AMERICAN INTERNATIONAL UNIVERSITY – BANGLADESH(AIUB)

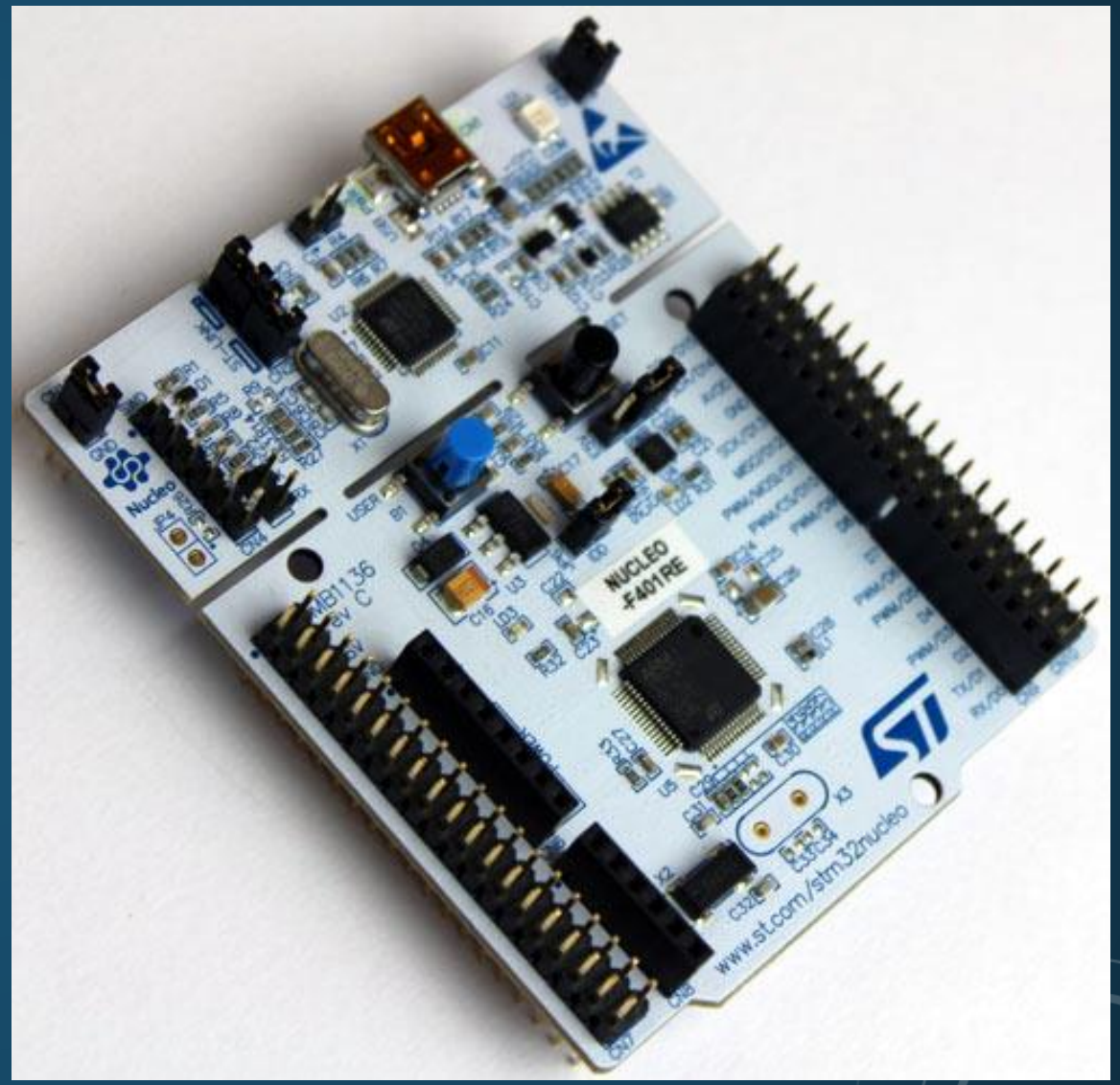
Where leaders are created

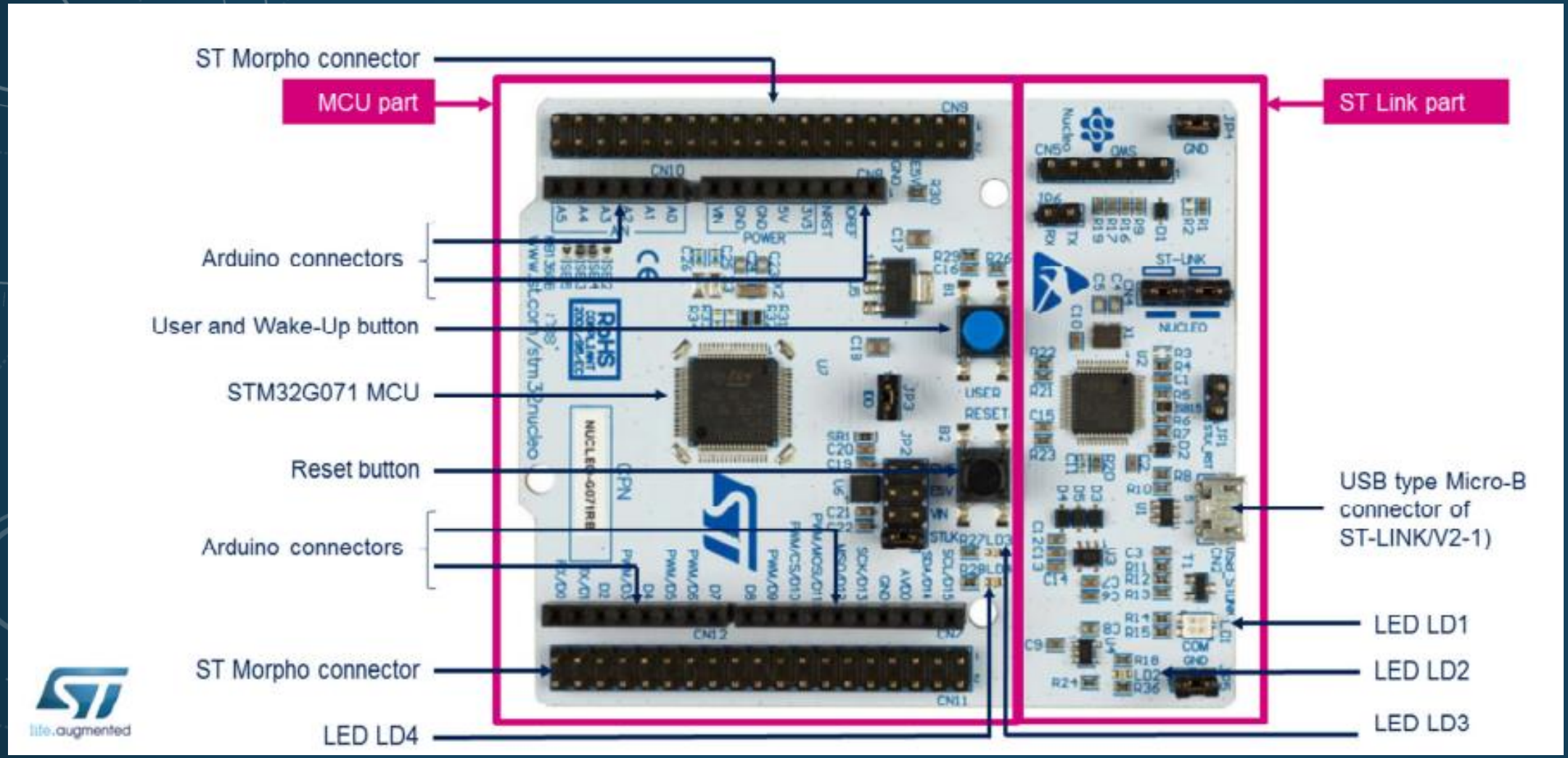
INTRODUCTION TO STM32

BY TAHSEEN ASMA MEEM

SPECIFICATIONS:

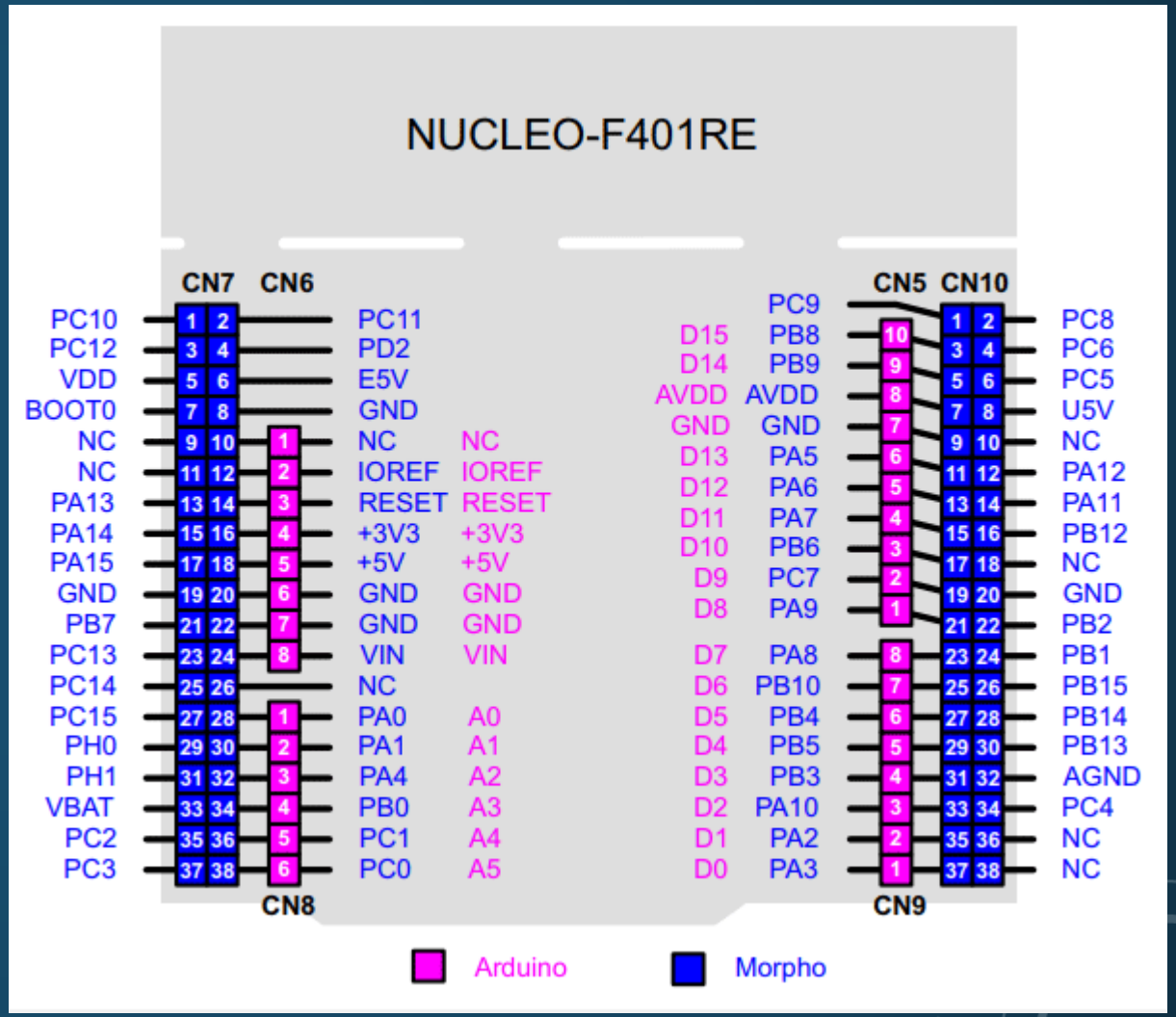
- Part number : STM32F401RE
- Core Processor: high-performance ARM® Cortex® -M4
- Operating Frequency of upto 84 MHz.
- The STM32F401xD/xE incorporate high-speed embedded memories (512 Kbytes of Flash memory, 96 Kbytes of SRAM)
- The STM32F401xD/xE operate in the –40 to +105 °C temperature range from a 1.7 (PDR OFF) to 3.6 V power supply. A comprehensive set of power-saving mode allows the design of low-power applications.
- Upto 12 communication interfaces
- Upto 81 I/O ports
- Upto 11 timers




ST Morpho connector
MCU part
ST Link part
Arduino connectors
User and Wake-Up button
STM32G071 MCU
Reset button
Arduino connectors
ST Morpho connector
LED LD4
USB type Micro-B connector of ST-LINK/V2-1)
LED LD1
LED LD2
LED LD3

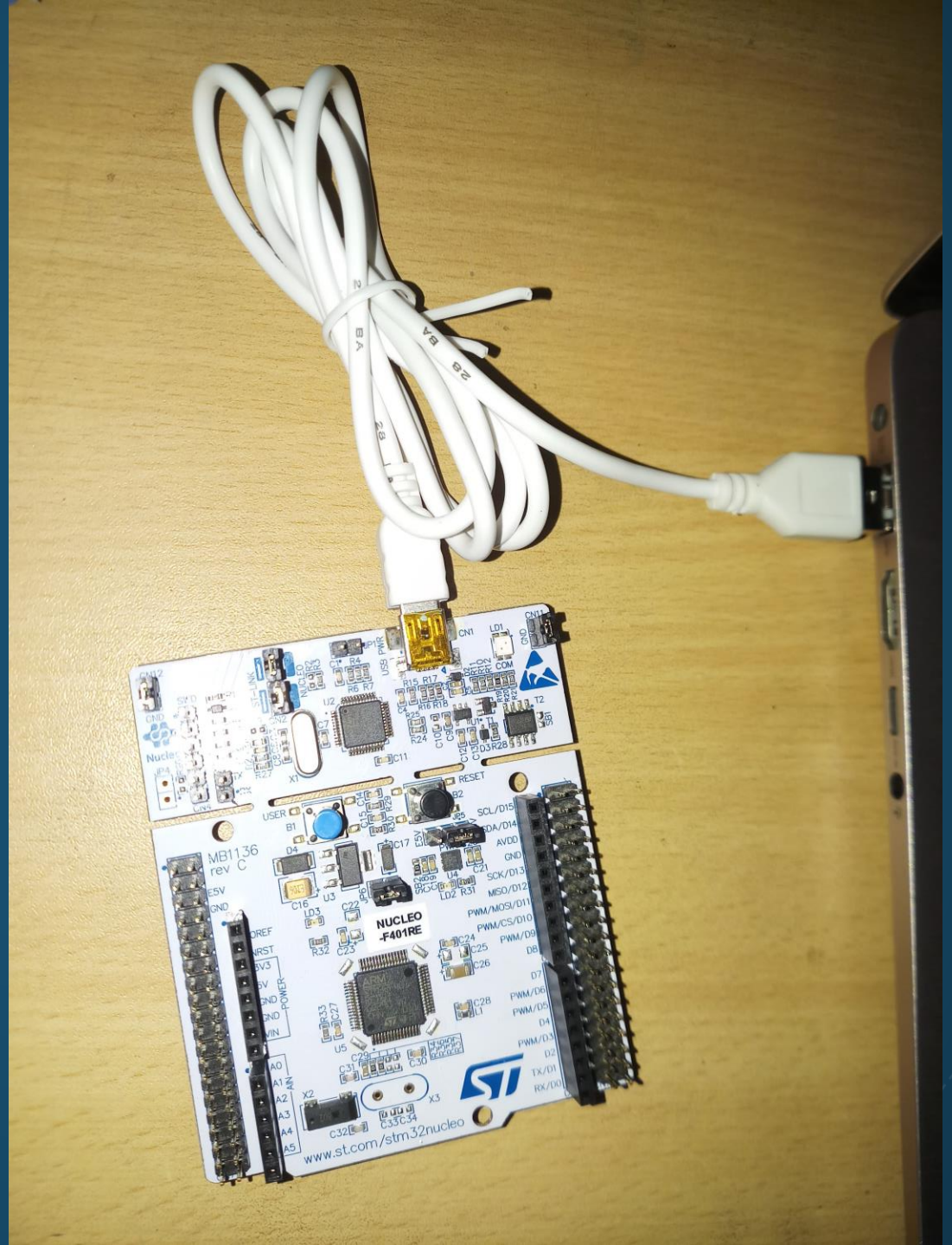
These features make the STM32F401xD/xE microcontrollers suitable for a wide range of applications:

- Motor drive and application control
- Medical equipment
- Industrial applications: PLC, inverters, circuit breakers
- Printers, and scanners
- Alarm systems, video intercom, and HVAC
- Home audio appliances
- Mobile phone sensor hub



