

嵌入式微处理器系统设计实验报告

实验一 嵌入式开发软硬件平台使用

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实验目的

- 熟悉CT117E-M4平台的电路连接和主要资源。
- 掌握STM32CUBEMX软件的使用。
- 掌握KEIL ARM-MDK软件的使用。
- 掌握新建工程和程序调试方法。

实验内容

利用STM32CUBEMX创建一个新工程，实现GPIO基本操作：

要求：

1. 正确创建一个新工程。
2. 合理配置GPIO与系统时钟。
3. CUBEMX配置 实现 第8颗LED常亮。
4. 了解工程文件结构和代码框架。
5. 通过KEIL编程实现 LED1常亮。LED2、LED3交替闪烁。
6. 间隔500ms。
7. 了解程序编译过程和调试方法。
8. 实现其他自选创意功能。

操作过程

软件选择

使用CubeMX与MAD-ARM

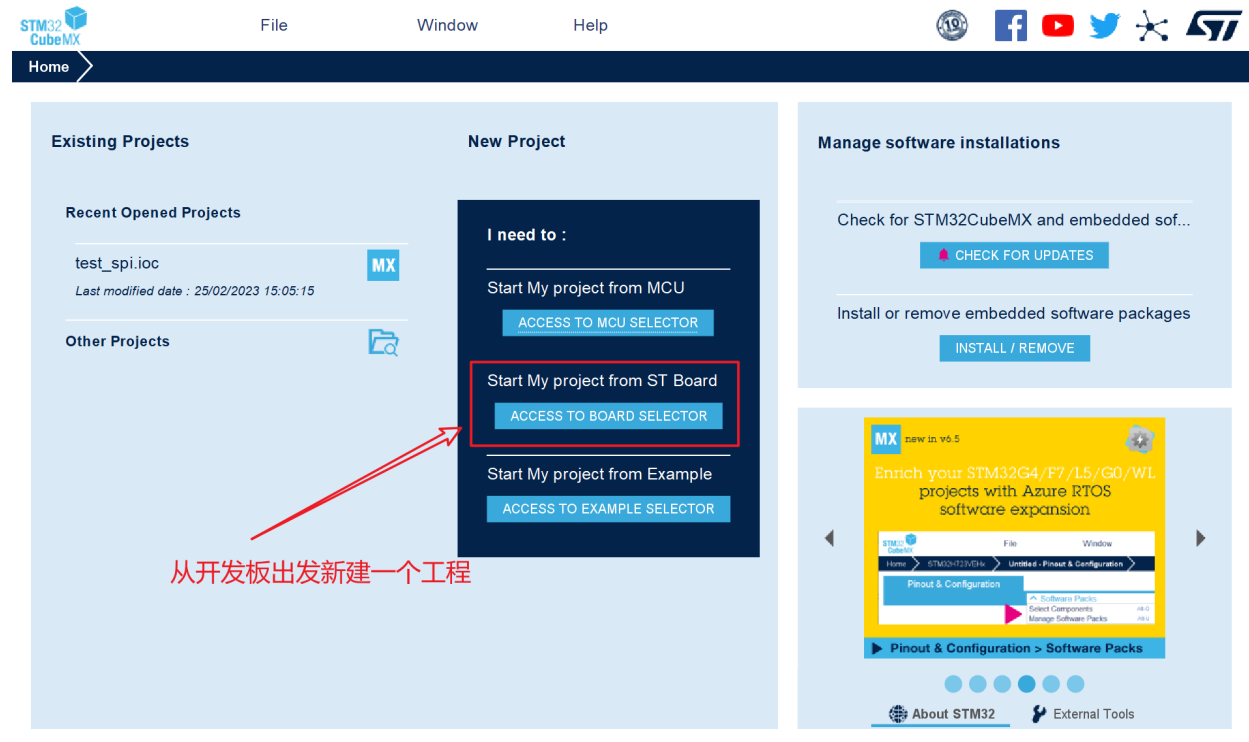
- STMCubeMX：
STMCubeMX是ST公司推出的一种自动创建单片机工程及初始化代码的工具。
- MDK-ARM：
Keil公司开发的ARM开发工具MDK，是用来开发基于ARM核的系列微控制器的嵌入式应用程序。

