

Lesson 5 - GPIO and Embedded C

Norman McEntire
norman.mcentre@gmail.com

Contents

- Introduction to GPIO and Embedded C
- STM32CubeMX and GPIO Code Generation
- Tour of GPIO
- TrueStudio and GPIO
 - Touch Button to turn LED On/Off

https://www.st.com/content/ccc/resource/technical/document/user_manual/63/a8/8f/e3/ca/a1/4c/84/DM00173145.pdf/files/DM00173145.pdf/jcr:content/translations/en.DM00173145.pdf



UM1884 User manual

Description of STM32L4/L4+ HAL and low-layer drivers

Introduction

STMCube™ is STMicroelectronics's original initiative to ease developers' life by reducing development efforts, time and cost. STM32Cube covers the STM32 portfolio.

STM32Cube Version 1.x includes:

- The STM32CubeMX, a graphical software configuration tool that allows generating C initialization code using graphical wizards.
- A comprehensive embedded software platform, delivered per series (such as STM32CubeL4 for STM32L4 series and STM32L4+ series)
 - The STM32Cube Hardware Abstraction Layer (HAL), an STM32 abstraction layer embedded software ensuring maximized portability across the STM32 portfolio. The HAL is available for all peripherals.
 - The low-layer APIs (LL) offering a fast light-weight expert-oriented layer which is closer to the hardware than the HAL. The LL APIs are available only for a set of peripherals.

Key Sections From Manual

28 HAL GPIO Generic Driver.....	387
28.1 GPIO Firmware driver registers structures	387
28.1.1 GPIO_InitTypeDef	387
28.2 GPIO Firmware driver API description	387
28.2.1 GPIO Peripheral features	387
28.2.2 How to use this driver	388
28.2.3 Initialization and de-initialization functions	388
28.2.4 IO operation functions	388
28.2.5 Detailed description of functions	389

Introduction to GPIO and Embedded C

28.2.1 GPIO Peripheral Features - Part 1

- GPIO = General Purpose Input/Output
- Each pin can be configured as:
 - Input Mode
 - Output Mode
 - Analog Mode
 - Alternate Function Mode
 - External Interrupt/Event Mode
- Just after reset: all pins configured as “input floating mode”

28.2.1 GPIO Peripheral Features - Part 2

- All GPIOs have weak pull up/down resistors
 - Can be enabled/disabled
- In Output mode or Alternate mode, each I/O can be configured as:
 - Push/Pull
 - Open-Drain
 - I/O Speed
- Only 1 peripheral alternate function (AF) can be connected to an I/O pin at a time - prevents pin sharing conflicts

28.2.1 GPIO Peripheral Features - Part 3

- All ports have external interrupt/event capability
 - Must be configured in input mode for interrupts/events
 - Connected to 16 external interrupt/event controller - EXTI0 - EXTI15
 - 39 Edge Detectors - each line can be configured to trigger on rising, falling, or both.
 - Each line can be masked independently

28.2.2 How to use driver - Part 1

- Step 1. Enable GPIO AHB Clock
 - `_HAL_RCC_GPIOx_CLK_ENABLE()`
- Step 2. Configure GPIO Pins
 - `HAL_GPIO_Init()`
- Step 3. (If using input for interrupts). Configure NVIC IRQ Priority mapped to the EXTI line
 - `HAL_NVIC_SetPriority()`
 - `HAL_NVIC_EnableIRQ()`

NVIC =
Nested
Vector
Interrupt
Controller

28.2.2 How to use driver - Part 2

- Step 4. To read input pin
 - HAL_GPIO_ReadPin()
- Step 5. To write output pin
 - HAL_GPIO_WritePin()
 - HAL_GPIO_TogglePin()
- Step 6. To lock a pin until reset
 - HAL_GPIO_LockPin()

HAL GPIO Data Types

28.1.1 GPIO_InitTypeDef

- GPIO = General Purpose Input/Output
- ```
typedef struct {
 uint32_t Pin;
 uint32_t Mode;
 uint32_t Pull;
 uint32_t Speed;
 uint32_t Alternate;
} GPIO_InitTypeDef
```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h GPIO\_InitTypeDef

```
60 /**
61 * @brief GPIO Init structure definition
62 */
63 typedef struct
64 {
65 uint32_t Pin; /*!< Specifies the GPIO pins to be configured.
66 | This parameter can be any value of @ref GPIO_pins */
67
68 uint32_t Mode; /*!< Specifies the operating mode for the selected pins.
69 | This parameter can be a value of @ref GPIO_mode */
70
71 uint32_t Pull; /*!< Specifies the Pull-up or Pull-Down activation for the selected pins.
72 | This parameter can be a value of @ref GPIO_pull */
73
74 uint32_t Speed; /*!< Specifies the speed for the selected pins.
75 | This parameter can be a value of @ref GPIO_speed */
76
77 uint32_t Alternate; /*!< Peripheral to be connected to the selected pins
78 | This parameter can be a value of @ref GPIOEx_Alternate_function_selection */
79 }GPIO_InitTypeDef;
80
```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h GPIO\_PinState

```
81 /**
82 * @brief GPIO Bit SET and Bit RESET enumeration
83 */
84 typedef enum
85 {
86 GPIO_PIN_RESET = 0U,
87 GPIO_PIN_SET
88 }GPIO_PinState;
```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h GPIO\_PIN\_X

```
```
97  /** @defgroup GPIO_pins GPIO pins
98  * @{
99  */
100 #define GPIO_PIN_0          ((uint16_t)0x0001) /* Pin 0 selected */
101 #define GPIO_PIN_1          ((uint16_t)0x0002) /* Pin 1 selected */
102 #define GPIO_PIN_2          ((uint16_t)0x0004) /* Pin 2 selected */
103 #define GPIO_PIN_3          ((uint16_t)0x0008) /* Pin 3 selected */
104 #define GPIO_PIN_4          ((uint16_t)0x0010) /* Pin 4 selected */
105 #define GPIO_PIN_5          ((uint16_t)0x0020) /* Pin 5 selected */
106 #define GPIO_PIN_6          ((uint16_t)0x0040) /* Pin 6 selected */
107 #define GPIO_PIN_7          ((uint16_t)0x0080) /* Pin 7 selected */
108 #define GPIO_PIN_8          ((uint16_t)0x0100) /* Pin 8 selected */
109 #define GPIO_PIN_9          ((uint16_t)0x0200) /* Pin 9 selected */
110 #define GPIO_PIN_10         ((uint16_t)0x0400) /* Pin 10 selected */
111 #define GPIO_PIN_11         ((uint16_t)0x0800) /* Pin 11 selected */
112 #define GPIO_PIN_12         ((uint16_t)0x1000) /* Pin 12 selected */
113 #define GPIO_PIN_13         ((uint16_t)0x2000) /* Pin 13 selected */
114 #define GPIO_PIN_14         ((uint16_t)0x4000) /* Pin 14 selected */
115 #define GPIO_PIN_15         ((uint16_t)0x8000) /* Pin 15 selected */
116 #define GPIO_PIN_All        ((uint16_t)0xFFFF) /* All pins selected */
117
118 #define GPIO_PIN_MASK       (0x0000FFFFu) /* PIN mask for assert test */
```