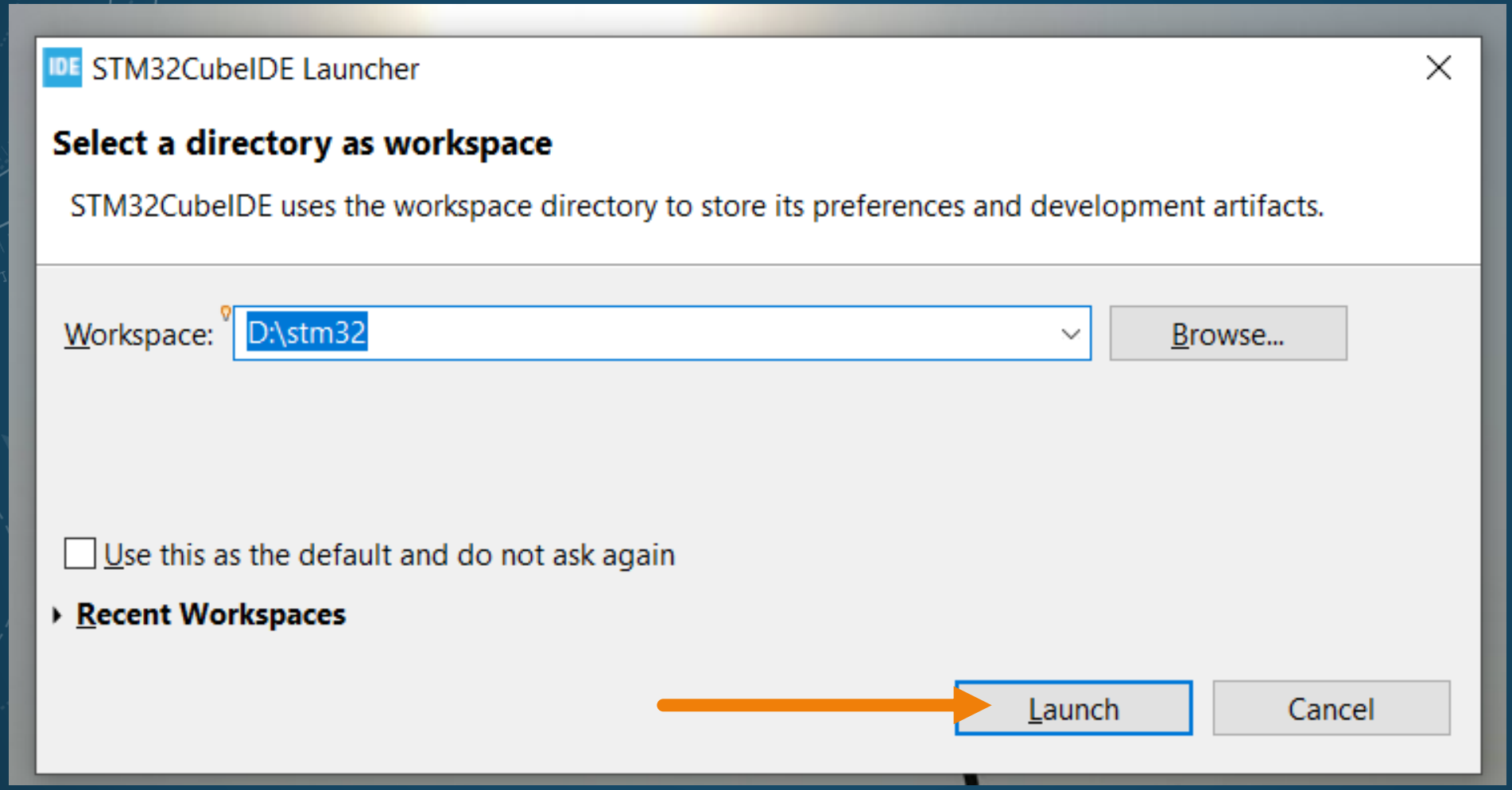
NOW , LETS LEARN HOW TO START A BASIC SYSTEM WITH THIS BOARD:

CONNECT THE BOARD TO A USB PORT:

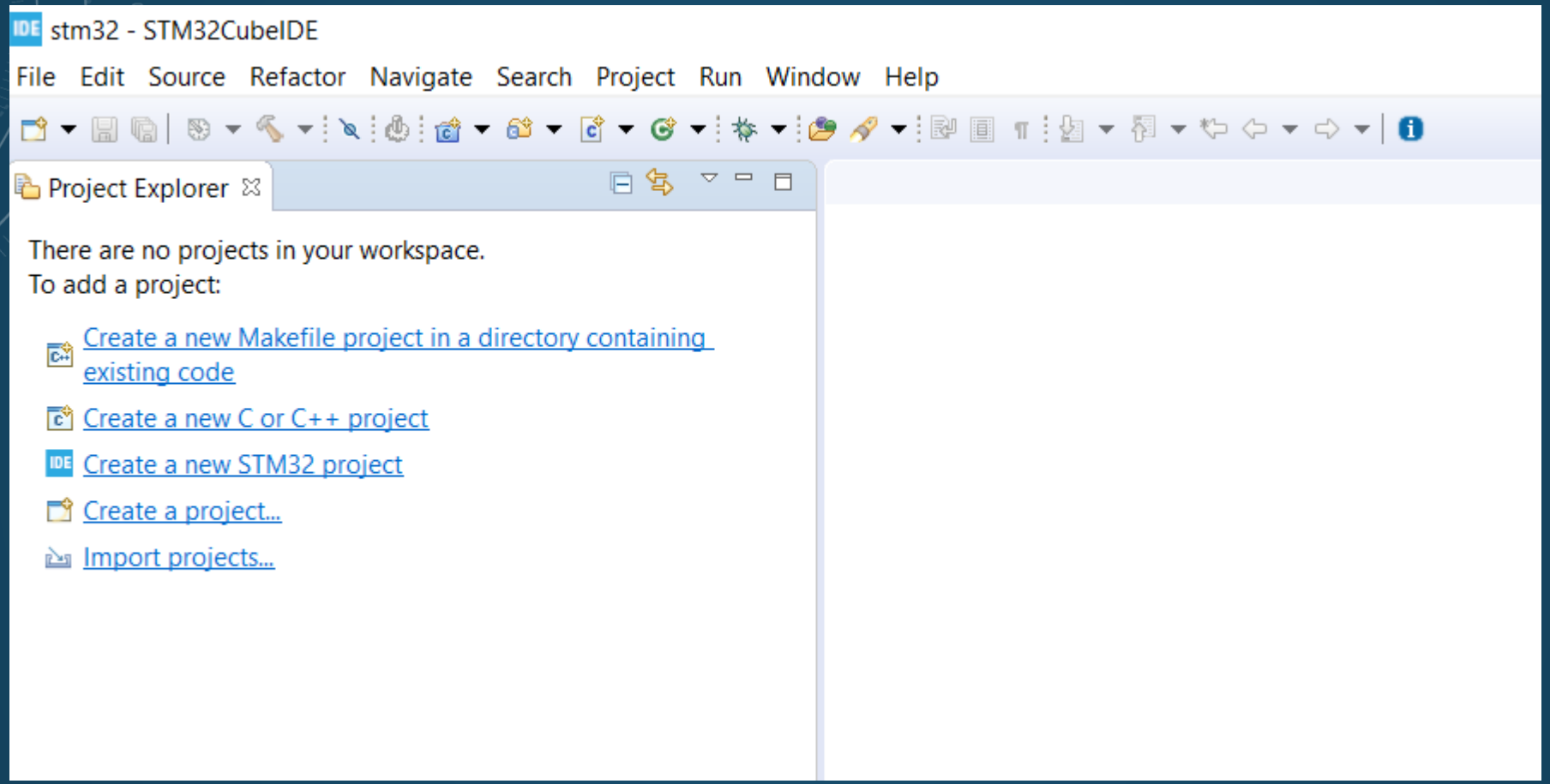


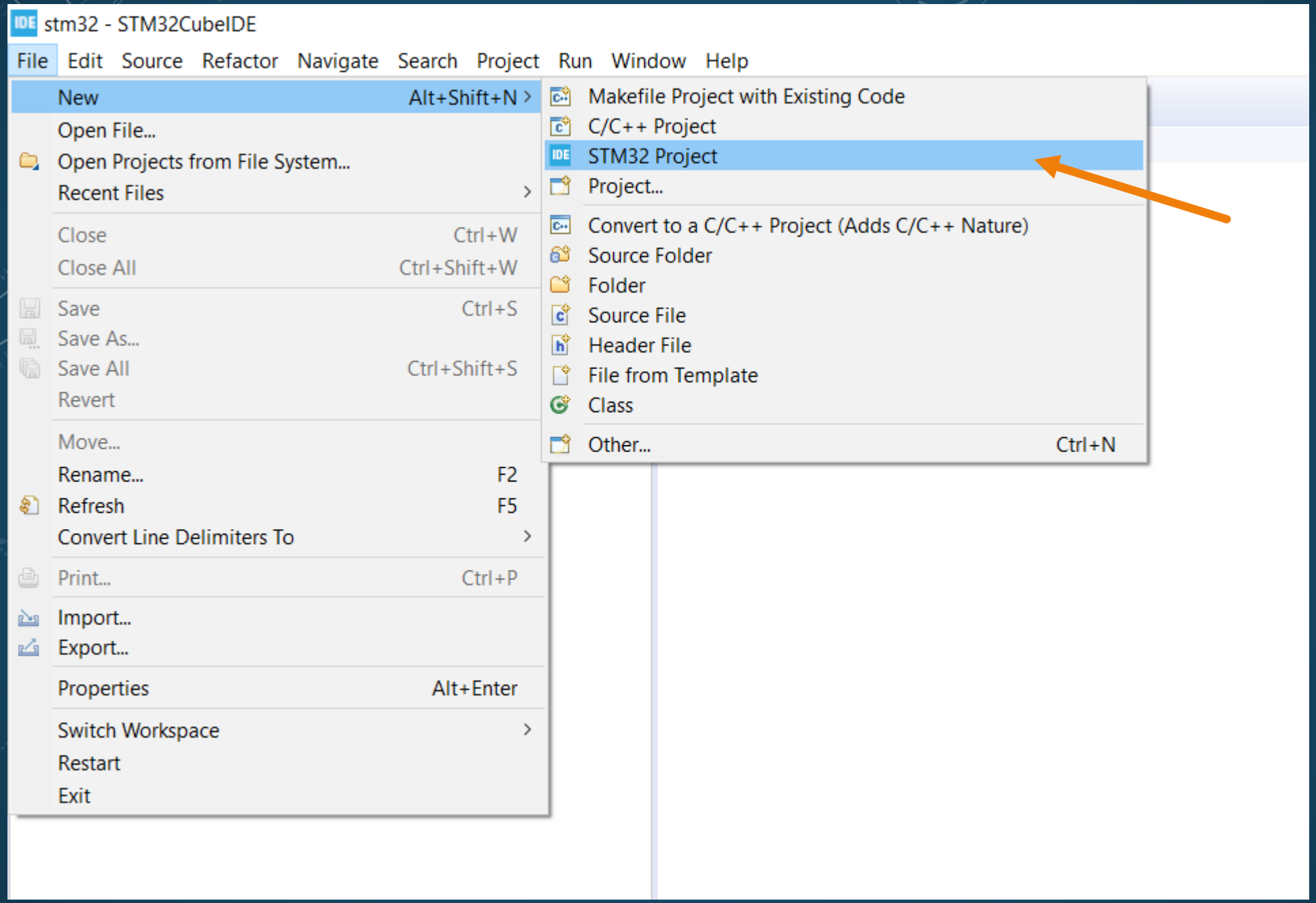
OPEN THE SOFTWARE STM32 CUBE IDE

CLICK LAUNCH TO SELECT A WORKSPACE IN A SPECIFIC DIRECTORY:

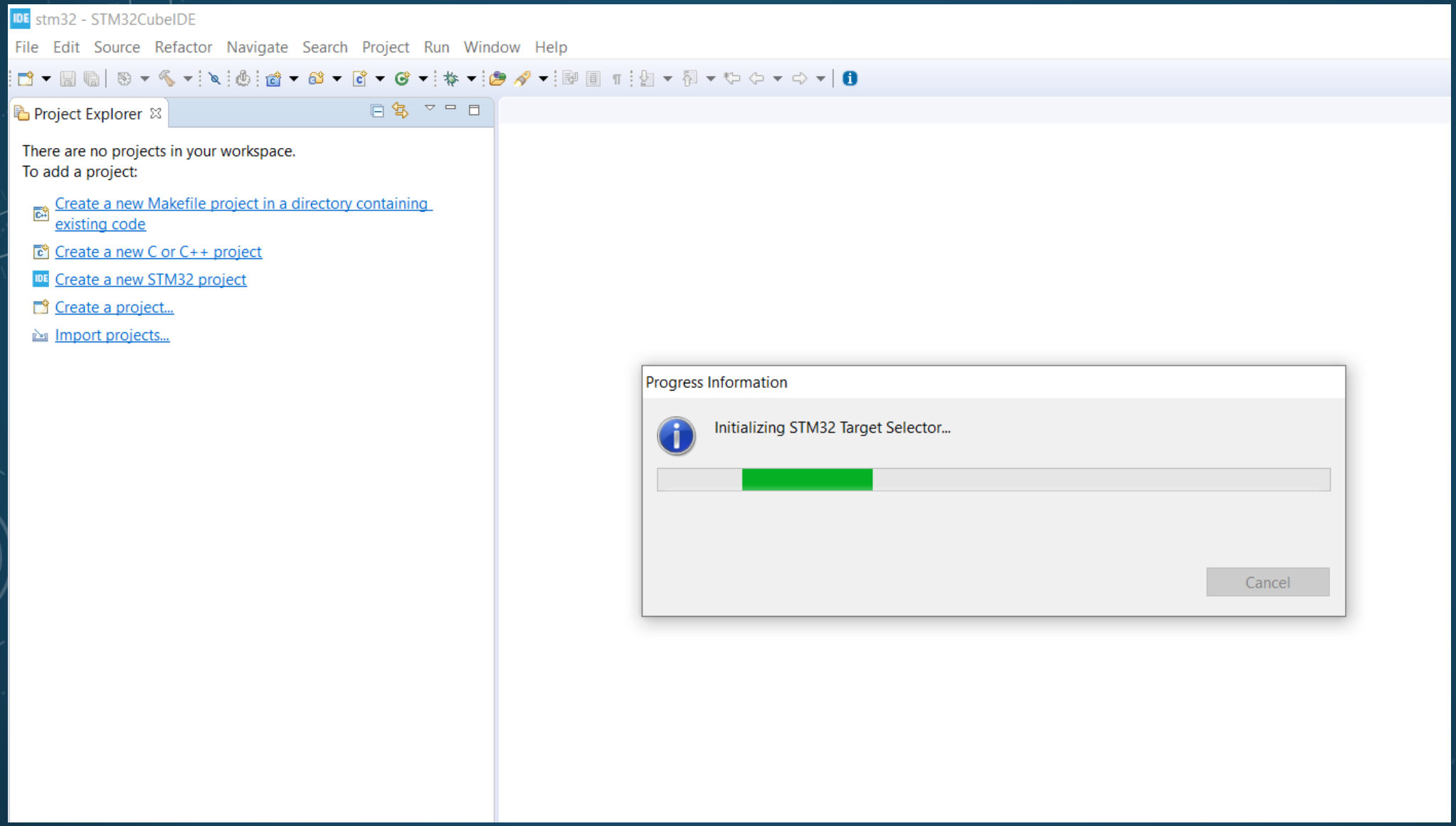


THE FOLLOWING WORKSPACE WINDOW WILL POP UP:

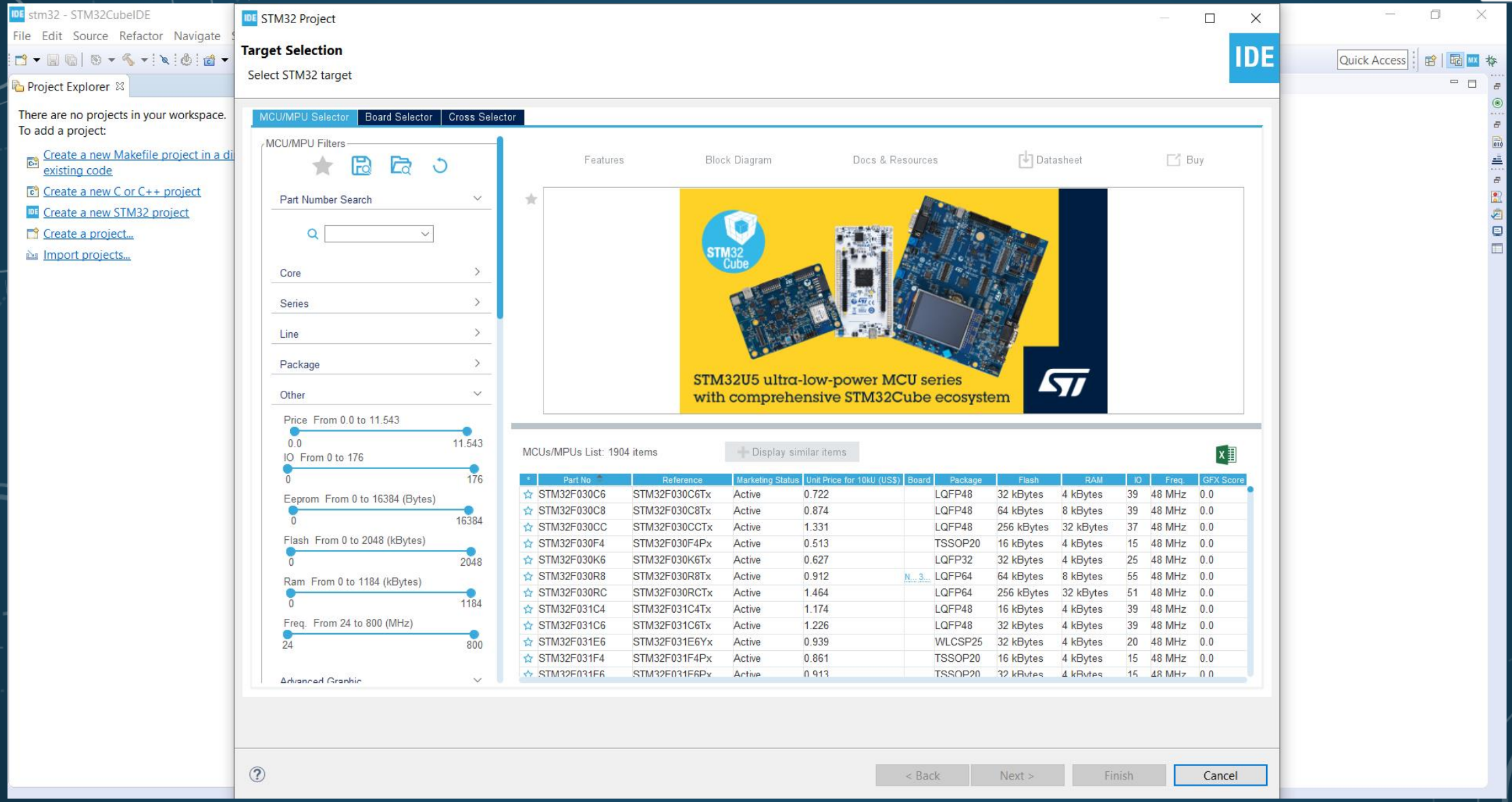



stm32 - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
New Alt+Shift+N
Open File...
Open Projects from File System...
Recent Files
Close Ctrl+W
Close All Ctrl+Shift+W
Save Ctrl+S
Save As...
Save All Ctrl+Shift+S
Revert
Move...
Rename... F2
Refresh F5
Convert Line Delimiters To
Print... Ctrl+P
Import...
Export...
Properties Alt+Enter
Switch Workspace
Restart
Exit
Makefile Project with Existing Code
C/C++ Project
STM32 Project
Project...
Convert to a C/C++ Project (Adds C/C++ Nature)
Source Folder
Folder
Source File
Header File
File from Template
Class
Other... Ctrl+N

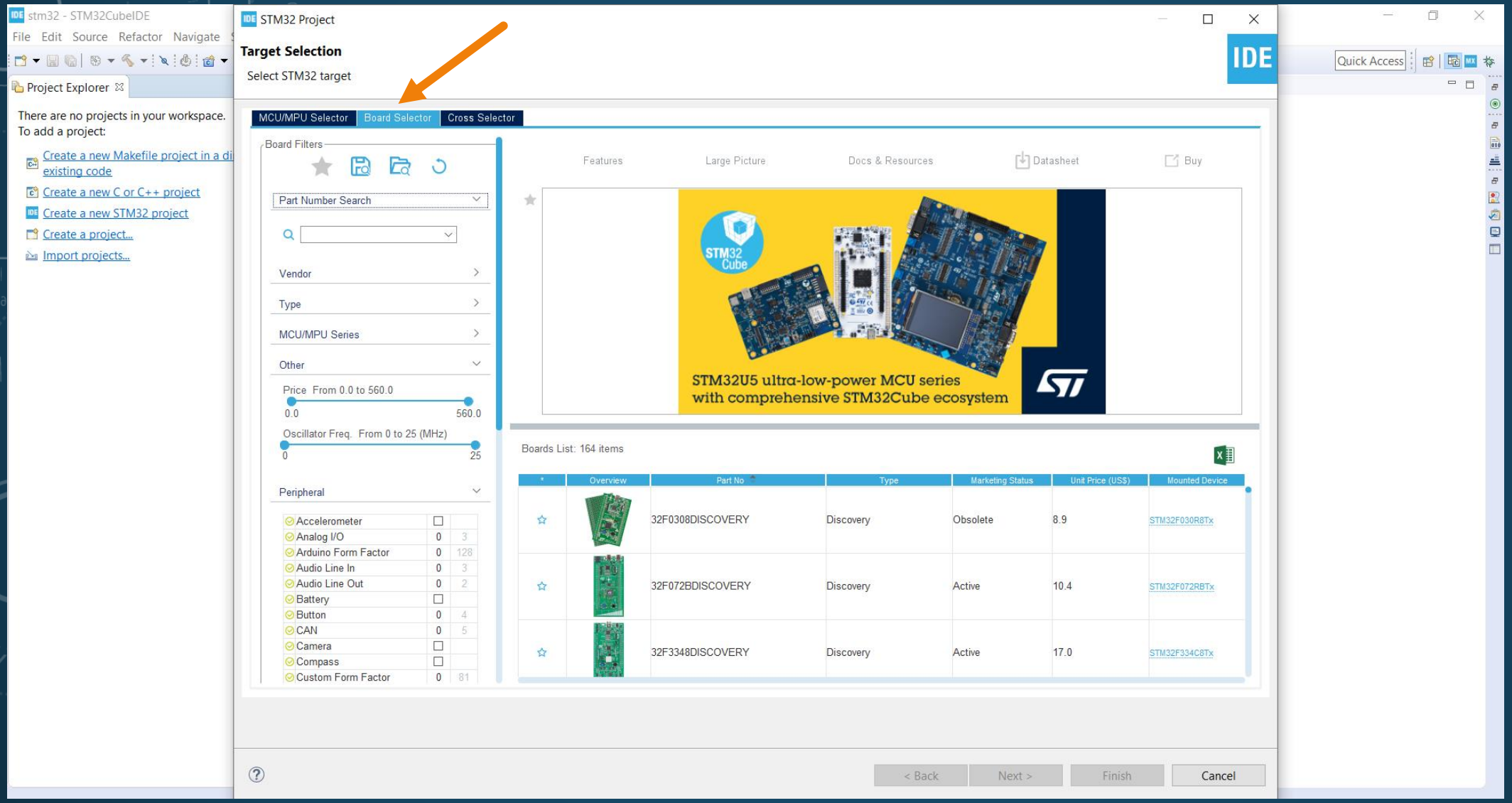
THIS WILL EVENTUALLY ACTIVATE A TARGET SELECTOR WINDOW:

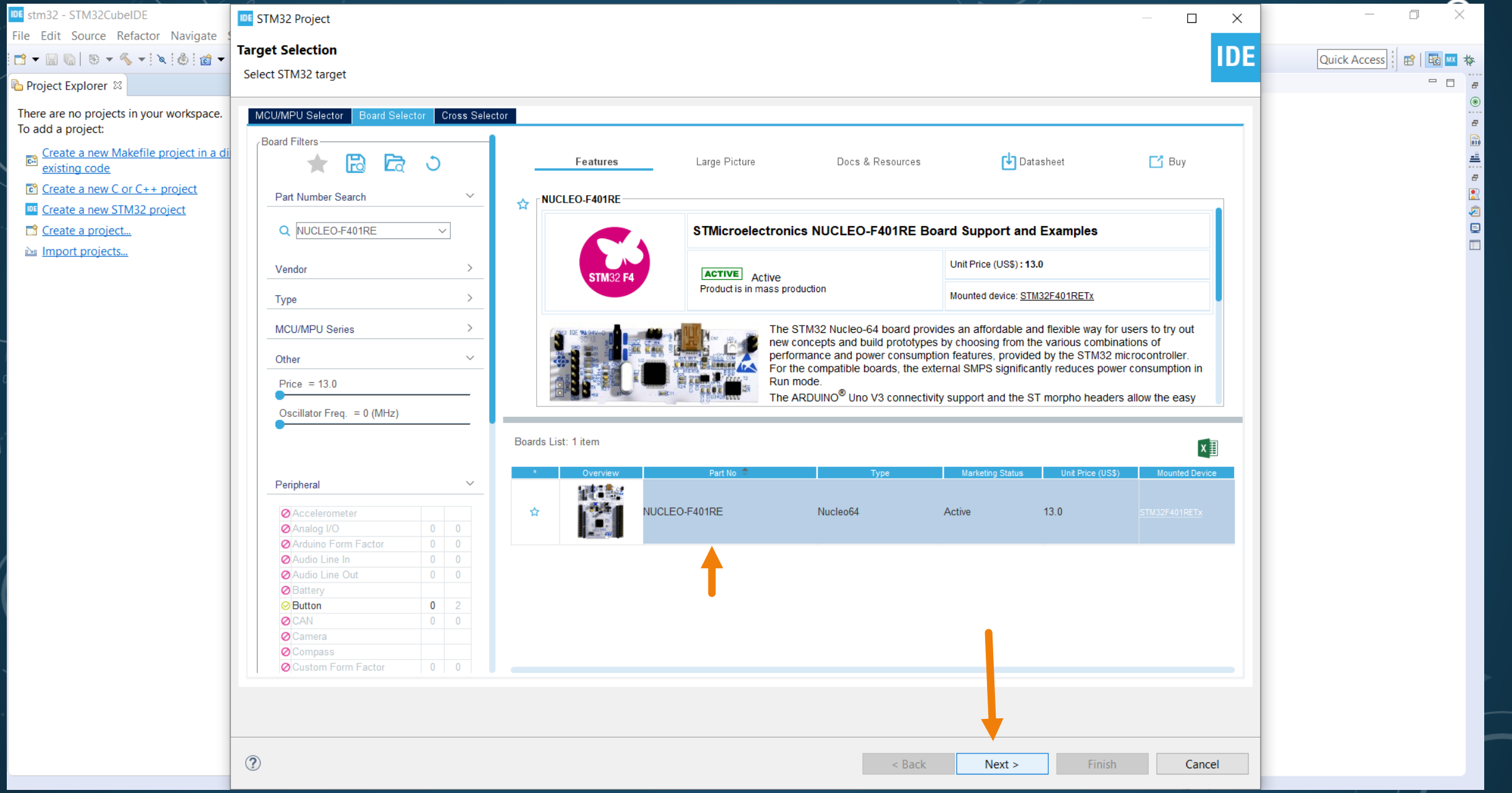


A WINDOW WILL POP UP:

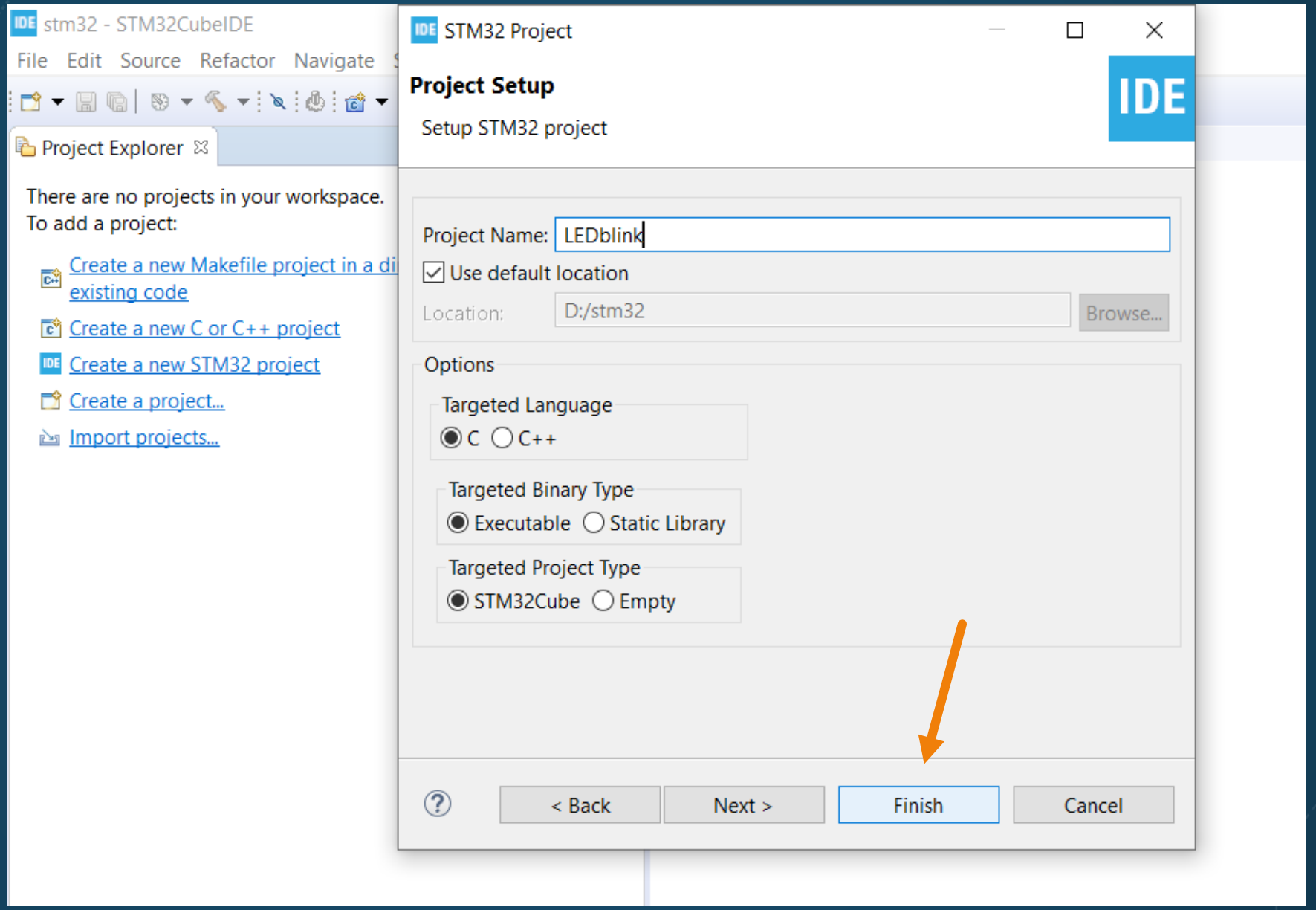


CLICK ON BOARD SELECTOR AND NOTICE BLANK SPACE OF PART NUMBER SEARCH:

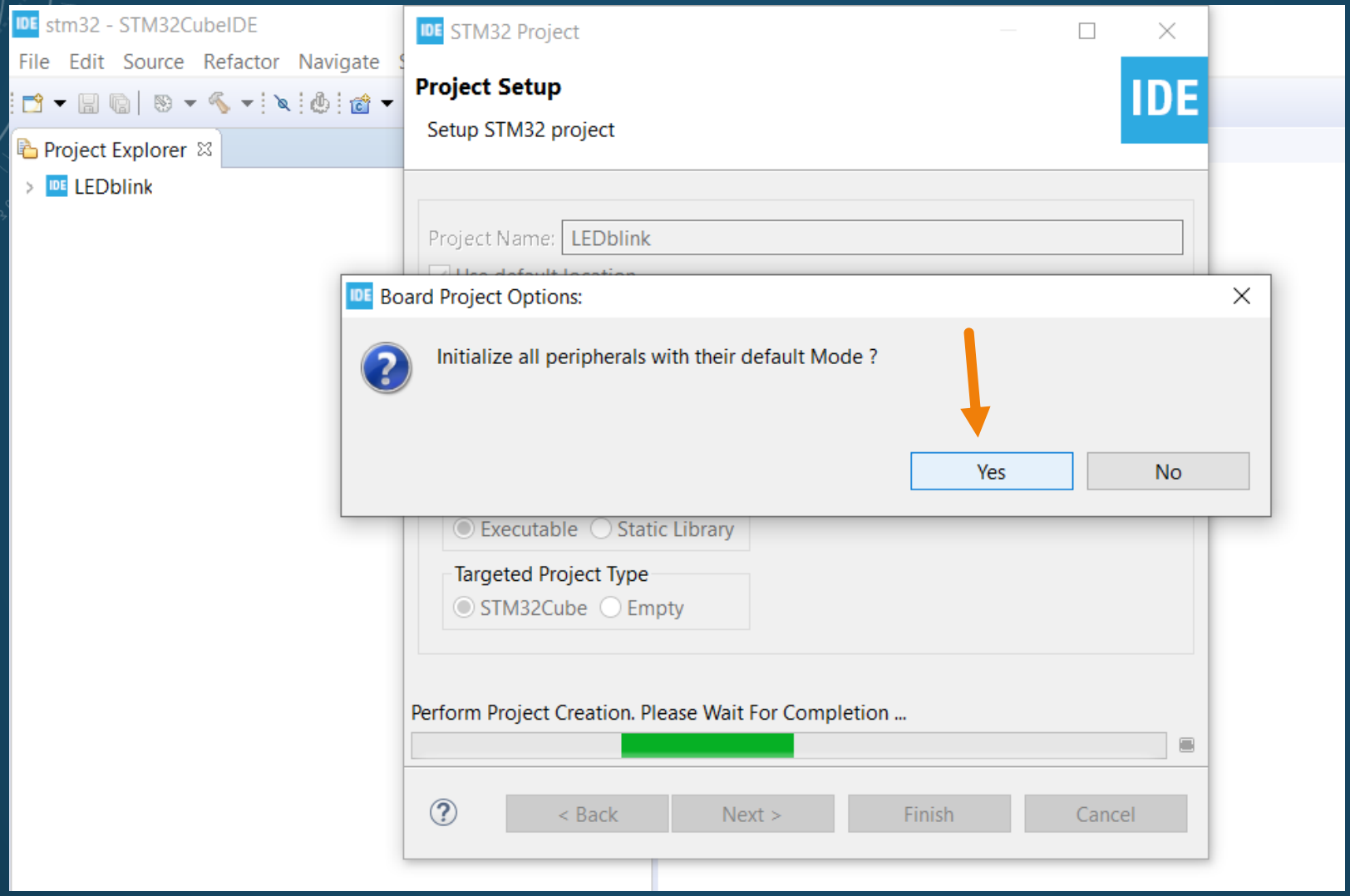



stm32 - STM32CubeIDE
File Edit Source Refactor Navigate
Project Explorer
There are no projects in your workspace.
To add a project:
Create a new Makefile project in a di
existing code
Create a new C or C++ project
Create a new STM32 project
Create a project...
Import projects...
STM32 Project
Target Selection
Select STM32 target
IDE
Quick Access
MCU/MPU Selector
Board Selector
Cross Selector
Board Filters
Part Number Search
NUCLEO-F401RE
Vendor
Type
MCU/MPU Series
Other
Price = 13.0
Oscillator Freq. = 0 (MHz)
Peripheral
Accelerometer
Analog I/O 0 0
Arduino Form Factor 0 0
Audio Line In 0 0
Audio Line Out 0 0
Battery
Button 0 2
CAN 0 0
Camera
Compass
Custom Form Factor 0 0
Features
Large Picture
Docs & Resources
Datasheet
Buy
NUCLEO-F401RE
STM32 F4
STMicroelectronics NUCLEO-F401RE Board Support and Examples
ACTIVE Active
Product is in mass production
Unit Price (US$) : 13.0
Mounted device: STM32F401RETx
The STM32 Nucleo-64 board provides an affordable and flexible way for users to try out new concepts and build prototypes by choosing from the various combinations of performance and power consumption features, provided by the STM32 microcontroller. For the compatible boards, the external SMPS significantly reduces power consumption in Run mode.
The ARDUINO® Uno V3 connectivity support and the ST morpho headers allow the easy
Boards List: 1 item
Overview
Part No
Type
Marketing Status
Unit Price (US$)
Mounted Device
NUCLEO-F401RE
Nucleo64
Active
13.0
STM32F401RETx
< Back
Next >
Finish
Cancel

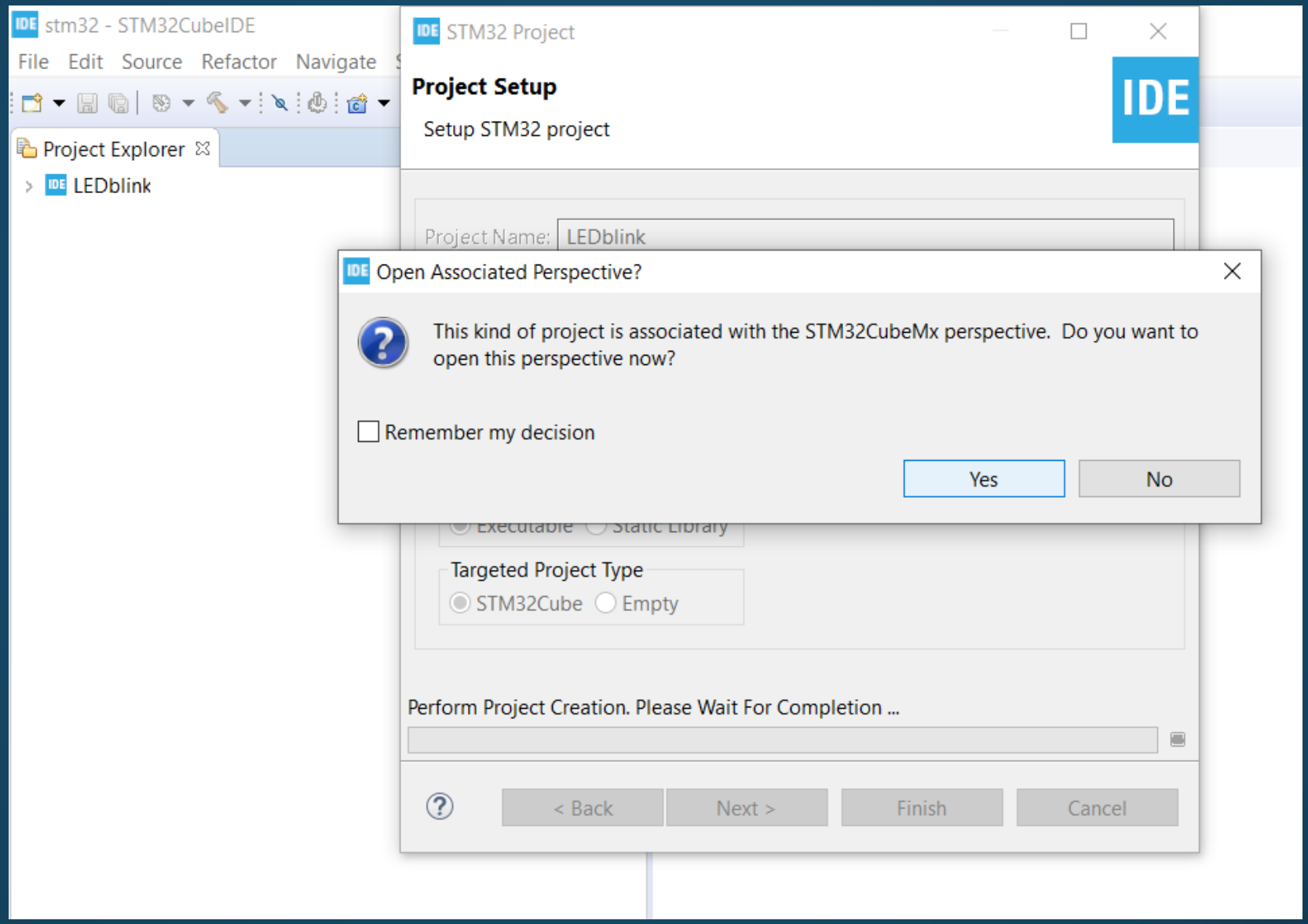
WRITE THE NAME OF THE PROGRAM IN PROJECT SETUP WINDOW:



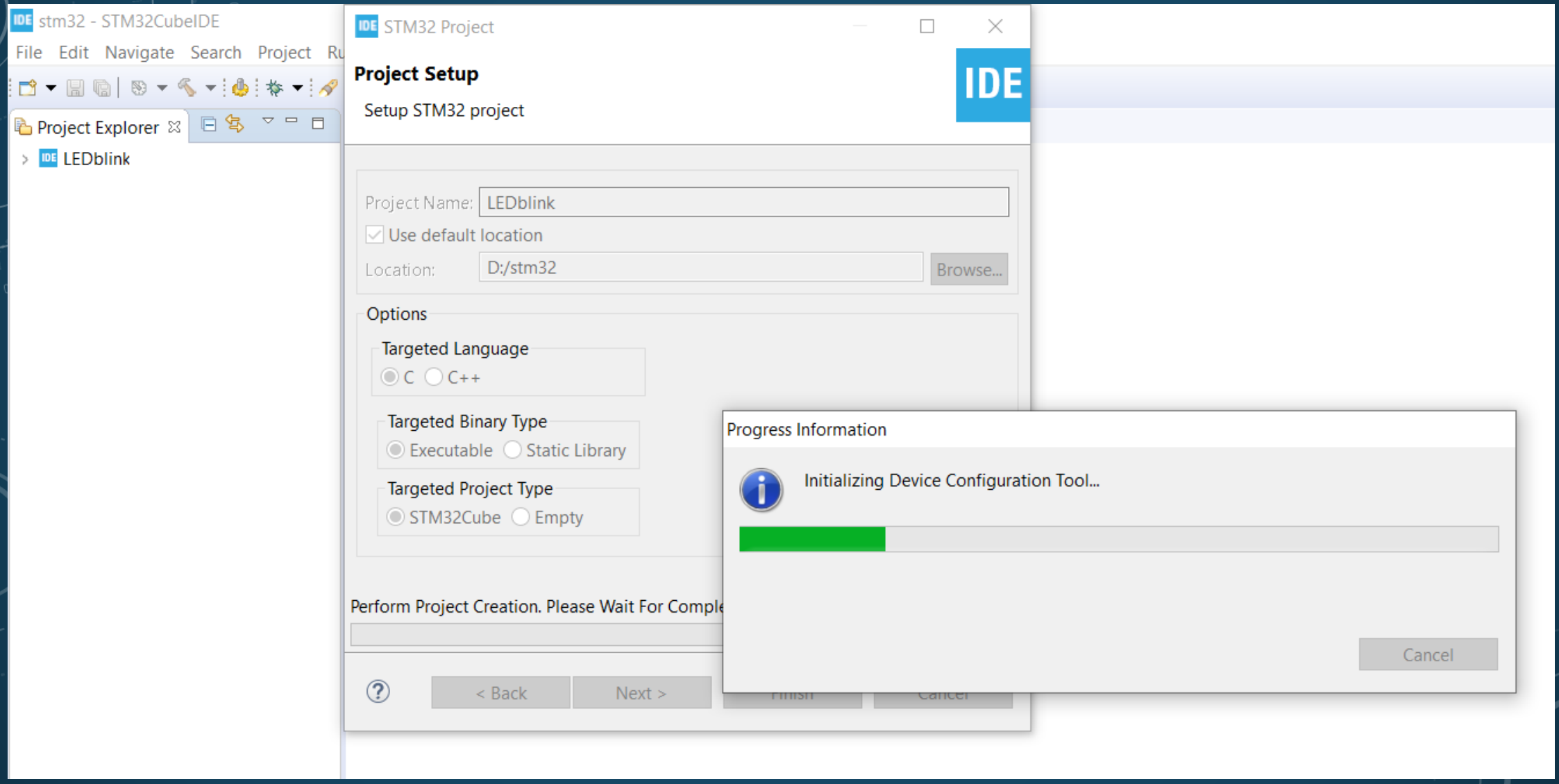
SELECT THE OPTION YES TO INITIALIZE ALL THE PERIPHERALS WITH DEFAULT MODE:



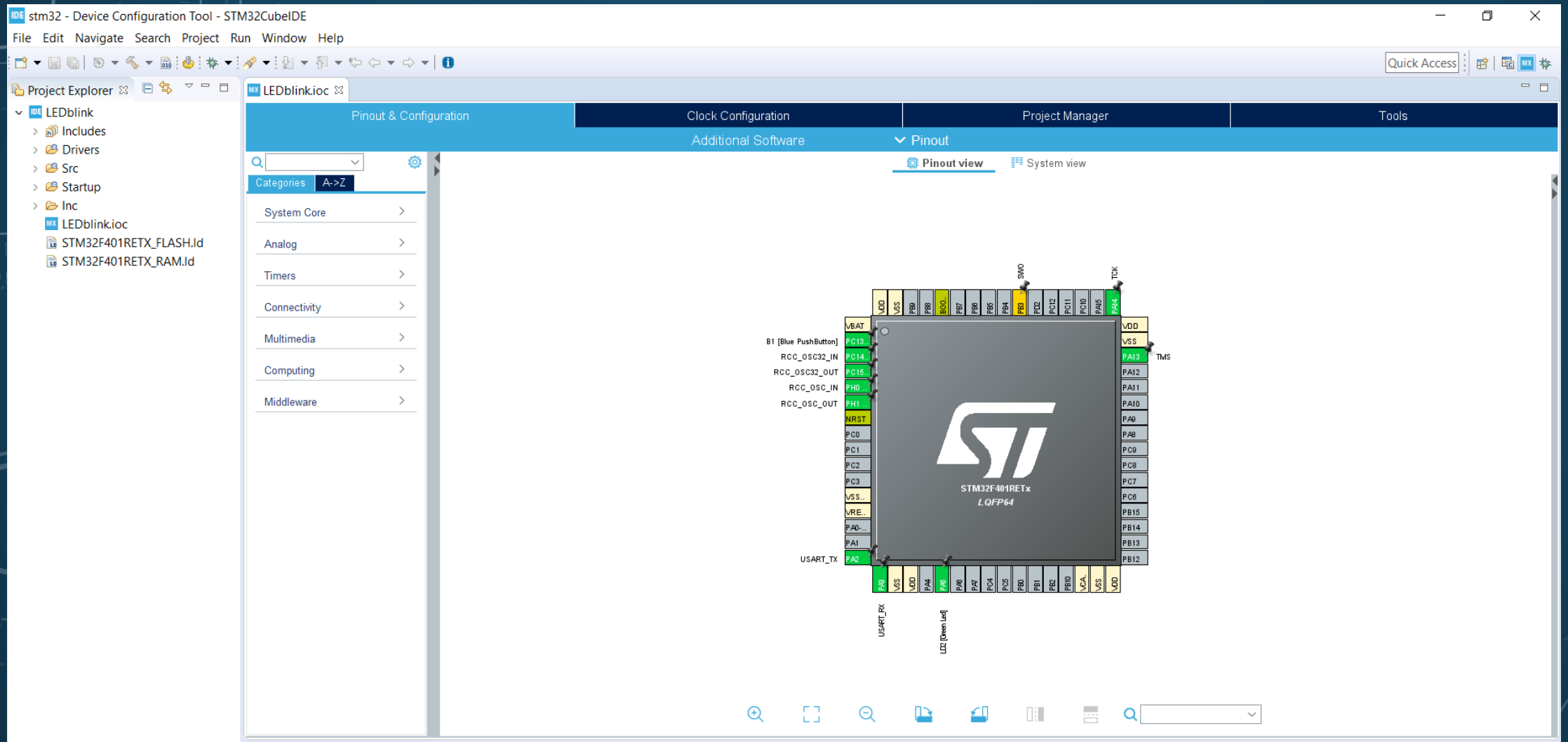
SELECT YES TO OPEN PERSPECTIVE:



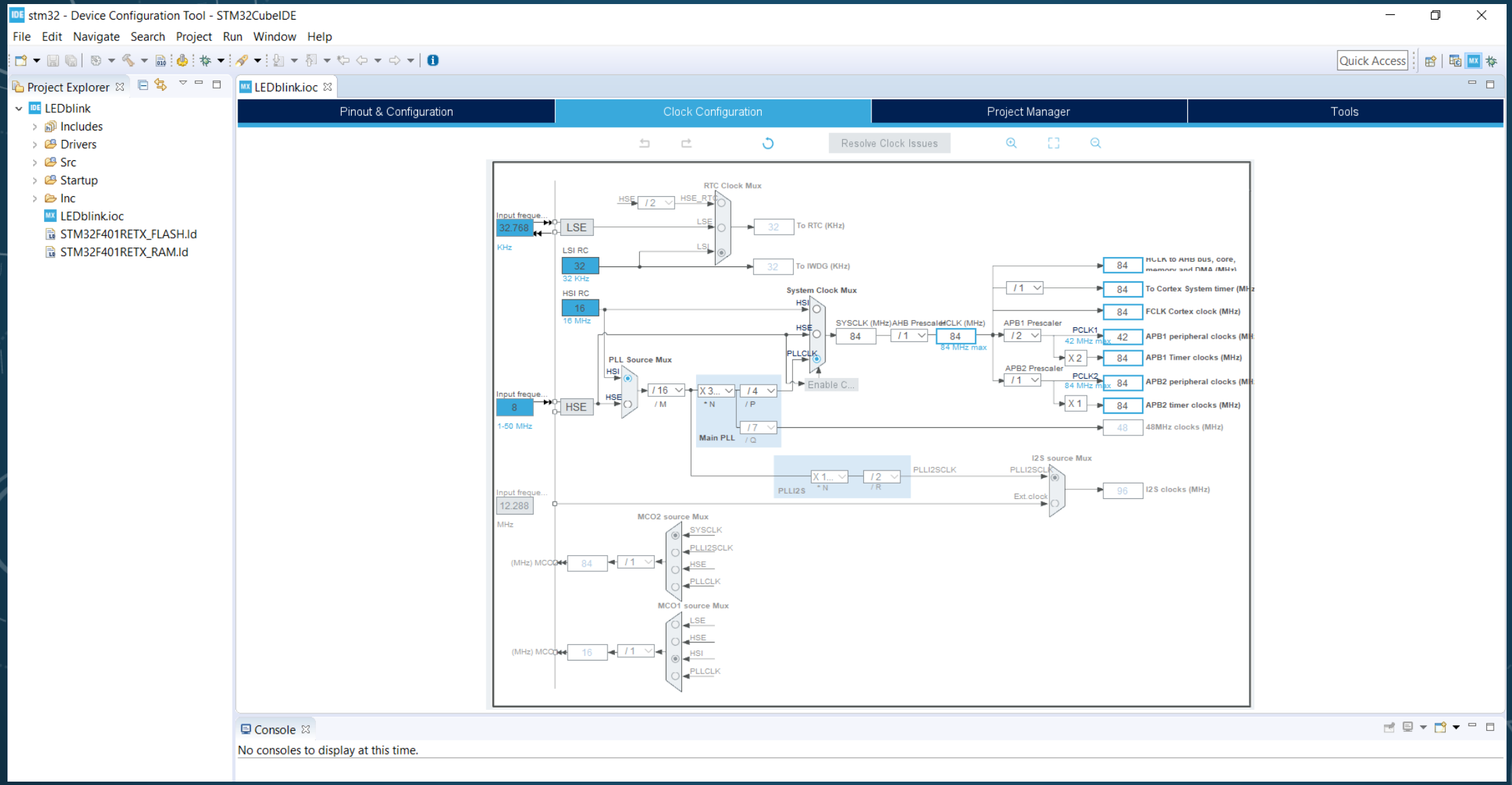
DEVICE CONFIGURATION TOOL IS INITIALIZING:

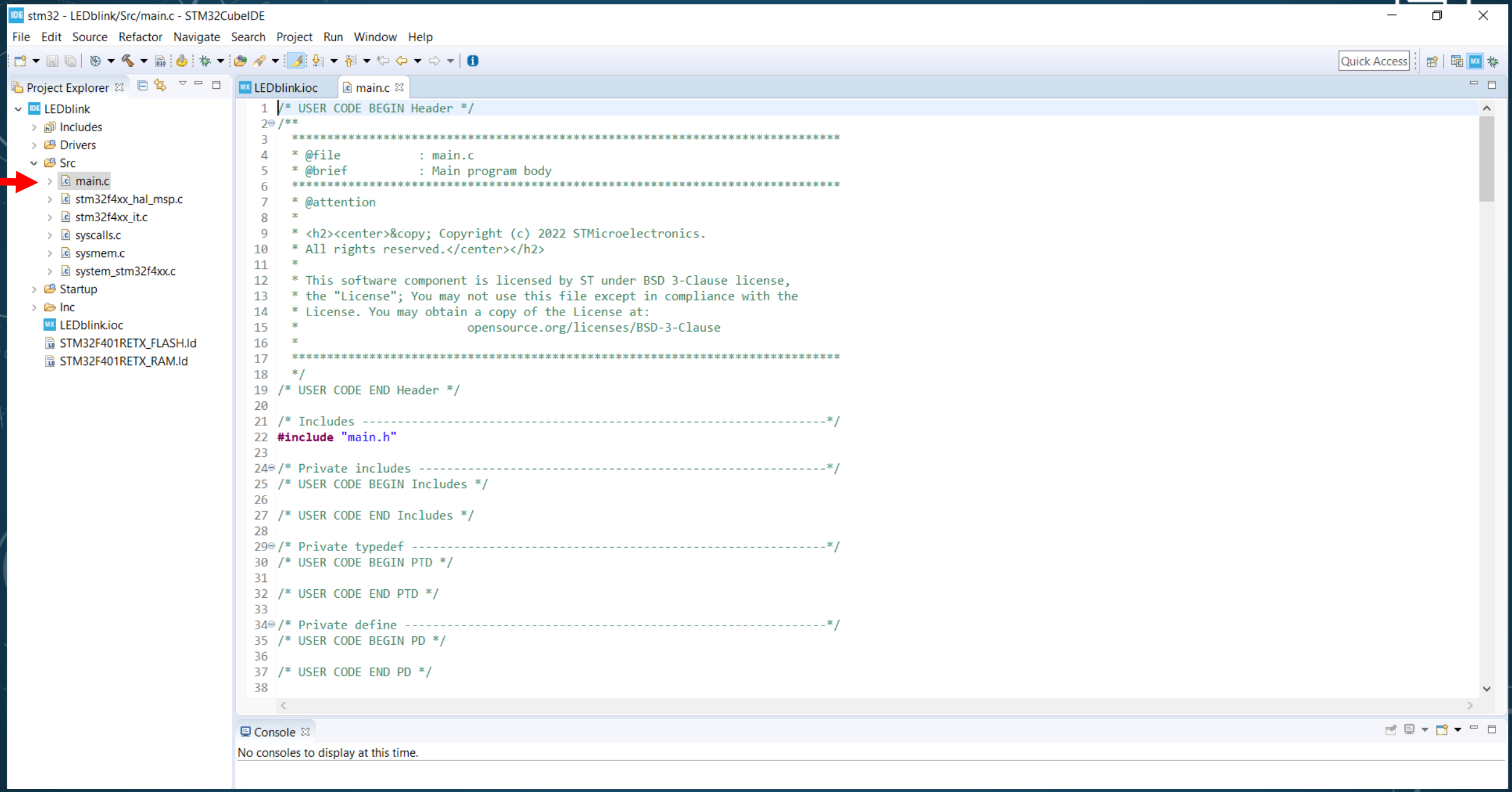


WAIT FOR THE PACKAGES TO BE DOWNLOADED: IT WILL BE EASY TO NAVIGATE THROUGH THE PORTS AND PINS, CLOCK FREQUENCY AND PROJECT MANAGER.

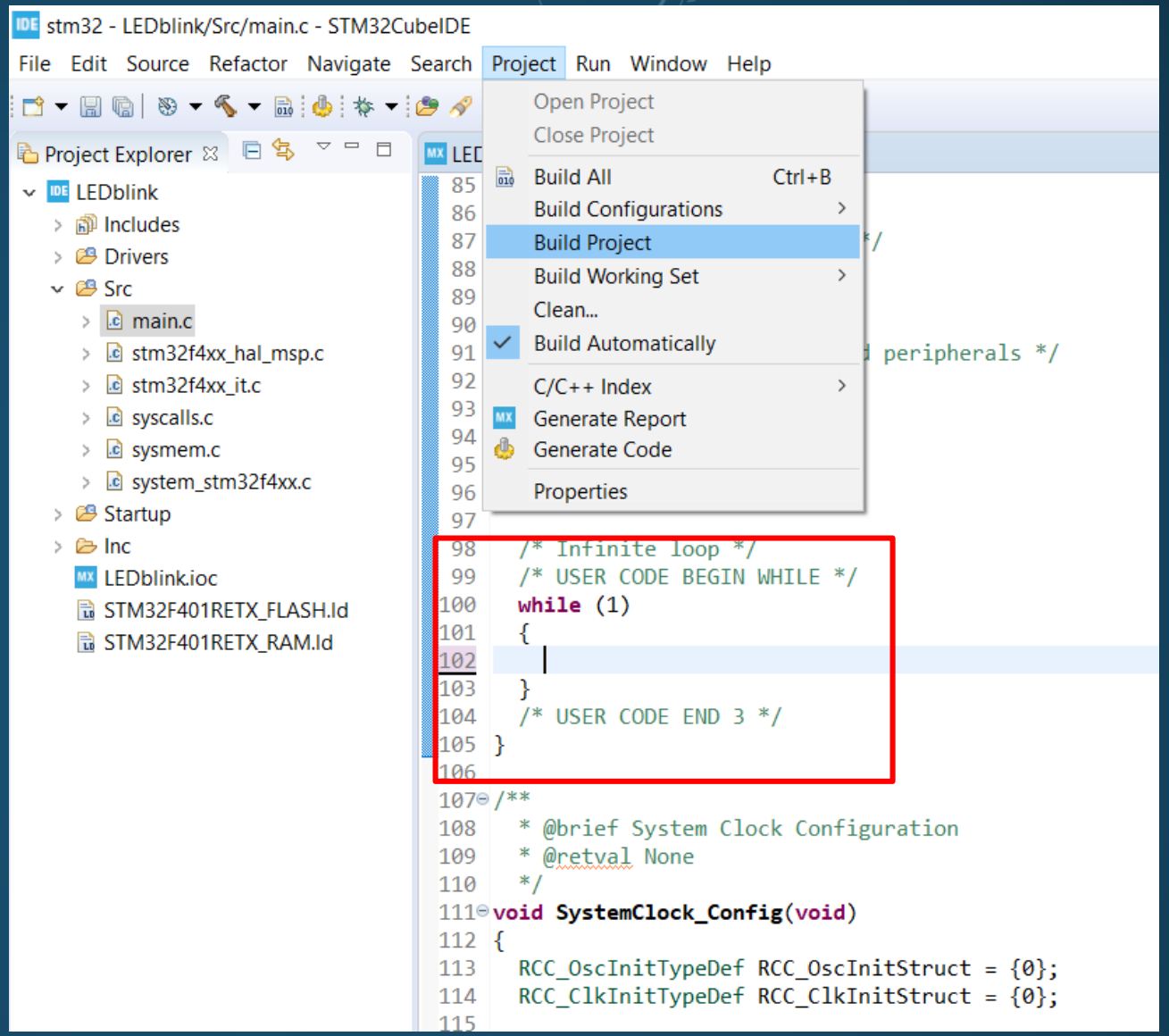


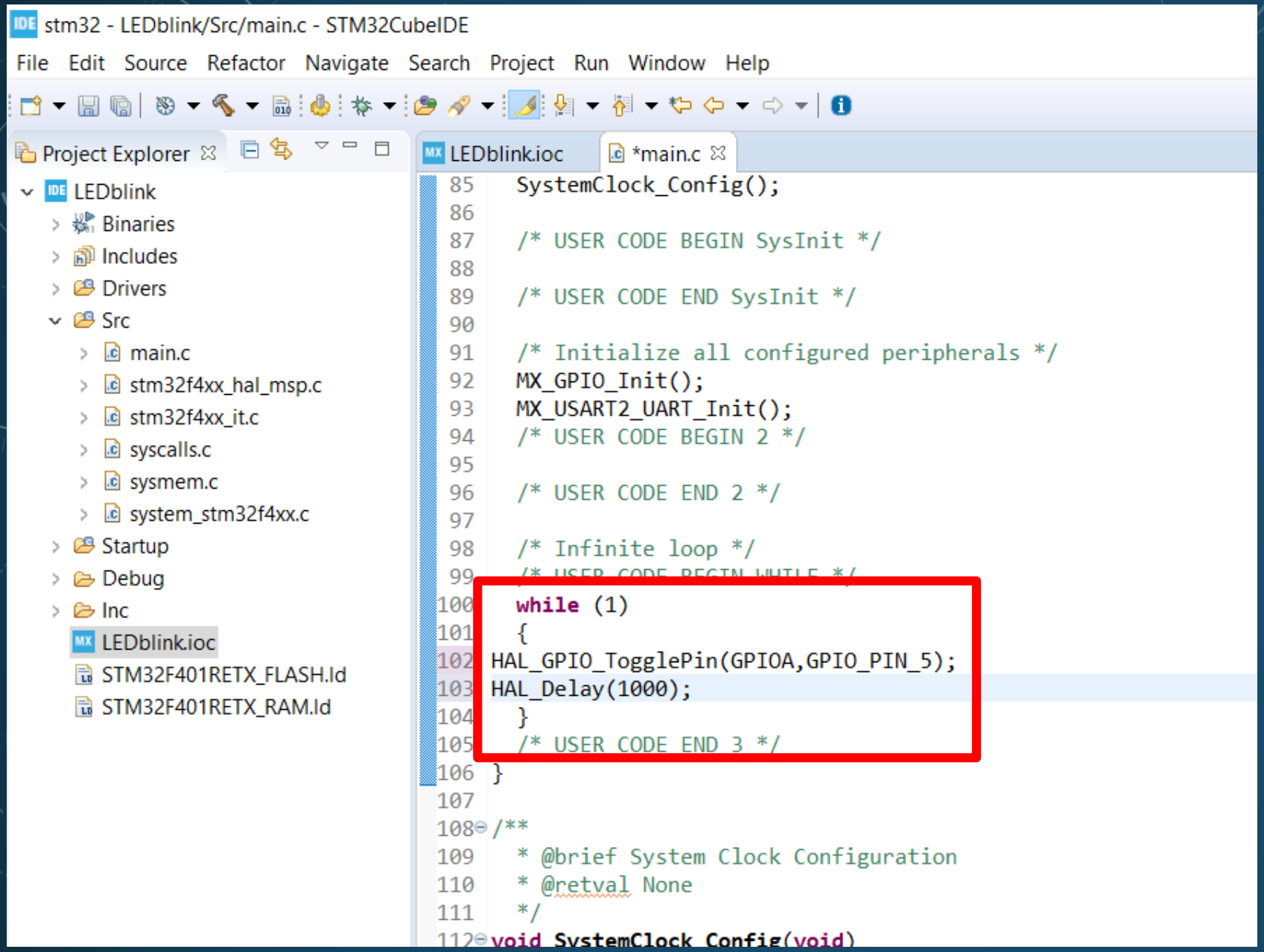
CLOCK CONFIGURATION:




stm32 - LEDblink/Src/main.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
Quick Access
Project Explorer
LEDblink
Includes
Drivers
Src
main.c
stm32f4xx_hal_msp.c
stm32f4xx_it.c
syscalls.c
sysmem.c
system_stm32f4xx.c
Startup
Inc
LEDblink.ioc
STM32F401RETX_FLASH.ld
STM32F401RETX_RAM.ld
LEDblink.ioc
main.c
1 /* USER CODE BEGIN Header */
2 /**
3 **
4 * @file : main.c
5 * @brief : Main program body
6 **
7 * @attention
8 *
9 * <h2> © Copyright (c) 2022 STMicroelectronics.
10 * All rights reserved. </h2>
11 *
12 * This software component is licensed by ST under BSD 3-Clause license,
13 * the "License"; You may not use this file except in compliance with the
14 * License. You may obtain a copy of the License at:
15 * opensource.org/licenses/BSD-3-Clause
16 *
17 **
18 */
19 /* USER CODE END Header */
20
21 /* Includes --*/
22 #include "main.h"
23
24 /* Private includes --*/
25 /* USER CODE BEGIN Includes */
26
27 /* USER CODE END Includes */
28
29 /* Private typedef ---*/
30 /* USER CODE BEGIN PTD */
31
32 /* USER CODE END PTD */
33
34 /* Private define --*/
35 /* USER CODE BEGIN PD */
36
37 /* USER CODE END PD */
38
Console
No consoles to display at this time.

