Window watchdog

Demonstration in this tutorial: Combining onboard LEDs (LED1 and LED2) to demonstrate the **Window Watchdog (WWDG)** hardware fault detection function.

1. Software-Hardware

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

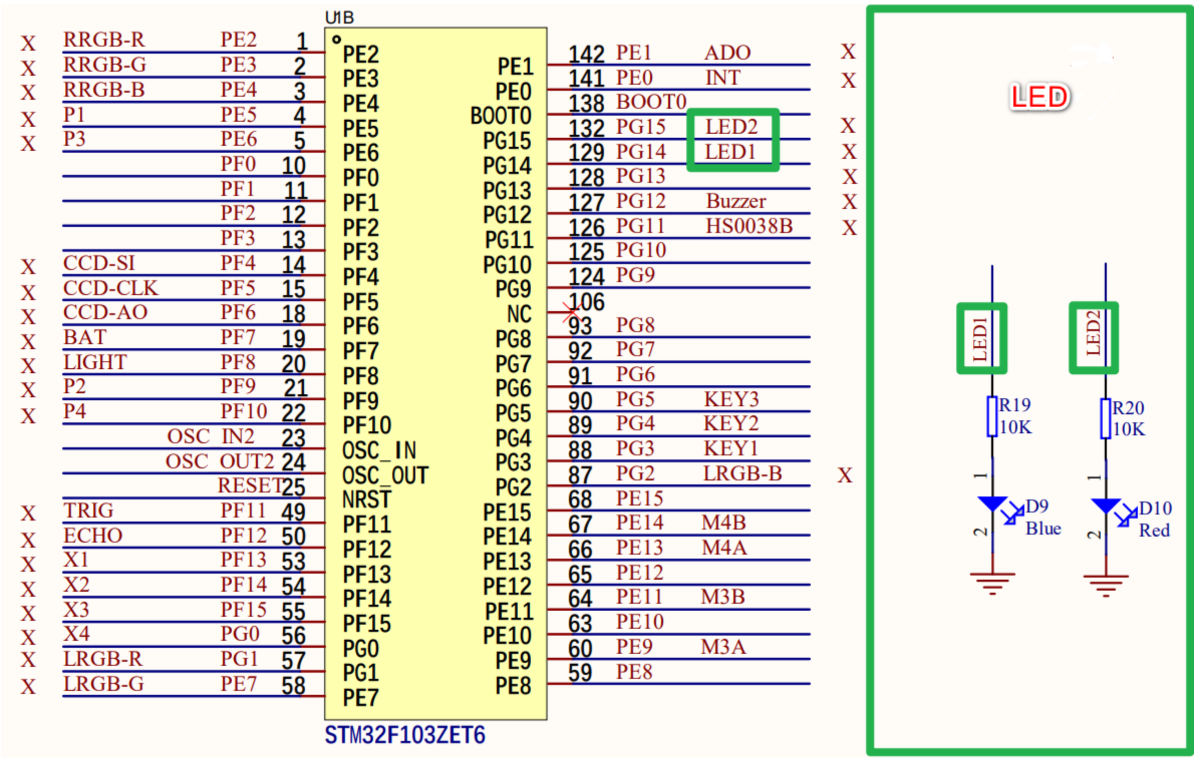
  WWDG: chip internal peripherals

  LED1, LED2: onboard
- **Type-C data cable or ST-Link**

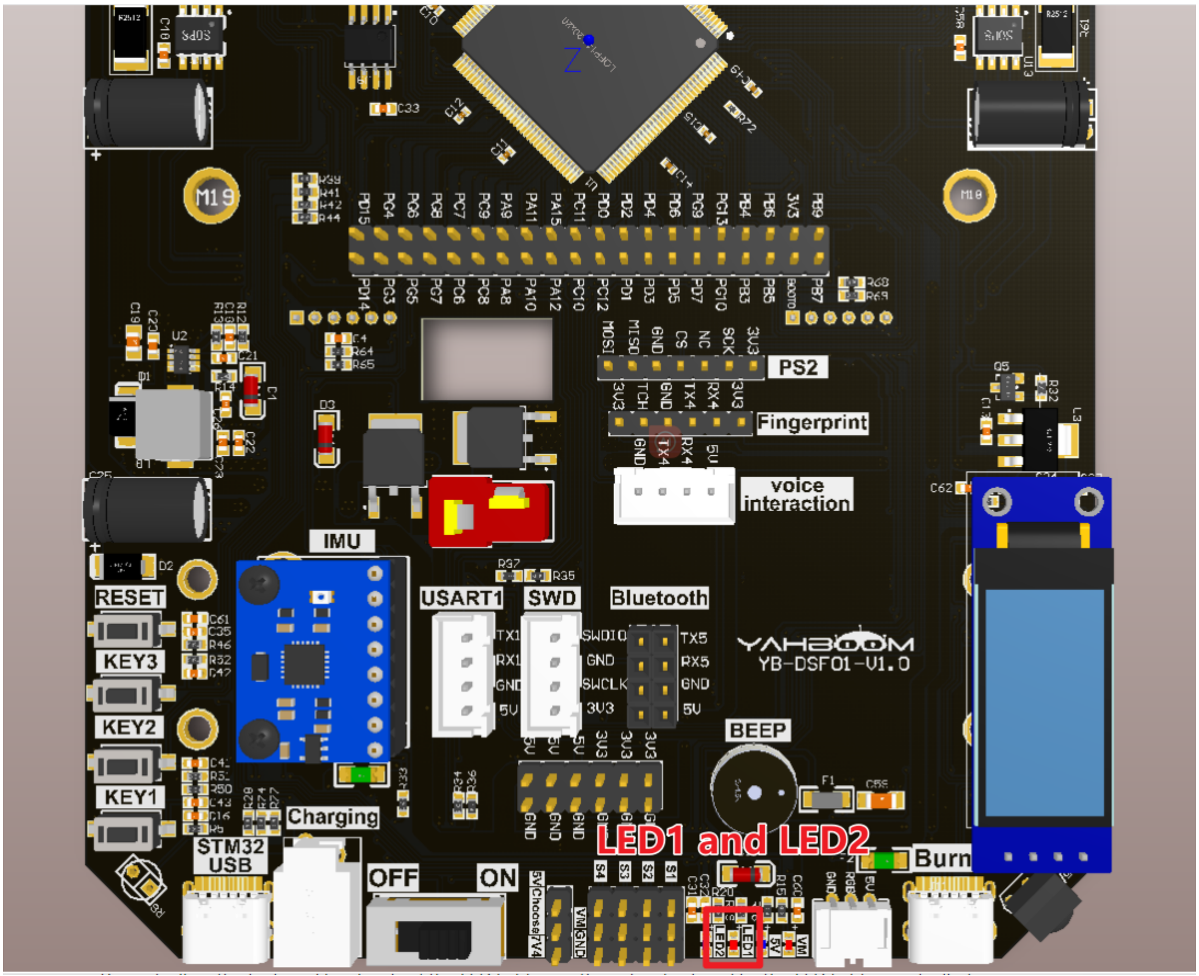
  Download programs or simulate the development board

2. Brief principle

1. Hardware schematic diagram



2. Physical connection diagram



3. Control principle

Use window watchdog to detect program running status.

- ## GPIO output