```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h Modes

```
123 /** @defgroup GPIO_mode GPIO mode
124 * @brief GPIO Configuration Mode
125 * Elements values convention: 0xX0yz00YZ
126 * - X : GPIO mode or EXTI Mode
127 * - y : External IT or Event trigger detection
128 * - z : IO configuration on External IT or Event
129 * - Y : Output type (Push Pull or Open Drain)
130 * - Z : IO Direction mode (Input, Output, Alternate or Analog)
131 * @{
132 */
133 #define GPIO_MODE_INPUT (0x00000000u) /*!< Input Fl
134 #define GPIO_MODE_OUTPUT_PP (0x00000001u) /*!< Output F
135 #define GPIO_MODE_OUTPUT_OD (0x00000011u) /*!< Output C
136 #define GPIO_MODE_AF_PP (0x00000002u) /*!< Alternat
137 #define GPIO_MODE_AF_OD (0x00000012u) /*!< Alternat
138 #define GPIO_MODE_ANALOG (0x00000003u) /*!< Analog M
139 #define GPIO_MODE_ANALOG_ADC_CONTROL (0x000000B0u) /*!< Analog M
140 #define GPIO_MODE_IT_RISING (0x10110000u) /*!< External
141 #define GPIO_MODE_IT_FALLING (0x10210000u) /*!< External
142 #define GPIO_MODE_IT_RISING_FALLING (0x10310000u) /*!< External
143 #define GPIO_MODE_EVT_RISING (0x10120000u) /*!< External
144 #define GPIO_MODE_EVT_FALLING (0x10220000u) /*!< External
145 #define GPIO_MODE_EVT_RISING_FALLING (0x10320000u) /*!< External
146 . . .
```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h Speeds

```
148 */
149
150 /** @defgroup GPIO_speed GPIO speed
151 * @brief GPIO Output Maximum frequency
152 * @{
153 */
154 #define GPIO_SPEED_FREQ_LOW (0x00000000u) /*!< range up to 5 MHz, please
155 #define GPIO_SPEED_FREQ_MEDIUM (0x00000001u) /*!< range 5 MHz to 25 MHz,
156 #define GPIO_SPEED_FREQ_HIGH (0x00000002u) /*!< range 25 MHz to 50 MHz,
157 #define GPIO_SPEED_FREQ_VERY_HIGH (0x00000003u) /*!< range 50 MHz to 80 MHz,
158 */

.
```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h Speeds

```
162 /** @defgroup GPIO_pull GPIO pull
163 * @brief GPIO Pull-Up or Pull-Down Activation
164 * @{
165 */
166 #define GPIO_NOPULL (0x00000000u) /*!< No Pull-up or Pull-down activation */
167 #define GPIO_PULLUP (0x00000001u) /*!< Pull-up activation */
168 #define GPIO_PULLDOWN (0x00000002u) /*!< Pull-down activation */
```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h \_\_HAL\_GPIO\_EXTI\_GET\_FLAG()

```
182 /**
183 * @brief Check whether the specified EXTI line flag is set or not.
184 * @param __EXTI_LINE__: specifies the EXTI line flag to check.
185 * This parameter can be GPIO_PIN_x where x can be(0..15)
186 * @retval The new state of __EXTI_LINE__ (SET or RESET).
187 */
188 #define __HAL_GPIO_EXTI_GET_FLAG(__EXTI_LINE__) (EXTI->PR1 & (__EXTI_LINE__))
189
```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h \_\_HAL\_GPIO\_EXTI\_CLEAR\_FLAG()

```
190 /**
191 * @brief Clear the EXTI's line pending flags.
192 * @param __EXTI_LINE__: specifies the EXTI lines flags to clear.
193 * This parameter can be any combination of GPIO_PIN_x where x can be (0..15)
194 * @retval None
195 */
196 #define __HAL_GPIO_EXTI_CLEAR_FLAG(__EXTI_LINE__) (EXTI->PR1 = (__EXTI_LINE__))

```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h \_\_HAL\_GPIO\_EXTI\_GET\_IT()

```
198 /**
199 * @brief Check whether the specified EXTI line is asserted or not.
200 * @param __EXTI_LINE__: specifies the EXTI line to check.
201 * This parameter can be GPIO_PIN_x where x can be(0..15)
202 * @retval The new state of __EXTI_LINE__ (SET or RESET).
203 */
204 #define __HAL_GPIO_EXTI_GET_IT(__EXTI_LINE__) (EXTI->PR1 & (__EXTI_LINE__))
205
```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h \_\_HAL\_GPIO\_EXTI\_CLEAR\_IT()

```
206 /**
207 * @brief Clear the EXTI's line pending bits.
208 * @param __EXTI_LINE__: specifies the EXTI lines to clear.
209 * This parameter can be any combination of GPIO_PIN_x where x can be (0..15)
210 * @retval None
211 */
212 #define __HAL_GPIO_EXTI_CLEAR_IT(__EXTI_LINE__) (EXTI->PR1 = (__EXTI_LINE__))
213
```

# Drivers/STM32L4xx\_HAL\_Driver/Inc/ stm32l4xx\_hal\_gpio.h \_\_HAL\_GPIO\_EXTI\_GENERATE\_SWIT()

```
214 /**
215 * @brief Generate a Software interrupt on selected EXTI line.
216 * @param __EXTI_LINE__: specifies the EXTI line to check.
217 * This parameter can be GPIO_PIN_x where x can be(0..15)
218 * @retval None
219 */
220 #define __HAL_GPIO_EXTI_GENERATE_SWIT(__EXTI_LINE__) (EXTI->SWIER1 |= (__EXTI_LINE__))
221
```

# HAL GPIO Functions

## 28.2.3 Initialization and De-Initialization Functions

```
274 |
274 /* Initialization and de-initialization functions *****/
275 void HAL_GPIO_Init(GPIO_TypeDef *GPIOx, GPIO_InitTypeDef *GPIO_InitStruct);
276 void HAL_GPIO_DeInit(GPIO_TypeDef *GPIOx, uint32_t GPIO_Pin);
277
```

