CubeMX 创建 WL LoRa EndNode 应用

关键字：STM32WL，LoRa

前言

本篇 LAT 介绍使用 CubeMX 创建基于采用 STM32WLE5JC/STM32WL55JC 的 STM32WL 板子 的 LoRaWAN 应用。

其中，参考使用了 STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\LoRaWAN_End_Node 创建一个 WLE5Jx_EndNode 的例子。

关于不同 MCU 间的移植可参考

UM1718 11.9 Switching to another MCU

UM1718 15 Tutorial 5: Exporting current project configuration to a compatible MCU

需要提前准备的环境：

STM32WL 官网		https://www.st.com/STM32WL https://www.stmcu.com.cn/STM32WL
硬件	HW	NUCLEO-WL55JC https://www.st.com/en/evaluation-tools/nucleo-wl55jc.html MB1389-WL55JC-highband-D04 Schematic MB1389-WL55JC-lowband-D04 Schematic
代码生成工具	CubeMX	STM32CubeMX v6.2.0 https://www.st.com/en/development-tools/stm32cubemx.html
软件源码库	CubeWL	STM32Cube_FW_WL_V1.0.0 https://www.st.com/en/embedded-software/stm32cubewl.html
集成开发环境	IAR	8.50.9 (以上版本不需要打补丁) https://netstorage.iar.com//SuppDB/Public/UPDINFO/015020/arm/doc/infocenter/readme.ENU.html

IAR v8.50.9 以下版本需要打补丁

STM32Cube_FW_WL_V1.0.0\Utilities\PC_Softwar\EWARMv8_STM32WLxx_V4.6.zip

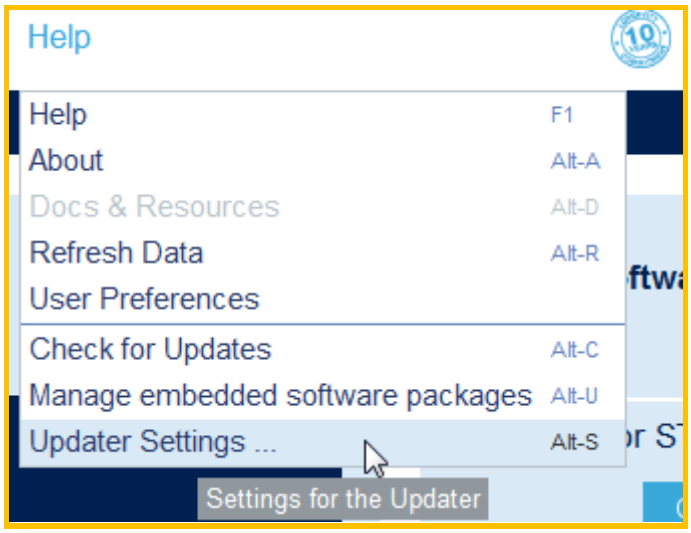
1 配置 CubeMX

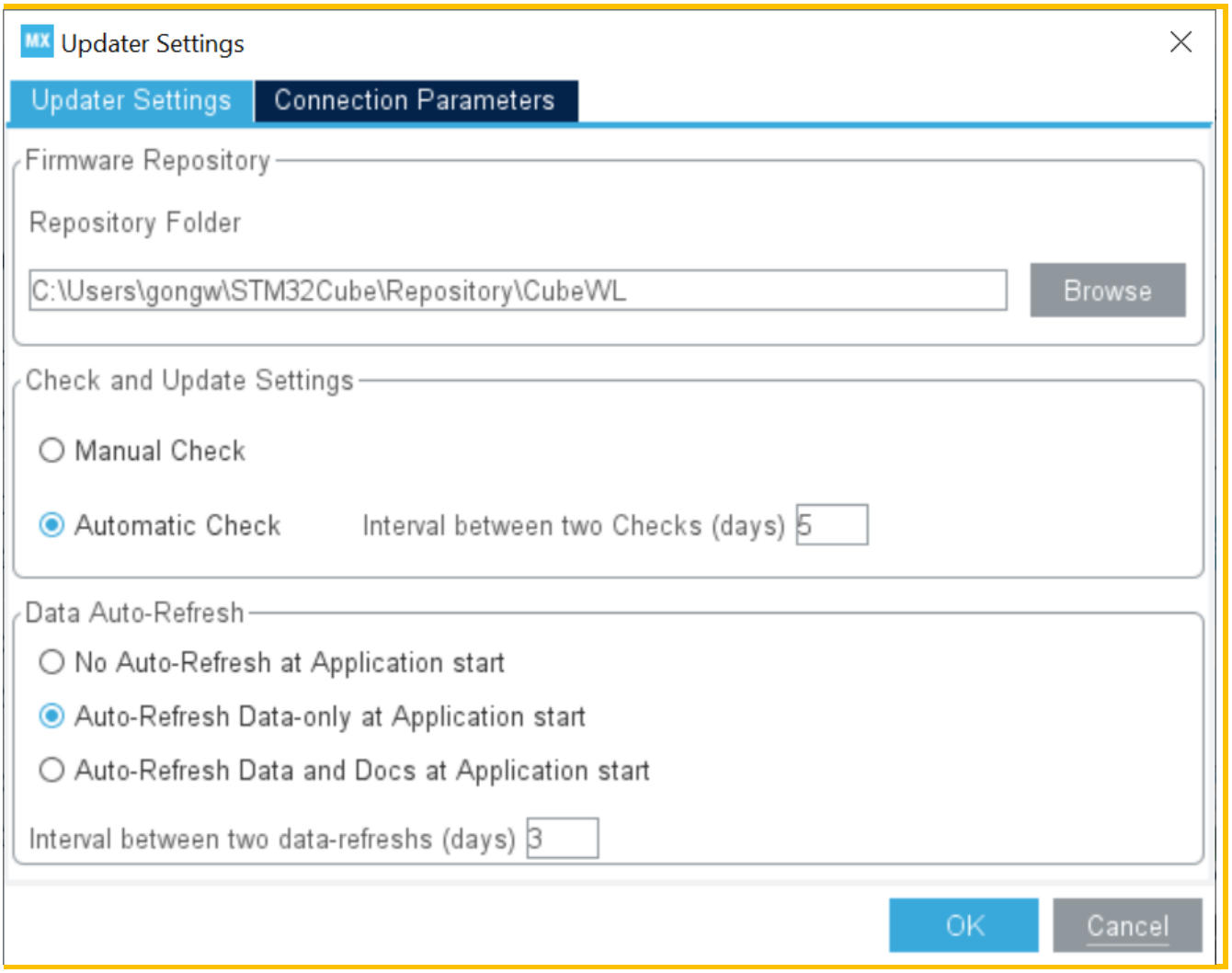
1.1 配置 CubeMX 并下载 CubeWL

可以使用 CubeMX 默认安装的仓库目录

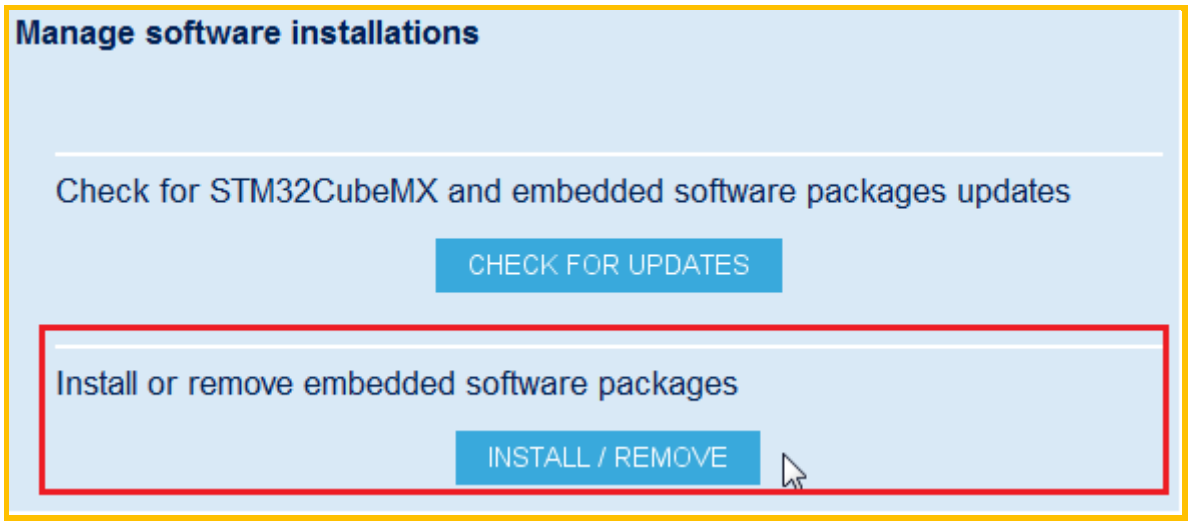
也可以自定义仓库目录，本例使用自定义的仓库目录 C:\Users\gongw\STM32Cube\Repository\CubeWL，如下

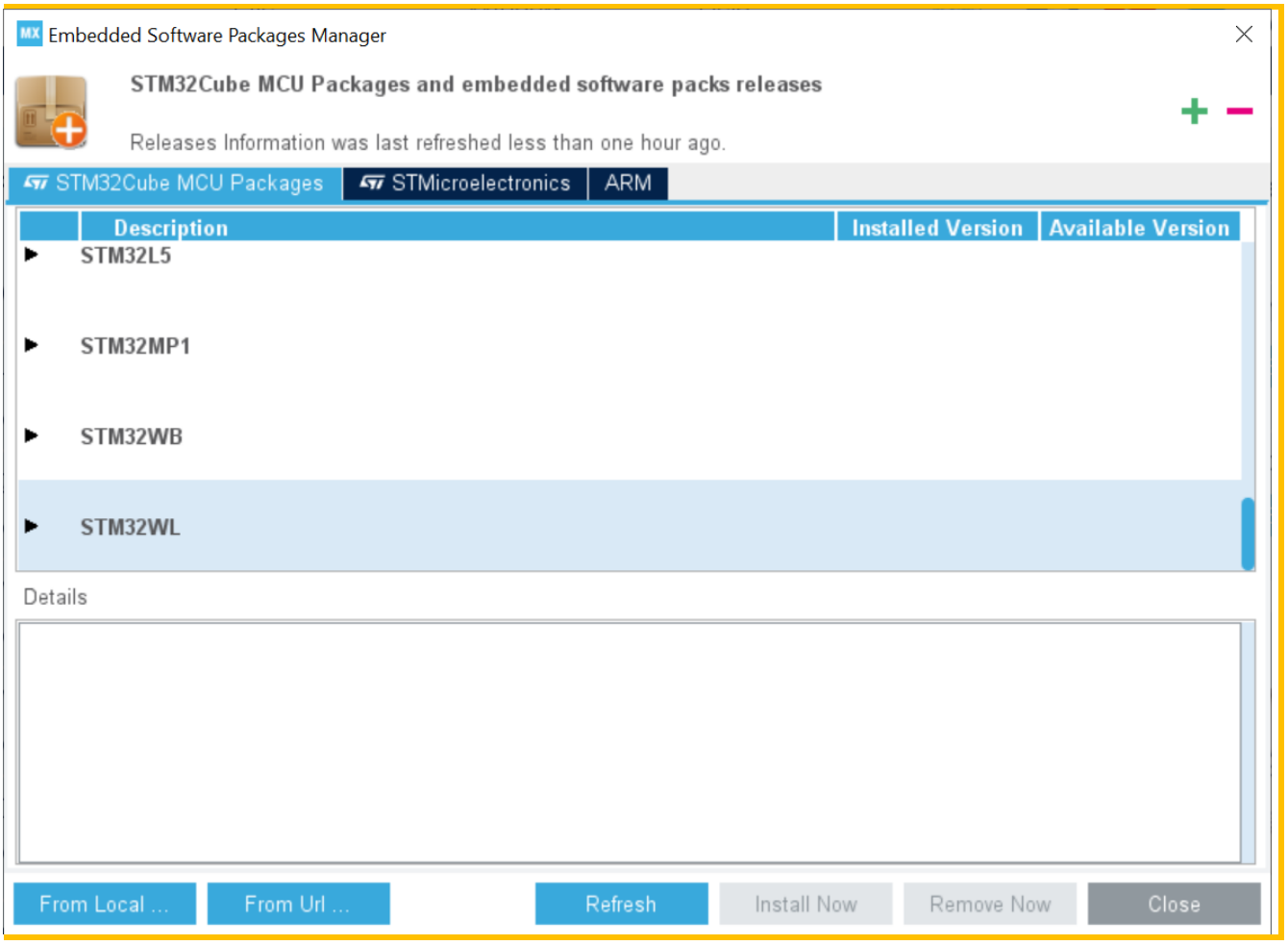
Help=>Updater Settings=>Repository Forlder=>C:\Users\gongw\STM32Cube\Repository\CubeWL=>OK



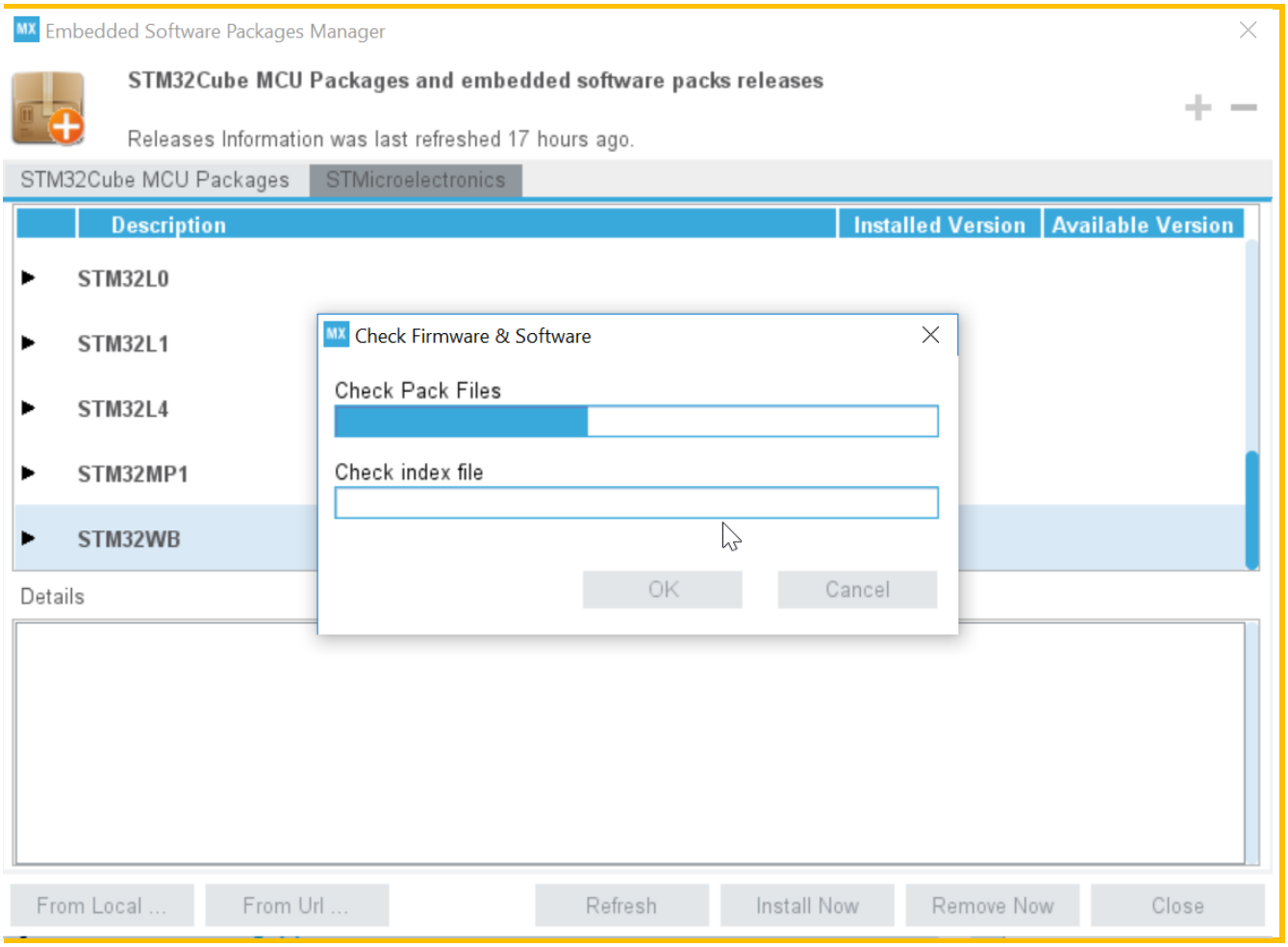


选择 Manage software installations 中的 Install or remove embedded software packages 下的 “INSTALL / REMOVE”

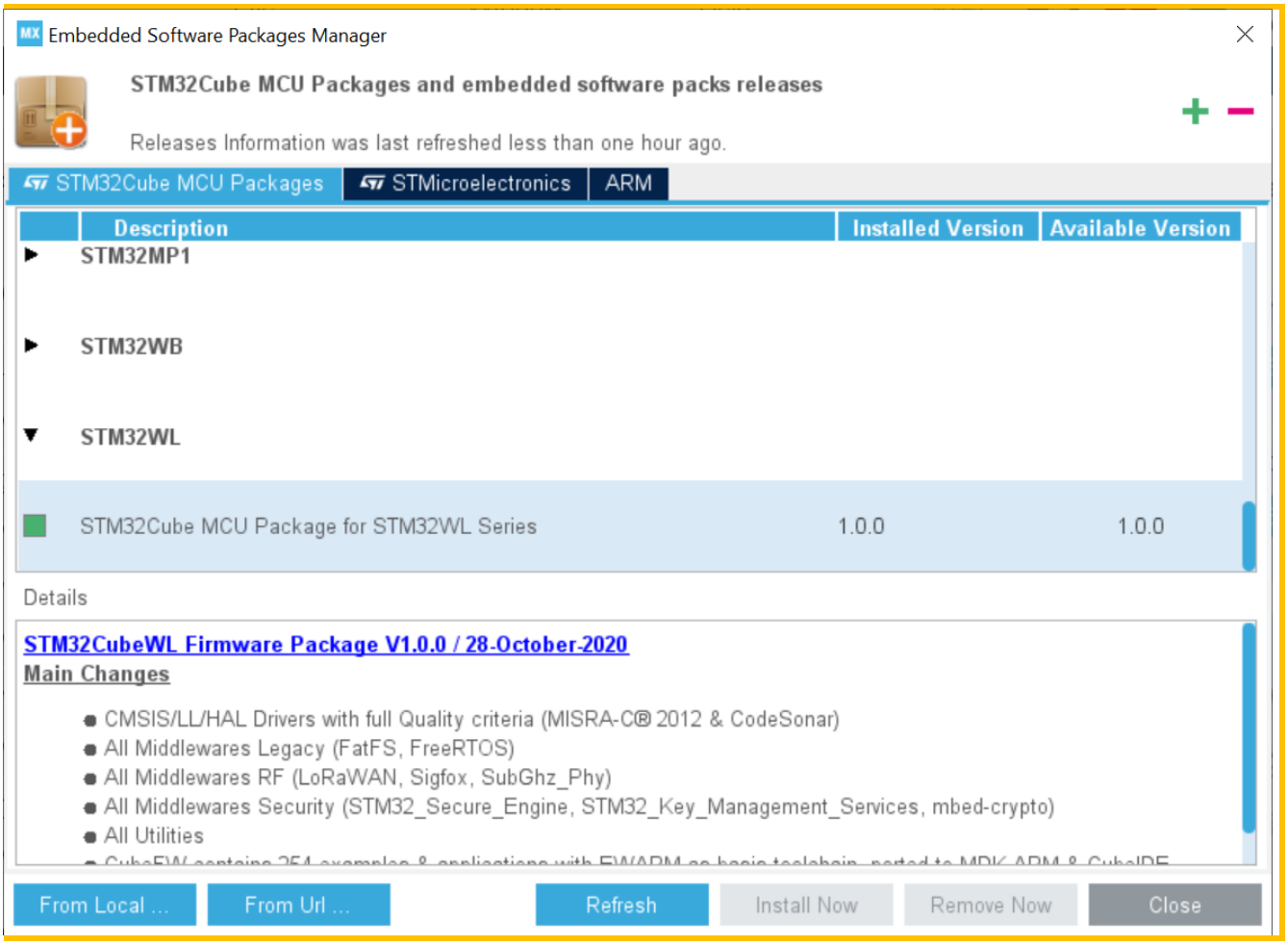




点 Refresh 更新数据库



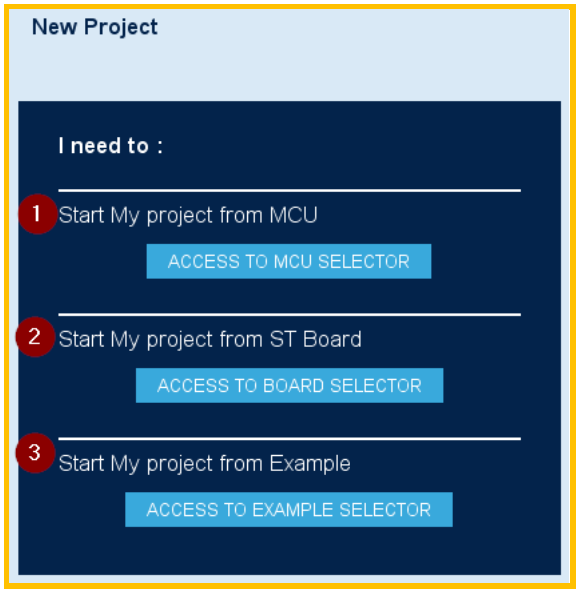
Fresh 结束后，点开 STM32WL 左侧的黑色三角，选中 STM32WL 下版本 1.0.0 的 STM32Cube MCU Package for STM32WL Series，点 Install Now



点击 Close

1.2 CubeMX 新建项目

打开 STM32CubeMX，在 New Project 下有三中选择，**请根据需求选择 New Project 的方式！**



1.2.1 Start My project from MCU

第 1 种可使用于所有的 WL 产品，只能生成和配置的用户自定义(User Defined)的 LoRaWAN/SigFox/SUBGHZ 应用，不能生成 CubeWL 中 AT_Slave/EndNode/PingPong demo

1.2.2 Start My project from BOARD

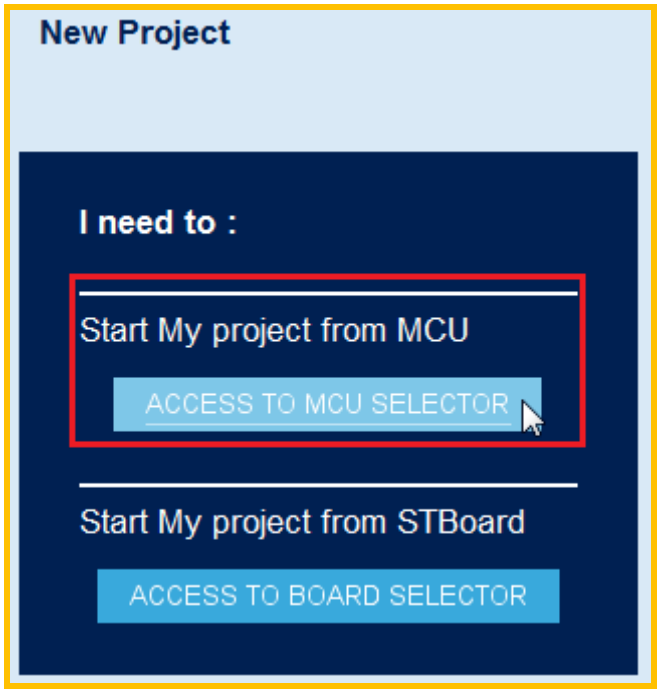
第 2 种适用于 NUCLEO-WL55JC1 和 NUCLEO-WL55JC1 两种 Demo 板，只能生成和配置的用户自定义(User Defined)的 LoRaWAN/SigFox/SUBGHZ 应用，不能生成 CubeWL 中 AT_Slave/EndNode/PingPong demo