实验流程

使用 CubeMX 生成初始化代码 -> 使用 MDK-ARM 编写主函数并编译 -> 使用开发板自带的ST-LINK将编译好的程序烧录到开发板 -> 搭建实物电路 -> 开发板上电，观察现象。

具体操作

打开CubeMX，可以看到如下界面。点击红色方框内的 ACCESS TO MCU SELECTRO 选择芯片型号。这里我使用的是 NUCLEO-F411RE，为了更好的建立工程，选择板子选择：



输入芯片型号查找对应芯片，选择“STM32F411RE”芯片。具体操作如图所示，操作执行后点击Start Project进入配置页面。

MCU/MPU Selector Board Selector Example Selector Cross Selector

Board Filters

Commercial Part Number: 输入F411

PRODUCT INFO

- Type
- Supplier
- MCU / MPU Series
- Marketing Status
- Price

MEMORY

FEATURES

Features Large Picture Docs & Resources Datasheet Buy Start Project

STM32U5 raises energy efficiency for IoT and embedded applications

Boards List: 178 items

Overview	Commercial Part No	Type	Marketing Status	Unit Price (US\$)	Mounted Device
	B-G474E-DPOW1	Discovery Kit	Active	59.0	STM32G474RET6
	B-L072Z-LRWAN1	Discovery Kit	Active	46.5	STM32L072CZY3TR
	B-L462E-CELL1	Discovery Kit	Active	74.0	STM32L462EY6TR
	B-L475E-IOT01A1	Discovery Kit	Active	53.0	STM32L475VGT6

MCU/MPU Selector Board Selector Example Selector Cross Selector

Board Filters

Commercial Part Number: NUCLEO-F411RE

PRODUCT INFO

- Type
- Supplier
- MCU / MPU Series
- Marketing Status
- Price

MEMORY

FEATURES

Features Large Picture Docs & Resources Datasheet Buy Start Project

STM32F4 Series

NUCLEO-F411RE

STM32 Nucleo-64 development board with STM32F411RE MCU, supports Arduino and ST morpho connectivity

ACTIVE
Product is in mass production

Part Number: NUCLEO-F411RE
Commercial Part Number: NUCLEO-F411RE

Unit Price (US\$): 13.0
Mounted Device: STM32F411RET6

The STM32 Nucleo-64 board provides an affordable and flexible way for users to try out new concepts and build prototypes by choosing from the various combinations of performance and power consumption features, provided by the STM32 microcontroller. For the compatible boards, the external SMPS significantly reduces power consumption in Run mode.

The ARDUINO® Uno V3 connectivity support and the ST morpho headers allow the easy expansion of the functionality of the STM32 Nucleo open development platform with a wide choice of specialized shields.

The STM32 Nucleo-64 does not require any separate

Boards List: 1 item

Overview	Commercial Part No	Type	Marketing Status	Unit Price (US\$)	Mounted Device
	NUCLEO-F411RE	Nucleo-64	Active	13.0	STM32F411RET6

芯片配置页面如下：在此处进行引脚，晶振，调试的配置。

STM32CubeMX File Window Help

Home > STM32F411RETx - NUCLEO-F411RE > Untitled - Pinout & Configuration > GENERATE CODE

Pinout & Configuration Clock Configuration Project Manager Tools

Software Packs Pinout

GPIO Mode and Configuration

Configuration

Group By Peripherals

GPIO Single Mapped Signals RCC SYS USART NVIC

Search Signals Search (Ctrl+F) Show only Modified Pins

Pin Name	Signal on	GPIO out	GPIO mode	GPIO Pul	Maximum	User Label	Mod
PA5	n/a	Low	Output Pu...	No pull-u...	Low	LD2 [Green Led]	<input checked="" type="checkbox"/>
PC13-ANTI_TAMP	n/a	n/a	External I...	No pull-u...	n/a	B1 [Blue PushBut...	<input checked="" type="checkbox"/>

可以看到板子的默认配置中包含PA5引脚与开发板板载LED相连接

Select Pins from table to configure them. Multiple selection is Allowed.