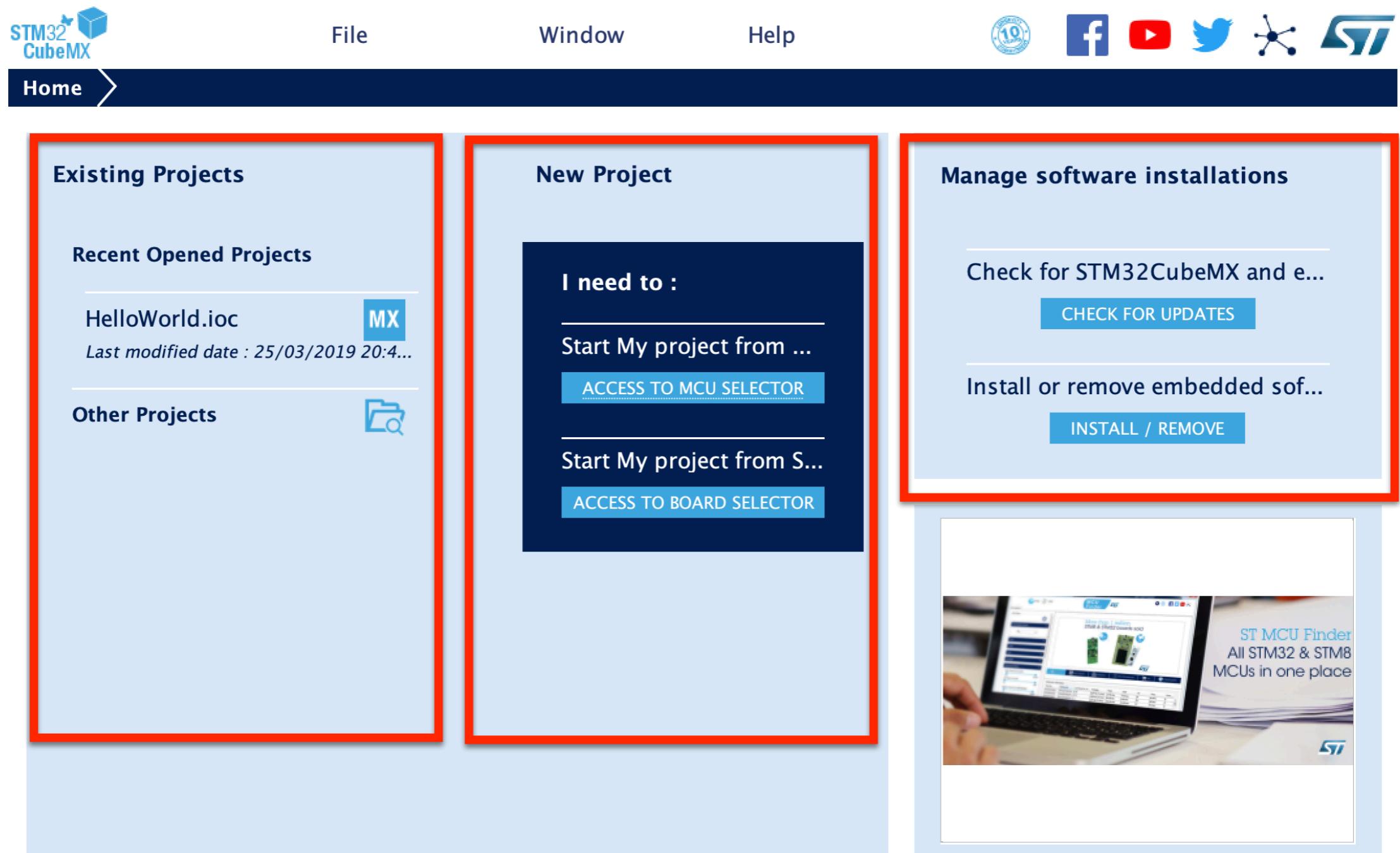
# 28.2.4 I/O Functions

```
286 /* I/O operation functions *****/
287 GPIO_PinState HAL_GPIO_ReadPin(GPIO_TypeDef* GPIOx, uint16_t GPIO_Pin);
288 void HAL_GPIO_WritePin(GPIO_TypeDef* GPIOx, uint16_t GPIO_Pin, GPIO_PinState PinState);
289 void HAL_GPIO_TogglePin(GPIO_TypeDef* GPIOx, uint16_t GPIO_Pin);
290 HAL_StatusTypeDef HAL_GPIO_LockPin(GPIO_TypeDef* GPIOx, uint16_t GPIO_Pin);
291 void HAL_GPIO_EXTI_IRQHandler(uint16_t GPIO_Pin);
292 void HAL_GPIO_EXTI_Callback(uint16_t GPIO_Pin);

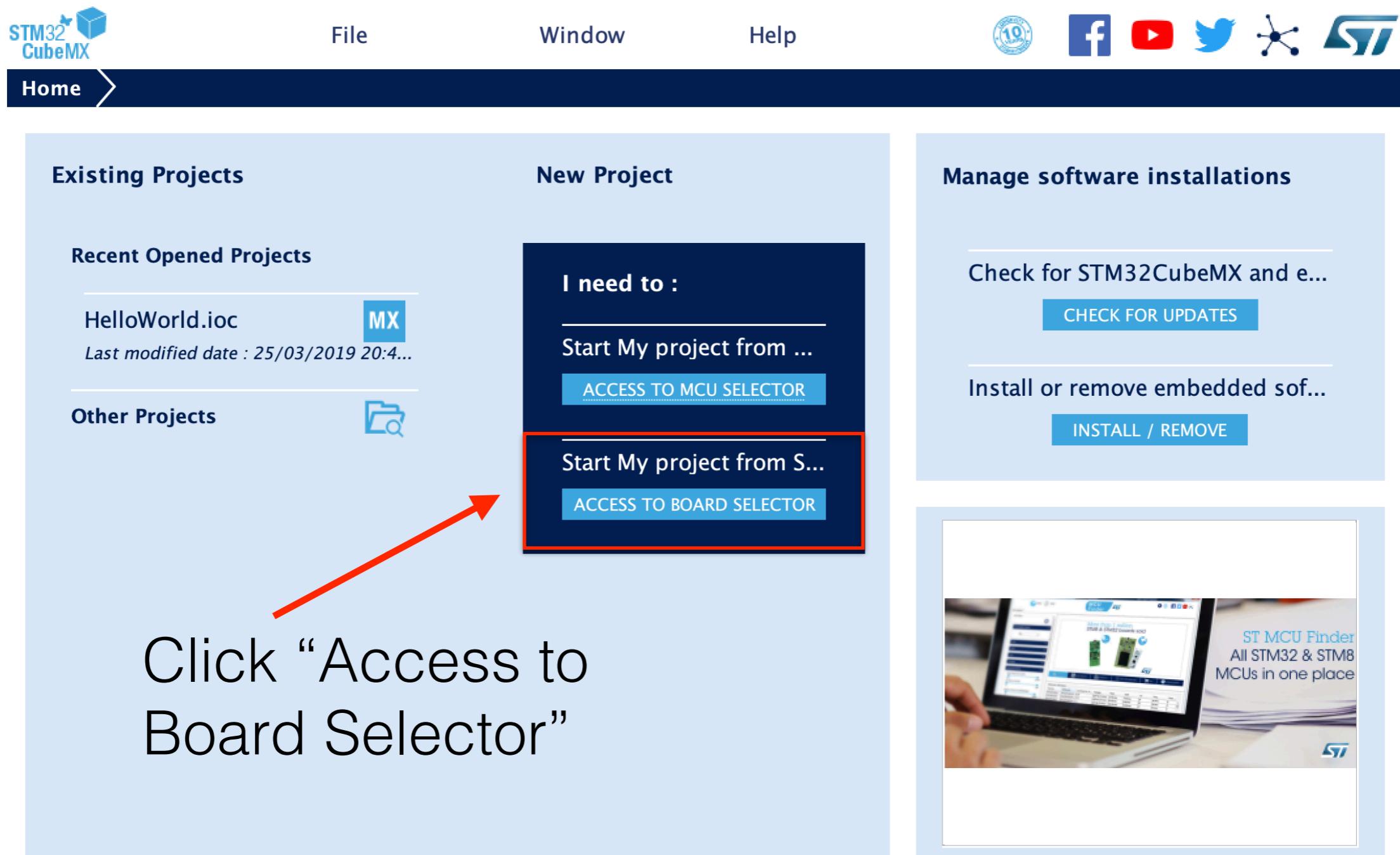
```

# STM32CubeMX and Generation of HAL Code

# Step: Startup STM32CubeMX



# Step: Click on “Access to Board Selector”



# Step: Observe “Part Number Search”

The screenshot shows the STMicroelectronics website interface. On the left, there's a sidebar with filters for 'Board Filters' (Part Number Search, Vendor), 'Type' (Discovery, Evaluation Board, Nucleo USB Dongle, Nucleo144, Nucleo32, Nucleo64), and 'MCU Series' (STM32F0, STM32F1, STM32F2, STM32F3, STM32F4). A red box highlights the 'Part Number Search' input field. The main content area features a banner for the 'New multicore STM32MP1 Series for Industrial and IoT applications'. It includes an STM32MP1 chip image, a Linux penguin icon, and the text 'OpenSTLinux Distribution'. Below the banner is a table titled 'Boards List: 107 items' with columns for Overview, Part No, Type, Marketing Status, Unit Price (US\$), and Mounted Device. Two rows are visible: one for '32F0308DISCOVERY' (Discovery, Active, \$8.9, STM32F030R8Tx) and another for '32F072BDISCOVERY' (Discovery, Active, \$10.4, STM32F072RBTx).

| * | Overview | Part No          | Type      | Marketing Status | Unit Price (US\$) | Mounted Device                |
|---|----------|------------------|-----------|------------------|-------------------|-------------------------------|
| ☆ |          | 32F0308DISCOVERY | Discovery | Active           | 8.9               | <a href="#">STM32F030R8Tx</a> |
| ☆ |          | 32F072BDISCOVERY | Discovery | Active           | 10.4              | <a href="#">STM32F072RBTx</a> |

# Step: Enter "B-L475E-IOT01A"

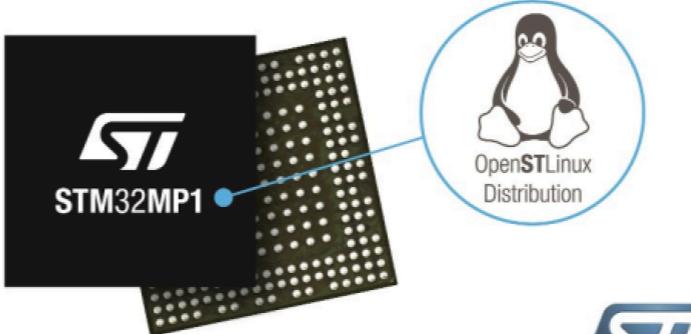
MCU Selector | Board Selector

Board Filters

- Part Number Search: B-L475E-IOT01A (highlighted with a red box)
- Vendor: STMicroelectronics
- Type: Discovery
- MCU Series: STM32L4
- Other: Price = 53.0, Oscillator Freq. = 0 (MHz)
- Peripheral

Features | Large Picture | Docs & Resources | Datasheet | Buy | Start Project

New multicore STM32MP1 Series for Industrial and IoT applications



STM32MP1

OpenSTLinux Distribution

Boards List: 1 item

| * | Overview                                                                             | Part No        | Type      | Marketing Status | Unit Price (US\$) | Mounted Device |
|---|--------------------------------------------------------------------------------------|----------------|-----------|------------------|-------------------|----------------|
| ★ |  | B-L475E-IOT01A | Discovery | Active           | 53.0              | STM32L475VGTx  |

Step: Click on Image, and observe “Features”

MCU Selector Board Selector

Board Filters

- 
- 
- 
- 

Part Number Search

B-L475E-IOT01A

Vendor

STMicroelectronics

Type

Discovery

MCU Series

STM32L4

Other

Price = 53.0

Oscillator Freq. = 0 (MHz)

Peripheral

Features Large Picture Docs & Resources Datasheet Buy Start Project

**B-L475E-IOT01A**



**STMicroelectronics B-L475E-IOT01A IOT Discovery Board Support and Examples**

**ACTIVE** Active  
Product is in mass production

Unit Price (US\$) : 53.0

Mounted device: [STM32L475VGTx](#)

The B-L475E-IOT01A Discovery kit for IoT node allows users to develop applications with direct connection to cloud servers. The Discovery kit enables a wide diversity of applications by exploiting low-power communication, multiway sensing and ARM Cortex -M4 core-based STM32L4 Series features. The support for Arduino Uno V3 and PMOD connectivity provides unlimited expansion capabilities with a large choice of specialized add-on boards.