By controlling the high and low levels of the LED light pins, the color displayed by the LED light is controlled.

LED: high level on, low level off

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

- **Watchdog**

STM32F103ZET6 has two built-in watchdogs (independent watchdog and window watchdog), which are mainly used for system fault detection and recovery.

Watchdog	Function
Independent Watchdog	Used to detect whether the system is running normally
Window Watchdog	Used to detect system failures

- **Window Watchdog**

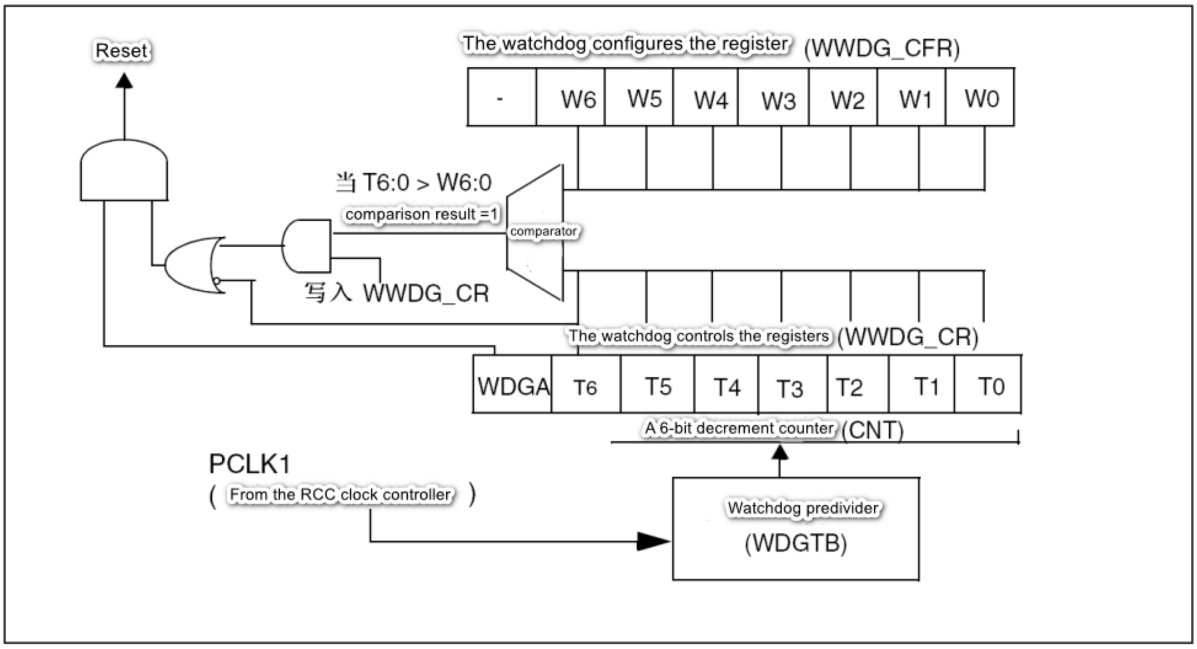
The window watchdog (WWDG) is driven by the clock obtained by dividing the APB1 clock and configures the time window to detect abnormal late or premature operations of the application.