Pinout view System view

STM32CubeMX File Window Help

Home > STM32F411RETx - NUCLEO-F411RE > Untitled - Pinout & Configuration > GENERATE CODE

Pinout & Configuration Clock Configuration Project Manager Tools

Software Packs Pinout

GPIO Mode and Configuration

Configuration

Group By Peripherals

GPIO Single Mapped Signals RCC SYS USART NVIC

Search Signals Search (Ctrl+F) Show only Modified Pins

Pin Name	Signal on	GPIO output	GPIO mode	GPIO Pull-u	Maximum out	User Label	Mod
PA5	n/a	Low	Output Push ...	Pull-down	Low	LD2 [Green Led]	<input checked="" type="checkbox"/>
PC13-ANTI_TAMP	n/a	n/a	External Inte...	No pull-up a...	n/a	B1 [Blue PushButton]	<input checked="" type="checkbox"/>

PA5 Configuration :

GPIO output level Low

GPIO mode Output Push Pull

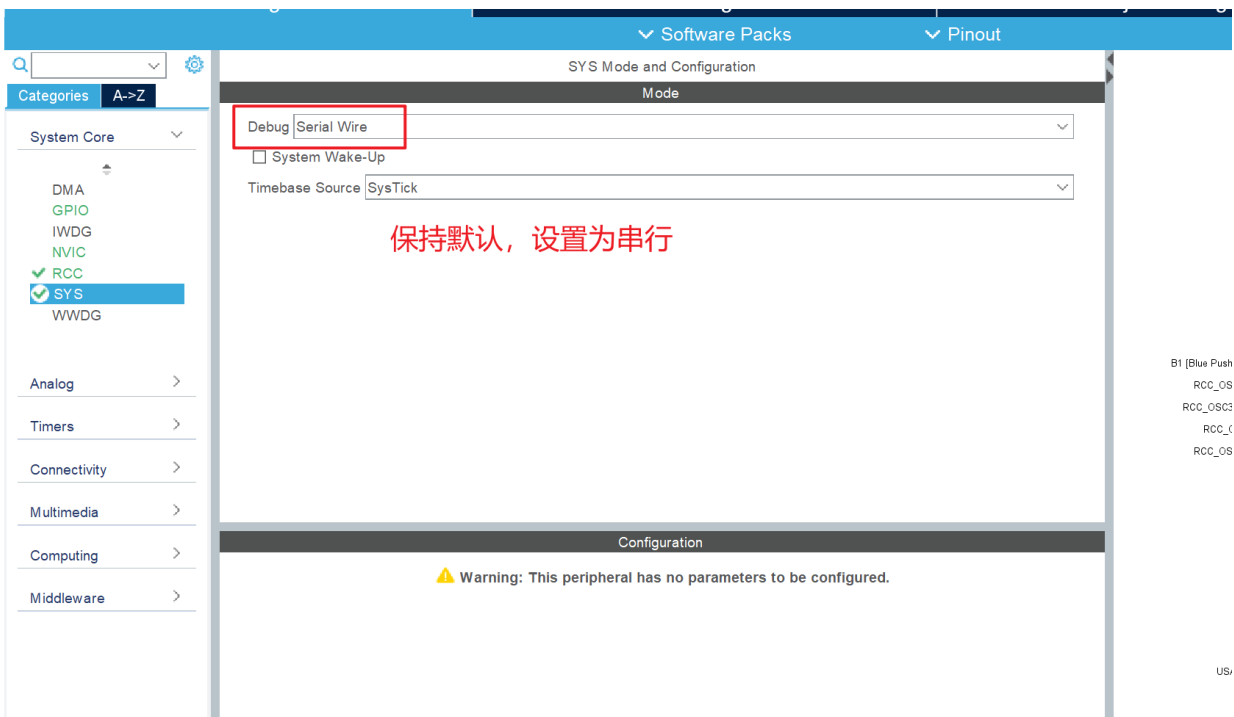
GPIO Pull-up/Pull-down Pull-down

Maximum output speed Low