1.2.3 Start My project from EXAMPLES

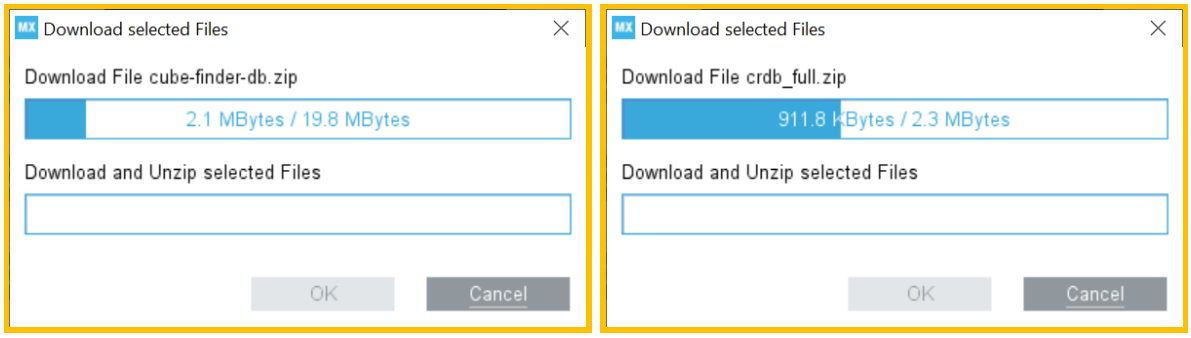
第 3 种适用于生成 CubeWL 中 NUCLEO-WL55JC1 和 NUCLEO-WL55JC1 的 Examples，可生成和配置 CubeWL 中 AT_Slave/EndNode/PingPong demo

1.2.4 Start My project from MCU STM32WLEx

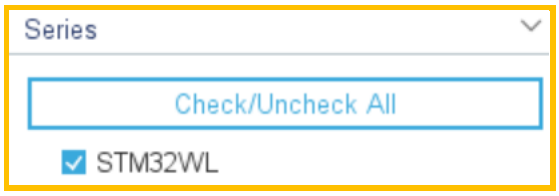
在 New Project 下选择，”Start My project from MCU ”下的”ACCESS TO MCU SELECTOR“



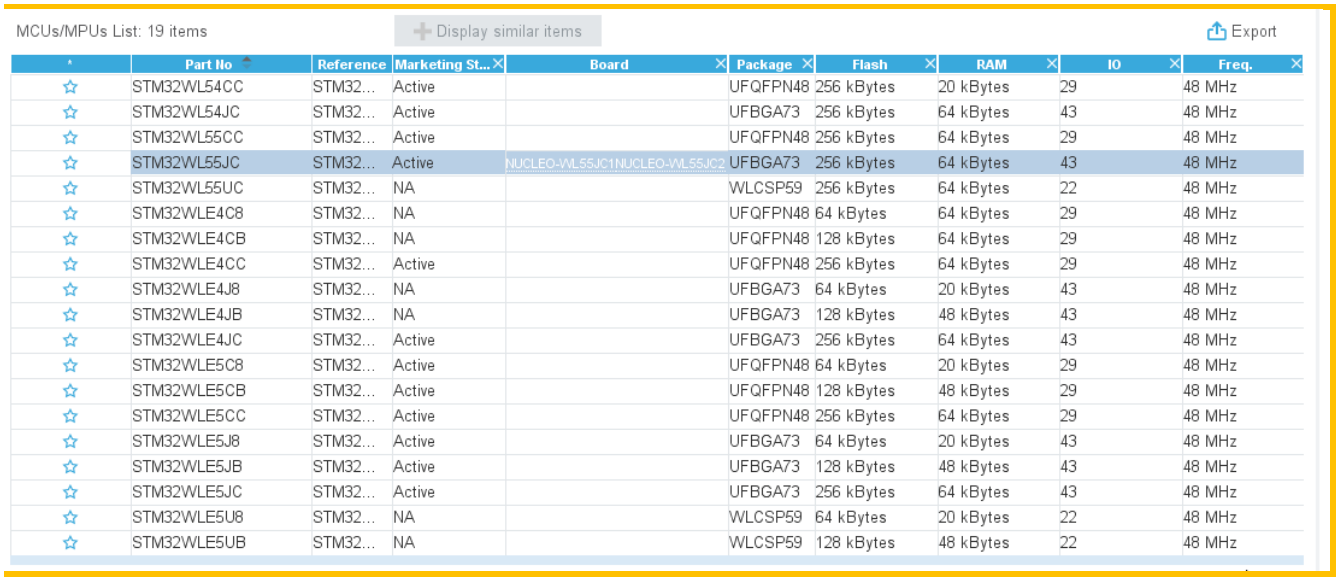
此过程中可能会更新些数据库，如



选择 Series 下的 STM32WL



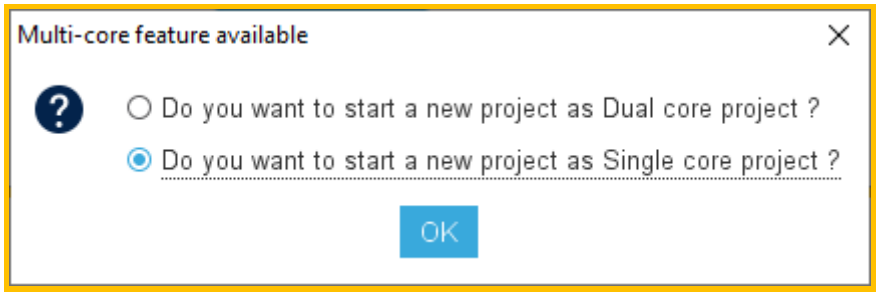
根据自己的需求选择 STM32WLE5Jx 中的任意一款

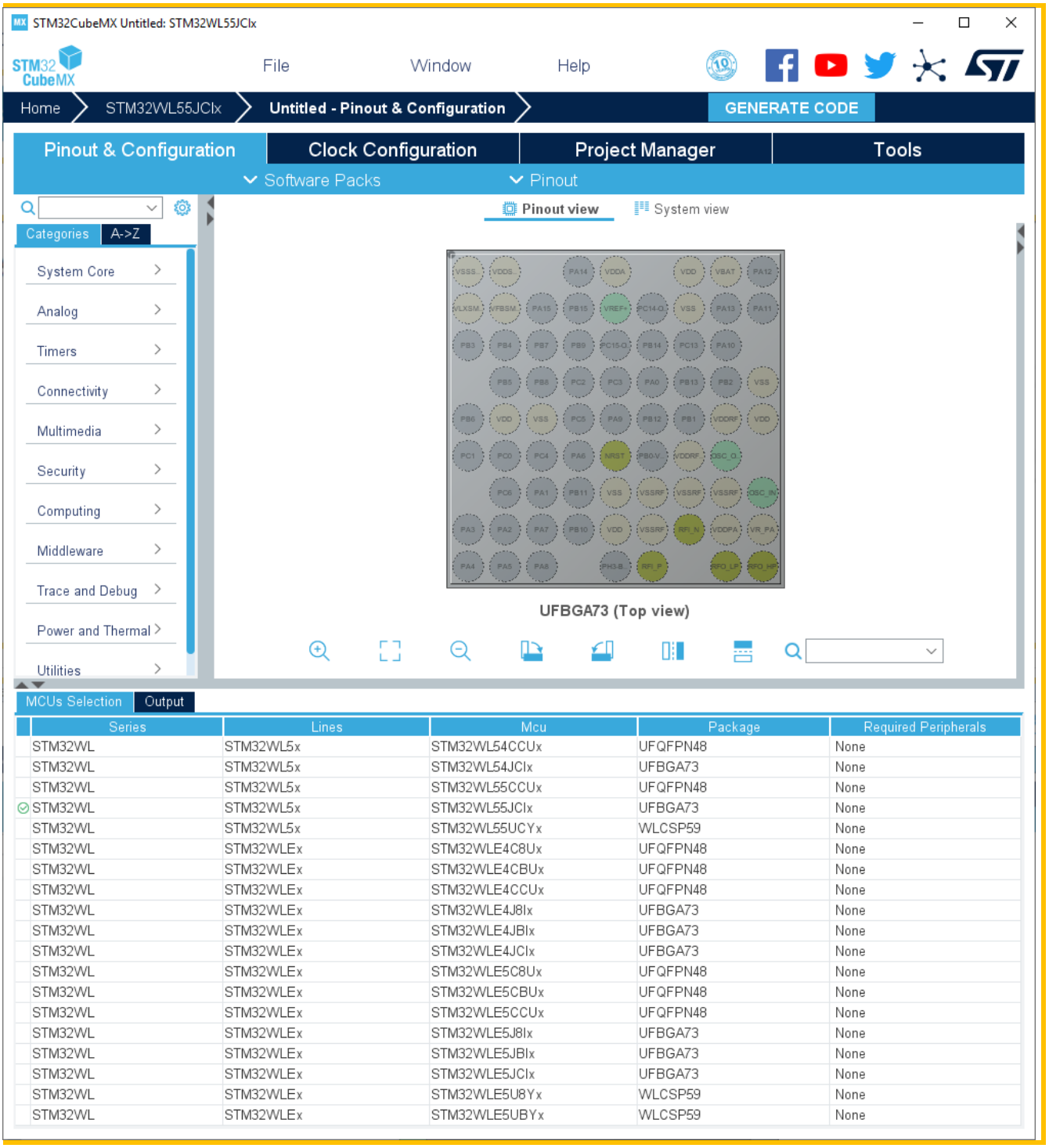


	Part No	Reference	Marketing St...	Board	Package	Flash	RAM	IO	Freq.
☆	STM32WL54CC	STM32...	Active		UFQFPN48	256 kBytes	20 kBytes	29	48 MHz
☆	STM32WL54JC	STM32...	Active		UFBGA73	256 kBytes	64 kBytes	43	48 MHz
☆	STM32WL55CC	STM32...	Active		UFQFPN48	256 kBytes	64 kBytes	29	48 MHz
☆	STM32WL55JC	STM32...	Active	NUCLEO-WL55JC1NUCLEO-WL55JC2	UFBGA73	256 kBytes	64 kBytes	43	48 MHz
☆	STM32WL55UC	STM32...	NA		WLCSP59	256 kBytes	64 kBytes	22	48 MHz
☆	STM32WLE4C8	STM32...	NA		UFQFPN48	64 kBytes	64 kBytes	29	48 MHz
☆	STM32WLE4CB	STM32...	NA		UFQFPN48	128 kBytes	64 kBytes	29	48 MHz
☆	STM32WLE4CC	STM32...	Active		UFQFPN48	256 kBytes	64 kBytes	29	48 MHz
☆	STM32WLE4J8	STM32...	NA		UFBGA73	64 kBytes	20 kBytes	43	48 MHz
☆	STM32WLE4JB	STM32...	NA		UFBGA73	128 kBytes	48 kBytes	43	48 MHz
☆	STM32WLE4JC	STM32...	Active		UFBGA73	256 kBytes	64 kBytes	43	48 MHz
☆	STM32WLE5C8	STM32...	Active		UFQFPN48	64 kBytes	20 kBytes	29	48 MHz
☆	STM32WLE5CB	STM32...	Active		UFQFPN48	128 kBytes	48 kBytes	29	48 MHz
☆	STM32WLE5CC	STM32...	Active		UFQFPN48	256 kBytes	64 kBytes	29	48 MHz
☆	STM32WLE5J8	STM32...	Active		UFBGA73	64 kBytes	20 kBytes	43	48 MHz
☆	STM32WLE5JB	STM32...	Active		UFBGA73	128 kBytes	48 kBytes	43	48 MHz
☆	STM32WLE5JC	STM32...	Active		UFBGA73	256 kBytes	64 kBytes	43	48 MHz
☆	STM32WLE5U8	STM32...	NA		WLCSP59	64 kBytes	20 kBytes	22	48 MHz
☆	STM32WLE5UB	STM32...	NA		WLCSP59	128 kBytes	48 kBytes	22	48 MHz

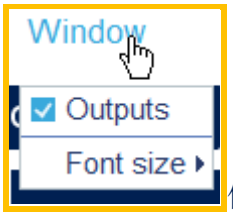
点击“Start Project”开始创建项目

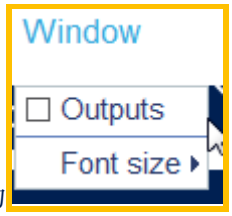
选择 Single Core Project，点击 OK



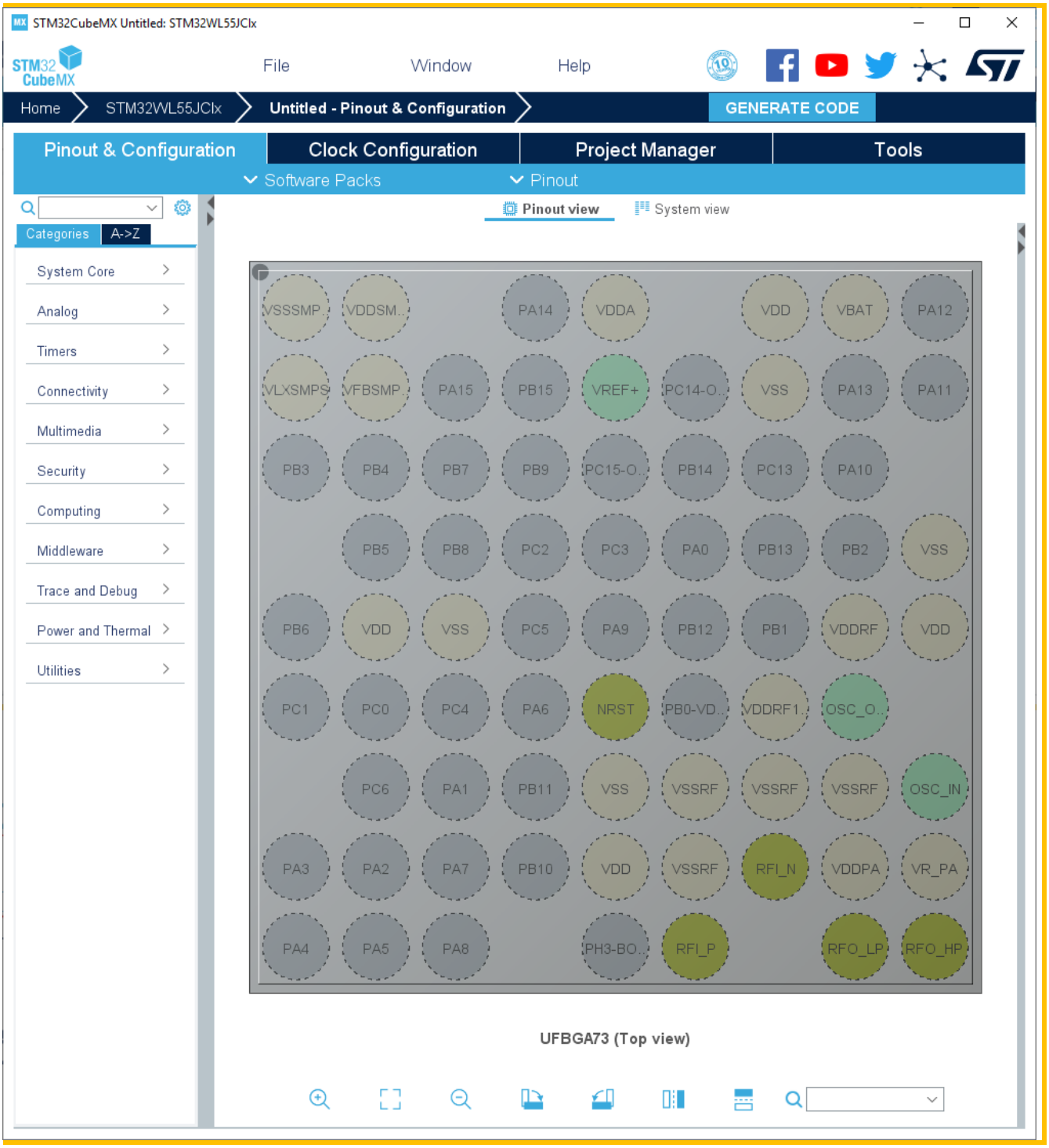


（可选）为最大化窗口，可在 Window 中取消 Output 窗口的选择

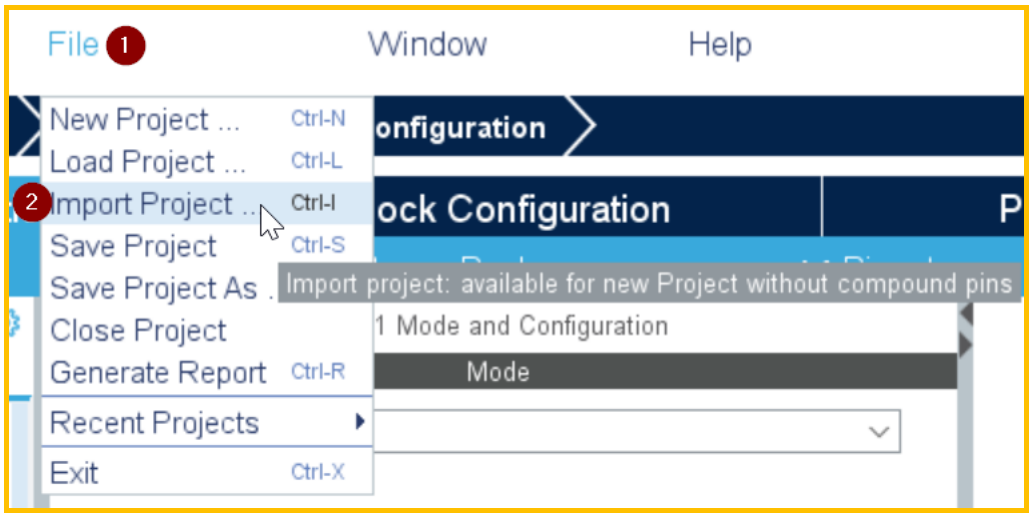
由 

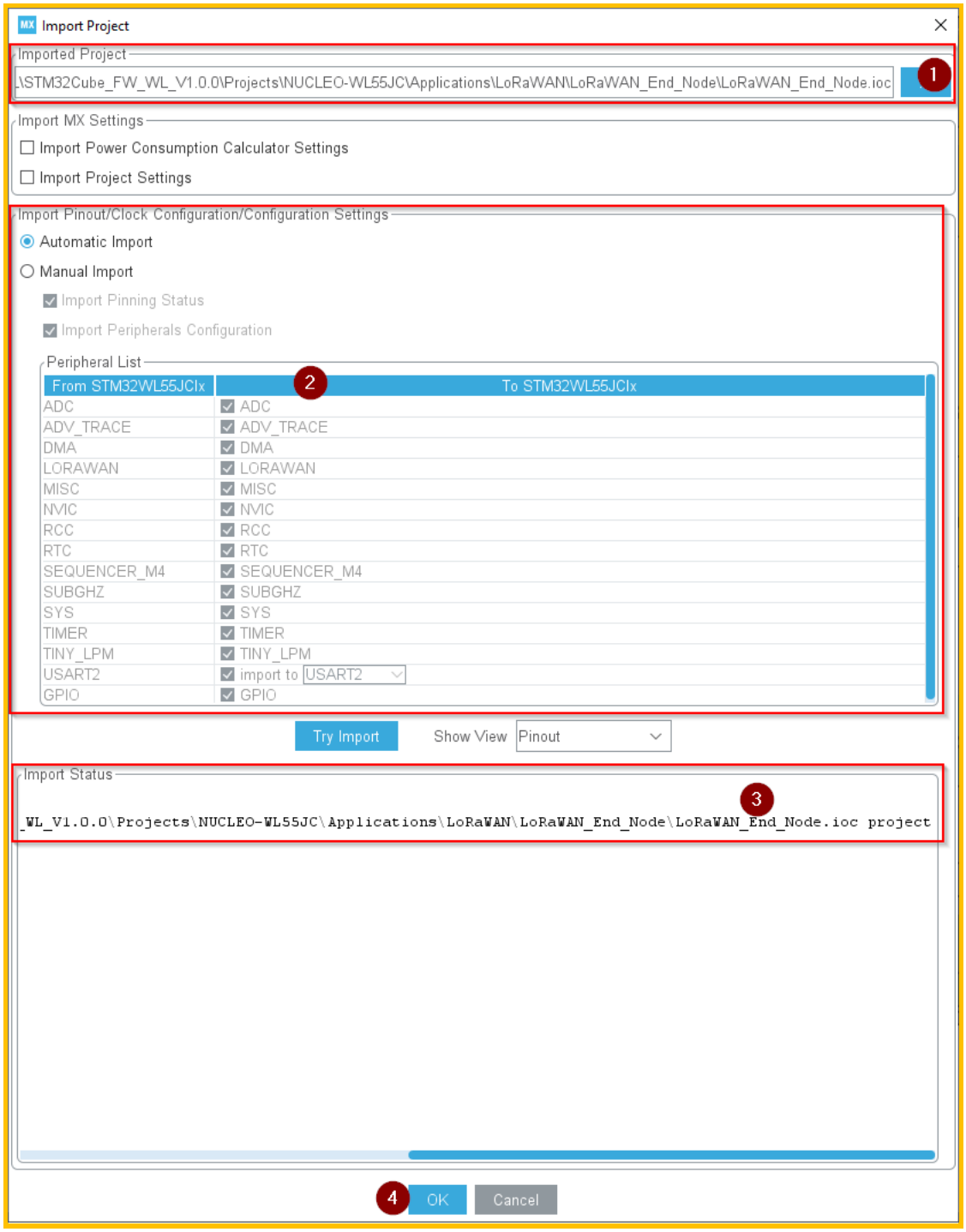
修改为 

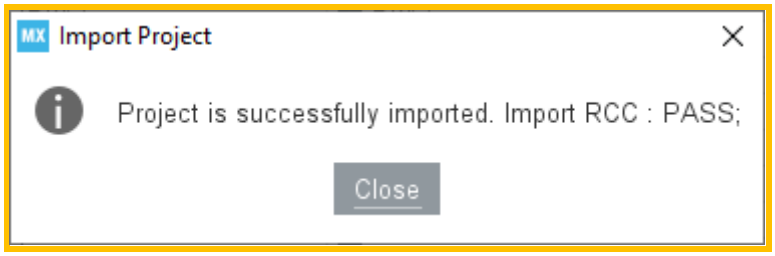
，则



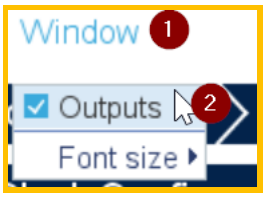
1.3 CubeMX 导入参考项目

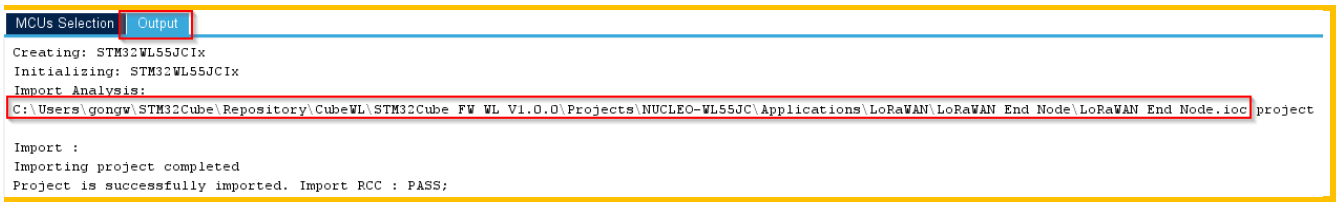

File
1
Window
Help
New Project ... Ctrl-N
Load Project ... Ctrl-L
2
Import Project ... Ctrl-I
Save Project Ctrl-S
Save Project As ...
Close Project
Generate Report Ctrl-R
Recent Projects
Exit Ctrl-X
onfiguration
ock Configuration
P
Import project: available for new Project without compound pins
1 Mode and Configuration
Mode