Window Watchdog	Status
When the count value > the upper limit of the window, feed the dog	Reset
When the upper limit of the window > the count value > the lower limit of the window, feed the dog	Do not reset
Count value < window lower limit value	Reset

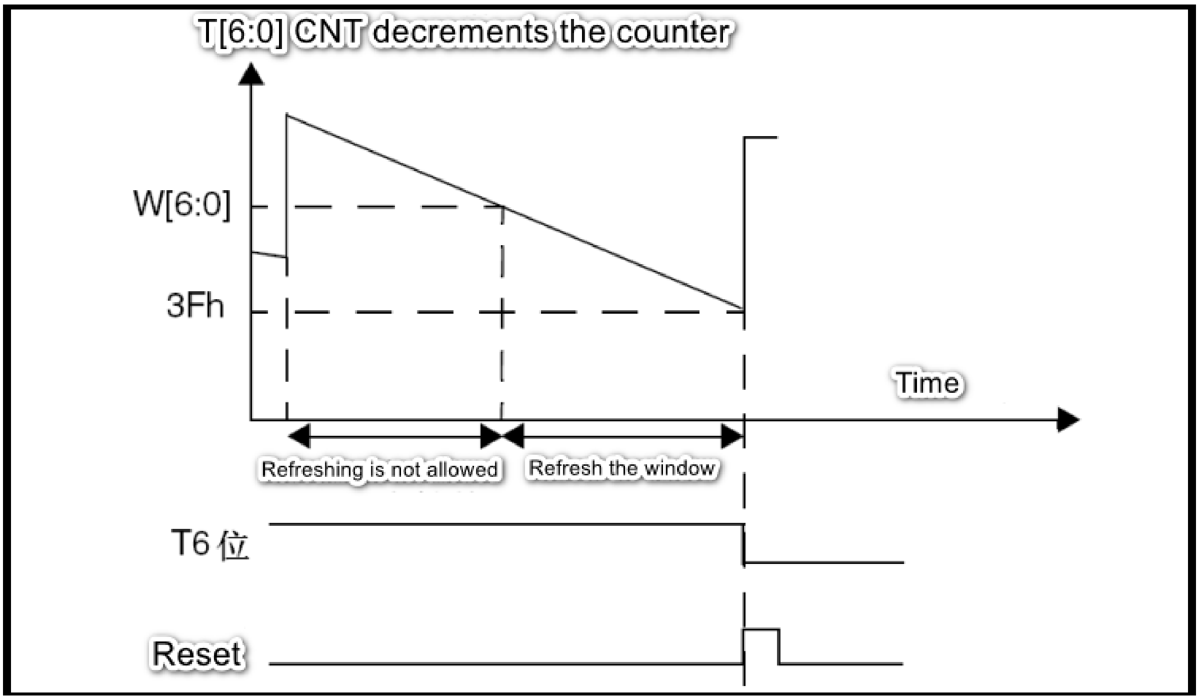
```
The main function of the window watchdog is to monitor the working status of the
system and prevent deadlocks or infinite loops caused by software errors or
unexpected events.
```

- **Independent watchdog feature**
    - Free running down counter
    - conditional reset
        - When the down counter is reloaded outside the window, a reset is generated
        - When the value of the down counter is less than 0x40, a reset is generated
    - If watchdog is enabled and interrupts are enabled

- Early wake-up interrupt (EWI) is generated when the down counter equals 0x40, used to reload the counter to avoid WWDG reset