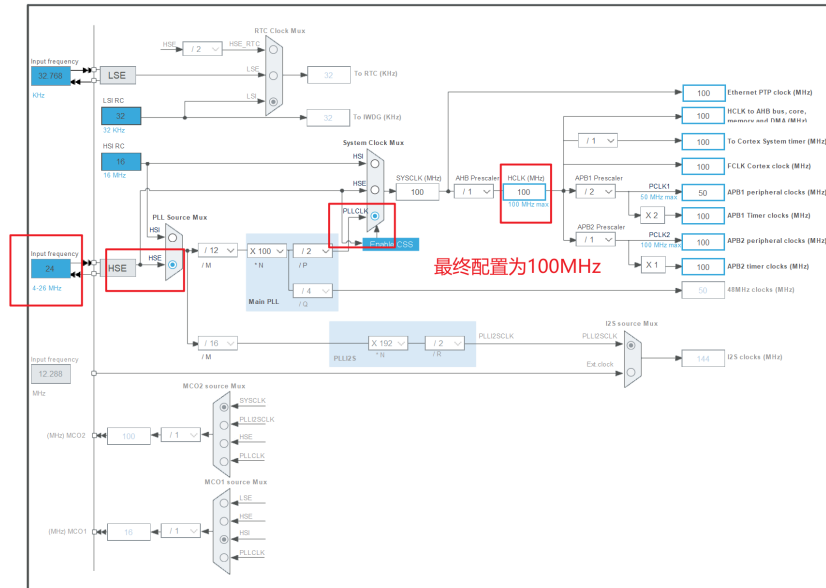
User Label LD2 [Green Led]

配置为默认下拉

Pinout view System view



然后配置时钟树：



工程属性配置:

STM32CubeMX File Window Help

Home > STM32F411RETx - NUCLEO-F411RE > Untitled - Project Manager > GENERATE CODE

Pinout & Configuration Clock Configuration Project Manager Tools

Project

Project Name: LED 名字为LED

Project Location: E:\User_Data_Files\MCU_Learning\nucleo_learning\lesson1 课程1目录

Application Structure: Advanced

Code Generator

Toolchain Folder Location: E:\User_Data_Files\MCU_Learning\nucleo_learning\lesson1\LED1

Toolchain / IDE: MDK-ARM Min Version: V5.32 开发工具选择MDK

Advanced Settings

Linker Settings

Minimum Heap Size: 0x200

Minimum Stack Size: 0x400

Thread-safe Settings

Cortex-M4NS

☐ Enable multi-threaded support

Thread-safe Locking Strategy: Default - Mapping suitable strategy depending on RTOS selection.

