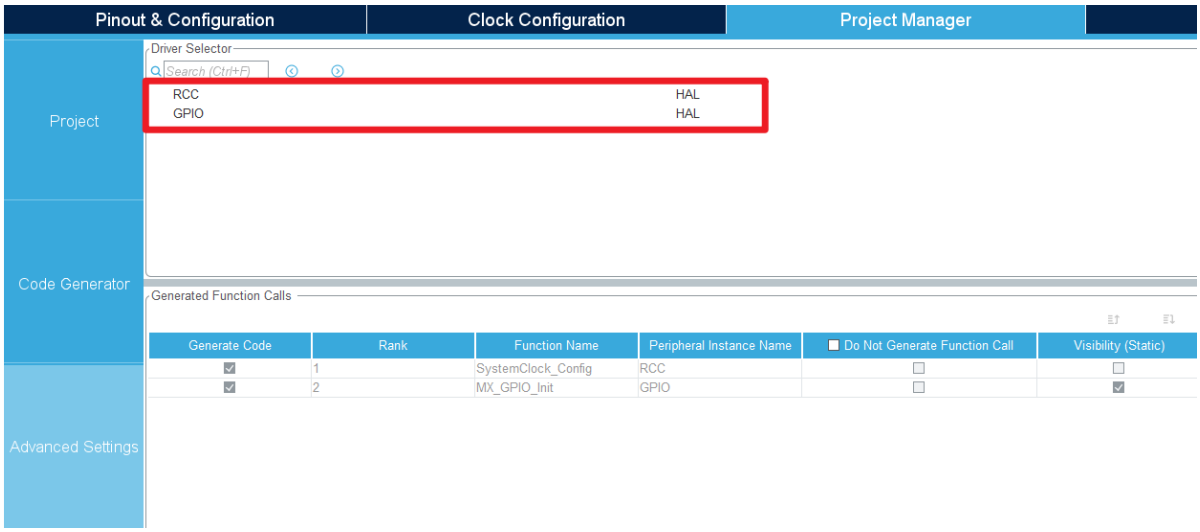


- **NVIC**

Later, when it comes to modifying the interrupt priority, you need to enter the NVIC interface settings. The default priority is used here.



- **Advanced Settings**



- **Generate code**

4. Main functions

It mainly introduces the functional code written by the user. For detailed code, you can open the project file provided by us yourself and enter the Bsp folder to view the source code. **

1. User function

> **function： Set_led**

function prototype	**void Set_led(uint8_t id, uint8_t i)**
Function description	Set the LED to turn on and off
Input parameter 1	**id**：LED id（1：LED1，2：LED2）
Input parameter 2	**i**：Switch (0: off, 1: on)
return value	none

2. HAL library function analysis

The HAL library functions that have been introduced in the previous tutorial will not be introduced again 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： HAL_NVIC_SetPriority**

function prototype	**void HAL_NVIC_SetPriority(IRQn_Type IRQn, uint32_t PreemptPriority, uint32_t SubPriority)**
Function description	Configure interrupt priority

function prototype	void HAL_NVIC_SetPriority(IRQn_Type IRQn, uint32_t PreemptPriority, uint32_t SubPriority)
Input parameter 1	**IRQn**： Interrupt source
Input parameter 2	**PreemptPriority**
Input parameter 3	**SubPriority**
return value	none

> **function： HAL_NVIC_EnableIRQ**

function prototype	void HAL_NVIC_EnableIRQ(IRQn_Type IRQn)
Function description	Enable interrupt source
Input parameter	**IRQn**: interrupt source
return value	none

> **function： HAL_GPIO_EXTI_IRQHandler**

function prototype	void HAL_GPIO_EXTI_IRQHandler(uint16_t GPIO_Pin)
Function description	General processing function after all external interrupts occur
Input parameter	**GPIO_Pin**: pin of external interrupt source
return value	none

> **function： HAL_GPIO_EXTI_Callback**

function prototype	void HAL_GPIO_EXTI_Callback(uint16_t GPIO_Pin)
Function description	External interrupt callback function
Input parameter	**GPIO_Pin**: pin of external interrupt source
return value	none
Precautions	1. This function is called by the external interrupt general processing function HAL_GPIO_EXTI_IRQHandler 2. This function is used to handle specific interrupt tasks

5. Experimental phenomena

After downloading the program successfully, press the RESET button of the development board and observe the development board phenomenon!

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

Phenomenon:

Press the KEY1 button and release it: the buzzer will not sound, LED1 and LED2 will turn off

Press the KEY2 button and release: LED1 lights up

Press the KEY3 button and release: the buzzer sounds and LED2 lights up

```
For experimental phenomena, please see [Button Control_Experimental
Phenomenon.mp4]
```