- **Window watchdog timeout**: PCLK1=36MHz



WDGB	Minimum timeout	Maximum timeout
0	113us	7.28ms
1	227us	14.56ms
2	455us	29.12ms
3	910us	58.25ms

```
The frequency division number set in the tutorial is 8, the window value is 5F,
and the count value is 7F.
```

$$T_{WWDG(ms)} = T_{PCLK1} * 4096 * 2^{WDGTB} * (T[5:0] + 1)$$

T_{WWDG}: WWDG timeout time

T_{PCLK1}: APB1 time interval in ms

Example: Counter decrement time (PCLK1=36MHz, frequency division number is 8)

$$T_{WWDG(ms)} = T_{PCLK1} * 4096 * 2^{WDGTB} * (T[5:0] + 1) = \frac{1}{36000} * 4096 * 2^3 * (1) = 0.910ms$$

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

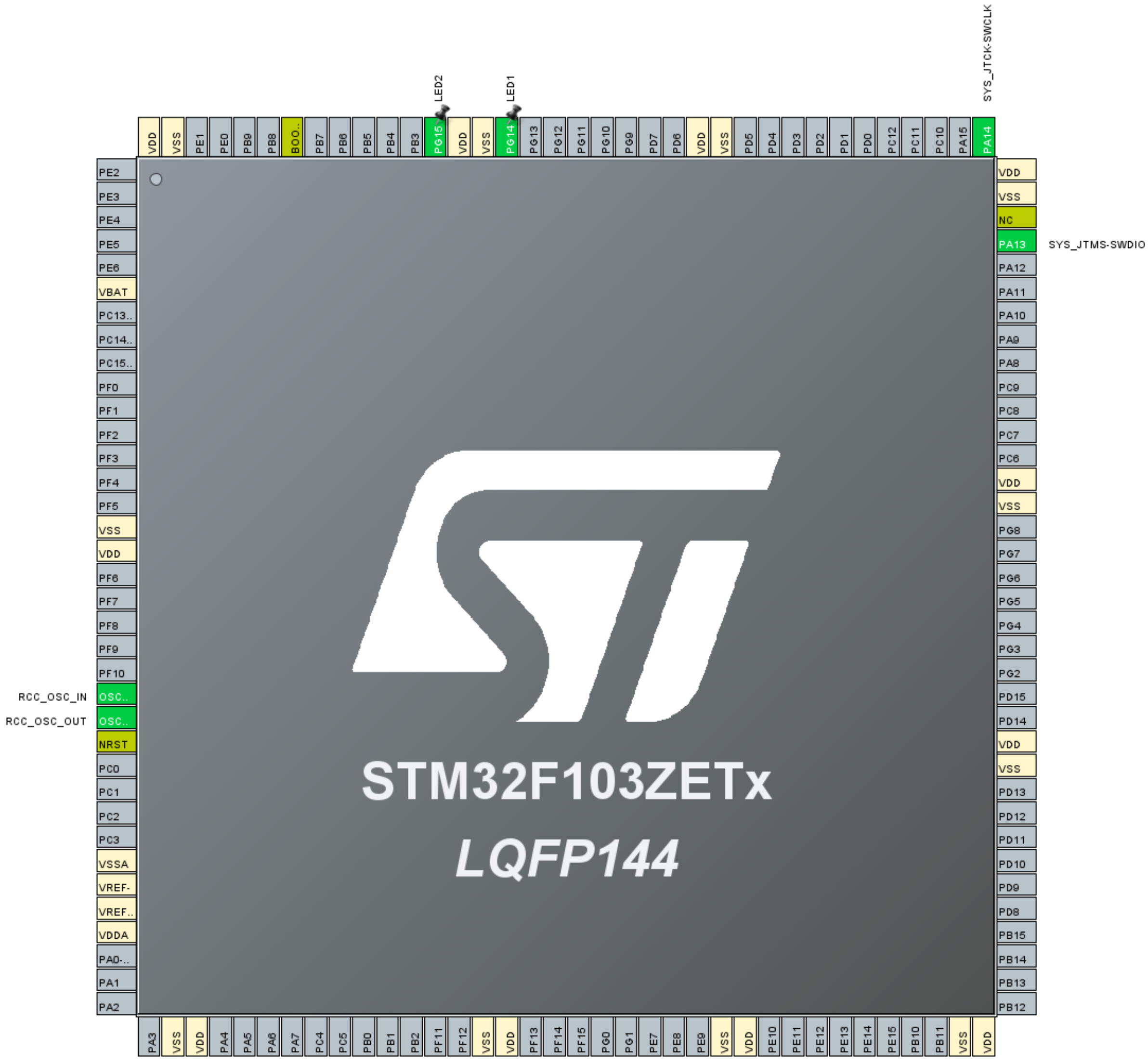
The project configuration part that is not omitted is the key point that needs to be configured in this tutorial.