**Features**

- On-board ST-LINK/V2-1
- Supply through ST-Link USB
- USB OTG(Full speed) with micro AB Connector

Boards List: 1 item

| *                                                                                    | Overview                       | Part No | Type      | Marketing Status | Unit Price (US\$) | Mounted Device                |
|--------------------------------------------------------------------------------------|--------------------------------|---------|-----------|------------------|-------------------|-------------------------------|
|  | <a href="#">B-L475E-IOT01A</a> |         | Discovery | Active           | 53.0              | <a href="#">STM32L475VGTx</a> |

# Step: Click on “Start Project”

The screenshot shows a web-based board selector interface. On the left, there is a sidebar with various filters:

- Board Filters:** Includes icons for star, favorite, search, and refresh.
- Part Number Search:** A dropdown menu showing "B-L475E-IOT01A".
- Vendor:** A dropdown menu with "Check/Uncheck All" and a checkbox for "STMicroelectronics".
- Type:** A dropdown menu with "Check/Uncheck All" and a checkbox for "Discovery".
- MCU Series:** A dropdown menu with "Check/Uncheck All" and a checkbox for "STM32L4".
- Other:** Includes sliders for "Price = 53.0" and "Oscillator Freq. = 0 (MHz)".
- Peripheral:** A dropdown menu.

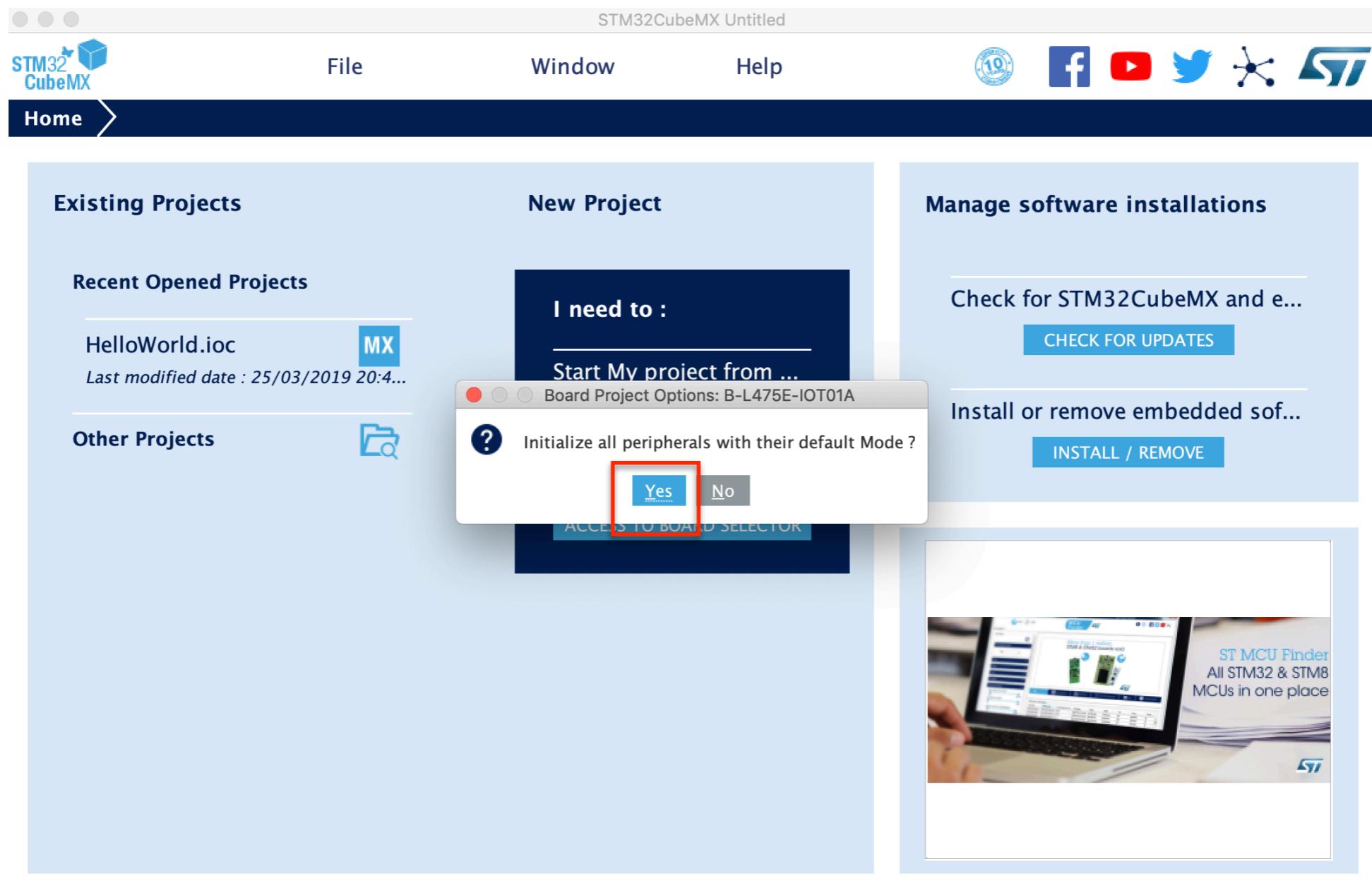
The main content area displays the following information for the **B-L475E-IOT01A** board:

- Features:** Large Picture, Docs & Resources (highlighted with a red box), Datasheet, Buy.
- Data brief:** DB3143 Discovery kit for IoT node, multi-channel communication with STM32L4 (version 4).
- User manual:** UM2153 Discovery kit for IoT node, multi-channel communication with STM32L4 (version 4).

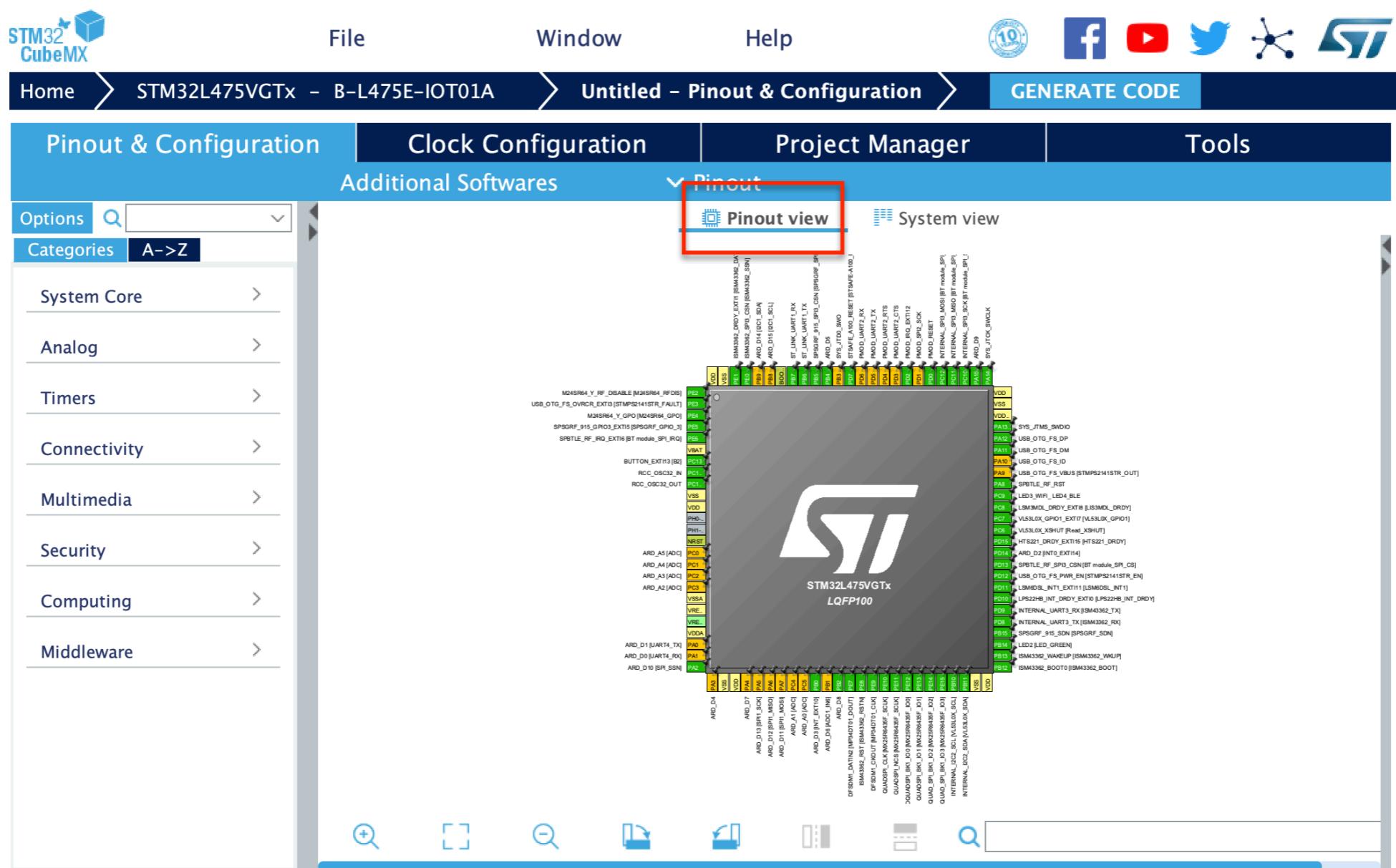
Below this is a table titled "Boards List: 1 item":

| * | Overview | Part No        | Type      | Marketing Status | Unit Price (US\$) | Mounted Device |
|---|----------|----------------|-----------|------------------|-------------------|----------------|
| ☆ |          | B-L475E-IOT01A | Discovery | Active           | 53.0              | STM32L475VGTx  |