Import Project
Imported Project
\STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\LoRaWAN_End_Node\LoRaWAN_End_Node.ioc
1
Import MX Settings
Import Power Consumption Calculator Settings
Import Project Settings
Import Pinout/Clock Configuration/Configuration Settings
Automatic Import
Manual Import
Import Pinning Status
Import Peripherals Configuration
Peripheral List
2
From STM32WL55JCIx
To STM32WL55JCIx
ADC
ADV_TRACE
DMA
LORAWAN
MISC
NVIC
RCC
RTC
SEQUENCER_M4
SUBGHZ
SYS
TIMER
TINY_LPM
USART2
import to USART2
GPIO
Try Import
Show View
Pinout
Import Status
3
_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\LoRaWAN_End_Node\LoRaWAN_End_Node.ioc project
4
OK
Cancel


Import Project
Project is successfully imported. Import RCC : PASS;
Close

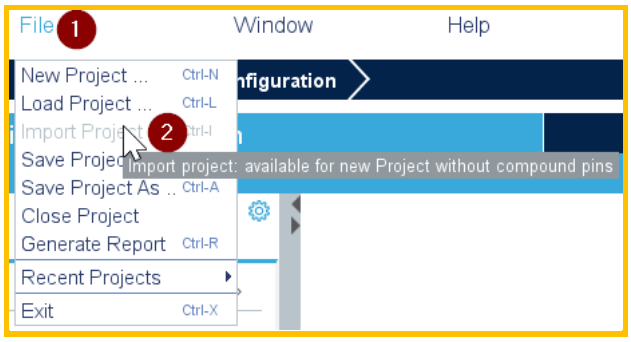
可通过 Window=>Output 切换是否查看 import 的提示 log






```
Creating: STM32WL55JCIx
Initializing: STM32WL55JCIx
Import Analysis:
C:\Users\gongw\STM32Cube\Repository\CubeWL\STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\LoRaWAN_End_Node\LoRaWAN_End_Node.ioc project

Import :
Importing project completed
Project is successfully imported. Import RCC : PASS;
```

此时再查看 File =>Import Project 选项，变为灰色，表示新项目已被配置，不能再 import 参考项目。



1.4 CubeMX 配置项目

1.4.1 CubeMX 配置 Project Manager

选择 Project Manager

1.4.1.1 配置 Project

选择右侧 Project 并配置如下：

```
Project Name: WLE5Jx_EndNode
Project Location :
C:\Users\gongw\STM32Cube\Repository\CubeWL\STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN
Application Structure : Advanced
```

Toolchain / IDE EWARM V8
Minimum Heap Size: 0x200
Minimum Stack Size: 0x800
CubeWL 版本: STM32Cube_FW_WL_V1.0.0

注意：

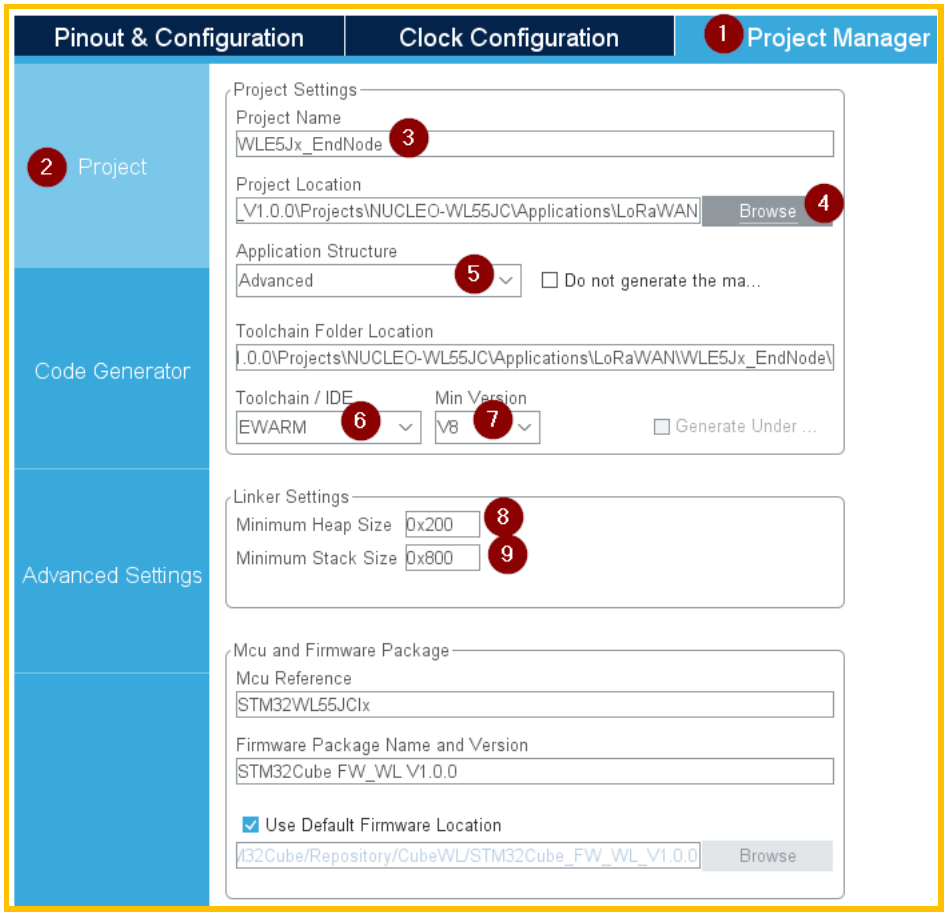
通过 Browse 选择 Project 保存的目录

- 项目名称 WLE5Jx_EndNode 创建在 STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN 下，和 LoRaWAN_End_Node 同级目录，即 C:\Users\gongw\STM32Cube\Repository\CubeWL\STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\WLE5Jx_EndNode，以便于与 LoRaWAN_End_Node 进行比较
- 配置 Application Structure 为 Advanced 与 basic 有什么区别?

Application Structure 为 Advanced 时目录结构分类分级目录更清晰。

Application Structure 为 Basic 时，所有的*.h 都在 WLE5Jx_EndNode\Inc 目录下，所有的*.c 在 WLE5Jx_EndNode\Src 目录下。

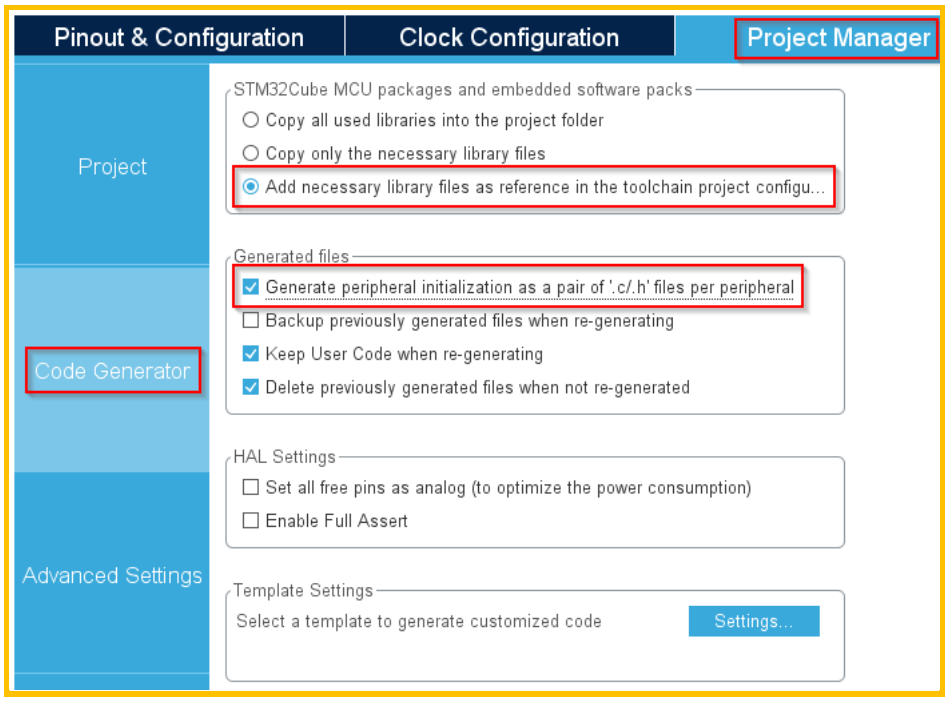
一旦生成过一次代码后目录结构就无法更改了！！！

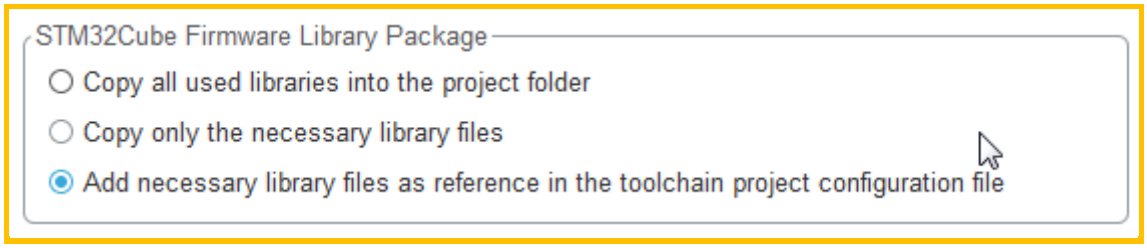


1.4.1.2 配置 Code Generator

选择右侧 Code Generator 并配置如下，选择”Add necessary library files as reference in the toolchain project configuration file “，这样将不生成 Drivers 和 Middlewares 目录。

选择 Generated files 下的 “Generate peripheral initialization as a pair of ‘.c/.h’ per peripheral ”

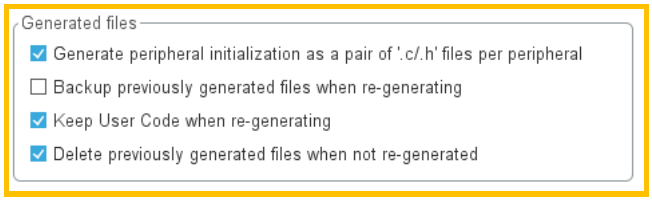




注意:

- Copy all used library Package (如复制 Drivers\STM32WLxx_HAL_Driver 下的所有驱动)
  WLE5Jx_EndNode 复制到其他目录下，还能工作
- Copy only the necessary library files(如仅复制 Drivers\STM32WLxx_HAL_Driver 下使用到的驱动)
  WLE5Jx_EndNode 复制到其他目录下，还能工作
- Add necessary library files as reference in the toolchain project configuration file(不生成 Drivers 和 Middlewares 目录，仅参考 Drivers\STM32WLxx_HAL_Driver 下的所有驱动)
  WLE5Jx_EndNode 复制到其他目录下，不能工作

参考 UM1718 4.9 Project Manager view

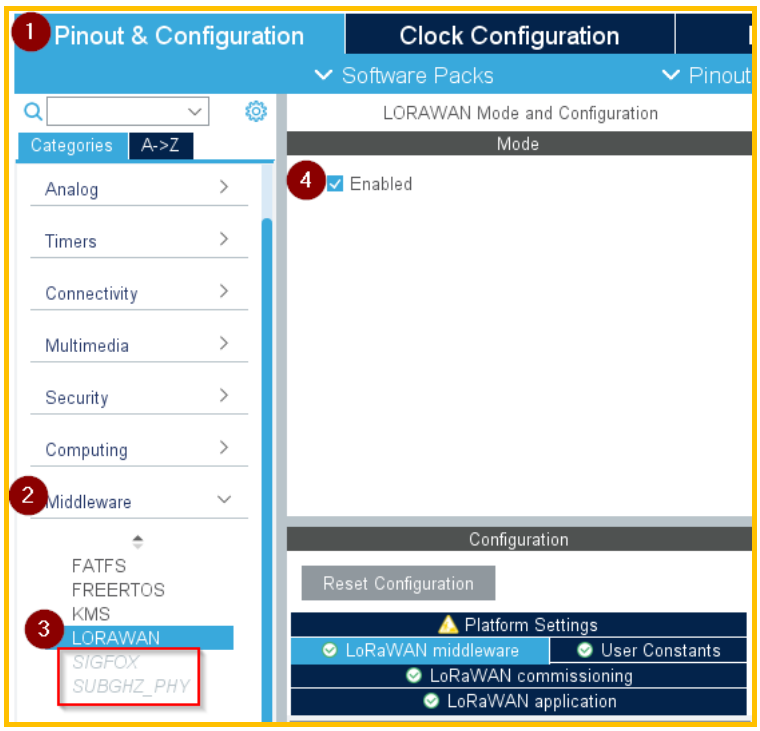


2 配置外设

2.1 使能外设

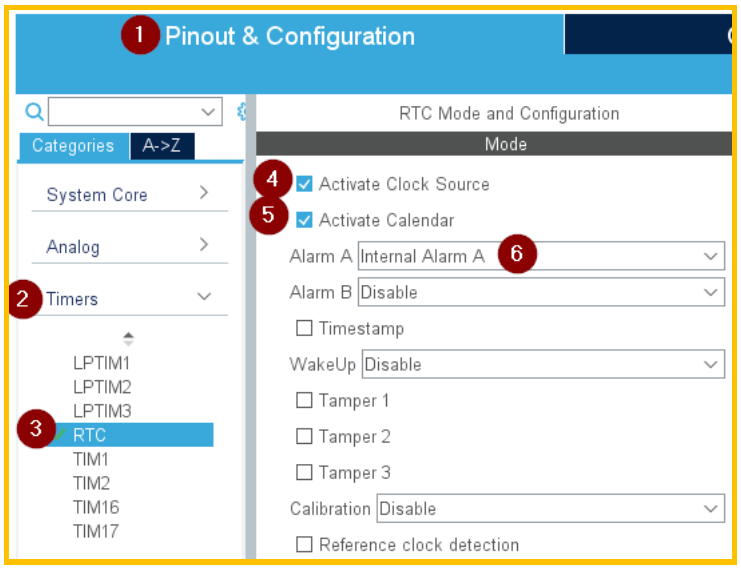
2.1.1 Middleware=>LORAWAN

Middleware=>LORAWAN=>Mode 中勾选 Enabled，LORAWAN 功能就使能了，同时 SIGFOX 和 SUBGHZ_PHY 就失能了，默认界面如下，后续再继续配置 LORAWAN 应用。



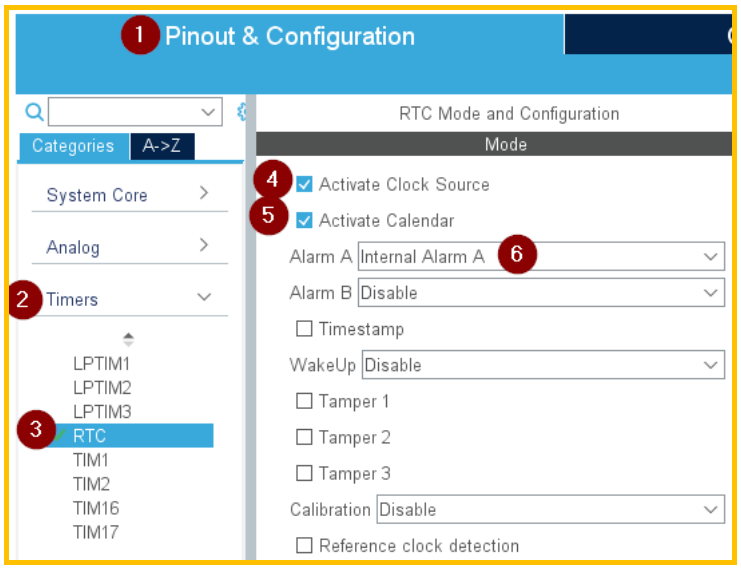
2.1.2 Timers=>RTC 使能

Timers=>RTC=>勾选 Activate Clock Source，并配置 Alarm A 为 Internal Alarm A



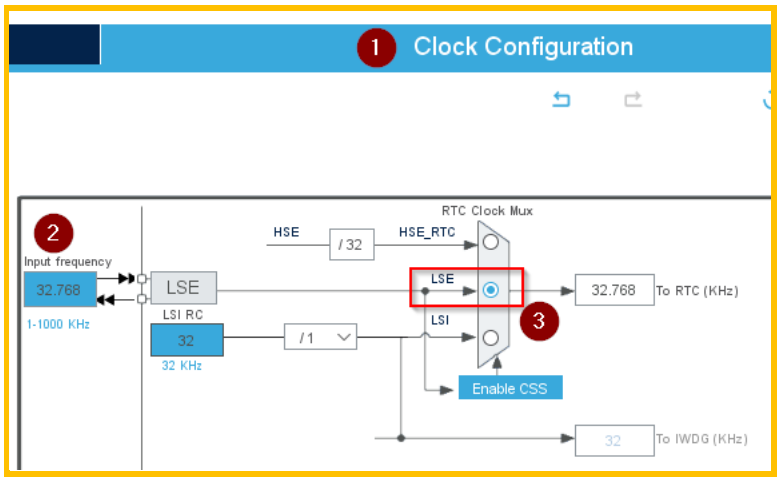
2.2 RTC

配置 Alarm A 为 Internal Alarm A

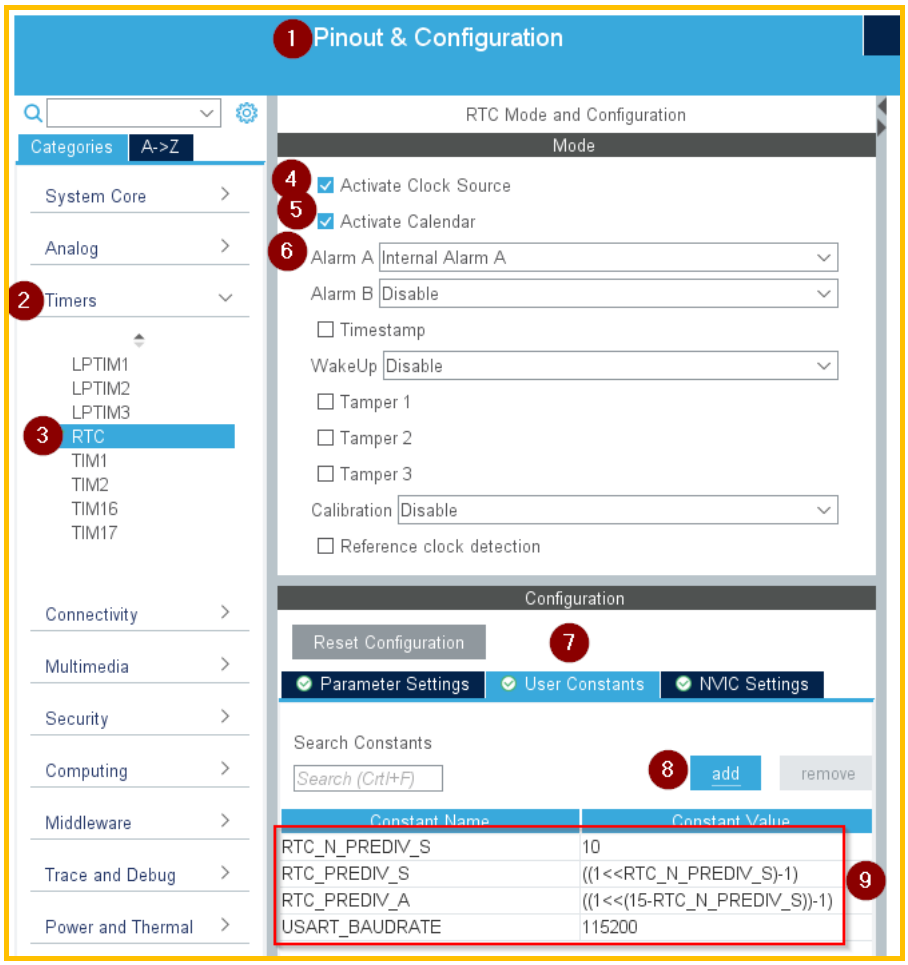


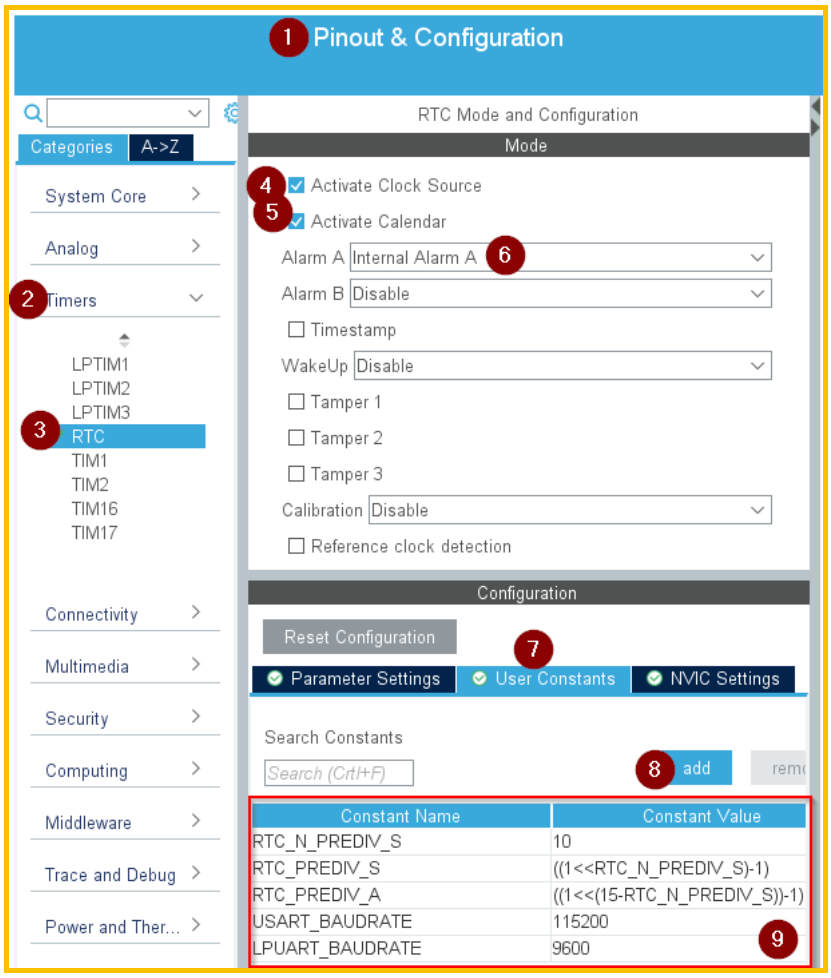
Clock Configuration => RTC Clock Mux=>LSE