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

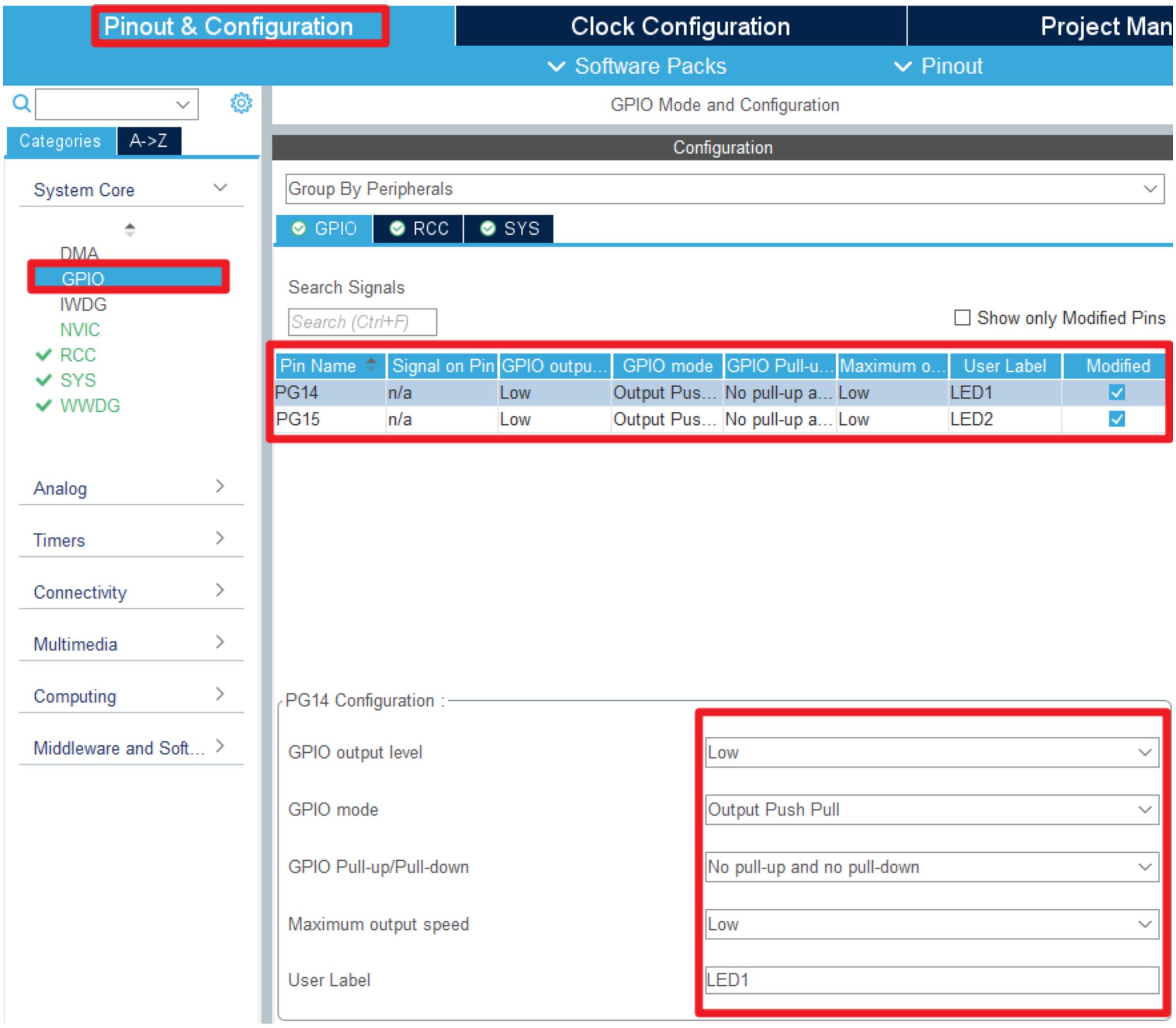
2. Pin configuration

- **Configure specified pin function**

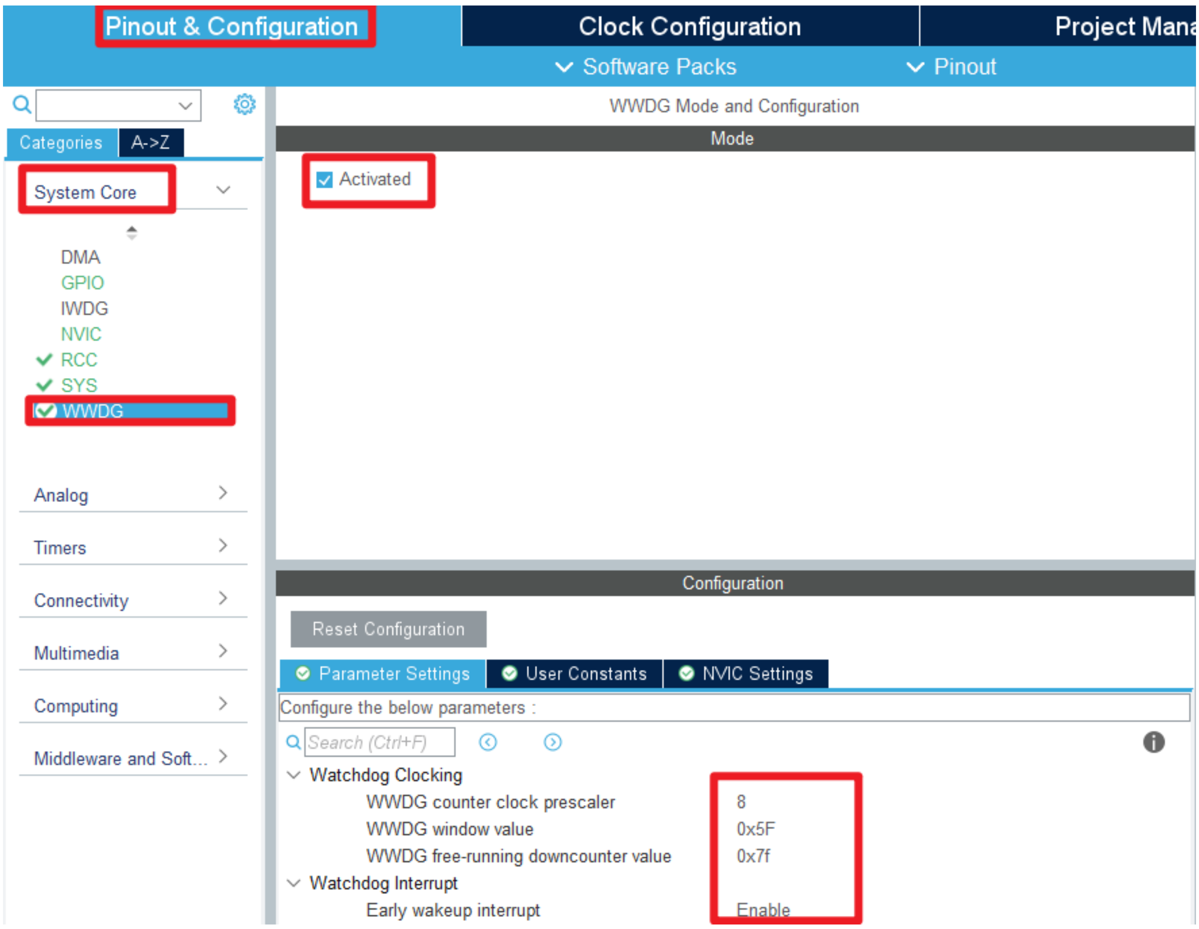
You can directly select the corresponding pin number in the pin view, and the corresponding options will appear when you left-click the mouse.


SYS_JTCK-SWCLK
LED2
LED1
SYS_JTMS-SWDIO
RCC_OSC_IN
RCC_OSC_OUT
STM32F103ZETx
LQFP144

- **GPIO**


Pinout & Configuration
Clock Configuration
Project Man
Software Packs
Pinout
Categories
A->Z
System Core
DMA
GPIO
IWDG
NVIC
RCC
SYS
WWDG
Analog
Timers
Connectivity
Multimedia
Computing
Middleware and Soft...
GPIO Mode and Configuration
Configuration
Group By Peripherals
GPIO
RCC
SYS
Search Signals
Search (Ctrl+F)
Show only Modified Pins
Pin Name
Signal on Pin
GPIO outpu...
GPIO mode
GPIO Pull-u...
Maximum o...
User Label
Modified
PG14
n/a
Low
Output Pus...
No pull-up a...
Low
LED1
PG15
n/a
Low
Output Pus...
No pull-up a...
Low
LED2
PG14 Configuration :
GPIO output level
Low
GPIO mode
Output Push Pull
GPIO Pull-up/Pull-down
No pull-up and no pull-down
Maximum output speed
Low
User Label
LED1