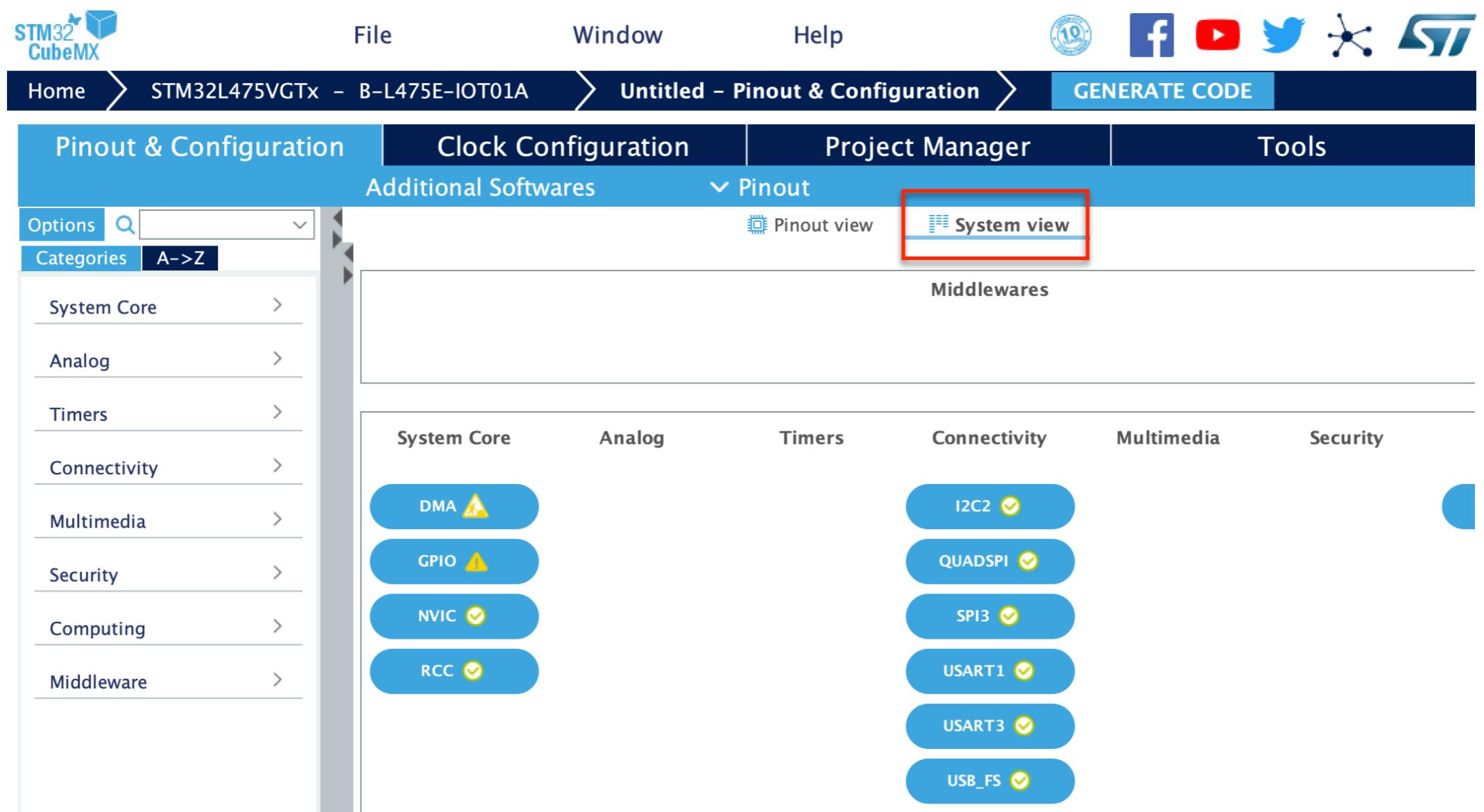
# Step: Click on “Yes” (Initialize all ...with default mode)



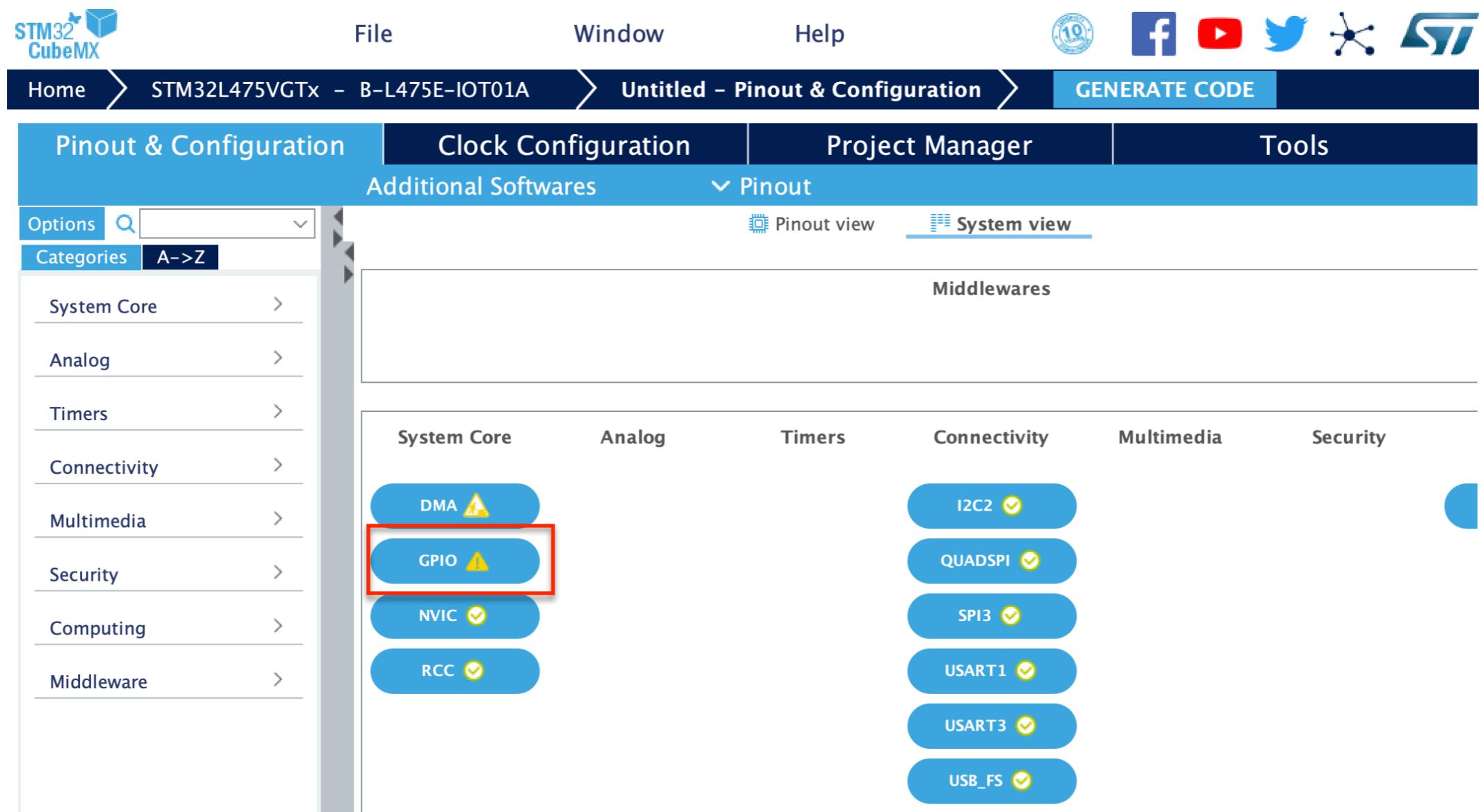
# Step: Observe “Pinout View”