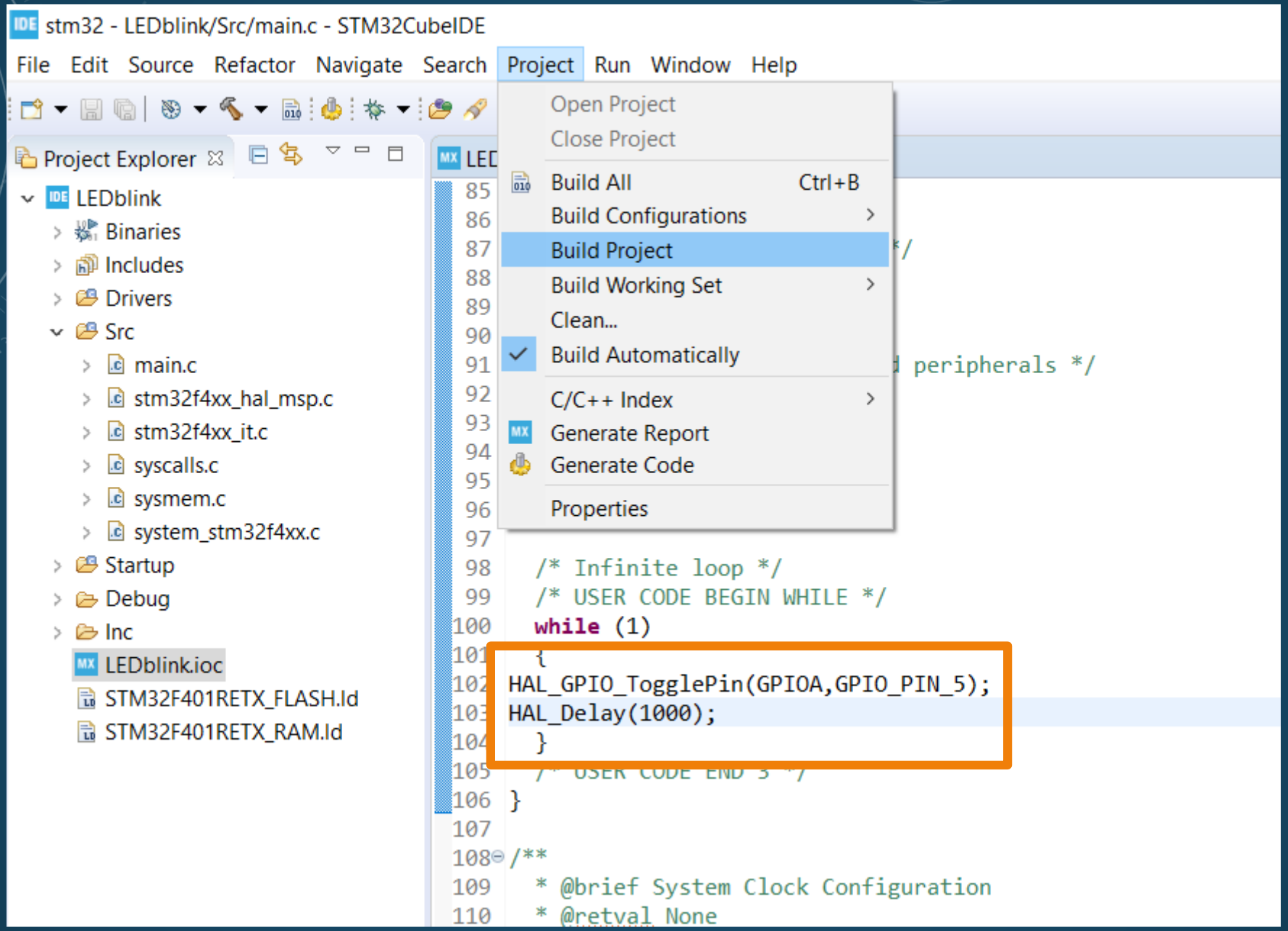
CLICK BUILD PROJECT

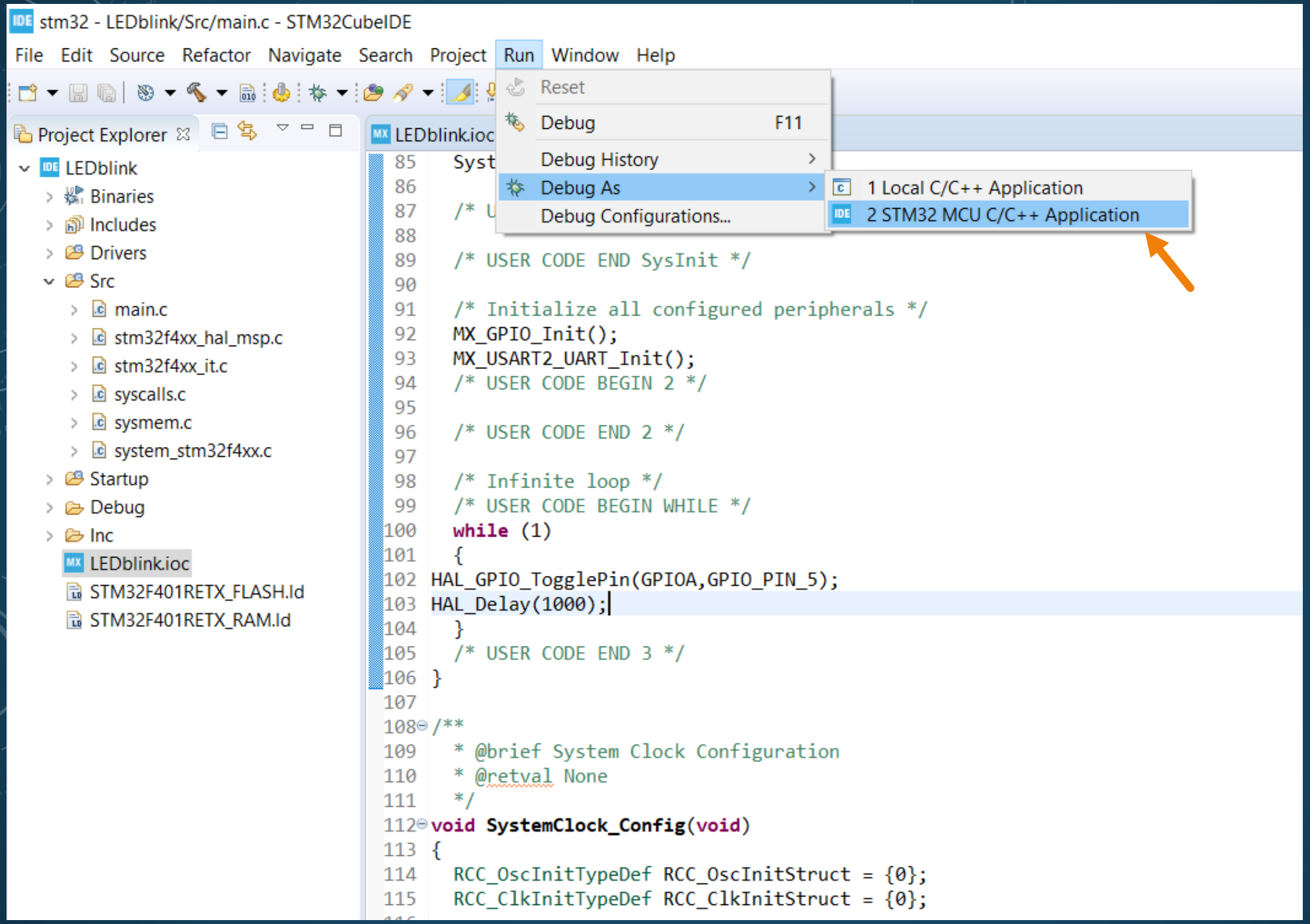


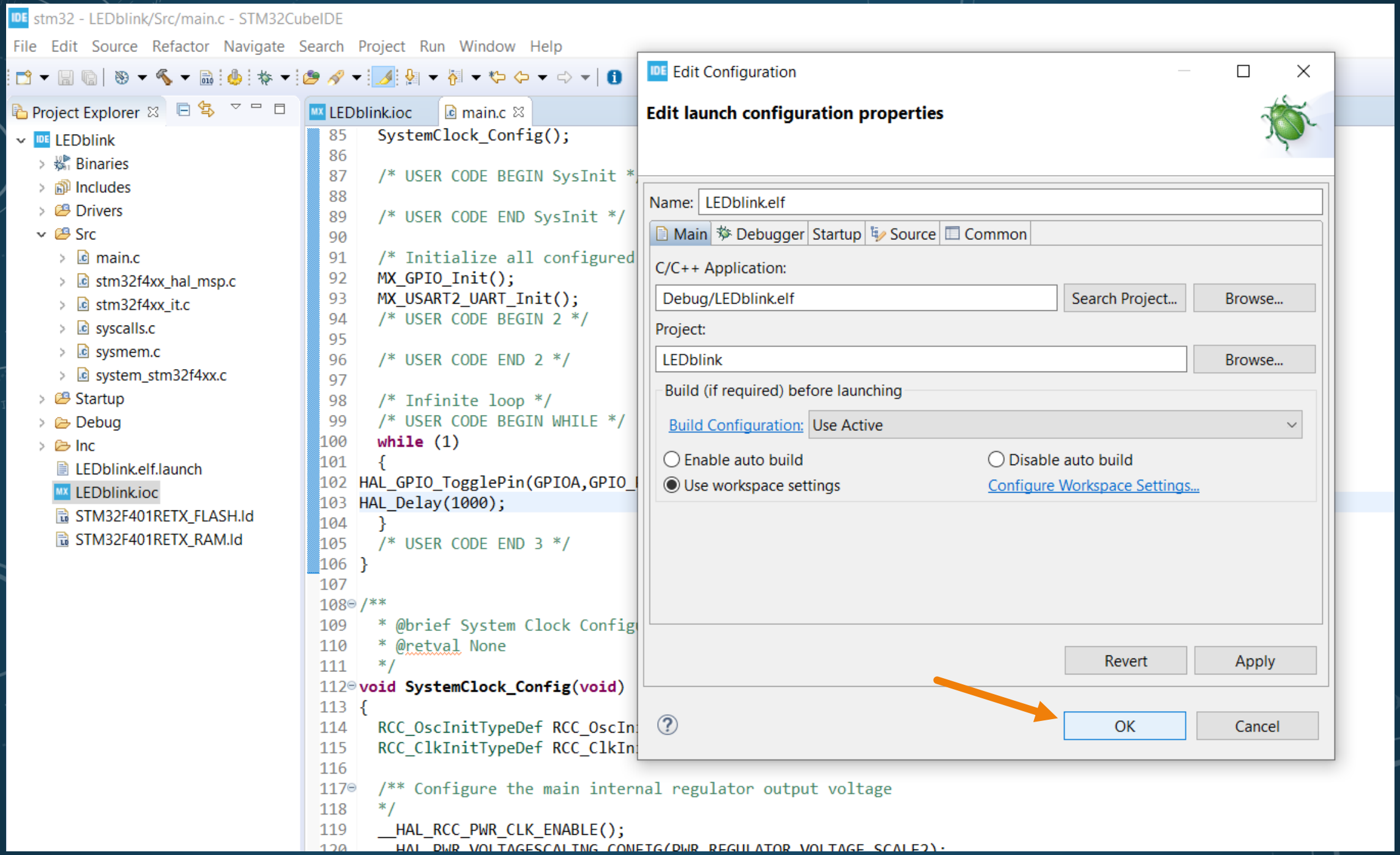


WRITE THE INSTRUCTIONS:

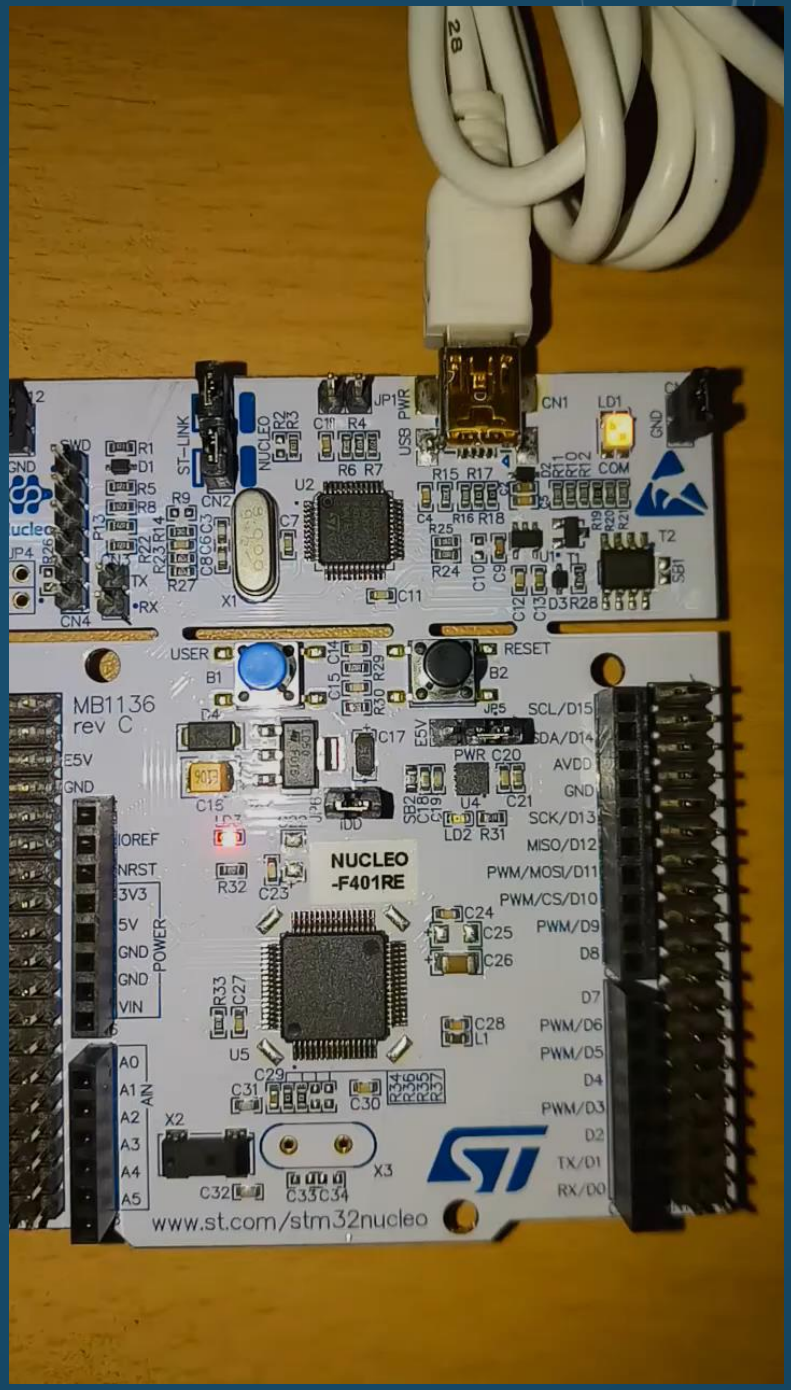
- Nucleo board comes with the STM32 comprehensive software Hardware abstraction layer (HAL) drivers together with various packaged software examples.
- It also embeds a debugger that helps you develop your own applications


stm32 - LEDblink/Src/main.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
LEDblink
Binaries
Includes
Drivers
Src
main.c
stm32f4xx_hal_msp.c
stm32f4xx_it.c
syscalls.c
sysmem.c
system_stm32f4xx.c
Startup
Debug
Inc
LEDblink.ioc
STM32F401RETX_FLASH.ld
STM32F401RETX_RAM.ld
Open Project
Close Project
Build All Ctrl+B
Build Configurations
Build Project
Build Working Set
Clean...
Build Automatically
C/C++ Index
Generate Report
Generate Code
Properties
/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
{
HAL_GPIO_TogglePin(GPIOA,GPIO_PIN_5);
HAL_Delay(1000);
}
}
/**
* @brief System Clock Configuration
* @retval None