在 Clock Configuration 中检查 RTC Clock Mux 是否配置为 LSE



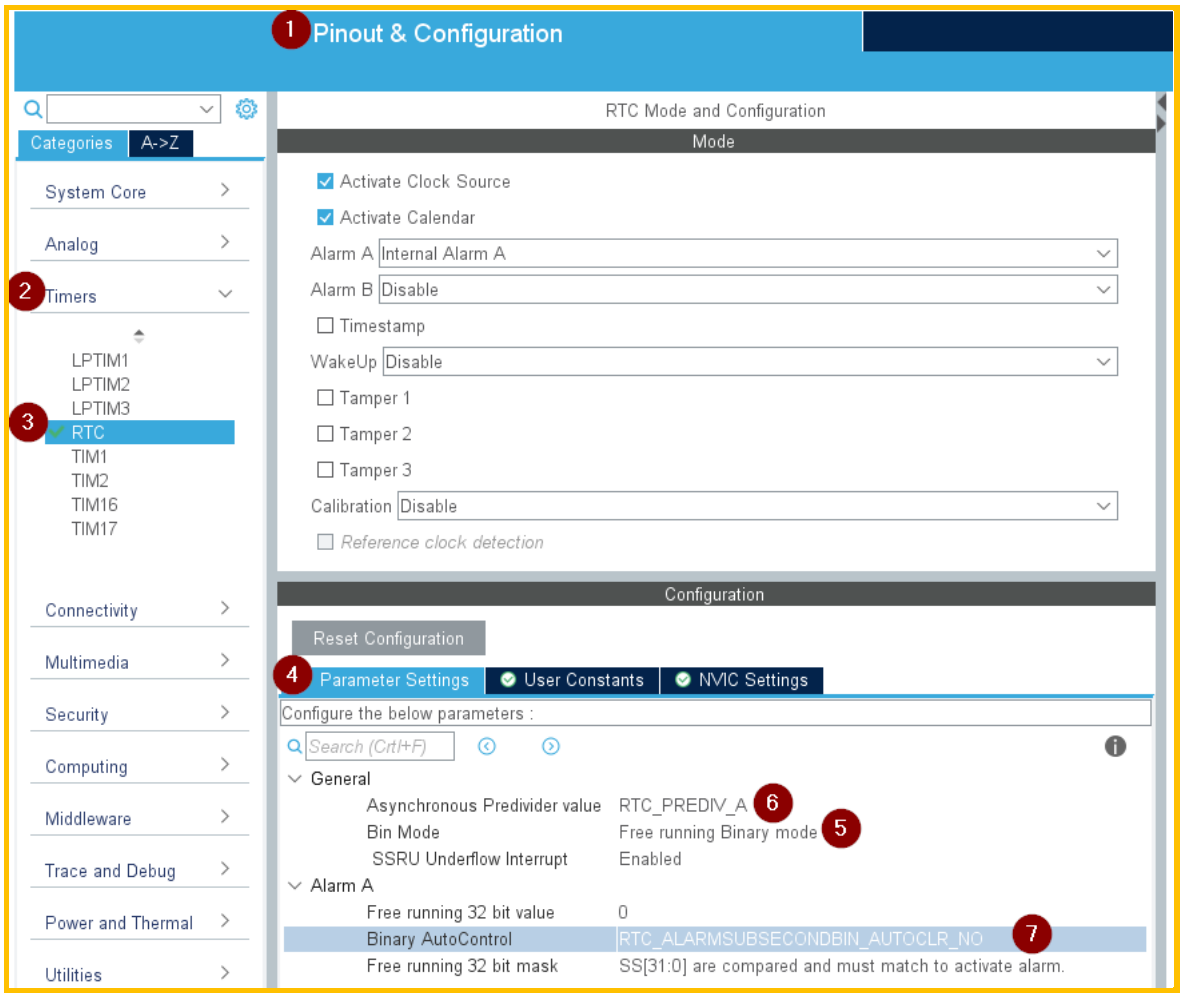
Timer =>RTC=>Users Constants


1 Pinout & Configuration
Categories
A->Z
System Core
Analog
2 Timers
LPTIM1
LPTIM2
LPTIM3
3 RTC
TIM1
TIM2
TIM16
TIM17
Connectivity
Multimedia
Security
Computing
Middleware
Trace and Debug
Power and Thermal
RTC Mode and Configuration
Mode
4 Activate Clock Source
5 Activate Calendar
6 Alarm A Internal Alarm A
Alarm B Disable
Timestamp
WakeUp Disable
Tamper 1
Tamper 2
Tamper 3
Calibration Disable
Reference clock detection
Configuration
Reset Configuration
7
Parameter Settings
User Constants
NVIC Settings
Search Constants
Search (Crtl+F)
8 add
remove
Constant Name
Constant Value
RTC_N_PREDIV_S
10
RTC_PREDIV_S
((1<<RTC_N_PREDIV_S)-1)
RTC_PREDIV_A
((1<<(15-RTC_N_PREDIV_S))-1)
USART_BAUDRATE
115200
9

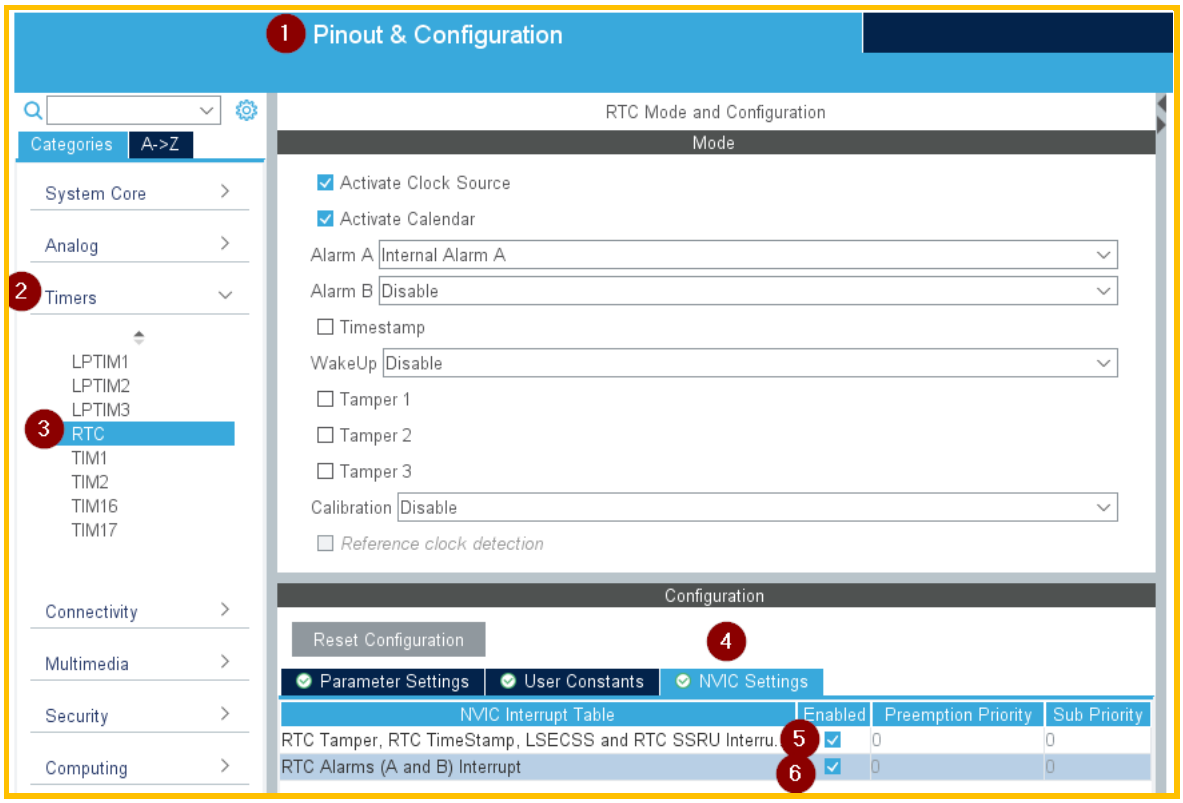


RTC_N_PREDIV_S	10
RTC_PREDIV_S	((1<<RTC_N_PREDIV_S)-1)
RTC_PREDIV_A	((1<<(15-RTC_N_PREDIV_S))-1)
USART_BAUDRATE	115200
LPUART_BAUDRATE	9600

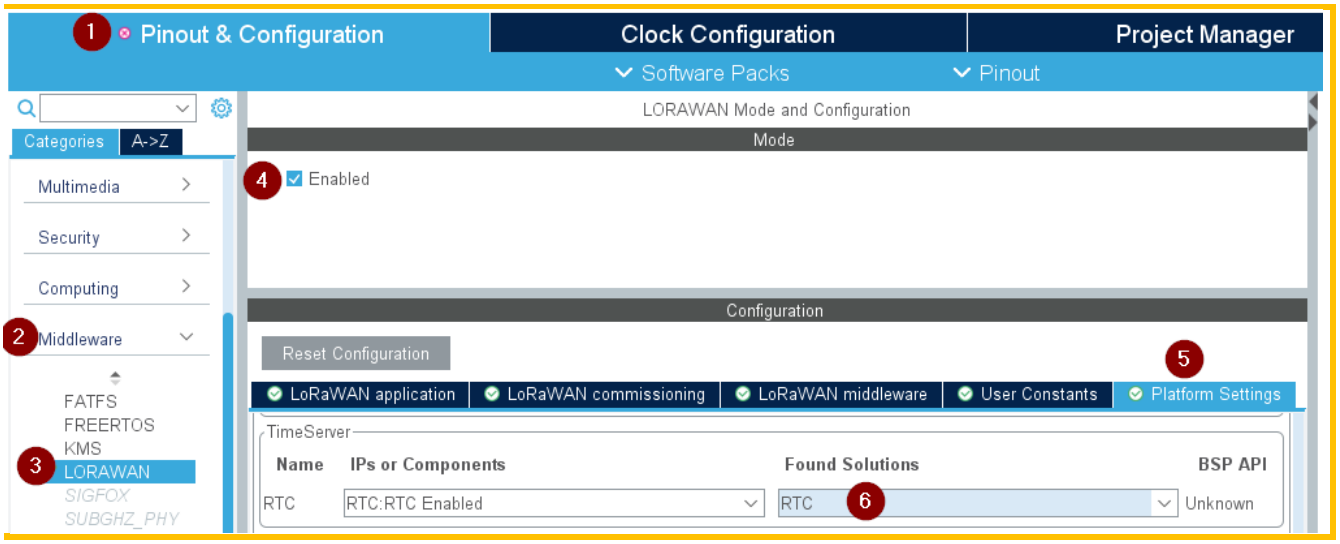
Timer =>RTC=>Parameter Settings



Timer =>RTC=>NVIC Settings

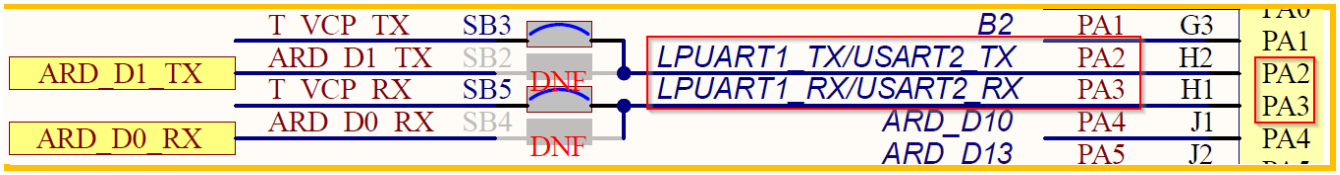


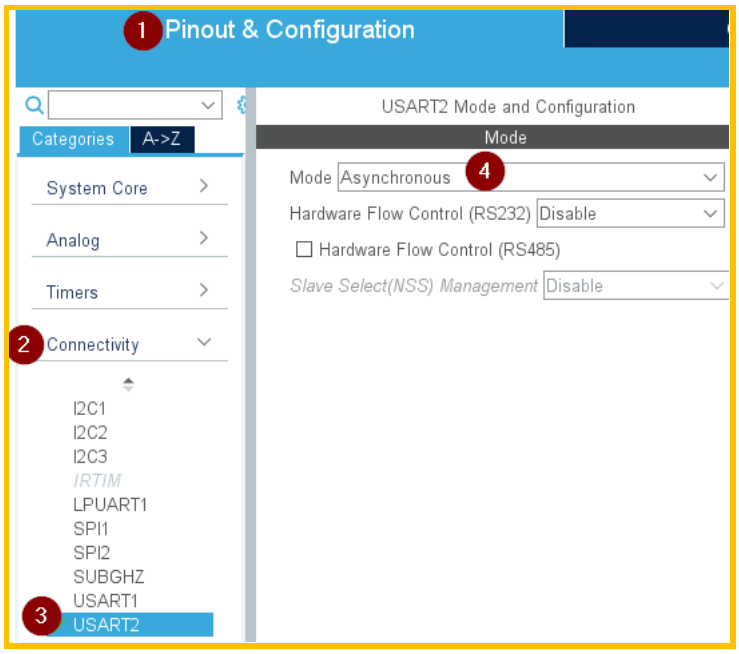
Middleware => LORAWAN => Platform Settings => Timer Server => RTC

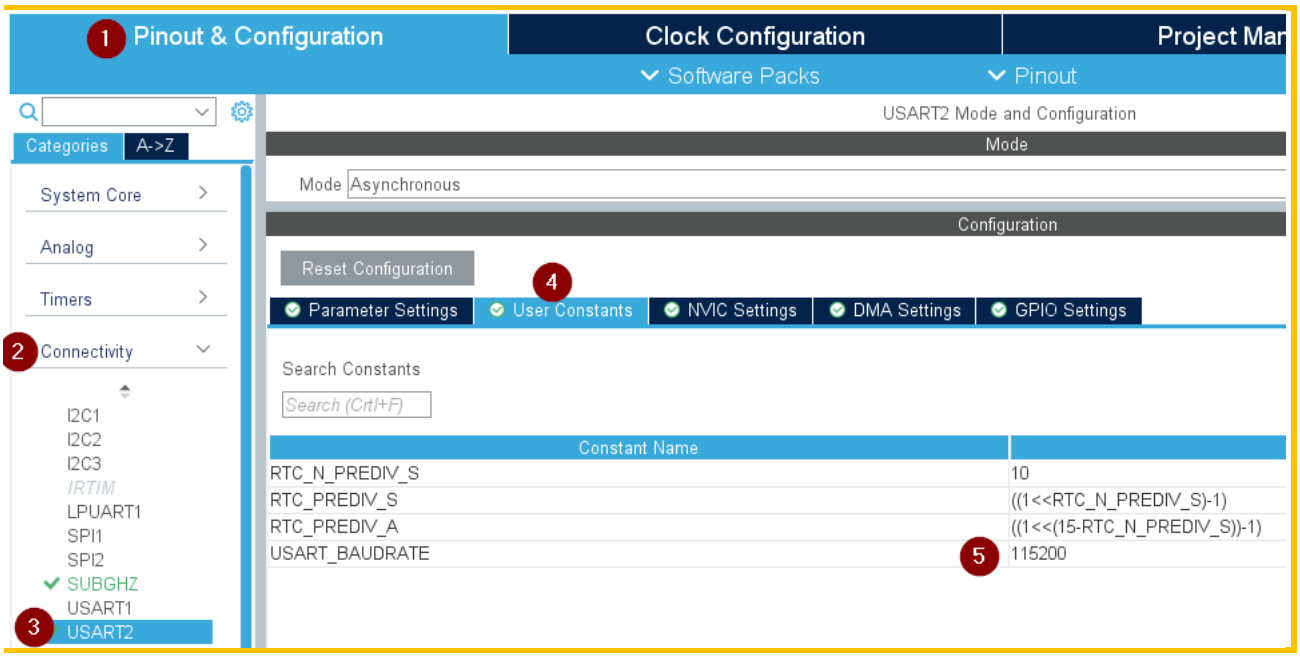


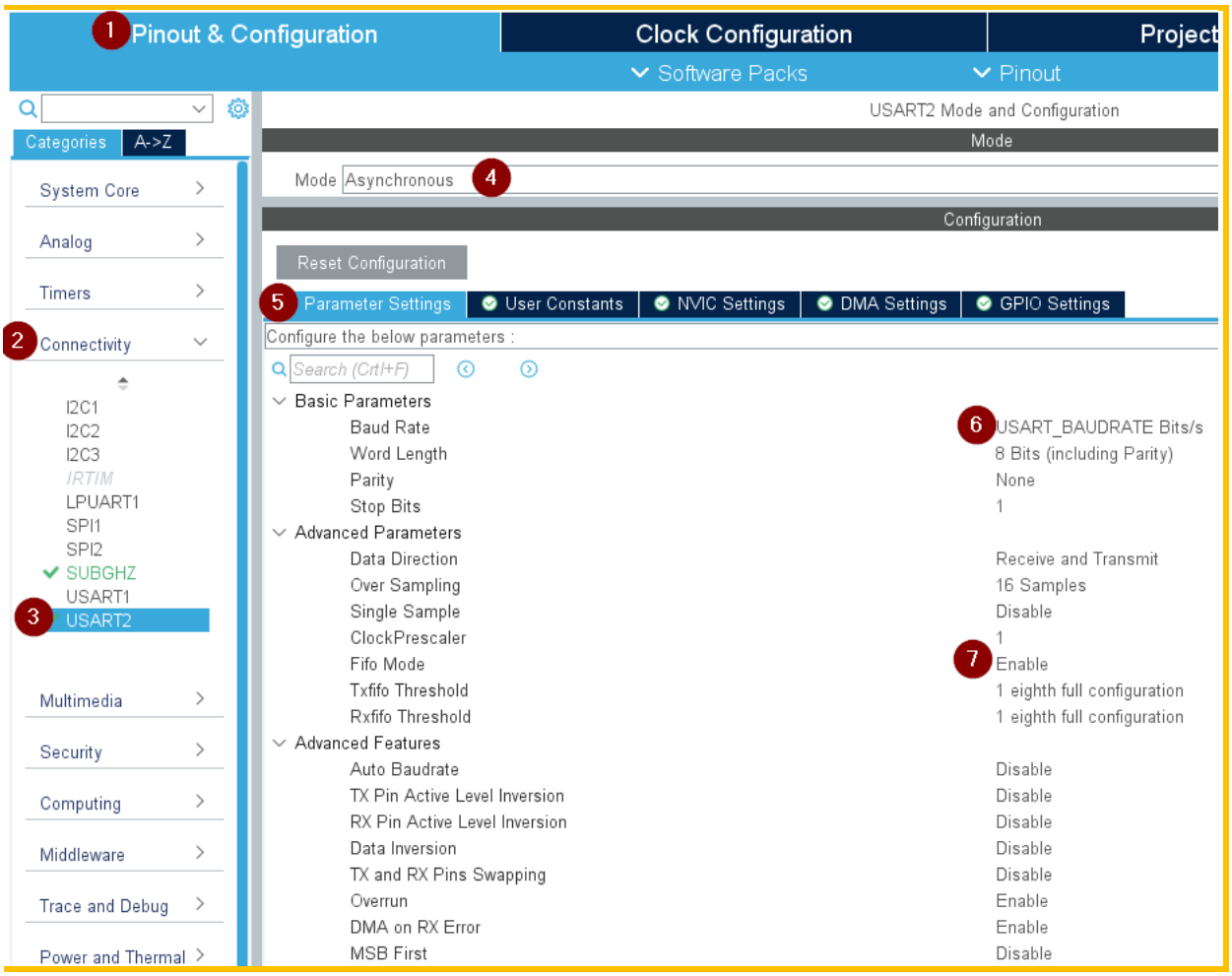
2.3 DebugLine

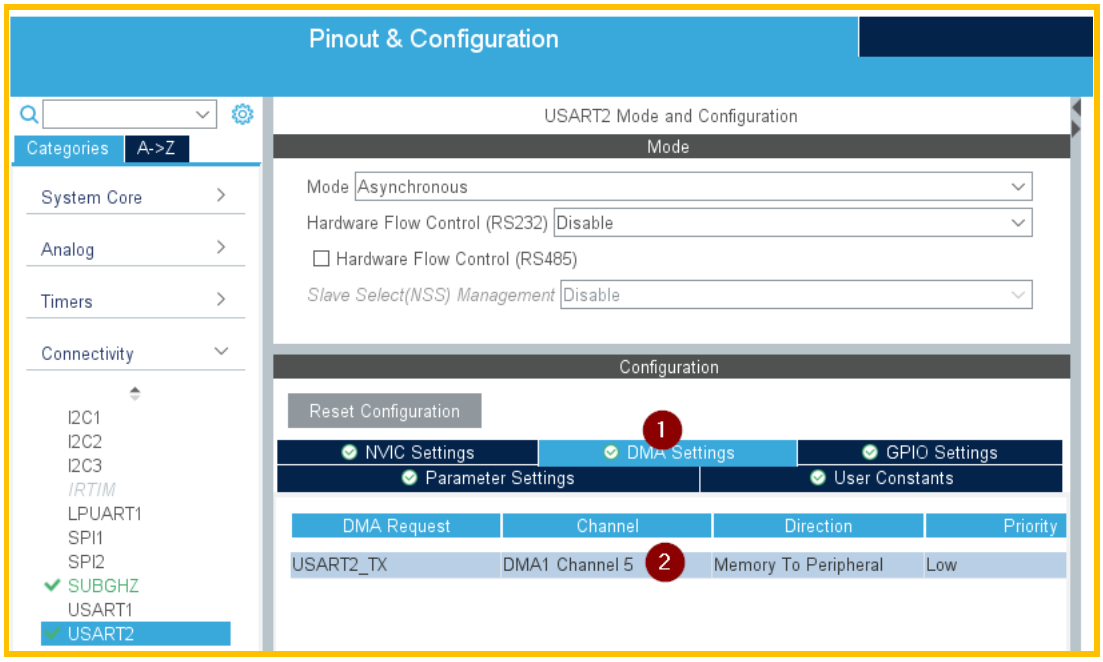
Connectivity=> USART2 (AT_Slave)

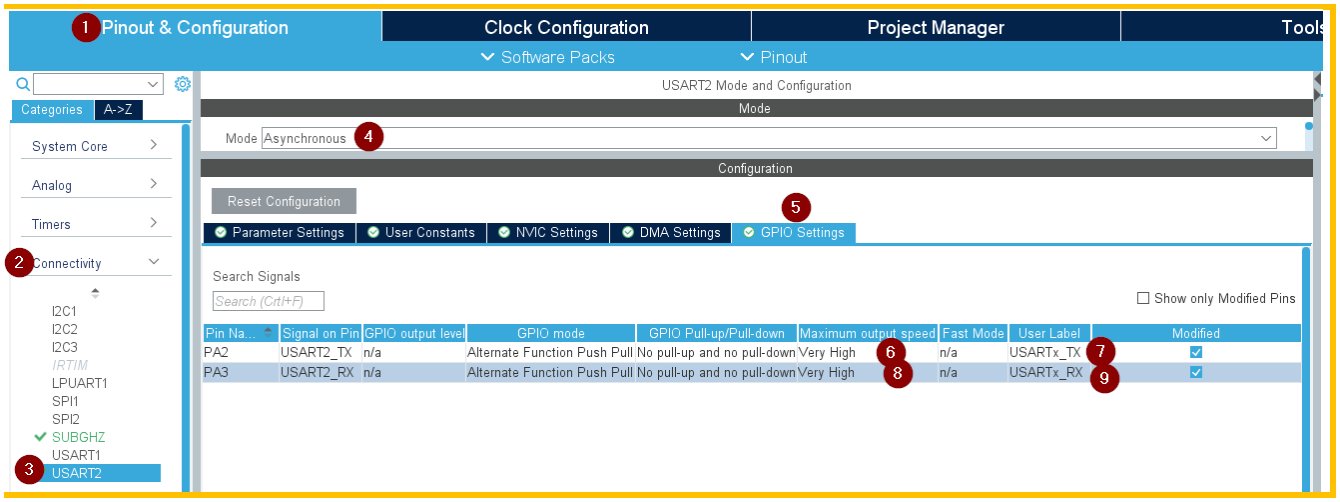


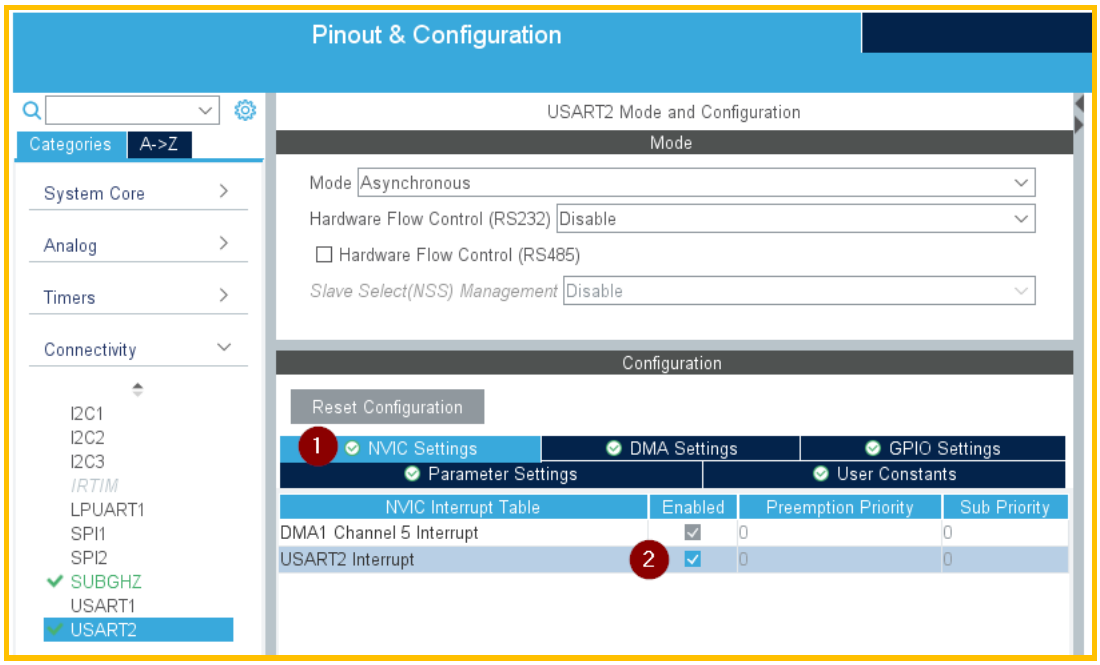

1 Pinout & Configuration
USART2 Mode and Configuration
Mode
Categories
A->Z
System Core
Analog
Timers
2 Connectivity
I2C1
I2C2
I2C3
IRTIM
LPUART1
SPI1
SPI2
SUBGHZ
USART1
3 USART2
Mode Asynchronous
4
Hardware Flow Control (RS232) Disable
Hardware Flow Control (RS485)
Slave Select(NSS) Management Disable