# Step: Select “System View”



# Step: Select “GPIO”



# Step: Select “PB14/LED2”

GPIO Mode and Configuration

Configuration

Group By Peripherals

|         |                       |        |      |        |
|---------|-----------------------|--------|------|--------|
| USART3  | USB_OTG_FS            | NVIC   |      |        |
| QUADSPI | RCC                   | SPI3   | SYS  | USART1 |
| GPIO    | Single Mapped Signals | DFSDM1 | I2C2 |        |

Search Signals

Show only Modified Pins

| Pin...     | Signal ... | GPIO o... | GPIO ...  | GPIO P... | Maxim... | Fast M... | User Label   | Mo...                               |
|------------|------------|-----------|-----------|-----------|----------|-----------|--------------|-------------------------------------|
| PA2        | n/a        | Low       | Output    | No pu...  | Low      | n/a       | ARD_D10...   | <input checked="" type="checkbox"/> |
| PA8        | n/a        | Low       | Output    | No pu...  | Low      | n/a       | SPBTLE_R...  | <input checked="" type="checkbox"/> |
| PA15       | (n/a)      | Low       | Output    | No pu...  | Low      | n/a       | ARD_D9       | <input checked="" type="checkbox"/> |
| PB0        | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | ARD_D3 [...] | <input checked="" type="checkbox"/> |
| PB2        | n/a        | Low       | Output    | No pu...  | Low      | n/a       | ARD_D8       | <input checked="" type="checkbox"/> |
| PB4 (N...) | n/a        | Low       | Output    | No pu...  | Low      | n/a       | ARD_D5       | <input checked="" type="checkbox"/> |
| PB5        | n/a        | High      | Output    | No pu...  | Low      | n/a       | SPSGRF_9...  | <input checked="" type="checkbox"/> |
| PB12       | n/a        | Low       | Output    | No pu...  | Low      | n/a       | ISM43362...  | <input checked="" type="checkbox"/> |
| PB13       | n/a        | Low       | Output    | No pu...  | Low      | n/a       | ISM43362...  | <input checked="" type="checkbox"/> |
| PB14       | n/a        | Low       | Output    | No pu...  | Low      | n/a       | LED2 [LE...  | <input checked="" type="checkbox"/> |
| PB15       | n/a        | Low       | Output    | No pu...  | Low      | n/a       | SPSGRF_9...  | <input checked="" type="checkbox"/> |
| PC6        | n/a        | Low       | Output    | No pu...  | Low      | n/a       | VL53L0X...   | <input checked="" type="checkbox"/> |
| PC7        | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | VL53L0X...   | <input checked="" type="checkbox"/> |

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

Pinout view System

System Core Analog

- DMA ⚠
- GPIO ⚠
- NVIC ✓
- RCC ✓

# Step: Observe Settings for PB14/LED2

GPIO Mode and Configuration

Configuration

Group By Peripherals

USART3     USB\_OTG\_FS     NVIC  
 RCC     SPI3     SYS     USART1  
 GPIO     Single Mapped Signals     DFSDM1     I2C2     QUADSPI

Search Signals

Show only Modified Pins

| Pin... | Signal ... | GPIO o... | GPIO ...  | GPIO P... | Maxim... | Fast M... | User L... | Modifi...                           |
|--------|------------|-----------|-----------|-----------|----------|-----------|-----------|-------------------------------------|
| PA2    | n/a        | Low       | Output... | No pu...  | Low      | n/a       | ARD_...   | <input checked="" type="checkbox"/> |
| PA8    | n/a        | Low       | Output... | No pu...  | Low      | n/a       | SPBTL...  | <input checked="" type="checkbox"/> |
| PA15   | n/a        | Low       | Output... | No pu...  | Low      | n/a       | ARD_D9    | <input checked="" type="checkbox"/> |

PA15 (PB14) Configuration :

GPIO output level : Low

GPIO mode : Output Push Pull

GPIO Pull-up/Pull-down : No pull-up and no pull-down

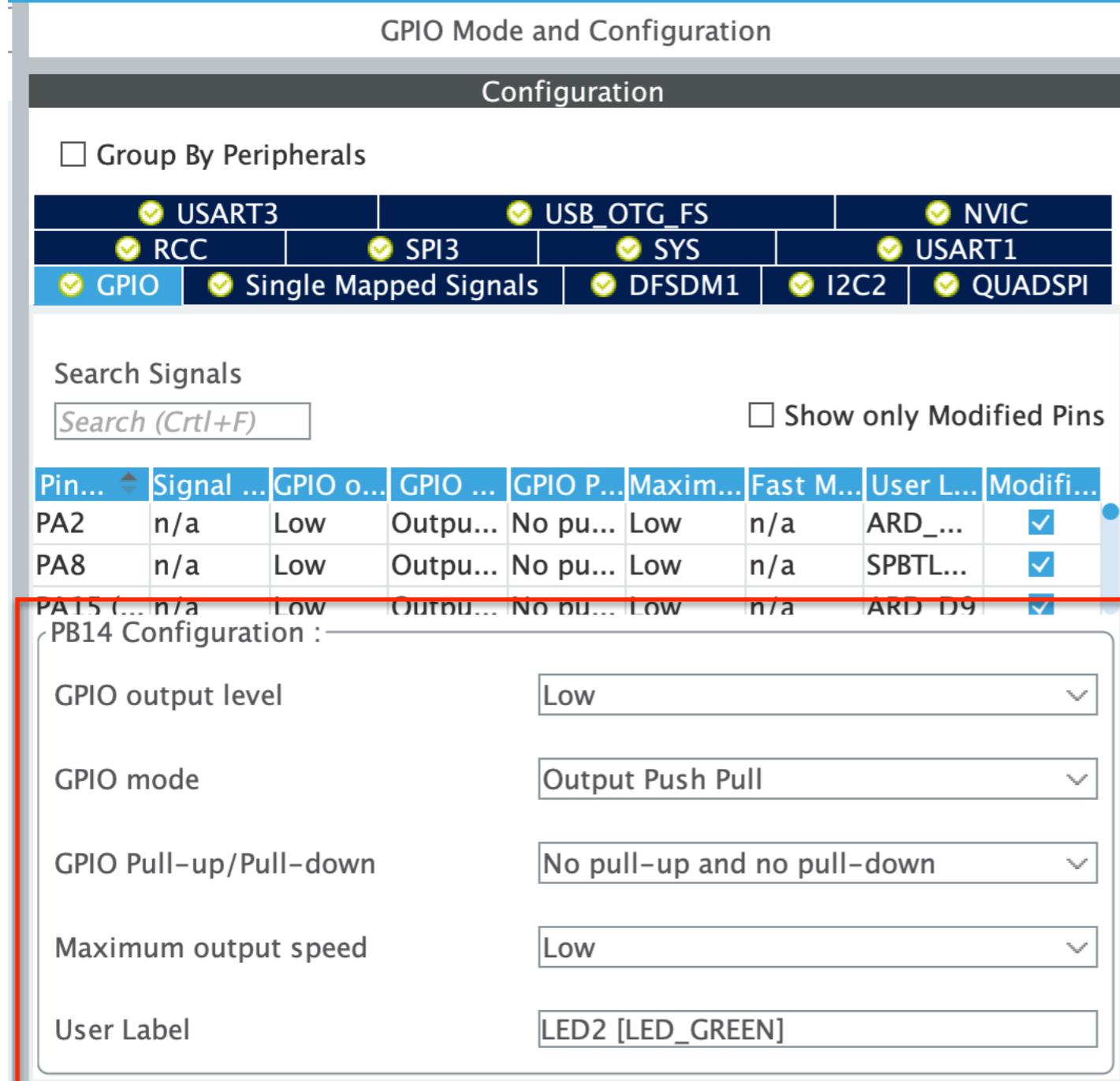
Maximum output speed : Low

User Label : LED2 [LED\_GREEN]

Pinout view    System

System Core    Analog

DMA   
GPIO   
NVIC   
RCC 



# Step: Select “PC13/Button”

GPIO Mode and Configuration

Configuration

Group By Peripherals

|         |                       |        |      |        |
|---------|-----------------------|--------|------|--------|
| USART3  | USB_OTG_FS            | NVIC   |      |        |
| QUADSPI | RCC                   | SPI3   | SYS  | USART1 |
| GPIO    | Single Mapped Signals | DFSDM1 | I2C2 |        |

Search Signals

Show only Modified Pins

| Pin... | Signal ... | GPIO o... | GPIO ...  | GPIO P... | Maxim... | Fast M... | User Label   | Mo...                               |
|--------|------------|-----------|-----------|-----------|----------|-----------|--------------|-------------------------------------|
| PC6    | n/a        | Low       | Output... | No pu...  | Low      | n/a       | VL53L0X_...  | <input checked="" type="checkbox"/> |
| PC7    | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | VL53L0X_...  | <input checked="" type="checkbox"/> |
| PC8    | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | LSM3MDL...   | <input checked="" type="checkbox"/> |
| PC9    | n/a        | Low       | Output... | No pu...  | Low      | n/a       | LED3_WIFI... | <input checked="" type="checkbox"/> |
| PC13   | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | BUTTON_...   | <input checked="" type="checkbox"/> |
| PDO    | n/a        | Low       | Output... | No pu...  | Low      | n/a       | PMOD_RE...   | <input checked="" type="checkbox"/> |
| PD2    | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | PMOD_IR...   | <input checked="" type="checkbox"/> |

PE5 Configuration :

GPIO mode : External Interrupt Mode with Rising edge trigger detect...