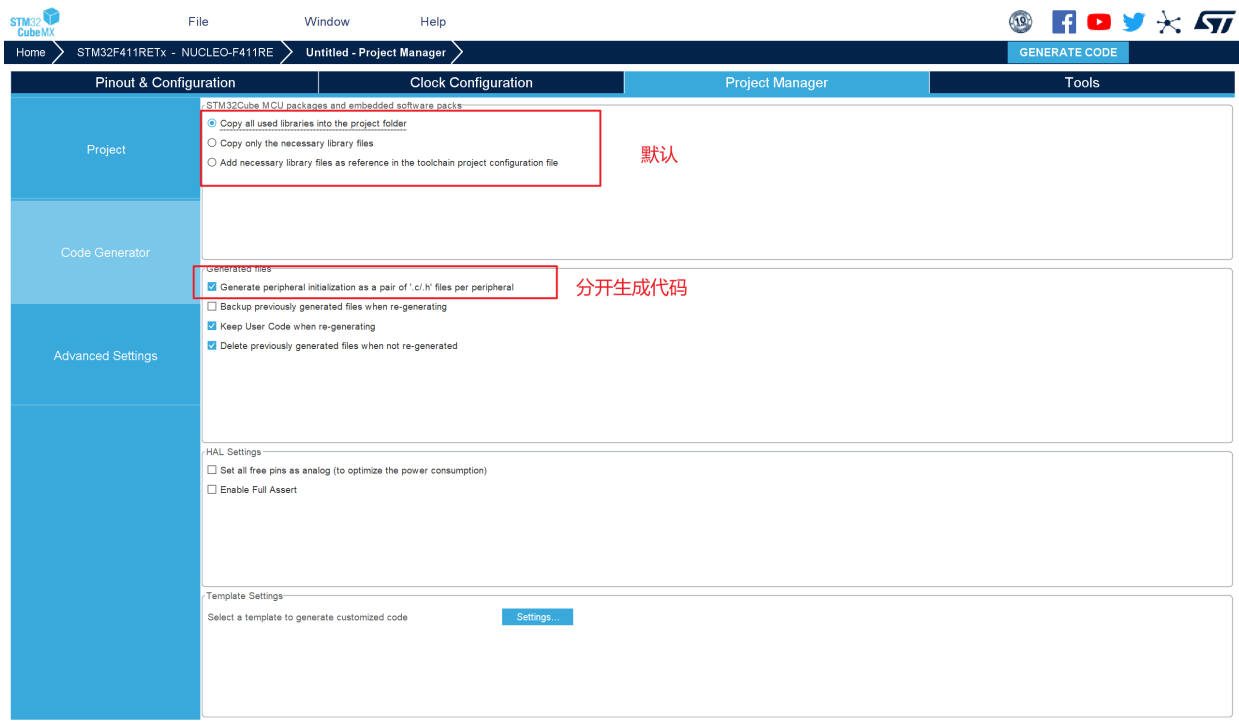
Mcu and Firmware Package

Mcu Reference: STM32F411RETx

Firmware Package Name and Version: STM32Cube_FW_F4_V1.27.1 Use latest available version

☒ Use Default Firmware Location

Firmware Relative Path: C:\Users\24204\STM32Cube\Repository\STM32Cube_FW_F4_V1.27.1



最后点击生成代码。

核心代码及注释

使用 MDK 打开生成的工程，编写实验代码。

```

1  /* USER CODE BEGIN 2 */
2  HAL_GPIO_WritePin(LD2_GPIO_Port, LD2_Pin, GPIO_PIN_SET);
3  HAL_Delay(1000);
4  led_cnt = 0;
5
6  /* USER CODE END 2 */
7
8  /* Infinite loop */
9  /* USER CODE BEGIN WHILE */
10 while (1)
11 {
12     if(led_cnt < 5)
13     {
14         HAL_GPIO_WritePin(LD2_GPIO_Port, LD2_Pin, GPIO_PIN_SET);
15         HAL_Delay(100);
16         HAL_GPIO_WritePin(LD2_GPIO_Port, LD2_Pin, GPIO_PIN_RESET);
17         HAL_Delay(100);
18         led_cnt++;
19     }
20     else if(led_cnt >= 5 && led_cnt < 10)
21     {
22         HAL_GPIO_WritePin(LD2_GPIO_Port, LD2_Pin, GPIO_PIN_SET);
23         HAL_Delay(500);
24         HAL_GPIO_WritePin(LD2_GPIO_Port, LD2_Pin, GPIO_PIN_RESET);
25         HAL_Delay(500);
26         led_cnt++;

```

```
27     }
28     else if(led_cnt >= 10)
29     {
30         led_cnt = 0;
31     }
32     /* USER CODE END WHILE */
```

实验结果

上电后点亮LED，然后等待1s后开始以100ms为周期闪烁，闪烁5次后以500ms为周期闪烁。