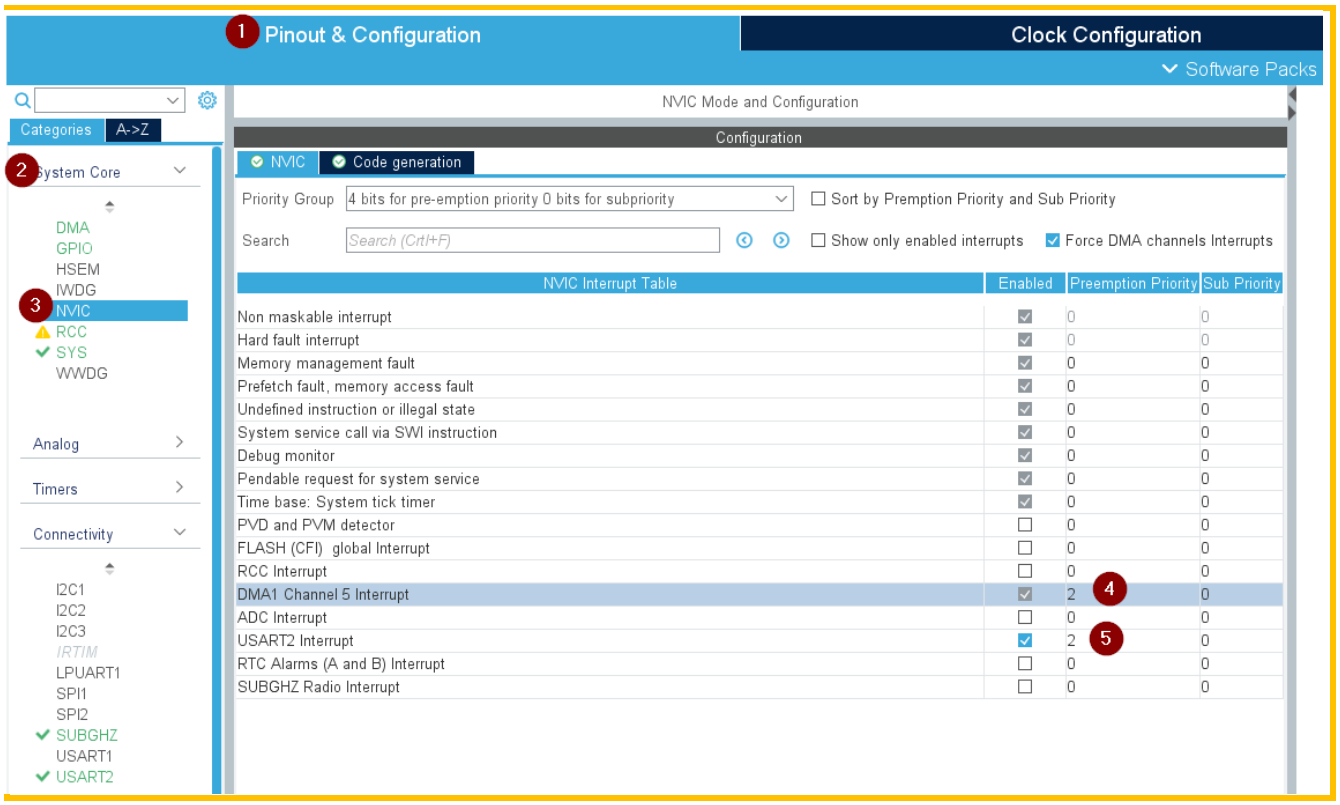

1 Pinout & Configuration
Clock Configuration
Project Mar
Software Packs
Pinout
USART2 Mode and Configuration
Mode
Categories
A->Z
System Core
Analog
Timers
2 Connectivity
I2C1
I2C2
I2C3
IRTIM
LPUART1
SPI1
SPI2
SUBGHZ
USART1
3 USART2
Mode Asynchronous
Configuration
Reset Configuration
4
Parameter Settings
User Constants
NVIC Settings
DMA Settings
GPIO Settings
Search Constants
Search (Crtl+F)
Constant Name
RTC_N_PREDIV_S 10
RTC_PREDIV_S ((1<<RTC_N_PREDIV_S)-1)
RTC_PREDIV_A ((1<<(15-RTC_N_PREDIV_S))-1)
USART_BAUDRATE 5 115200


1 Pinout & Configuration
Clock Configuration
Project
Software Packs
Pinout
Categories
A->Z
System Core
Analog
Timers
2 Connectivity
I2C1
I2C2
I2C3
IRTIM
LPUART1
SPI1
SPI2
SUBGHZ
USART1
3 USART2
Multimedia
Security
Computing
Middleware
Trace and Debug
Power and Thermal
USART2 Mode and Configuration
Mode
Mode Asynchronous
4
Configuration
Reset Configuration
5 Parameter Settings
User Constants
NVIC Settings
DMA Settings
GPIO Settings
Configure the below parameters :
Search (Crtl+F)
Basic Parameters
Baud Rate
6 USART_BAUDRATE Bits/s
Word Length
8 Bits (including Parity)
Parity
None
Stop Bits
1
Advanced Parameters
Data Direction
Receive and Transmit
Over Sampling
16 Samples
Single Sample
Disable
ClockPrescaler
1
Fifo Mode
7 Enable
Txfifo Threshold
1 eighth full configuration
Rxfifo Threshold
1 eighth full configuration
Advanced Features
Auto Baudrate
Disable
TX Pin Active Level Inversion
Disable
RX Pin Active Level Inversion
Disable
Data Inversion
Disable
TX and RX Pins Swapping
Disable
Overrun
Enable
DMA on RX Error
Enable
MSB First
Disable

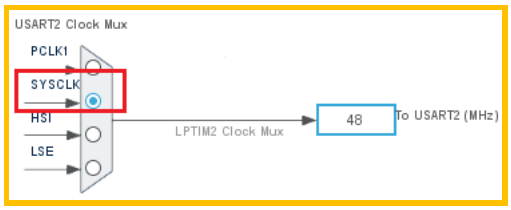

Pinout & Configuration
Categories
A->Z
System Core
Analog
Timers
Connectivity
I2C1
I2C2
I2C3
IRTIM
LPUART1
SPI1
SPI2
SUBGHZ
USART1
USART2
USART2 Mode and Configuration
Mode
Mode Asynchronous
Hardware Flow Control (RS232) Disable
Hardware Flow Control (RS485)
Slave Select(NSS) Management Disable
Configuration
Reset Configuration
1
NVIC Settings
DMA Settings
GPIO Settings
Parameter Settings
User Constants
DMA Request
Channel
Direction
Priority
USART2_TX
DMA1 Channel 5
2
Memory To Peripheral
Low


1 Pinout & Configuration
Clock Configuration
Project Manager
Tools
Software Packs
Pinout
Categories
A->Z
System Core
Analog
Timers
2 Connectivity
I2C1
I2C2
I2C3
IRTIM
LPUART1
SPI1
SPI2
SUBGHZ
USART1
3 USART2
USART2 Mode and Configuration
Mode
Mode Asynchronous 4
Configuration
Reset Configuration
5
Parameter Settings
User Constants
NVIC Settings
DMA Settings
GPIO Settings
Search Signals
Search (Crtl+F)
Show only Modified Pins
Pin Na...
Signal on Pin
GPIO output level
GPIO mode
GPIO Pull-up/Pull-down
Maximum output speed
Fast Mode
User Label
Modified
PA2 USART2_TX n/a Alternate Function Push Pull No pull-up and no pull-down Very High 6 n/a USARTx_TX 7
PA3 USART2_RX n/a Alternate Function Push Pull No pull-up and no pull-down Very High 8 n/a USARTx_RX 9

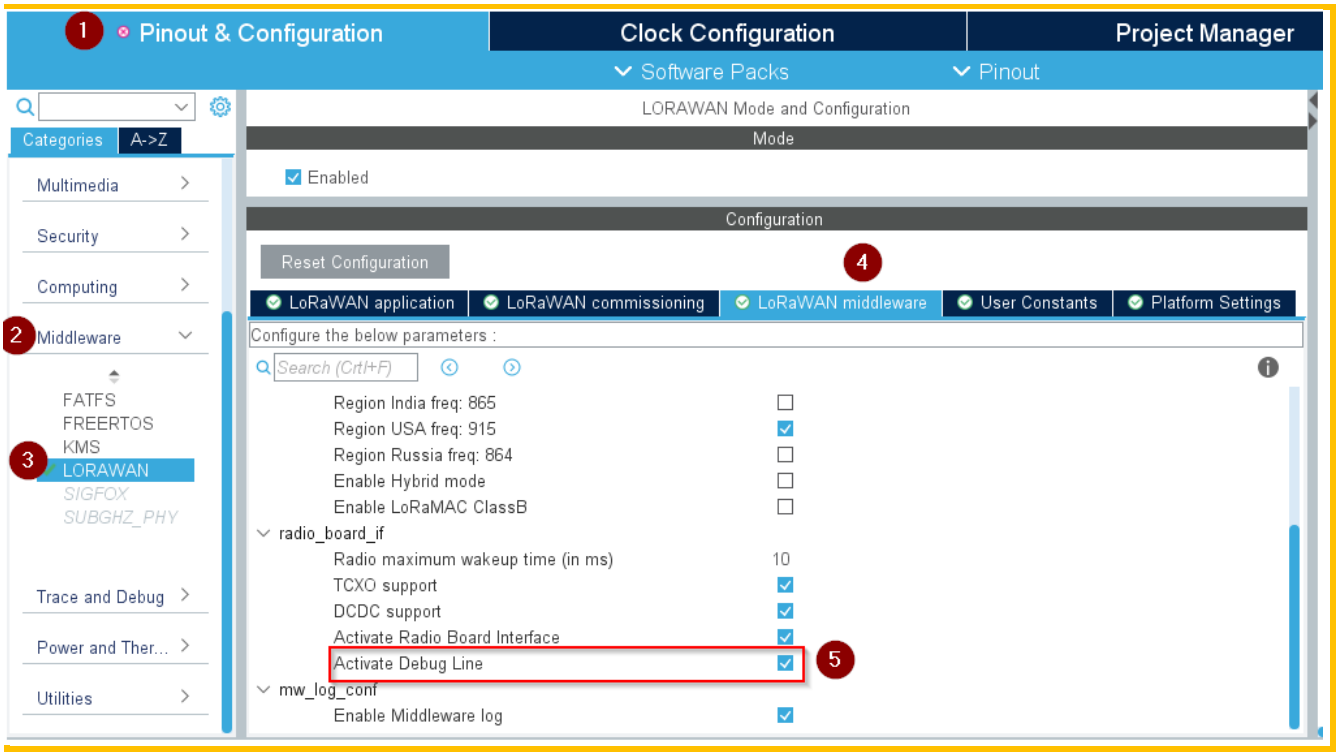

Pinout & Configuration
Categories
A->Z
System Core
Analog
Timers
Connectivity
I2C1
I2C2
I2C3
IRTIM
LPUART1
SPI1
SPI2
SUBGHZ
USART1
USART2
USART2 Mode and Configuration
Mode
Mode Asynchronous
Hardware Flow Control (RS232) Disable
Hardware Flow Control (RS485)
Slave Select(NSS) Management Disable
Configuration
Reset Configuration
1 NVIC Settings
DMA Settings
GPIO Settings
Parameter Settings
User Constants
NVIC Interrupt Table
Enabled
Preemption Priority
Sub Priority
DMA1 Channel 5 Interrupt 0 0
USART2 Interrupt 2 0 0



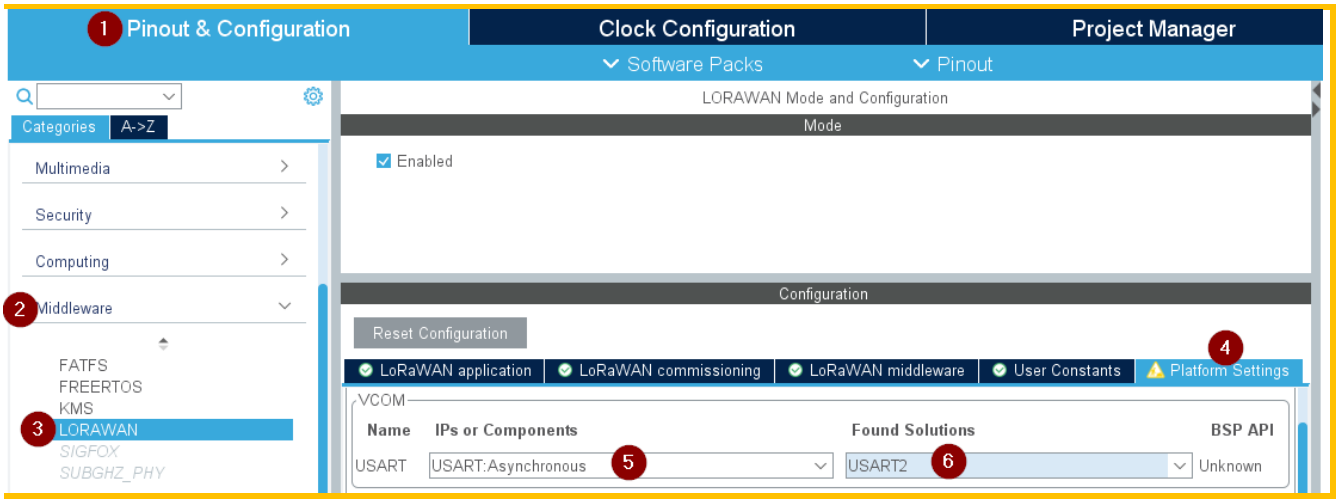
Clock Configuration => USART2 Clock Mux => SYSCLK



Middleware => LORAWAN => LoRaWAN middleware => radio_board_if =>Activate Debug Line



Platform Settings => VCOM => USART2

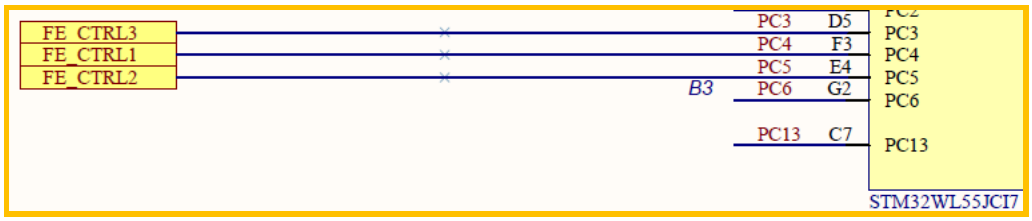


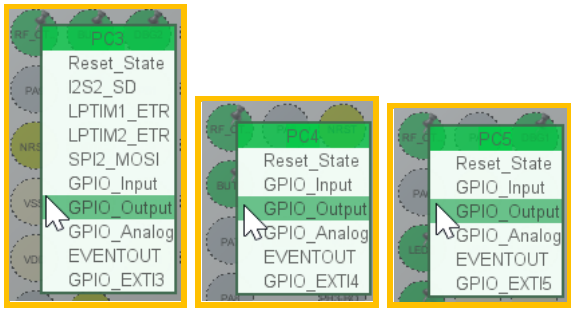
2.4 System Core => GPIO (RF SW CTRL / BUTTON / LED)

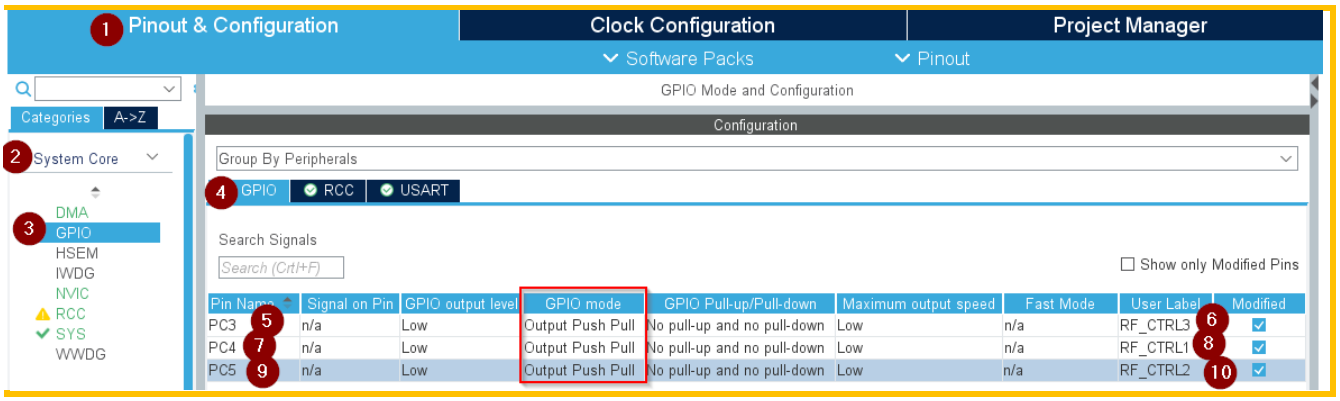
2.4.1 RF_CTRL

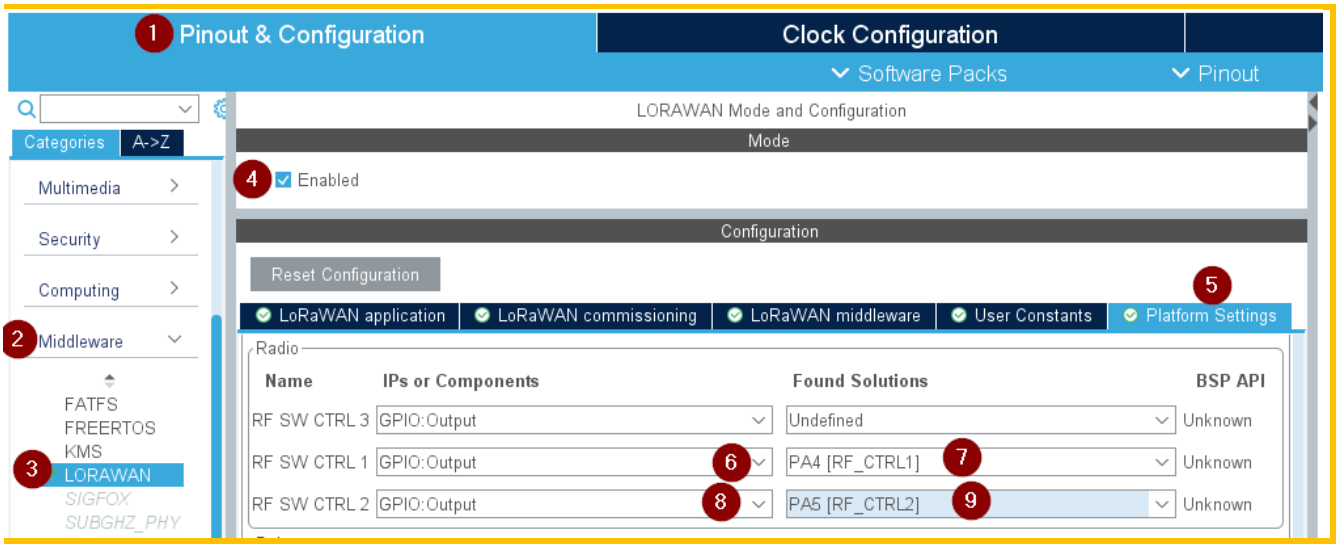
NUCLEO-WL55JC

RF front-end configuration	FE_CTRL1	FE_CTRL2	FE_CTRL3
Transmit high output power	Low	High	High
Transmit low output power	High	High	High
Receive	High	Low	High