GPIO Pull-up... : No pull-up and no pull-down

User Label : SPSGRF\_915\_GPIO3\_EXTI5 [SPSGRF\_GPIO\_3]

Pinout view  System

System Core Analog

- DMA
- GPIO
- NVIC
- RCC

# Step: Observe Settings for PC13/Button

Group By Peripherals

|         |                       |        |
|---------|-----------------------|--------|
| USART3  | USB_OTG_FS            | NVIC   |
| QUADSPI | RCC                   | SPI3   |
| GPIO    | Single Mapped Signals | SYS    |
|         |                       | USART1 |
|         |                       | DFSDM1 |
|         |                       | I2C2   |

Search Signals

Show only Modified Pins

| Pin... | Signal ... | GPIO o... | GPIO ... | GPIO P... | Maxim... | Fast M... | User Label  | Mo...                               |
|--------|------------|-----------|----------|-----------|----------|-----------|-------------|-------------------------------------|
| PC6    | n/a        | Low       | Output   | No pu...  | Low      | n/a       | VL53L0X_... | <input checked="" type="checkbox"/> |
| PC7    | n/a        | n/a       | External | No pu...  | n/a      | n/a       | VL53L0X_... | <input checked="" type="checkbox"/> |
| PC8    | n/a        | n/a       | External | No pu...  | n/a      | n/a       | LSM3MDL...  | <input checked="" type="checkbox"/> |
| PC9    | n/a        | Low       | Output   | No pu...  | Low      | n/a       | LED3_WIF... | <input checked="" type="checkbox"/> |
| PC13   | n/a        | n/a       | External | No pu...  | n/a      | n/a       | BUTTON_...  | <input checked="" type="checkbox"/> |
| PD0    | n/a        | Low       | Output   | No pu...  | Low      | n/a       | PMOD_RE...  | <input checked="" type="checkbox"/> |
| PD2    | n/a        | n/a       | External | No pu...  | n/a      | n/a       | PMOD_IR...  | <input checked="" type="checkbox"/> |
| PD7    | n/a        | Low       | Output   | No pu...  | Low      | n/a       | STSAFE_A... | <input checked="" type="checkbox"/> |
| PD10   | n/a        | n/a       | External | No pu...  | n/a      | n/a       | LPS22HB_... | <input checked="" type="checkbox"/> |
| PD11   | n/a        | n/a       | External | No pu...  | n/a      | n/a       | LSM6DSL...  | <input checked="" type="checkbox"/> |

PC13 Configuration :

|                 |                                                             |
|-----------------|-------------------------------------------------------------|
| GPIO mode       | External Interrupt Mode with Falling edge trigger detection |
| GPIO Pull-up... | No pull-up and no pull-down                                 |
| User Label      | BUTTON_EXTI13 [B2]                                          |

# Step: Observe Settings for PD15 HTS221\_DRDY\_EXTI15

Group By Peripherals

|         |                       |                        |
|---------|-----------------------|------------------------|
| USART3  | USB_OTG_FS            | NVIC                   |
| QUADSPI | RCC                   | SPI3                   |
| GPIO    | Single Mapped Signals | SYS USART1 DFSDM1 I2C2 |

Search Signals

Show only Modified Pins

| Pin... | Signal ... | GPIO o... | GPIO ...  | GPIO P... | Maxim... | Fast M... | User Label   | Mo...                               |
|--------|------------|-----------|-----------|-----------|----------|-----------|--------------|-------------------------------------|
| PD10   | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | LPS22HB_...  | <input checked="" type="checkbox"/> |
| PD11   | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | LSM6DSL...   | <input checked="" type="checkbox"/> |
| PD12   | n/a        | Low       | Output... | No pu...  | Low      | n/a       | USB_OTG...   | <input checked="" type="checkbox"/> |
| PD13   | n/a        | High      | Output... | No pu...  | Low      | n/a       | SPBTLE_R...  | <input checked="" type="checkbox"/> |
| PD14   | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | ARD_D2 [...] | <input checked="" type="checkbox"/> |
| PD15   | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | HTS221_...   | <input checked="" type="checkbox"/> |
| PE0    | n/a        | High      | Output... | No pu...  | Low      | n/a       | ISM43362...  | <input checked="" type="checkbox"/> |
| PE1    | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | ISM43362...  | <input checked="" type="checkbox"/> |
| PE2    | n/a        | Low       | Output... | No pu...  | Low      | n/a       | M24SR64...   | <input checked="" type="checkbox"/> |
| PE3    | n/a        | n/a       | Extern... | No pu...  | n/a      | n/a       | USB OTG...   | <input checked="" type="checkbox"/> |

PD15 Configuration :

GPIO mode: External Interrupt Mode with Rising edge trigger detected

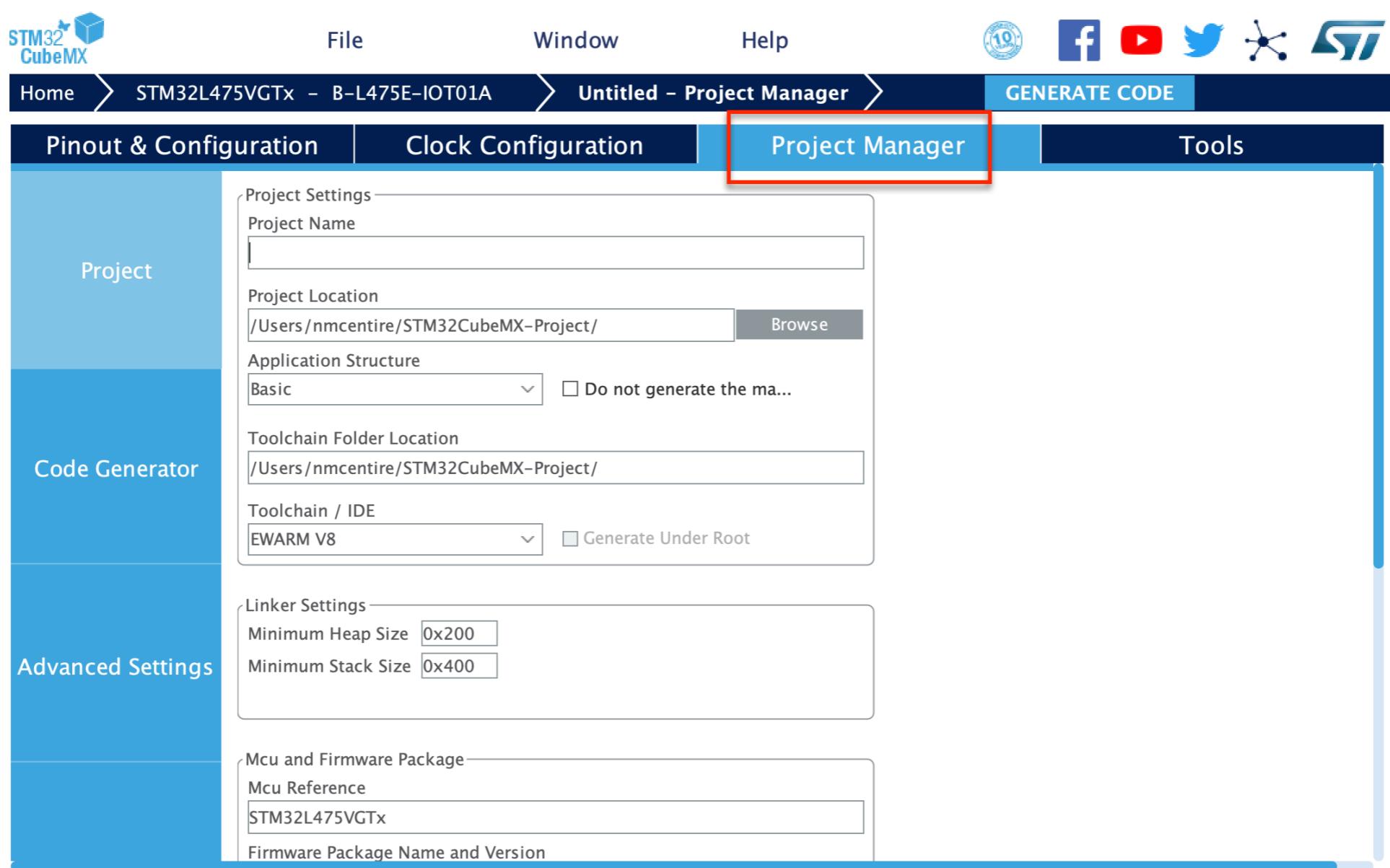
GPIO Pull-up...: No pull-up and no pull-down