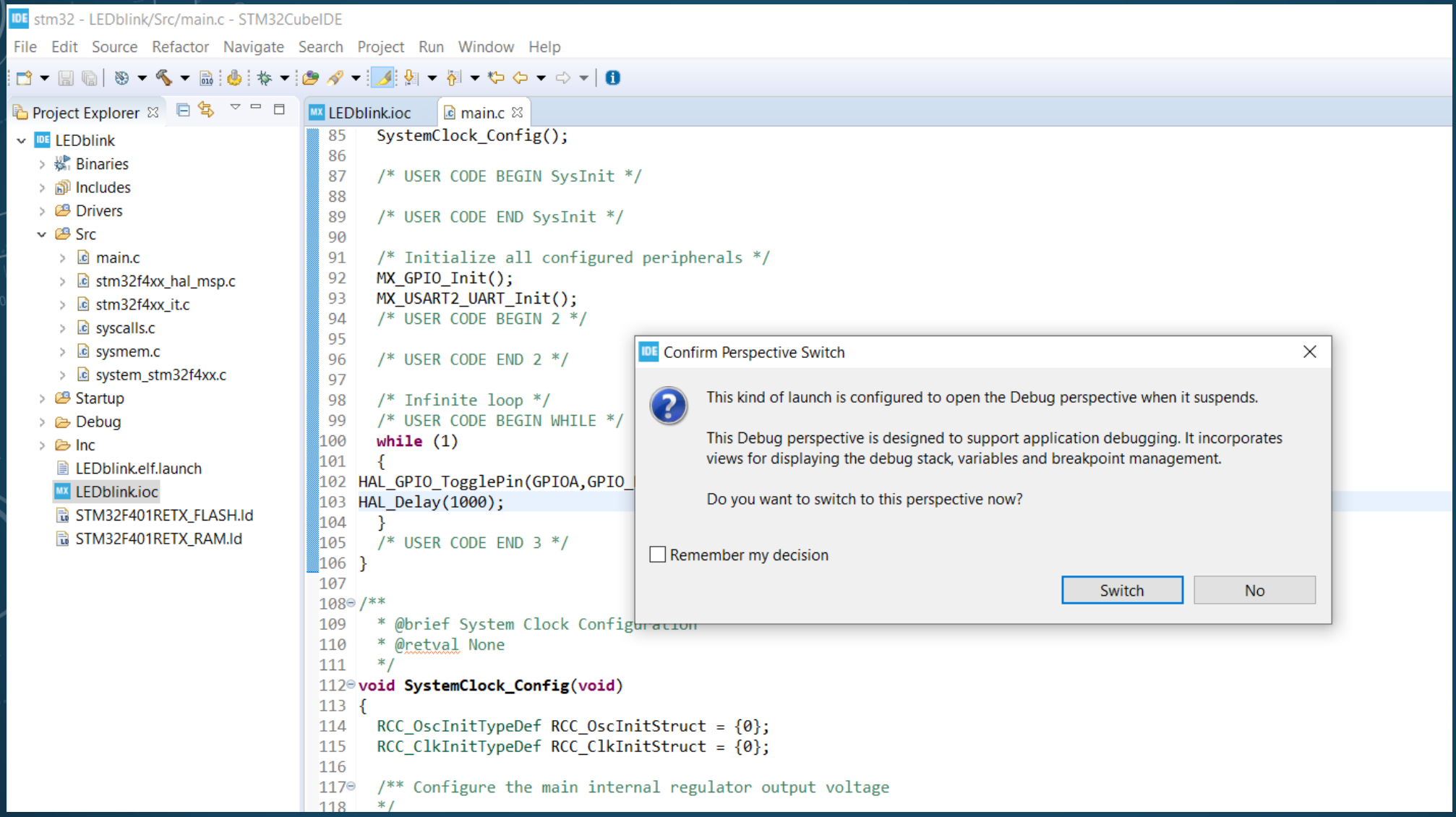

stm32 - LEDblink/Src/main.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
Reset
Debug F11
Debug History
Debug As
Debug Configurations...
1 Local C/C++ Application
2 STM32 MCU C/C++ Application
Project Explorer
LEDblink
Binaries
Includes
Drivers
Src
main.c
stm32f4xx_hal_msp.c
stm32f4xx_it.c
syscalls.c
sysmem.c
system_stm32f4xx.c
Startup
Debug
Inc
LEDblink.ioc
STM32F401RETX_FLASH.ld
STM32F401RETX_RAM.ld
LEDblink.ioc
/* USER CODE END SysInit */
/* Initialize all configured peripherals */
MX_GPIO_Init();
MX_USART2_UART_Init();
/* USER CODE BEGIN 2 */
/* USER CODE END 2 */
/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
{
HAL_GPIO_TogglePin(GPIOA,GPIO_PIN_5);
HAL_Delay(1000);
}
/* USER CODE END 3 */
}
/**
* @brief System Clock Configuration
* @retval None
*/
void SystemClock_Config(void)
{
RCC_OscInitTypeDef RCC_OscInitStruct = {0};
RCC_ClkInitTypeDef RCC_ClkInitStruct = {0};


stm32 - LEDblink/Src/main.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
LEDblink
Binaries
Includes
Drivers
Src
main.c
stm32f4xx_hal_msp.c
stm32f4xx_it.c
syscalls.c
sysmem.c
system_stm32f4xx.c
Startup
Debug
Inc
LEDblink.elf.launch
LEDblink.ioc
STM32F401RETX_FLASH.ld
STM32F401RETX_RAM.ld
LEDblink.ioc
main.c
SystemClock_Config();
/* USER CODE BEGIN SysInit */
/* USER CODE END SysInit */
/* Initialize all configured
MX_GPIO_Init();
MX_USART2_UART_Init();
/* USER CODE BEGIN 2 */
/* USER CODE END 2 */
/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
{
HAL_GPIO_TogglePin(GPIOA,GPIO_
HAL_Delay(1000);
}
/* USER CODE END 3 */
}
/**
* @brief System Clock Config
* @retval None
*/
void SystemClock_Config(void)
{
RCC_OscInitTypeDef RCC_OscIn
RCC_ClkInitTypeDef RCC_ClkIn
/** Configure the main internal regulator output voltage
*/
__HAL_RCC_PWR_CLK_ENABLE();
Edit Configuration
Edit launch configuration properties
Name: LEDblink.elf
Main Debugger Startup Source Common
C/C++ Application:
Debug/LEDblink.elf
Search Project...
Browse...
Project:
LEDblink
Browse...
Build (if required) before launching
Build Configuration: Use Active
Enable auto build
Disable auto build
Use workspace settings
Configure Workspace Settings...
Revert
Apply
OK
Cancel

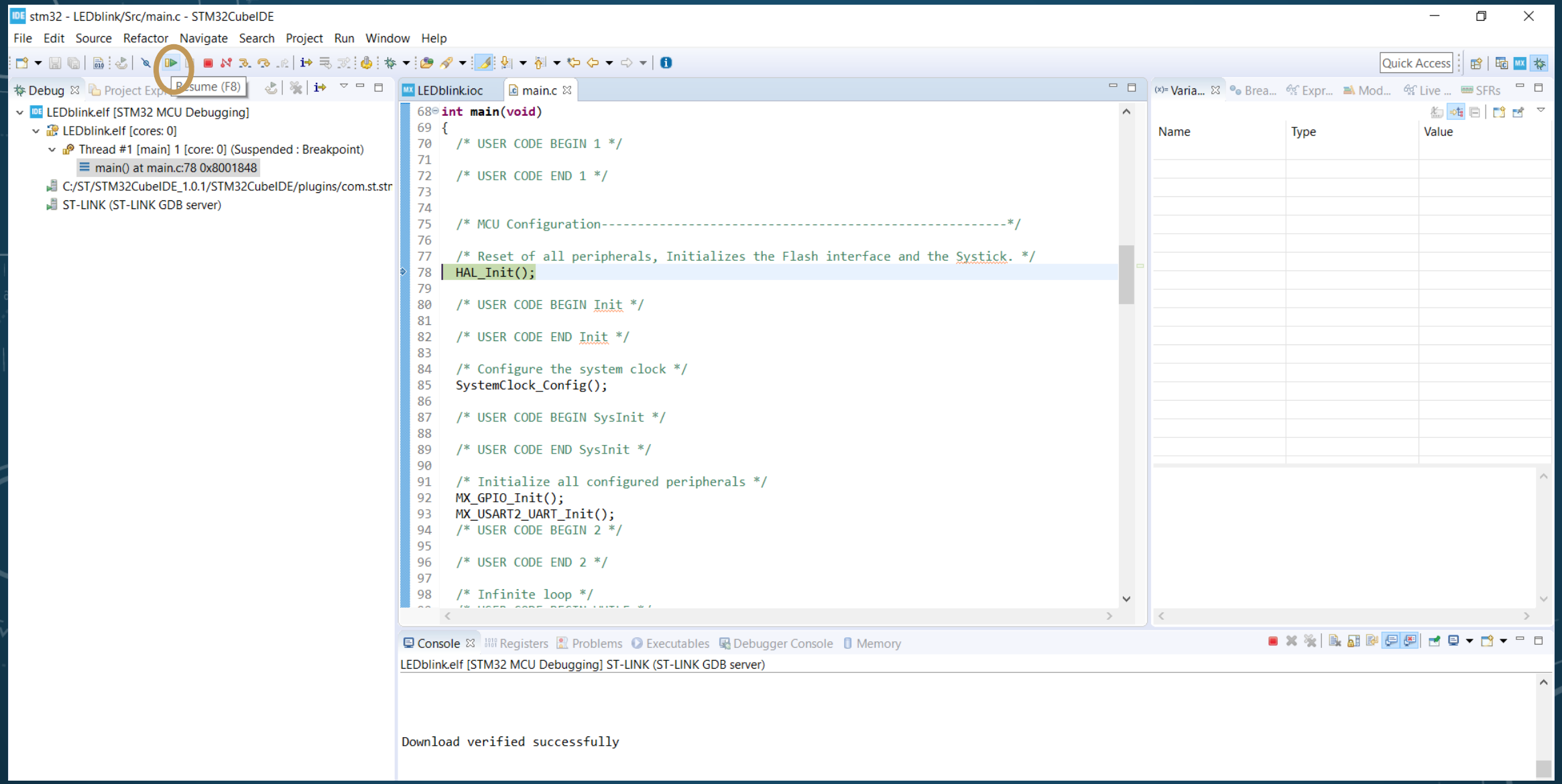
AFTER DEBUGGING:



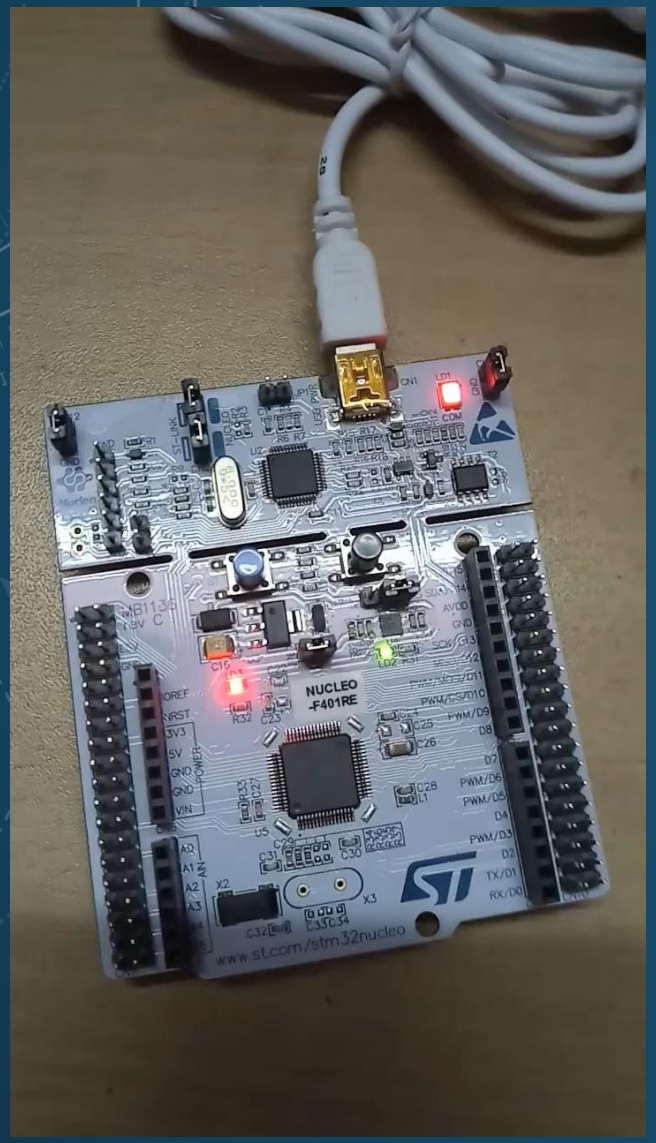
SELECT SWITCH TO THE CURRENT PERSPECTIVE:



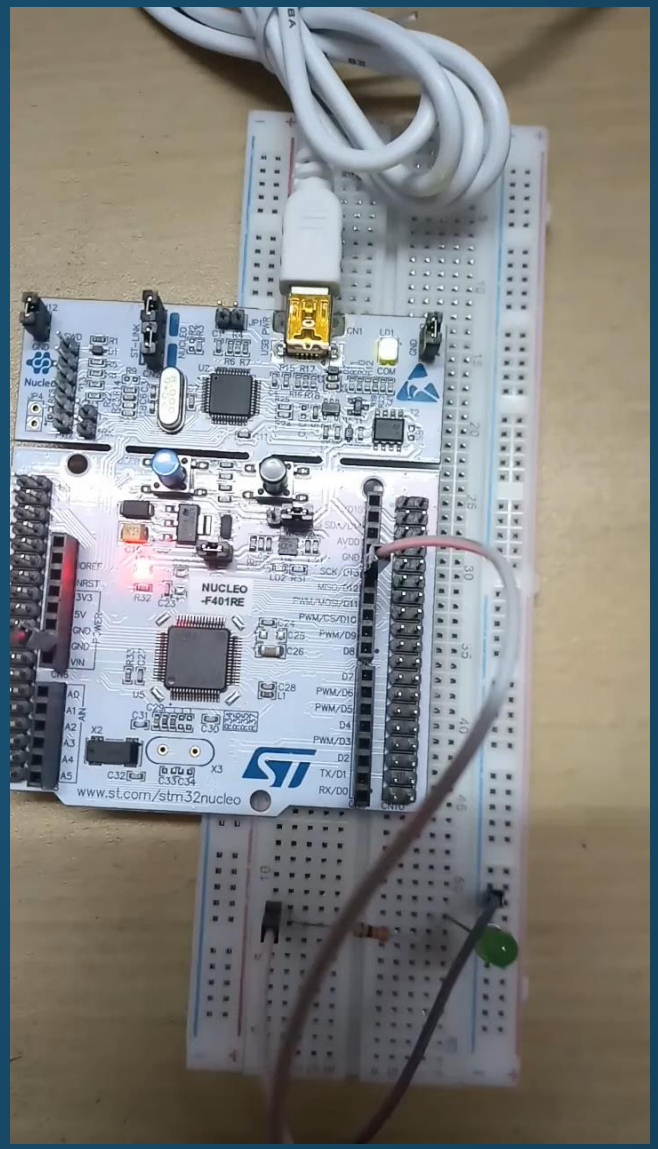
SELECT RESUME AND NEXT SEE THE LED GLOWING UP AS PER PROGRAM



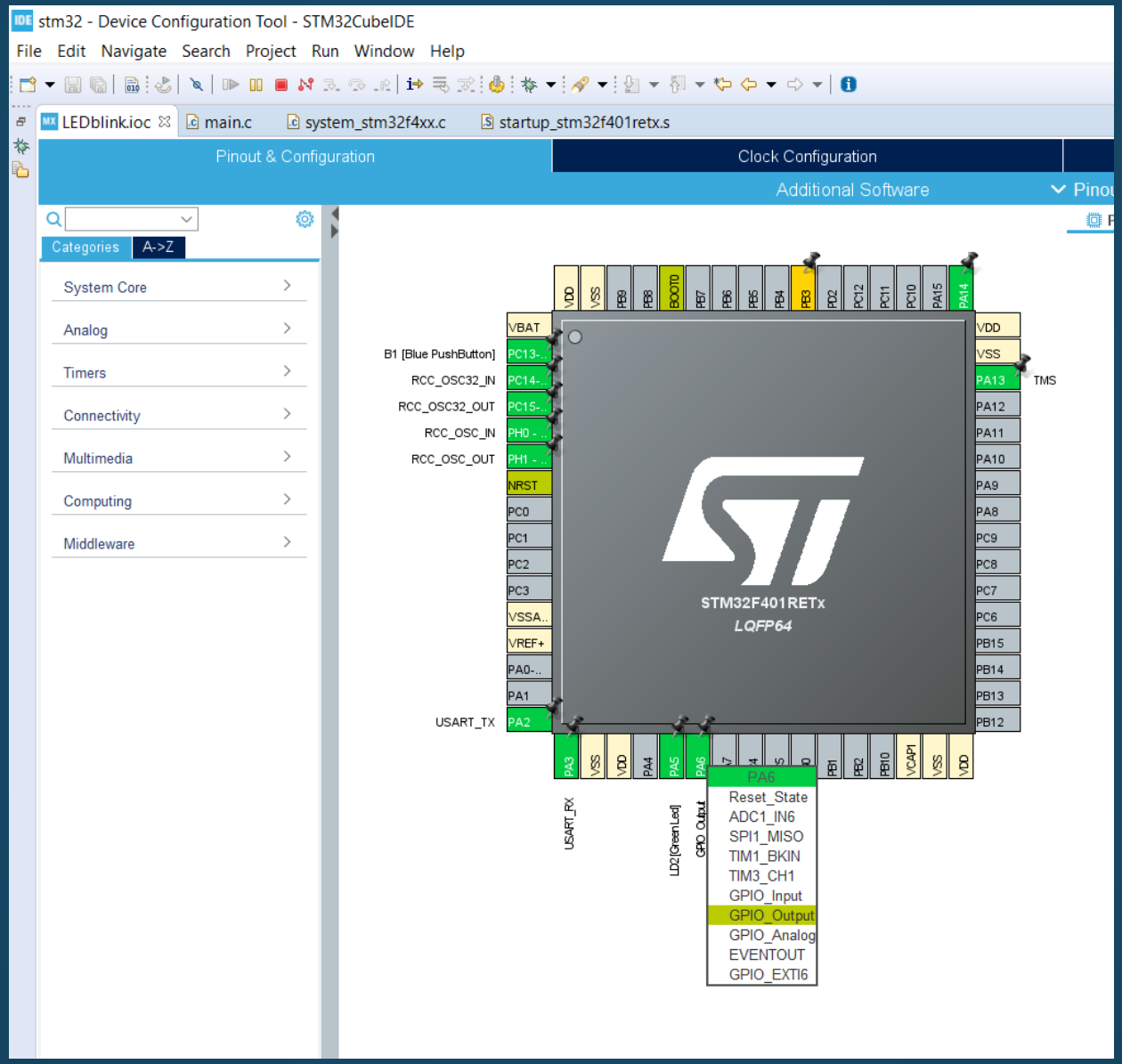
THE BUILT IN LED BLINKS:



LED BLINKS AT SIMULTANEOUSLY:



SELECT A PIN AS OUTPUT FOR THE SECOND LED:



WRITE THE INSTRUCTIONS AS FOLLOWS:

stm32 - LEDblink/Src/main.c - STM32CubeIDE

File Edit Source Refactor Navigate Search Project Run Window Help

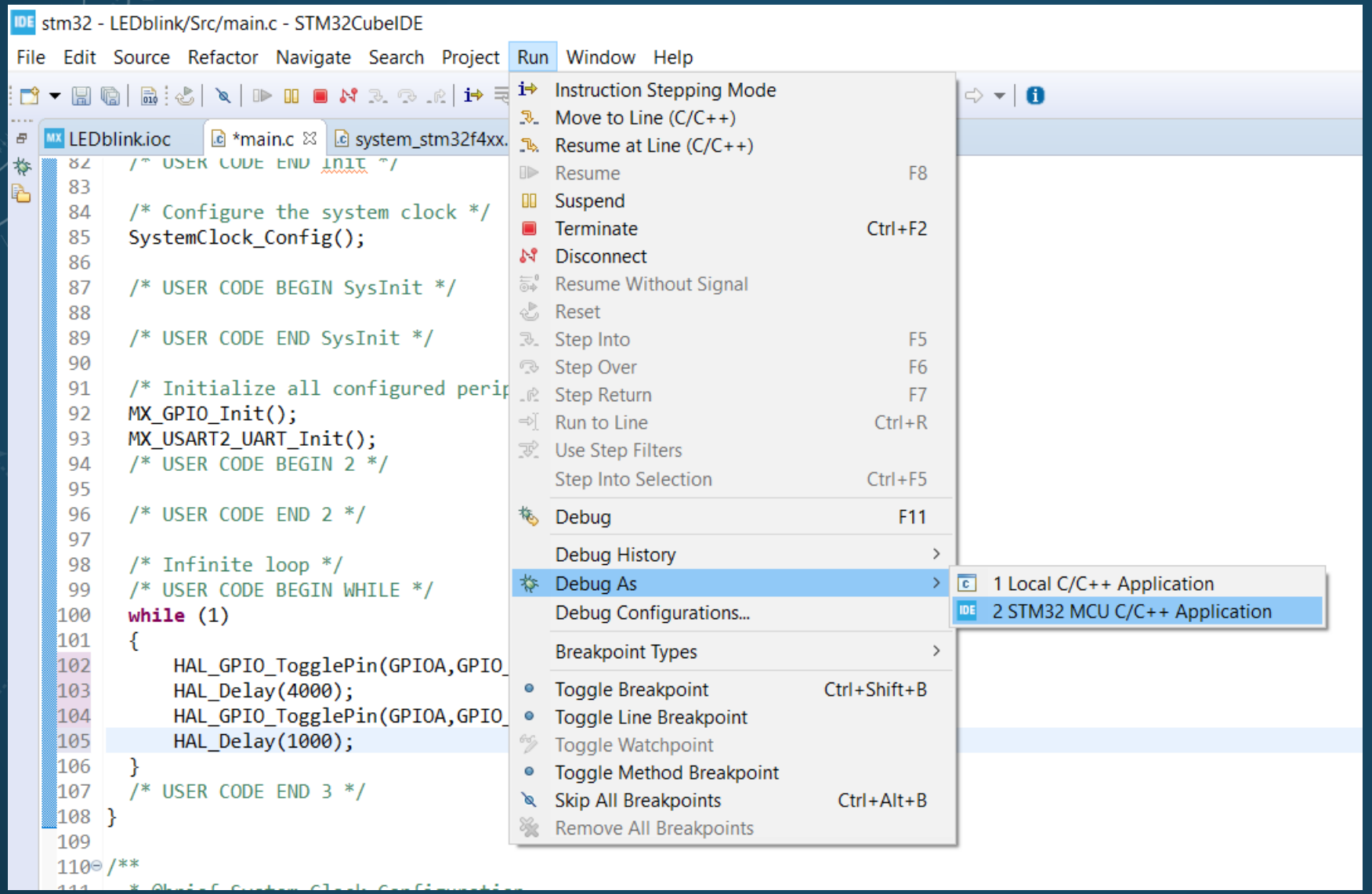
Debug | Project Explo | Resume (F8)

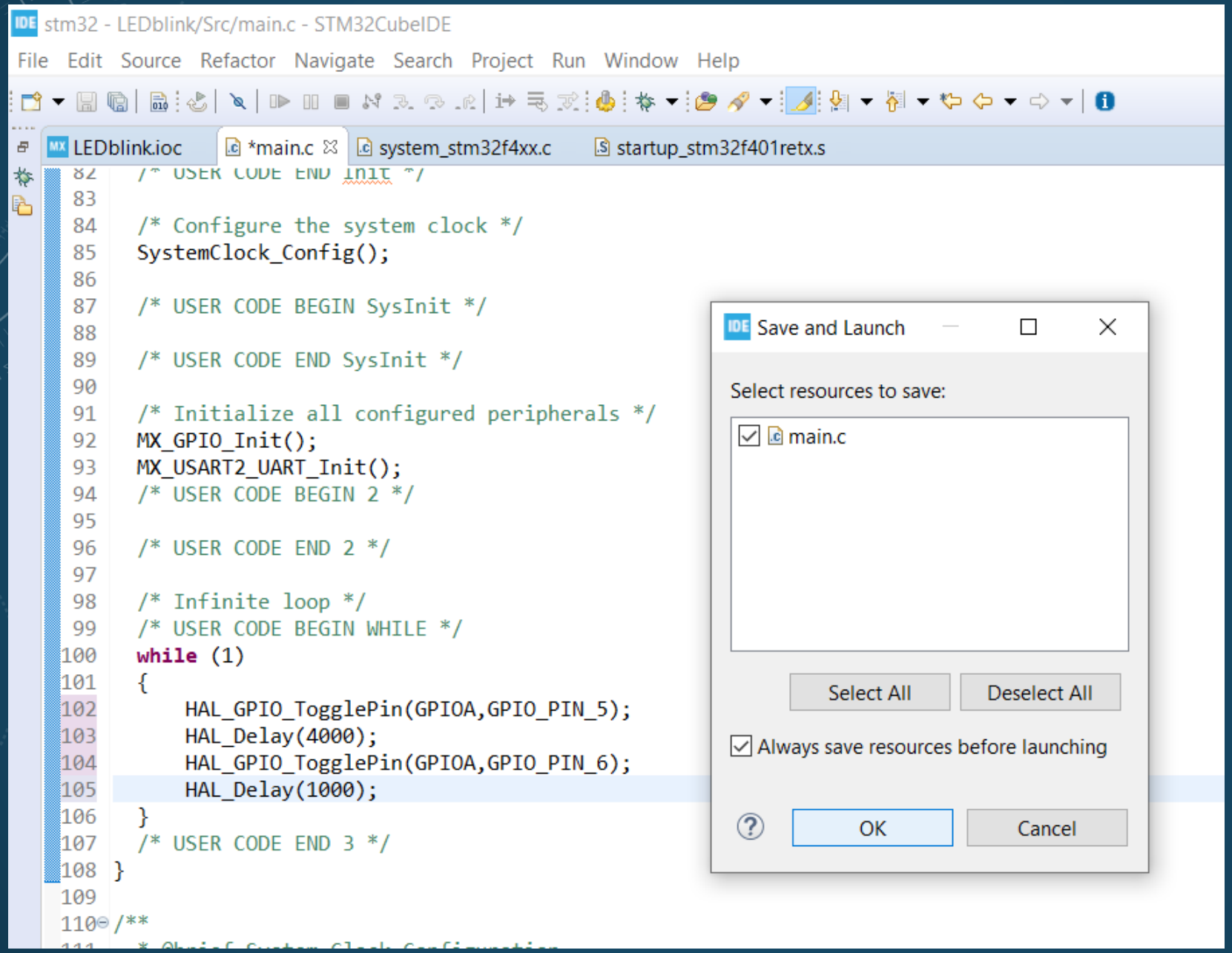
LEDblink.elf [STM32 MCU Debugging]
LEDblink.elf [cores: 0]
Thread #1 [main] 1 [core: 0] (Suspended : Breakpoint)
main() at main.c:78 0x8001848
C:/ST/STM32CubeIDE_1.0.1/STM32CubeIDE/plugins/com.st.str
ST-LINK (ST-LINK GDB server)

LEDblink.ioc | main.c | system_stm32f4xx.c

```
  /* USER CODE END SysInit */

  /* Initialize all configured peripherals */
  MX_GPIO_Init();
  MX_USART2_UART_Init();
  /* USER CODE BEGIN 2 */

  /* USER CODE END 2 */

  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {
HAL_GPIO_TogglePin(GPIOA,GPIO_PIN_5);
HAL_Delay(1000);
HAL_GPIO_TogglePin(GPIOA,GPIO_PIN_6);
HAL_Delay(4000);
  }
  /* USER CODE END 3 */
}

/**
  * @brief System Clock Configuration
  * @retval None
  */
void SystemClock_Config(void)
```

THEN BUILD THE PROJECT AND DEBUG AGAIN AS BEFORE .




stm32 - LEDblink/Src/main.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
LEDblink.ioc
*main.c
system_stm32f4xx.c
startup_stm32f401retx.s
/* USER CODE END Init */
/* Configure the system clock */
SystemClock_Config();
/* USER CODE BEGIN SysInit */
/* USER CODE END SysInit */
/* Initialize all configured peripherals */
MX_GPIO_Init();
MX_USART2_UART_Init();
/* USER CODE BEGIN 2 */
/* USER CODE END 2 */
/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
{
HAL_GPIO_TogglePin(GPIOA,GPIO_PIN_5);
HAL_Delay(4000);
HAL_GPIO_TogglePin(GPIOA,GPIO_PIN_6);
HAL_Delay(1000);
}
/* USER CODE END 3 */
}
/**
Save and Launch
Select resources to save:
main.c
Select All
Deselect All
Always save resources before launching
OK
Cancel

stm32 - LEDblink/Src/main.c - STM32CubeIDE

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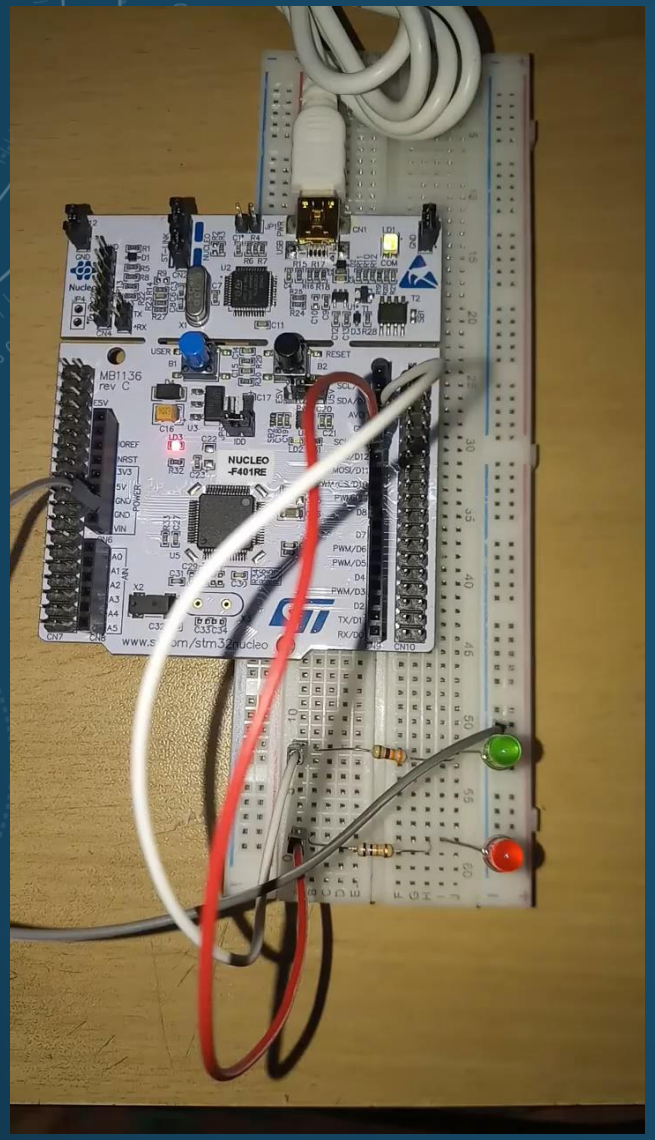
LEDblink.ioc | ma | Resume (F8) | tem_stm32f4xx.c

```
 94  /* USER CODE BEGIN 2 */
 95
 96  /* USER CODE END 2 */
 97
 98  /* Infinite loop */
 99  /* USER CODE BEGIN WHILE */
100  while (1)
101  {
102      HAL_GPIO_TogglePin(GPIOA,GPIO_PIN_5);
103      HAL_Delay(4000);
104      HAL_GPIO_TogglePin(GPIOA,GPIO_PIN_6);
105      HAL_Delay(1000);
106  }
107  /* USER CODE END 3 */
108 }
109
110 /**
111   * @brief System Clock Configuration
112   * @retval None
113   */
114 void SystemClock_Config(void)
115 {
116   RCC_OscInitTypeDef RCC_OscInitStruct = {0};
117   RCC_ClkInitTypeDef RCC_ClkInitStruct = {0};
```

THEN THE LEDS WILL DISPLAY OUTPUT ACCORDINGLY:



Now try to implement a traffic system using the basic knowledge of stm32 f401RE:

REFERENCES

- https://www.st.com/en/evaluation-tools/nucleo-f401re.html for STM32F401RE,datasheet
- www.st.com
- https://www.st.com/resource/en/user_manual/dm00105879-description-of-stm32f4-hal-and-ll-drivers-stmicroelectronics.pdf
- www.st.com/en/development-tools/stm32cubeide.html