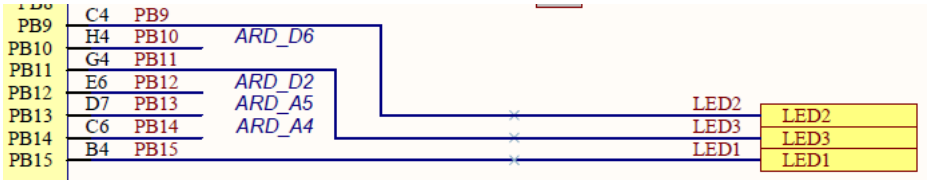


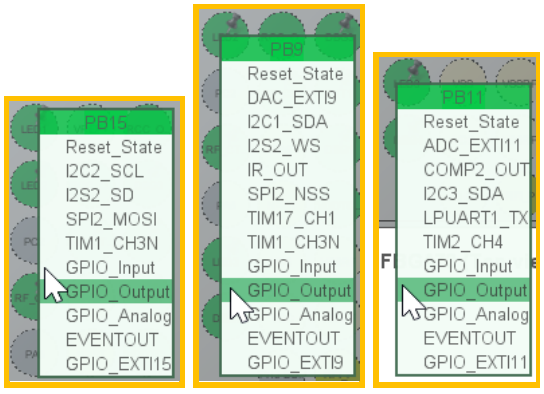


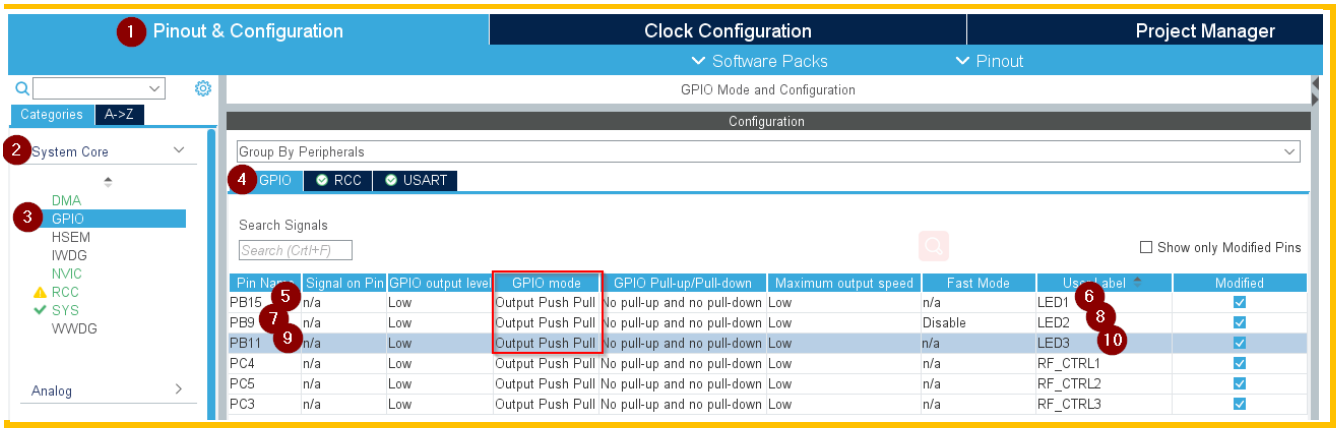


2.4.2 LED

配置控制 LED 的 GPIO

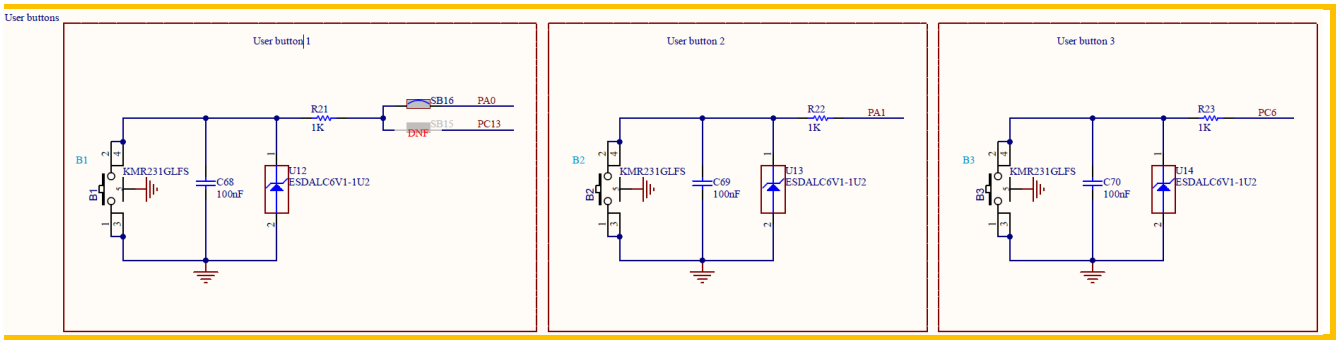


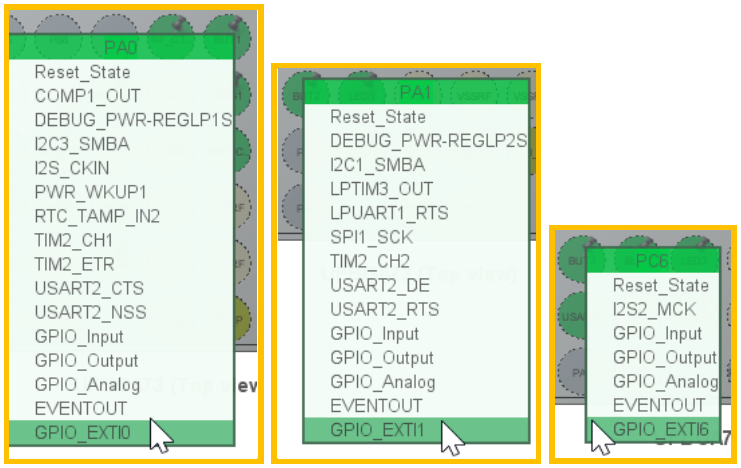


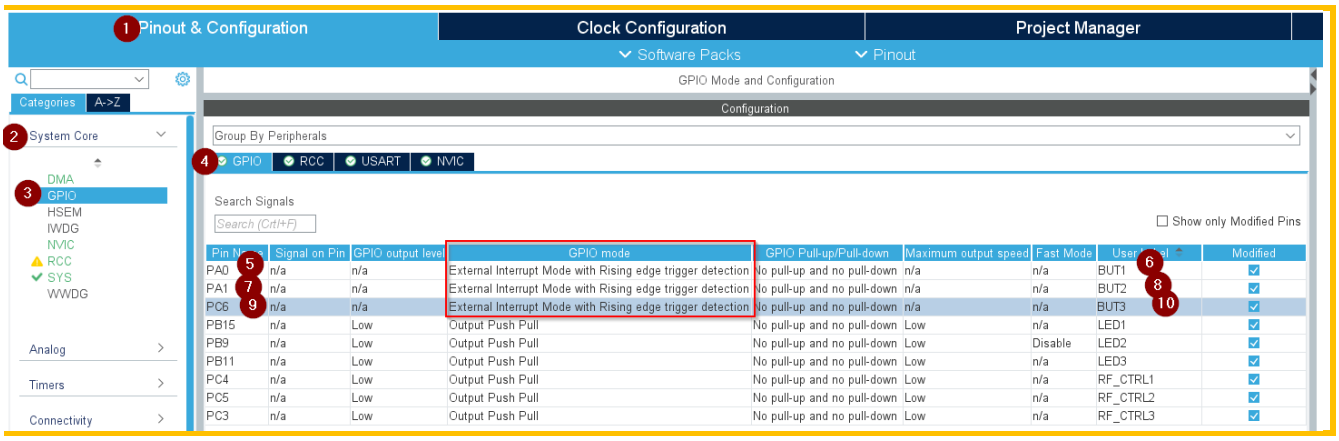


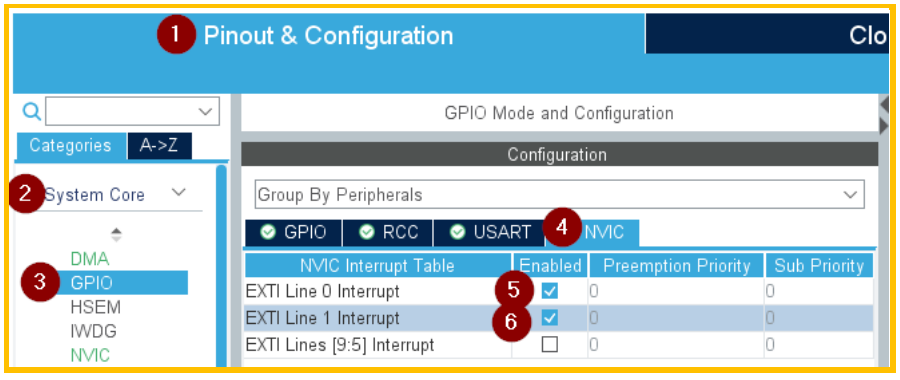
2.4.3 BUT

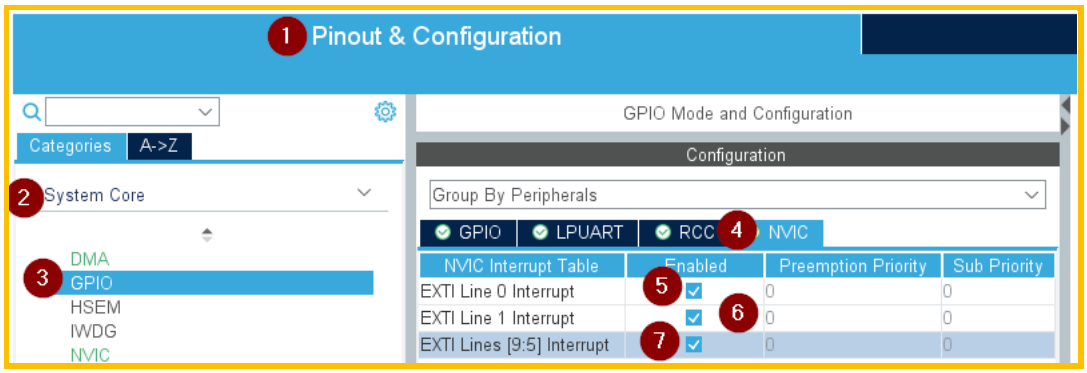
配置控制 BUTTON 的 GPIO


User buttons
User button 1
User button 2
User button 3
R21
1K
SB16
PA0
SB15
PC13
DNF
B1
KMR231GLFS
C68
100nF
U12
ESDALC6V1-1U2
R22
1K
PA1
B2
C69
100nF
U13
ESDALC6V1-1U2
R23
1K
PC6
B3
C70
100nF
U14
ESDALC6V1-1U2

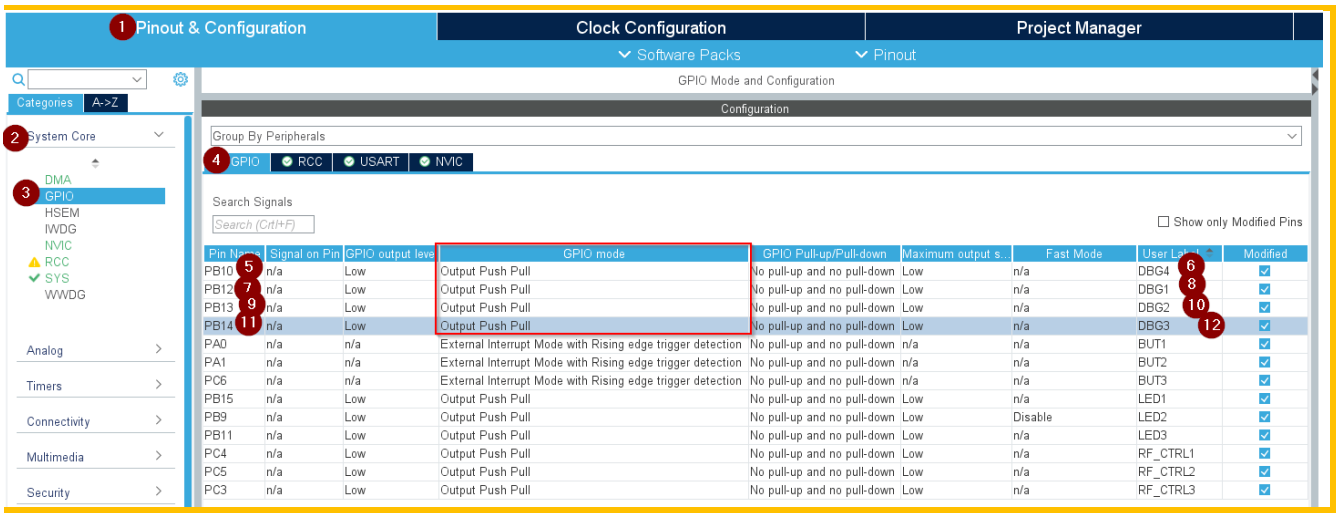

PA0
Reset_State
COMP1_OUT
DEBUG_PWR-REGLP1S
I2C3_SMBA
I2S_CKIN
PWR_WKUP1
RTC_TAMP_IN2
TIM2_CH1
TIM2_ETR
USART2_CTS
USART2_NSS
GPIO_Input
GPIO_Output
GPIO_Analog
EVENTOUT
GPIO_EXTI0
PA1
Reset_State
DEBUG_PWR-REGLP2S
I2C1_SMBA
LPTIM3_OUT
LPUART1_RTS
SPI1_SCK
TIM2_CH2
USART2_DE
USART2_RTS
GPIO_Input
GPIO_Output
GPIO_Analog
EVENTOUT
GPIO_EXTI1
PC6
Reset_State
I2S2_MCK
GPIO_Input
GPIO_Output
GPIO_Analog
EVENTOUT
GPIO_EXTI6


1 Pinout & Configuration
Clock Configuration
Project Manager
Software Packs
Pinout
GPIO Mode and Configuration
Configuration
Categories
A->Z
2 System Core
Group By Peripherals
4 GPIO
RCC
USART
NVIC
3 GPIO
Search Signals
Search (Crtl+F)
Show only Modified Pins
Pin Name
Signal on Pin
GPIO output level
GPIO mode
GPIO Pull-up/Pull-down
Maximum output speed
Fast Mode
User Label
Modified
PA0 5 n/a n/a External Interrupt Mode with Rising edge trigger detection No pull-up and no pull-down n/a n/a BUT1 6
PA1 7 n/a n/a External Interrupt Mode with Rising edge trigger detection No pull-up and no pull-down n/a n/a BUT2 8
PC6 9 n/a n/a External Interrupt Mode with Rising edge trigger detection No pull-up and no pull-down n/a n/a BUT3 10
PB15 n/a Low Output Push Pull No pull-up and no pull-down Low n/a LED1
PB9 n/a Low Output Push Pull No pull-up and no pull-down Low Disable LED2
PB11 n/a Low Output Push Pull No pull-up and no pull-down Low n/a LED3
PC4 n/a Low Output Push Pull No pull-up and no pull-down Low n/a RF_CTRL1
PC5 n/a Low Output Push Pull No pull-up and no pull-down Low n/a RF_CTRL2
PC3 n/a Low Output Push Pull No pull-up and no pull-down Low n/a RF_CTRL3
DMA
GPIO
HSEM
IWDG
NVIC
RCC
SYS
WWDG
Analog
Timers
Connectivity


1 Pinout & Configuration
Clo
GPIO Mode and Configuration
Configuration
Categories
A->Z
2 System Core
Group By Peripherals
GPIO
RCC
USART
4 NVIC
3 GPIO
NVIC Interrupt Table
Enabled
Preemption Priority
Sub Priority
EXTI Line 0 Interrupt 5 0 0
EXTI Line 1 Interrupt 6 0 0
EXTI Lines [9:5] Interrupt 0 0
DMA
HSEM
IWDG
NVIC



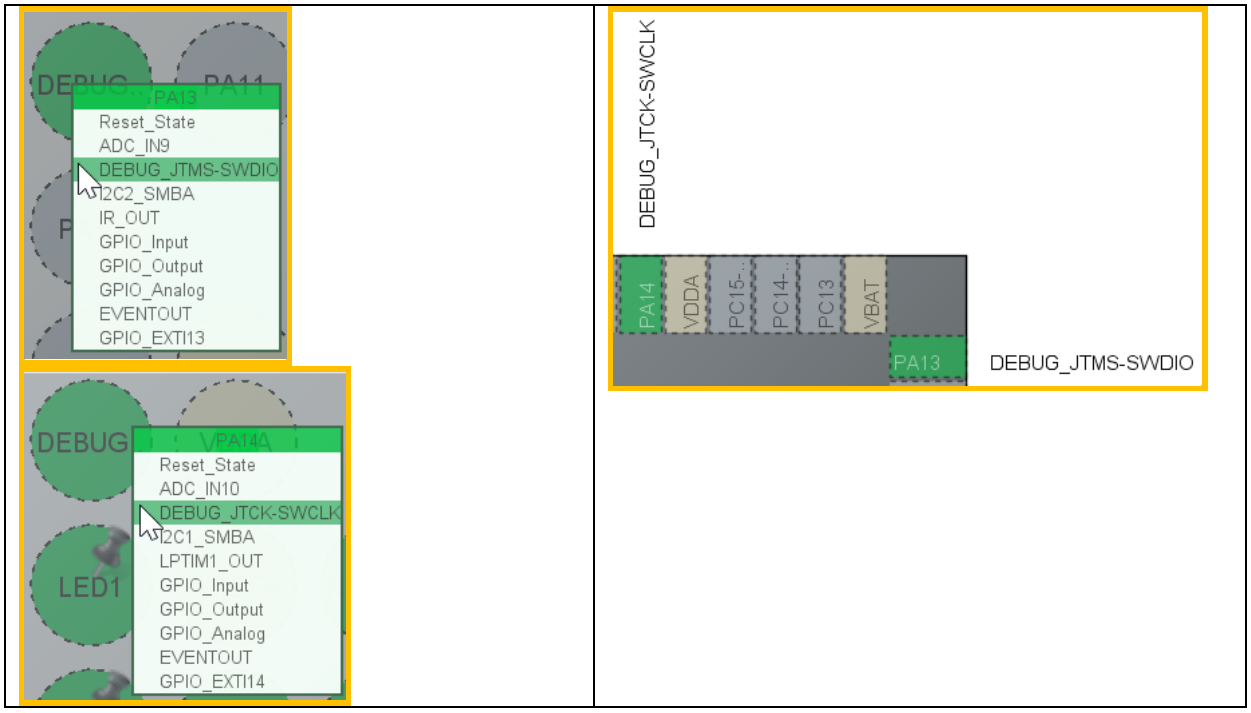
2.4.4 DBG



2.4.5 SWD(可选)

需使能 Trace and Debug => DEBUG => JTAG and Trace => Serial Wire

BGA73	QFN48



SWD : PA13-DEBUG_JTMS-SWDIO, DEBUG_PA14-JTCK-SWCLK,

JTAG (4 pins) + : PA15-DEBUG_JTDI, PB3-DEBUG_JTDO-SWO

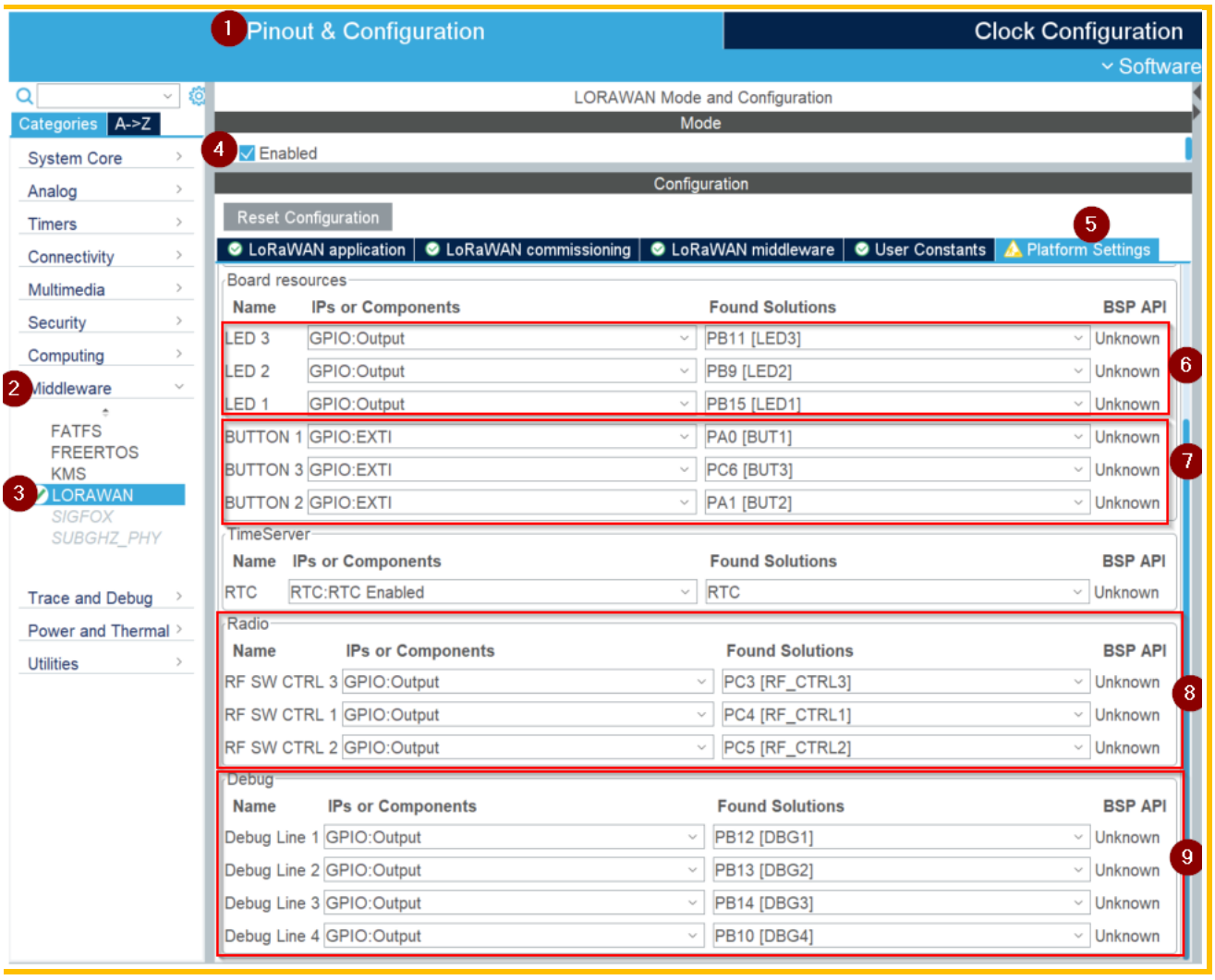
JTAG (5 pins) + : PB4-DEBUG_NJTRST

2.4.6 Middleware=>LORAWAN=>Platform Settings

Board resources => LED & BUTTON

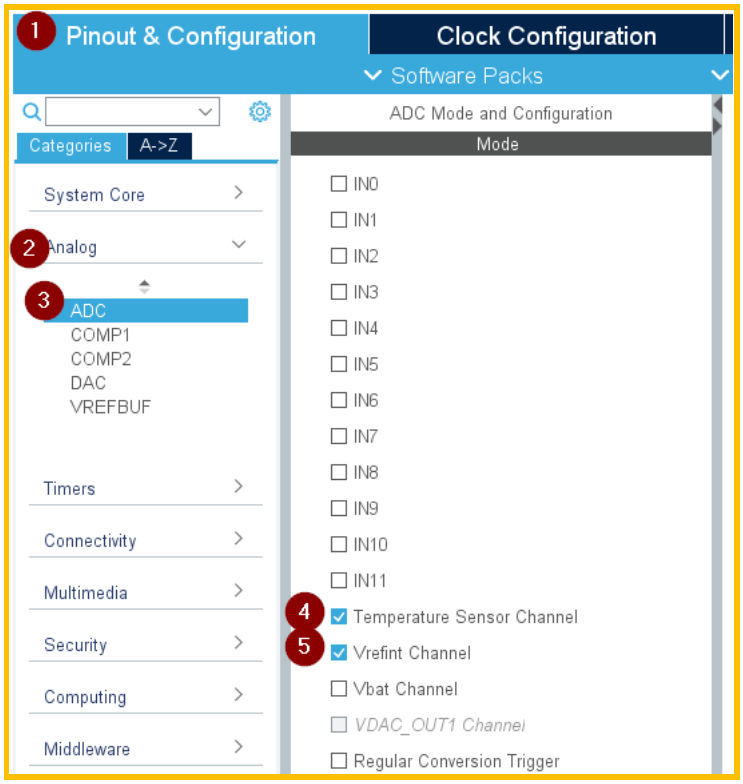
Radio => RF SW CTRL

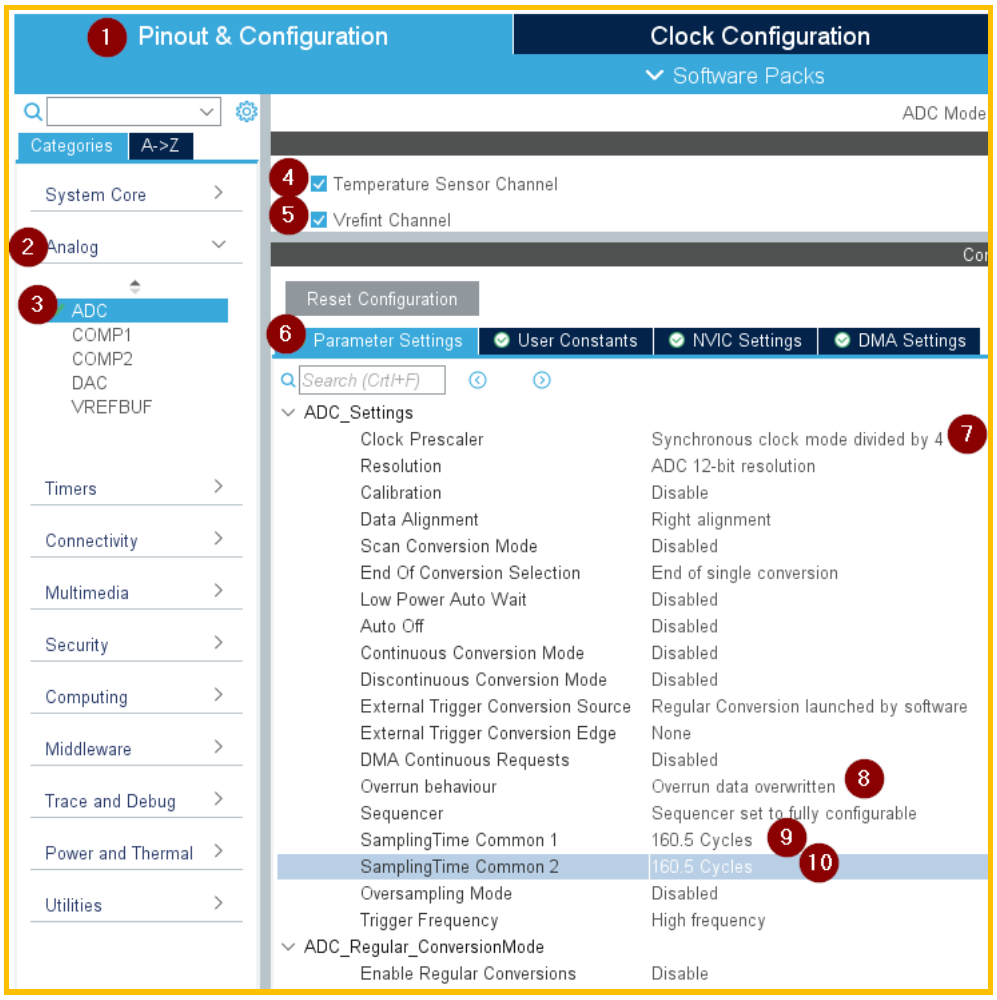
Debug = > Debug Line


1 Pinout & Configuration
Clock Configuration
Software
Categories
A->Z
System Core
Analog
Timers
Connectivity
Multimedia
Security
Computing
2 Middleware
FATFS
FREERTOS
KMS
3 LORAWAN
SIGFOX
SUBGHZ_PHY
Trace and Debug
Power and Thermal
Utilities
LORAWAN Mode and Configuration
Mode
4 Enabled
Configuration
Reset Configuration
5
LoRaWAN application
LoRaWAN commissioning
LoRaWAN middleware
User Constants
Platform Settings
Board resources
Name
IPs or Components
Found Solutions
BSP API
LED 3 GPIO:Output PB11 [LED3] Unknown
LED 2 GPIO:Output PB9 [LED2] Unknown
LED 1 GPIO:Output PB15 [LED1] Unknown
6
BUTTON 1 GPIO:EXTI PA0 [BUT1] Unknown
BUTTON 3 GPIO:EXTI PC6 [BUT3] Unknown
BUTTON 2 GPIO:EXTI PA1 [BUT2] Unknown
7
TimeServer
RTC RTC:RTC Enabled RTC Unknown
Radio
RF SW CTRL 3 GPIO:Output PC3 [RF_CTRL3] Unknown
RF SW CTRL 1 GPIO:Output PC4 [RF_CTRL1] Unknown
RF SW CTRL 2 GPIO:Output PC5 [RF_CTRL2] Unknown
8
Debug
Debug Line 1 GPIO:Output PB12 [DBG1] Unknown
Debug Line 2 GPIO:Output PB13 [DBG2] Unknown
Debug Line 3 GPIO:Output PB14 [DBG3] Unknown
Debug Line 4 GPIO:Output PB10 [DBG4] Unknown
9