- **WWDG**


Pinout & Configuration
Clock Configuration
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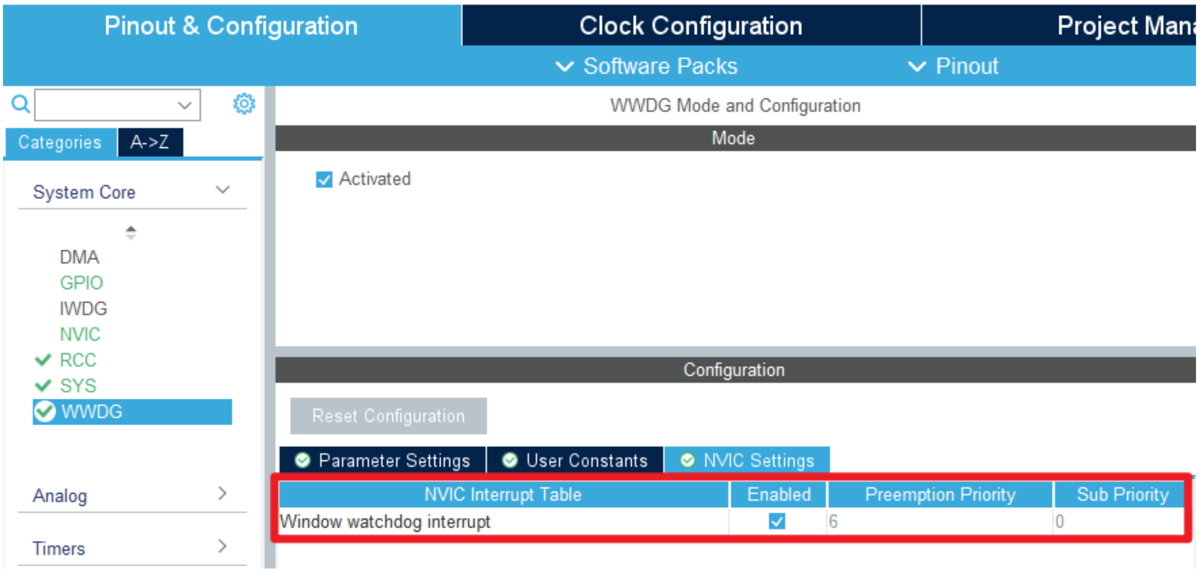
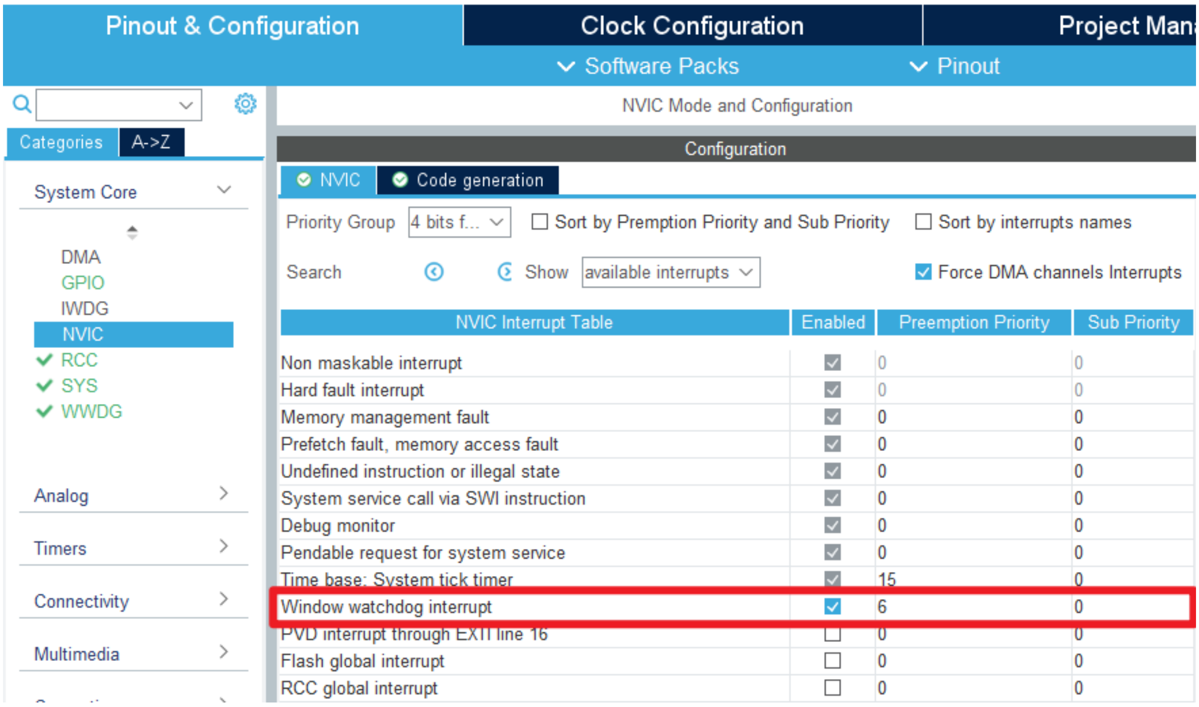
Pinout
Categories
A->Z
System Core
DMA
GPIO
IWDG
NVIC
RCC
SYS
WWDG
Analog
Timers
Connectivity
Multimedia
Computing
Middleware and Soft...
WWDG Mode and Configuration
Mode
Activated
Configuration
Reset Configuration
Parameter Settings
User Constants
NVIC Settings
Configure the below parameters :
Search (Ctrl+F)
Watchdog Clocking
WWDG counter clock prescaler
8
WWDG window value
0x5F
WWDG free-running downcounter value
0x7f
Watchdog Interrupt
Early wakeup interrupt
Enable