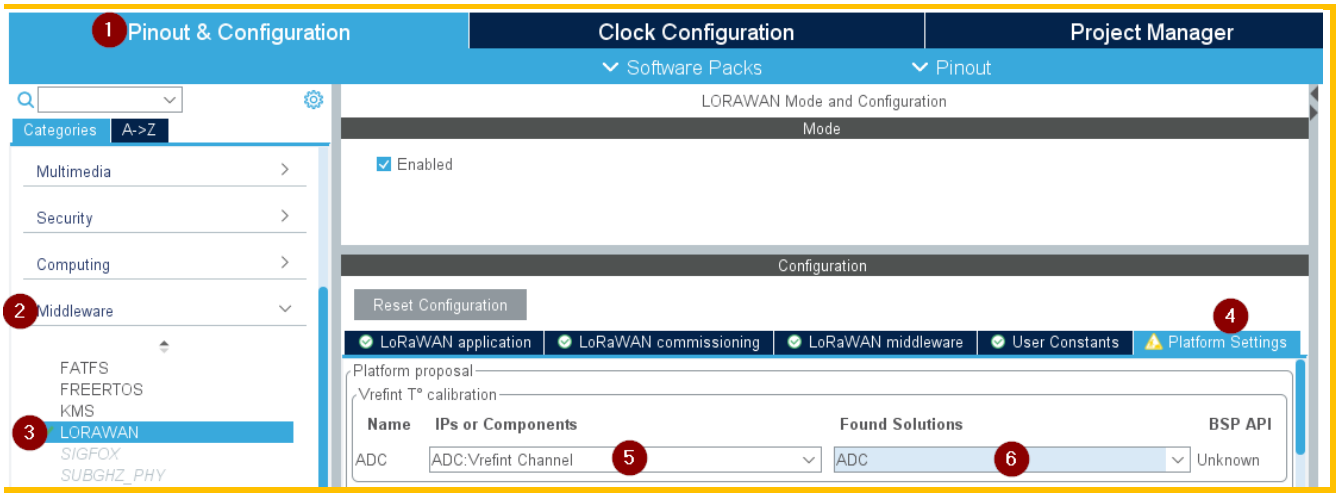
2.5 ADC

Analog=>ADC





Middleware=>LORAWAN=>Platform Settings => Vrefint T calibration => ADC (EndNode)



3 STM32WL Templates Patches for CubeMX

STM32WL Templates 在如下目录，如需要可自行定制自己的 Templates

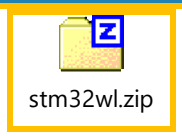
```
C:\Program Files\STMicroelectronics\STM32Cube\STM32CubeMX\db\templates\stm32wl
```

针对不同的客户定制化的板子，硬件外设配置不一致，客户可根据需要定制化自己的外设配置。从 NUCLEO-WL55JC(BGA73) 移植到 STM32WLExCxUx(QFN48)定制化的板子上，射频开关(RF SW CTRL)，按键(BUTTON), LED 的配置会不一样，可能导致编译错误，如想生成的代码不会产生编译错误，需要编辑一下 STM32WL 的 template

3.1 CubeMX template patches for stm32wl

请参考

```
C:\Program Files\STMicroelectronics\STM32Cube\STM32CubeMX\db\templates\stm32wl
```



其中包含

radio_board_if_c.ftl for RF SW CTRL

radio_conf_h.ftl for DBG_GPIO_RADIO_TX

board_resources_c.ftl & board_resources_h.ftl for BUTTON

SubGHz_Phy_subghz_phy_app_c.ftl for LED

LoRaWAN_lora_app_c.ftl for LED

3.2 CubeMX Updates from v6.1.1 to v6.2.0

main.c

void SystemClock_Config(void)
{
  RCC_OscInitTypeDef RCC_OscInitStruct = {0};
  RCC_ClkInitTypeDef RCC_ClkInitStruct = {0};
 	
  /** Configure LSE Drive Capability
  */
 	
__HAL_RCC_LSEDRIVE_CONFIG(RCC_LSEDRIVE_LOW);
  /** Configure the main internal regulator output voltage
	void SystemClock_Config(void)
	{
	  RCC_OscInitTypeDef RCC_OscInitStruct = {0};
	  RCC_ClkInitTypeDef RCC_ClkInitStruct = {0};
	
	  /** Configure LSE Drive Capability
	  */
	  HAL_PWR_EnableBkUpAccess();
	
	__HAL_RCC_LSEDRIVE_CONFIG(RCC_LSEDRIVE_LOW);

/**
  * @brief Macro to configure the External Low Speed oscillator (LSE) drive capability.
  * @note As the LSE is in the Backup domain and write access is denied to
  * this domain after reset, you have to enable write access using
  * HAL_PWR_EnableBkUpAccess() function before to configure the LSE
  * (to be done once after reset).
  * @param __LSEDRIVE__ specifies the new state of the LSE drive capability.
  * This parameter can be one of the following values:	

* @arg @ref RCC_LSEDRIVE_LOW LSE oscillator low drive capability. * @arg @ref RCC_LSEDRIVE_MEDIUMLOW LSE oscillator medium low drive capability. * @arg @ref RCC_LSEDRIVE_MEDIUMHIGH LSE oscillator medium high drive capability. * @arg @ref RCC_LSEDRIVE_HIGH LSE oscillator high drive capability. * @retval None */ #define __HAL_RCC_LSEDRIVE_CONFIG(__LSEDRIVE__) LL_RCC_LSE_SetDriveCapability(__LSEDRIVE__)

rtc.c

CubeMX v6.1.1	CubeMX v6.2.0
if (HAL_RTC_SetAlarm_IT(&hrtc, &sAlarm, RTC_FORMAT_BCD) != HAL_OK)	if (HAL_RTC_SetAlarm_IT(&hrtc, &sAlarm, 0) != HAL_OK)
#define RTC_FORMAT_BIN 0x00000000u /* This parameter will trigger a SW conversion to fit with the native BCD format of the HW Calendar. It should not be confused with the Binary mode @ref RTCEx_Binary_Mode. */ #define RTC_FORMAT_BCD 0x00000001u /* Native format of the HW Calendar. It should not be confused with the Binary mode @ref RTCEx_Binary_Mode. */	
Ticket 96721 - [Diff Examples] WL RTC: RTC_FORMAT_BCD removed from HAL_RTC_SetAlarm_IT call **Ticket 100003** - [Diff Examples] WL RTC: RTC_FORMAT_BCD removed from HAL_RTC_SetAlarm_IT call **Ticket 90404** - [HAL_RTC_SetAlarm & HAL_RTC_SetAlarm_IT] Unnecessary assertion on parameter when Alarm Masks defined	

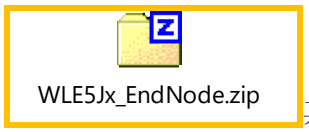
usart.c

CubeMX v6.1.1	CubeMX v6.2.0

if (HAL_DMA_ConfigChannelAttributes(&hdma_lpuart1_tx, DMA_CHANNEL_NPRIV) != HAL_OK)
{
Error_Handler();
}
	删除了

4 验证

4.0 参考工程

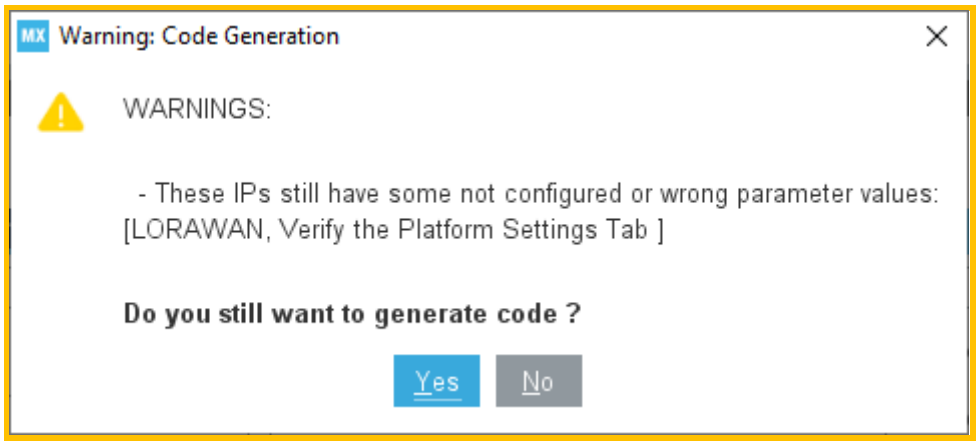


其中包含 WLE5Jx_EndNode.ioc

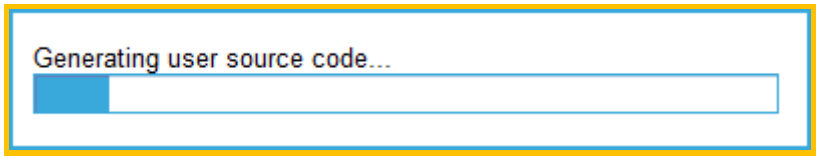
4.1 生成代码 GENERATE CODE

此时，可以先选择 GENERATE CODE 

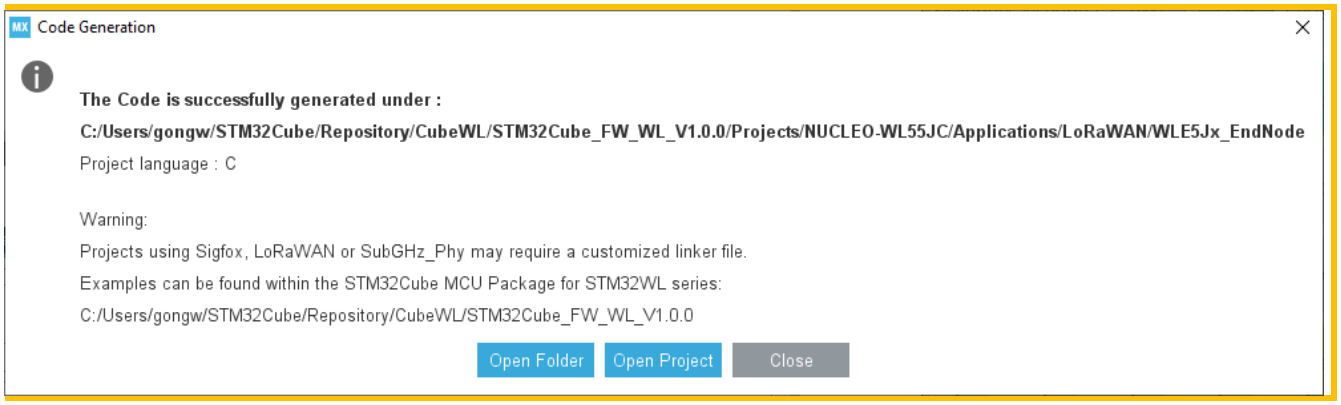
生成 Project，(如需，请自己选择项目保存的目录)



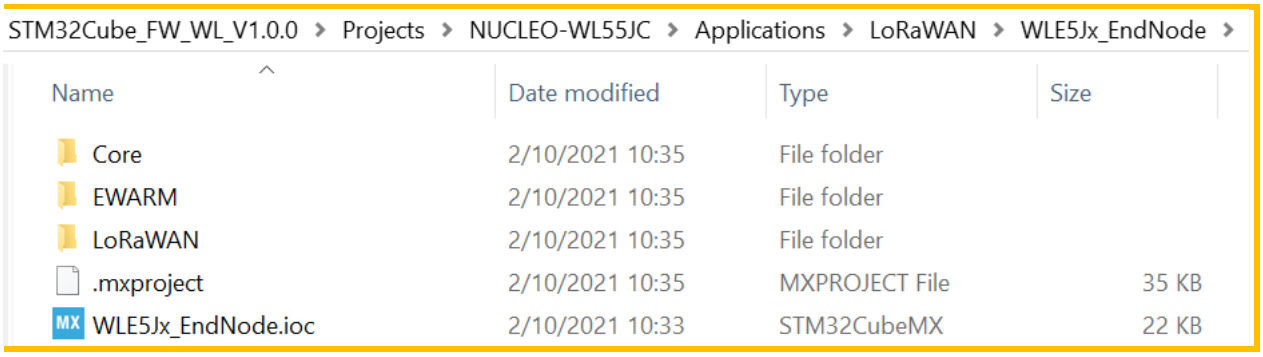
选择 Yes



可选择 Open Project 使用 IDE 直接打开 Project。



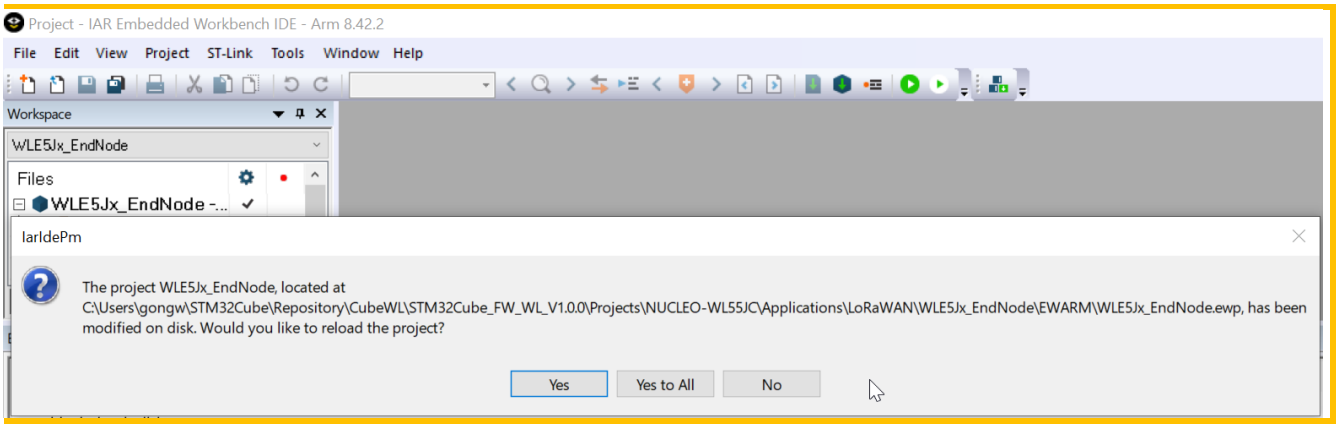
或选择 Open Folder 后，还需再选择 EWARM\Project.eww 打开 Project



4.2 编译并下载

用 IAR 打开 STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\WLE5Jx_EndNode\EWARM\Project.eww

如果 IAR 之前已经打开了 WLE5Jx_EndNode，在每次重新生成代码时都如有如下提示，选择“Yes to All”



按 F7 或选择 Project=>Make(F7)来编译工程，如果编译无错误，选择 Project=>Download=>Download Active Application 下载 WLE5Jx_EndNode 应用

5 接入 cn1.LoRiot Network Server

如果不需要将 WL 的 Sensor 数据转发到 cn1.LoRiot Network Server 网络服务器上，可跳过此步骤。

如果需要将 WL 的 Sensor 数据转发到 cn1.LoRiot Network Serve 网络服务器上，需用 CubeMX 重新配置下 LORAWAN 的一些参数。

5.1 WL Sensor End Device 信息更改

5.1.1 配置 REGION_EU868

```
Middleware=>LORAWAN=>LoRaWAN middleware=>lorawan_conf
Middleware=>LORAWAN=>LoRaWAN application=>lora_app=>Active
region=>LORAMAC_REGION_CN470
```

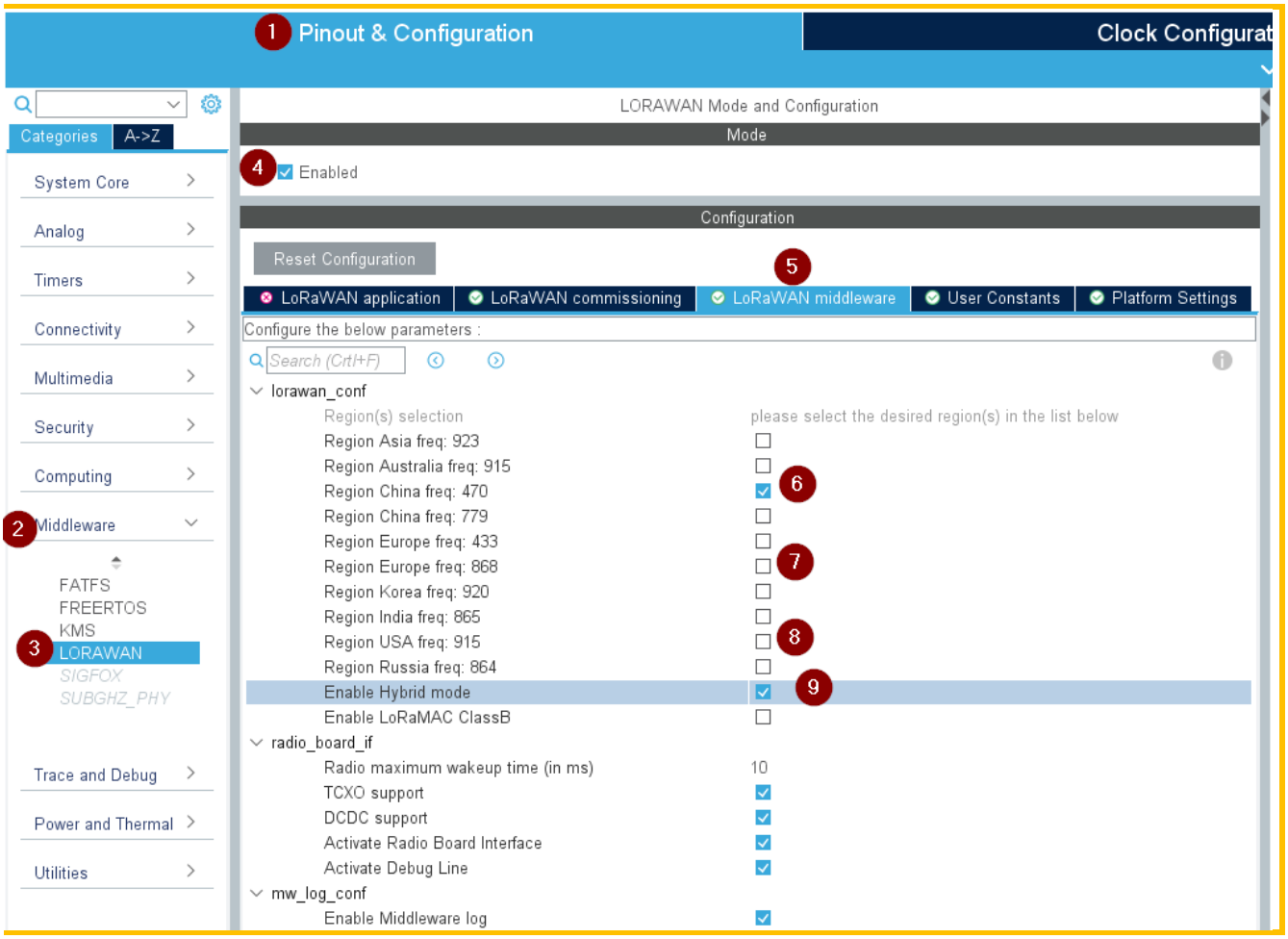
默认配置即可

5.1.1 配置 REGION_CN470

```
Middleware=>LORAWAN=>LoRaWAN middleware=>lorawan_conf
```

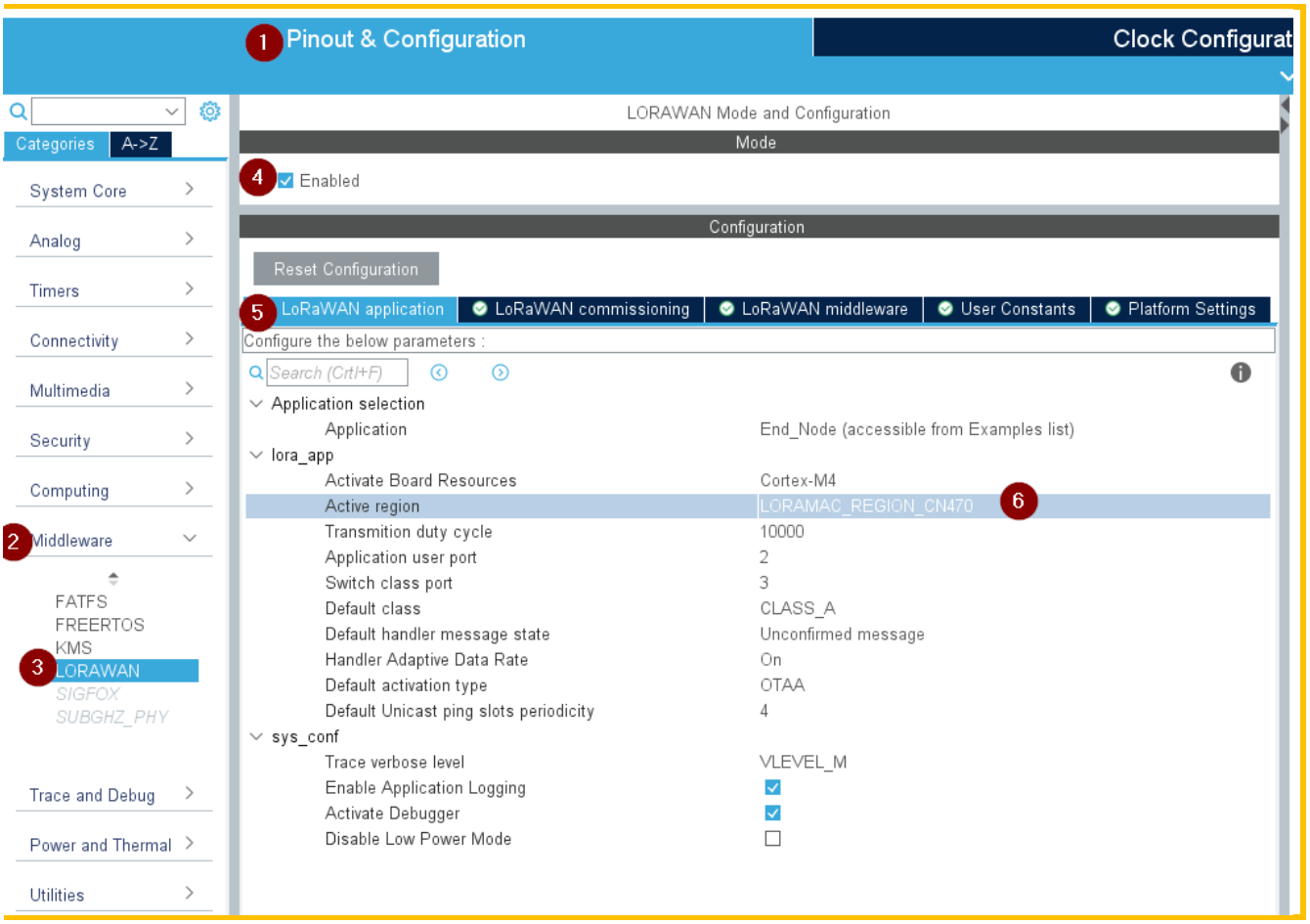
勾选 Region China freq :470，勾选 Enable Hybrid mode，即在 LoRaWAN\Target\lorawan_conf.h 中使能 REGION_CN470 和 HYBRID_ENABLED