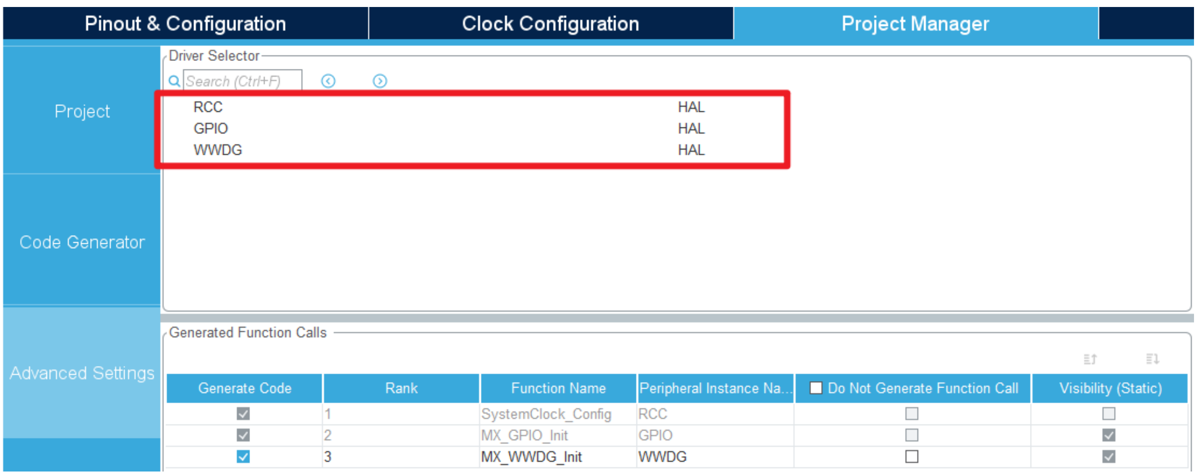


- **NVIC**

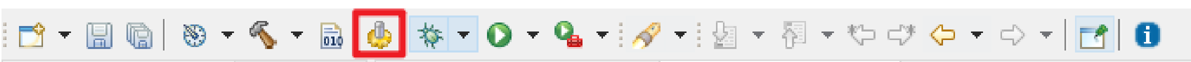
Modify interrupt priority



- **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. **

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_WWDG_Init**

Function prototype	**HAL_StatusTypeDef HAL_WWDG_Init(WWDG_HandleTypeDef *hwwdg)**
Function description	Initialize WWDG peripheral parameters
Input parameters	**hwwdg**: WWDG handle address
Return value	**HAL status value**: HAL_OK, HAL_ERROR, HAL_BUSY, HAL_TIMEOUT

> **Function: HAL_WWDG_MspInit**

Function prototype	**void HAL_WWDG_MspInit(WWDG_HandleTypeDef* wwdgHandle)**
Function description	Initialize the clock and NVIC of WWDG peripherals
Input parameters	**wwdgHandle**: WWDG handle address
Return value	None

> **Function: HAL_WWDG_IRQHandler**

Function prototype	**void HAL_WWDG_IRQHandler(WWDG_HandleTypeDef *hwwdg)**
Function description	WWDG interrupt handling function
Input parameters	**hwwdg**: WWDG handle address
Return value	None

> **Function: HAL_WWDG_Refresh**

Function prototype	**HAL_StatusTypeDef HAL_WWDG_Refresh(WWDG_HandleTypeDef *hwwdg)**
Function description	Refresh WWDG (feed the dog)

Function prototype	HAL_StatusTypeDef HAL_WWDG_Refresh(WWDG_HandleTypeDef *hwwdg)
Input parameters	**hwwdg**: WWDG handle address
Return value	**HAL status value**: HAL_OK, HAL_ERROR, HAL_BUSY, HAL_TIMEOUT

> **Function: HAL_WWDG_EarlyWakeupCallback**

Function prototype	void HAL_WWDG_EarlyWakeupCallback(WWDG_HandleTypeDef *hwwdg)
Function description	Window watchdog wake-up interrupt processing callback function
Input parameters	**hwwdg**: WWDG handle address
Return value	None

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:

Feed the dog: LED2 goes off, LED1 flashes

The dog is not fed: LED1 goes out and LED2 flashes, indicating that the hardware watchdog is abnormal.

```
For experimental phenomena, you can see [Window Watchdog_Experimental Phenomenon.mp4]
```