取消勾选 Region Europe freq :868 和 Region USA freq :915 , 失能 EU868 和 US915




```
Middleware=>LORAWAN=>LoRaWAN application=>lora_app=>Active
region=>LORAMAC_REGION_CN470
```

在 LoRaWAN\App\lora_app.h 中更改默认 ACTIVE_REGION 为 LORAMAC_REGION_CN470



配置 CN470 的起止频率和调频频道的 MASK

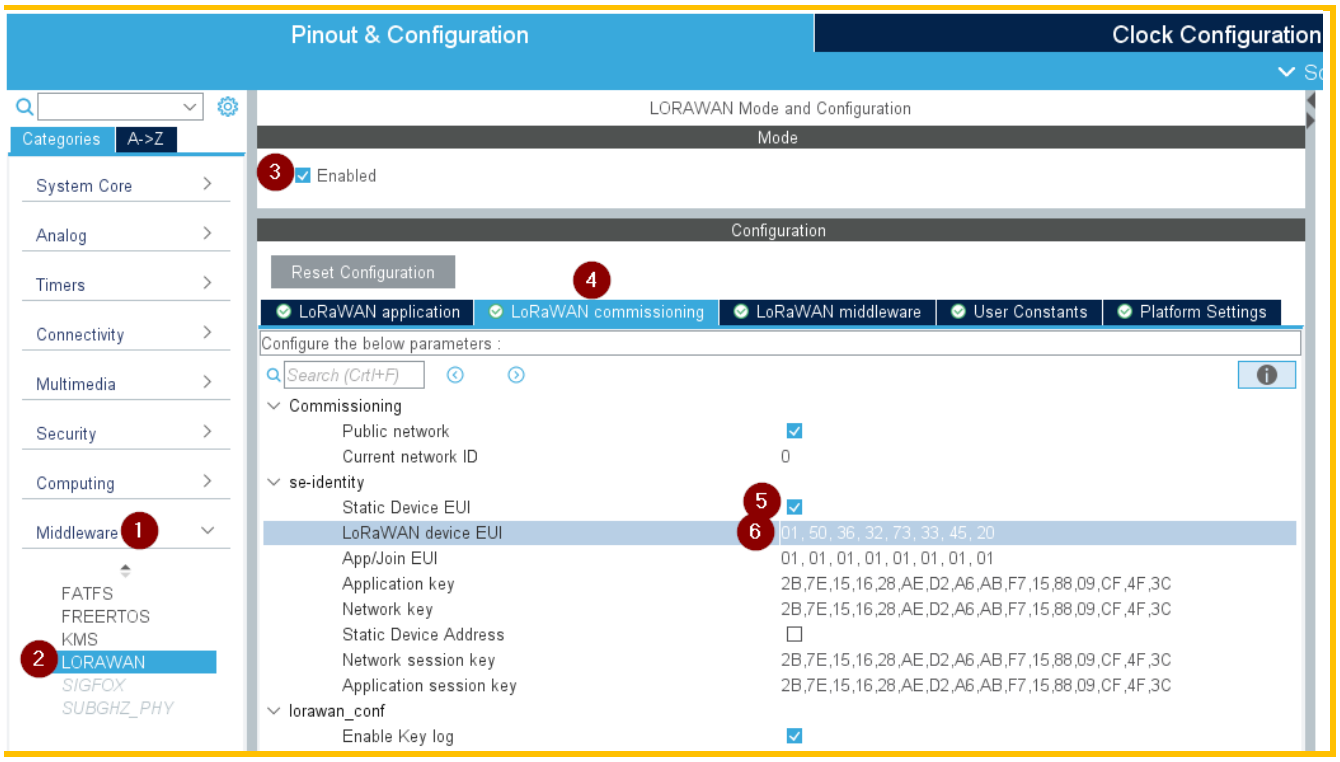
Middlewares\Third_Party\LoRaWAN\Mac\region\RegionCN470.h	
/*! * Defines the first channel for RX window 1 for CN470 band */	/*! * Defines the first channel for RX window 1 for CN470 band */
#define CN470_FIRST_RX1_CHANNEL ((uint32_t) 500300000)	#define CN470_FIRST_RX1_CHANNEL ((uint32_t) 470300000)
/*! * Defines the last channel for RX window 1 for CN470 band */	/*! * Defines the last channel for RX window 1 for CN470 band */
#define CN470_LAST_RX1_CHANNEL ((uint32_t) 509700000)	#define CN470_LAST_RX1_CHANNEL ((uint32_t) 489300000)
Middlewares\Third_Party\LoRaWAN\Mac\region\RegionCN470.c 更改 NvmCtx.ChannelsDefaultMask[0]以使 WL 使用更少的信道加入 LoRa 网络，这样可使 WL 更快的加入 LoRa 网络	
void RegionCN470InitDefaults(InitDefaultsParams_t* params) case INIT_TYPE_DEFAULTS: {	void RegionCN470InitDefaults(InitDefaultsParams_t* params) case INIT_TYPE_DEFAULTS: {

```
        // Default bands
        memcpy1( ( uint8_t* )NvmCtx.Bands,
( uint8_t* )bands, sizeof( Band_t ) *
CN470_MAX_NB_BANDS );

        // Channels
        for( uint8_t i = 0; i <
CN470_MAX_NB_CHANNELS; i++ )
        {
            // 125 kHz channels
            NvmCtx.Channels[i].Frequency = 470300000
+ i * 200000;
            NvmCtx.Channels[i].DrRange.Value =
( DR_5 << 4 ) | DR_0;
            NvmCtx.Channels[i].Band = 0;
        }

        // Initialize channels default mask
        /* ST_WORKAROUND_BEGIN: Hybrid mode */
#if ( HYBRID_ENABLED == 1 )
        NvmCtx.ChannelsDefaultMask[0] = 0x00FF;
        NvmCtx.ChannelsDefaultMask[1] = 0x0000;
        NvmCtx.ChannelsDefaultMask[2] = 0x0000;
        NvmCtx.ChannelsDefaultMask[3] = 0x0000;
        NvmCtx.ChannelsDefaultMask[4] = 0x0000;
        NvmCtx.ChannelsDefaultMask[5] = 0x0000;
#else
        NvmCtx.ChannelsDefaultMask[0] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[1] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[2] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[3] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[4] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[5] = 0xFFFF;
#endif /* HYBRID_ENABLED == 1 */
        /* ST_WORKAROUND_END */


        // Copy channels default mask

RegionCommonChanMaskCopy( NvmCtx.ChannelsMa
sk, NvmCtx.ChannelsDefaultMask,
CHANNELS_MASK_SIZE );
        break;
    }
```

```
        // Default bands
        memcpy1( ( uint8_t* )NvmCtx.Bands,
( uint8_t* )bands, sizeof( Band_t ) *
CN470_MAX_NB_BANDS );

        // Channels
        for( uint8_t i = 0; i <
CN470_MAX_NB_CHANNELS; i++ )
        {
            // 125 kHz channels
            NvmCtx.Channels[i].Frequency = 470300000
+ i * 200000;
            NvmCtx.Channels[i].DrRange.Value =
( DR_5 << 4 ) | DR_0;
            NvmCtx.Channels[i].Band = 0;
        }

        // Initialize channels default mask
        /* ST_WORKAROUND_BEGIN: Hybrid mode */
#if ( HYBRID_ENABLED == 1 )
        NvmCtx.ChannelsDefaultMask[0] = 0x03C0;
        NvmCtx.ChannelsDefaultMask[1] = 0x0000;
        NvmCtx.ChannelsDefaultMask[2] = 0x0000;
        NvmCtx.ChannelsDefaultMask[3] = 0x0000;
        NvmCtx.ChannelsDefaultMask[4] = 0x0000;
        NvmCtx.ChannelsDefaultMask[5] = 0x0000;
#else
        NvmCtx.ChannelsDefaultMask[0] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[1] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[2] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[3] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[4] = 0xFFFF;
        NvmCtx.ChannelsDefaultMask[5] = 0xFFFF;
#endif /* HYBRID_ENABLED == 1 */
        /* ST_WORKAROUND_END */


        // Copy channels default mask

RegionCommonChanMaskCopy( NvmCtx.ChannelsMa
sk, NvmCtx.ChannelsDefaultMask,
CHANNELS_MASK_SIZE );
        break;
    }
```

5.2 配置 DevEUI, AppEUI 和 AppKey

在 LoRaWAN\App\se-identity.h 中更改设备信息 DevEUI, AppEUI 和 AppKey



DevAddr 不需要设置静态地址，可以配置的

在 LoRaWAN\App\se-identity.h 中更改设备信息

```
/*!
 * When set to 1 DevEui is LORAWAN_DEVICE_EUI
 * When set to 0 DevEui is automatically set with a value provided by MCU platform
 */
#define STATIC_DEVICE_EUI                           1

/*!
 * end-device IEEE EUI (big endian)
 */
//#define LORAWAN_DEVICE_EUI          { 0x00, 0x80, 0xE1, 0x01, 0x01, 0x01, 0x01,
0x01 }
#define LORAWAN_DEVICE_EUI          { 0x01, 0x50, 0x36, 0x32, 0x73, 0x33, 0x45,
0x20 }

/*!
 * App/Join server IEEE EUI (big endian)
 */
#define LORAWAN_JOIN_EUI                    { 0x01, 0x01, 0x01, 0x01, 0x01, 0x01, 0x01,
0x01 }
```

```
/*!
 * When set to 1 DevdAddr is LORAWAN_DEVICE_ADDRESS
 * When set to 0 DevAddr is automatically set with a value provided by a pseudo
 *      random generator seeded with a value provided by the MCU platform
 */
#define STATIC_DEVICE_ADDRESS                       1

/*!
 * Device address on the network (big endian)
 *
 * \remark see STATIC_DEVICE_ADDRESS comments
 */
//#define LORAWAN_DEVICE_ADDRESS                        ( uint32_t )0x0100000A
#define LORAWAN_DEVICE_ADDRESS                      ( uint32_t )0x303CC786
/*!
 * Application root key
 */
#define LORAWAN_APP_KEY                             2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,09,CF,4F,3C

/*!
 * Network root key
 */
#define LORAWAN_NWK_KEY                             2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,09,CF,4F,3C

/*!
 * Forwarding Network session key
 */
#define LORAWAN_NWK_S_KEY                           2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,09,CF,4F,3C

/*!
 * Application session key
 */
#define LORAWAN_APP_S_KEY                           2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,09,CF,4F,3C
```

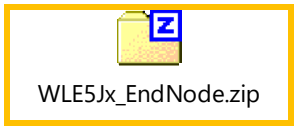
5.3 转发到 myDevuces Cayenne 应用服务器(可选)

LoRaWAN\App\lora_app.h 中使能 CAYENNE_LPP

```
/*!
 * CAYENNE_LPP is myDevices Application server.
 */
/*#define CAYENNE_LPP*/
```

```
/*!
 * CAYENNE_LPP is myDevices Application server.
 */
#define CAYENNE_LPP
```

5.4 WL Sensor End Device 信息获取和确认



其中包含更新过的 WLE5Jx_EndNode.ioc

用 IAR 编译 Projects\NUCLEO-WL55JC\Applications\LoRaWAN\WLE5Jx_EndNode\EWARM\Project.eww，并下载到 WL 中，注意 STLINKv3 的设置。

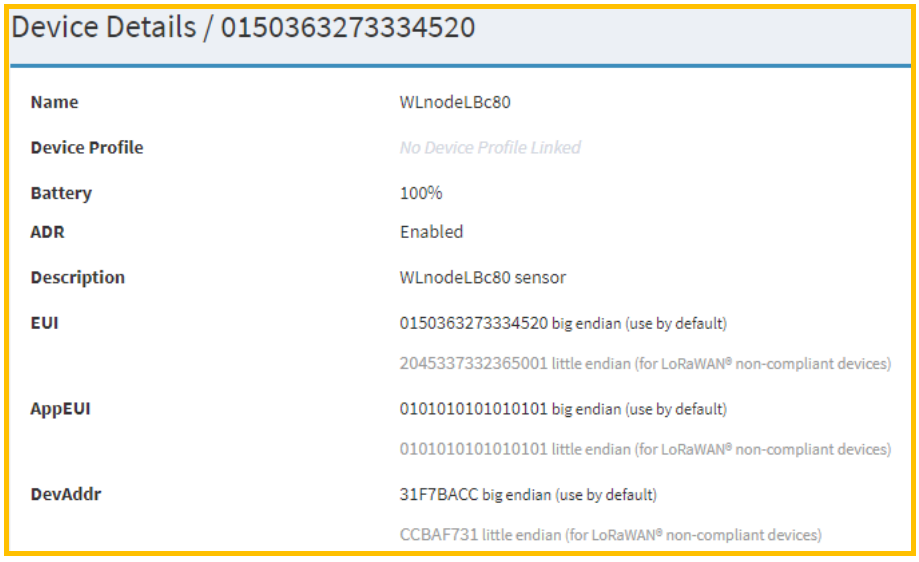
连接 WL 串口到 PC，PC 端打开串口，配置如下，然后重启 WL，会看到 DEV EUI，APP EUI，APP KEY

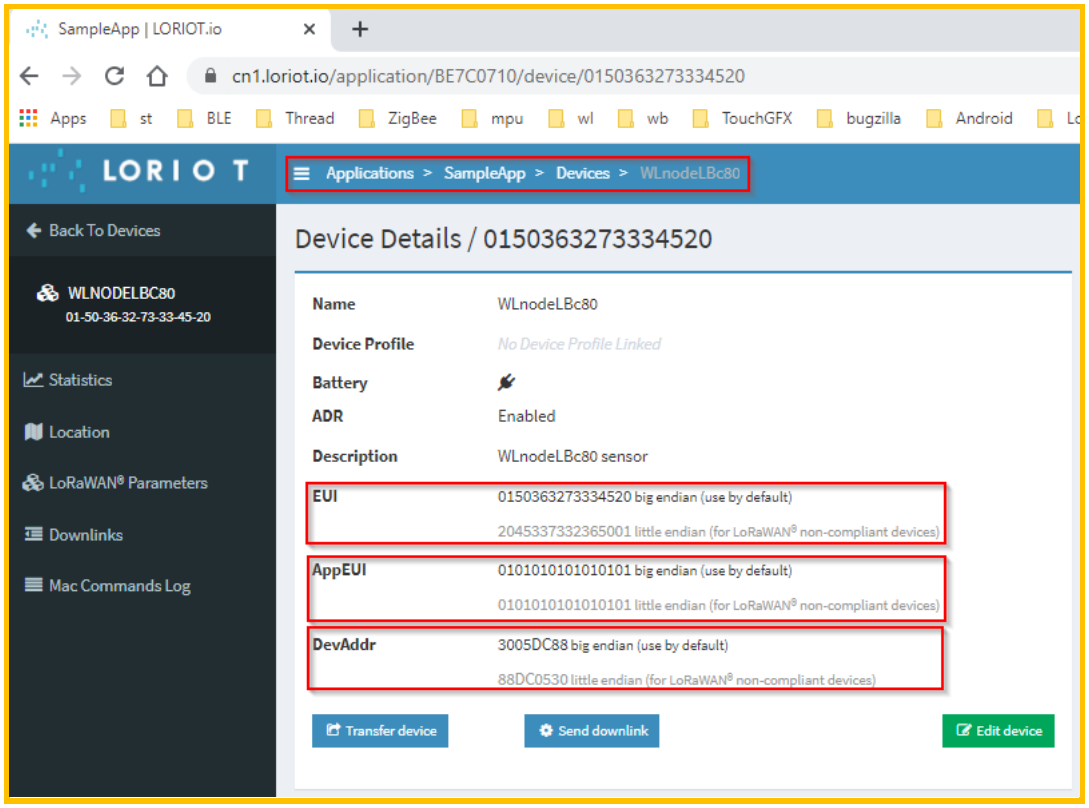
Open a terminal emulation software such as Tera Term and configure it with the following settings:

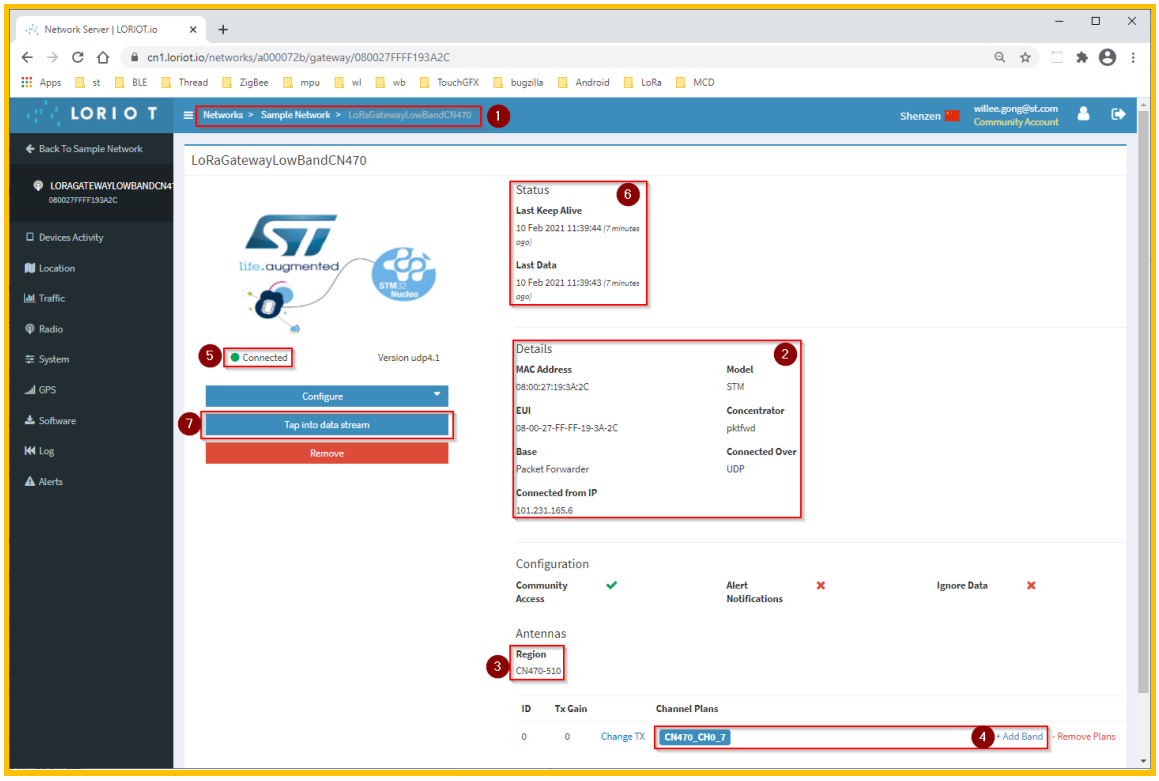
- Port: (Virtual COM port number assigned to the board)
- Baud rate: 115200
- Data: 8 bit
- Parity: none
- Stop: 1 bit

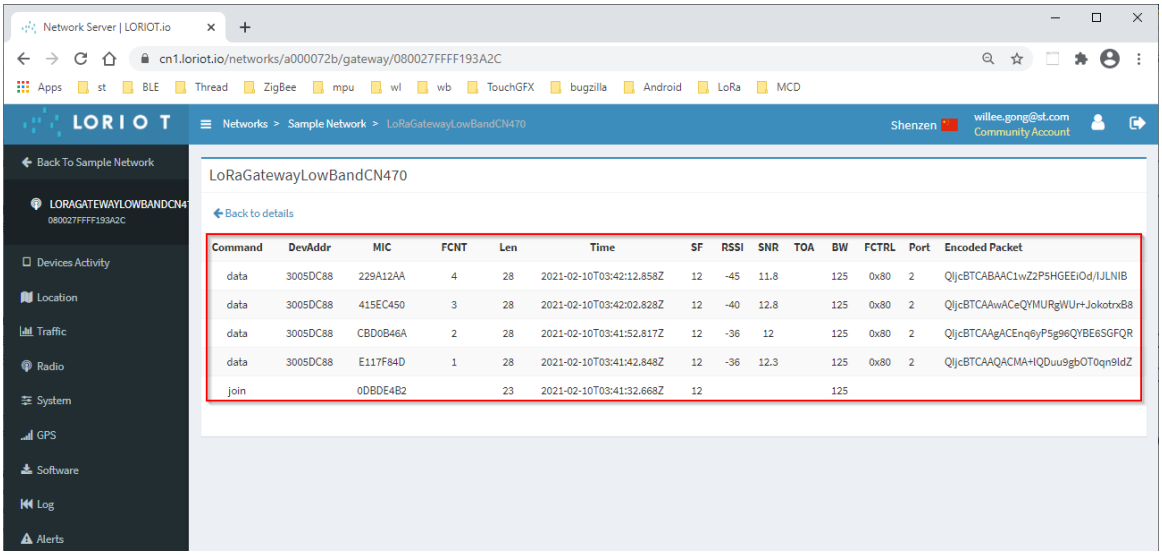
```
APP_VERSION:        V1.0.0
MW_LORAWAN_VERSION: V2.2.1
MW_RADIO_VERSION:   V0.6.1
###### OTAA ######
###### AppKey:  2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C
###### NwkKey:  2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C
###### ABP  ######
###### AppSKey: 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C
###### NwkSKey: 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C
###### DevEui:  01-50-36-32-73-33-45-20
###### AppEui:  01-01-01-01-01-01-01-01
0s111:TX on freq 471700000 Hz at DR 0
1s614:MAC txDone
6s636:RX_1 on freq 471700000 Hz at DR 0
6s774:PRE OK
7s309:HDR OK
7s965:MAC rxDone

###### = JOINED = OTAA ====================
10s132:temp= -274
10s132:VDDA= 0
10s133:TX on freq 472100000 Hz at DR 0
10s144:SEND REQUEST
11s791:MAC txDone
12s813:RX_1 on freq 472100000 Hz at DR 0
13s020:MAC rxTimeOut
13s813:RX_2 on freq 505300000 Hz at DR 0
```

```
14s020:MAC rxTimeOut

###### ========== MCPS-Confirm ==============
20s132:temp= -274
20s132:VDDA= 0
```









版本历史

日期	版本	变更
2022 年 04 月 11 日	1.0	首版发布

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