User Label: HTS221\_DRDY\_EXTI15 [HTS221\_DRDY]

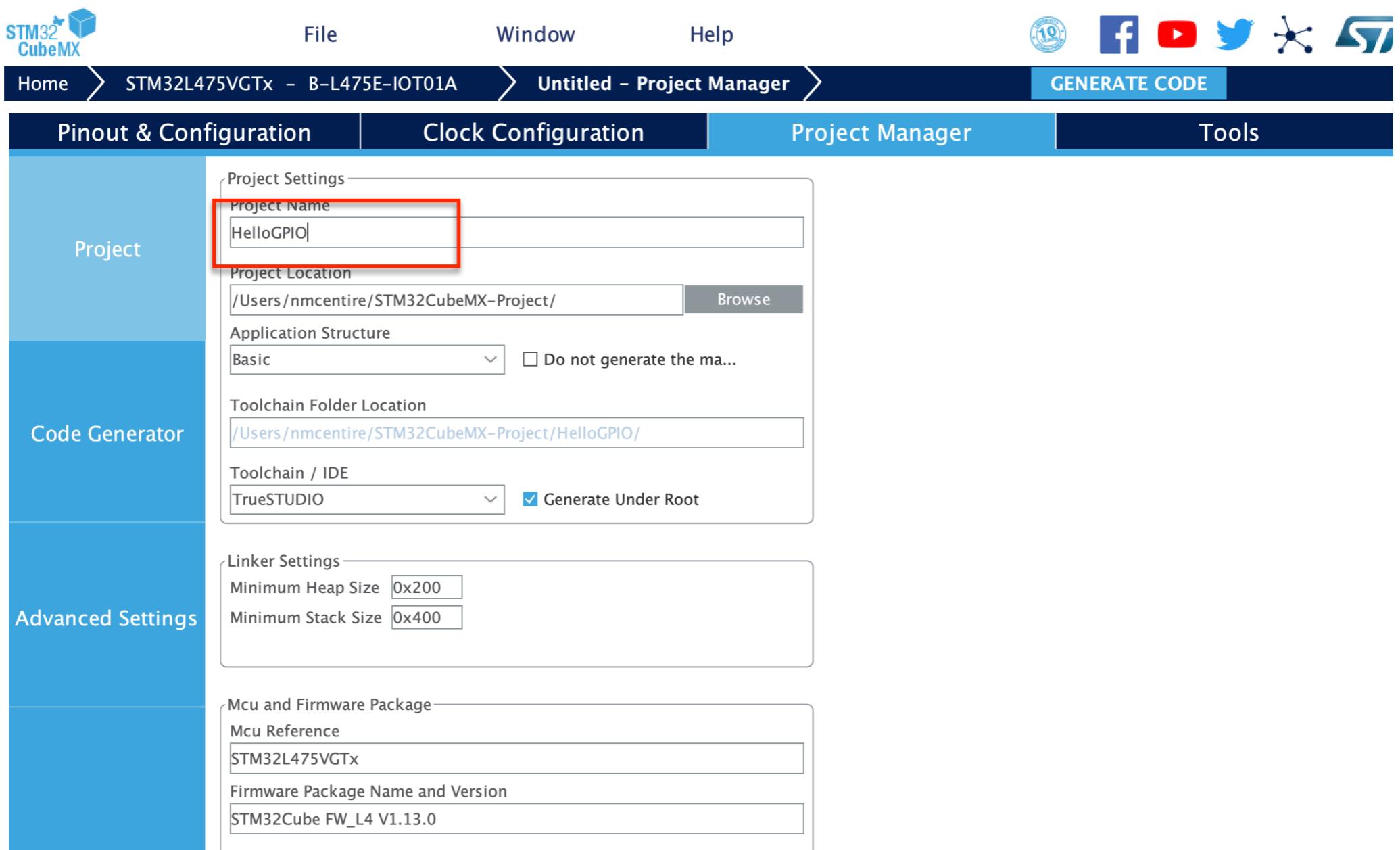
System Core Analog

- DMA
- GPIO
- NVIC
- RCC

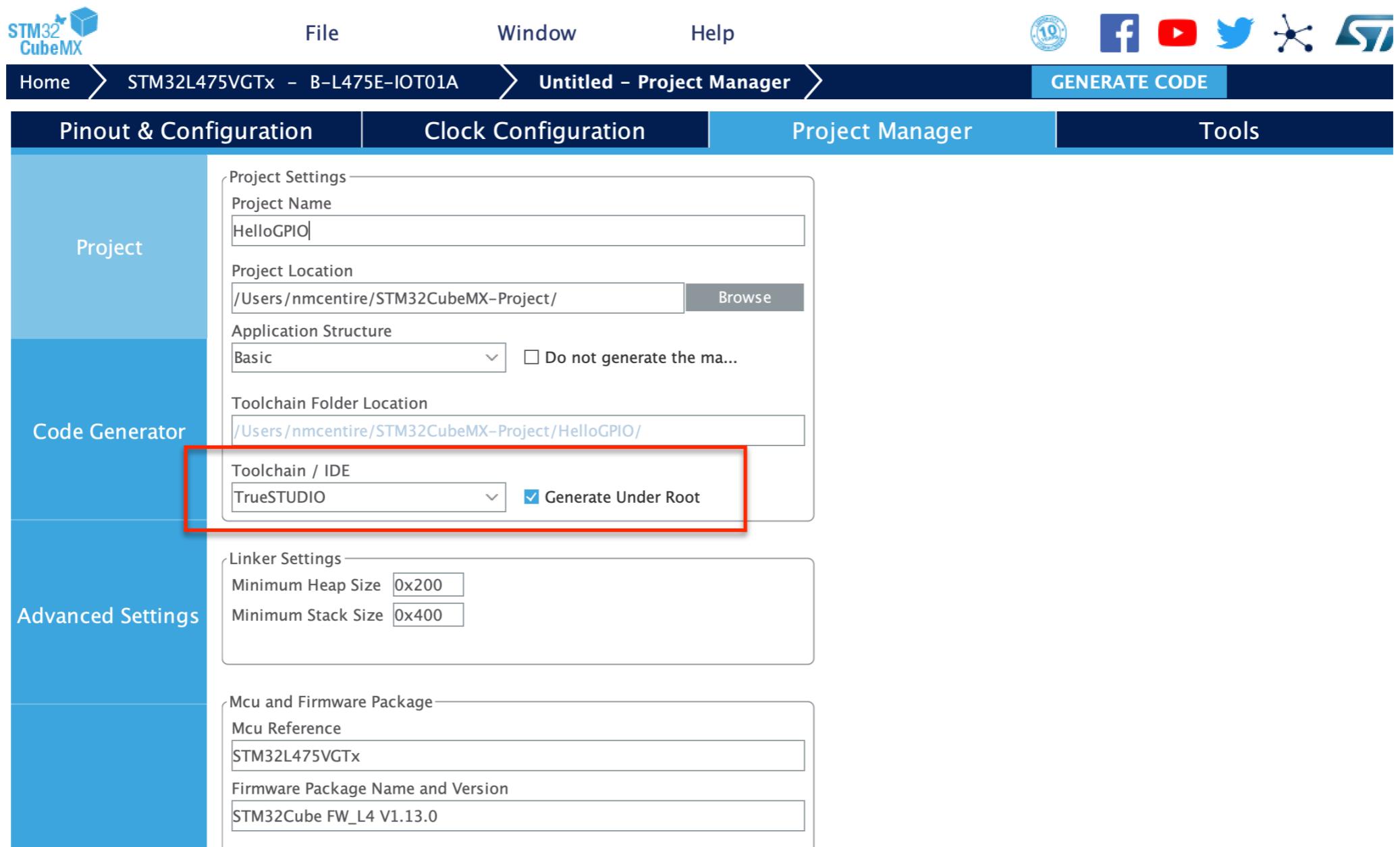
# Step: Observe “Project Manager”



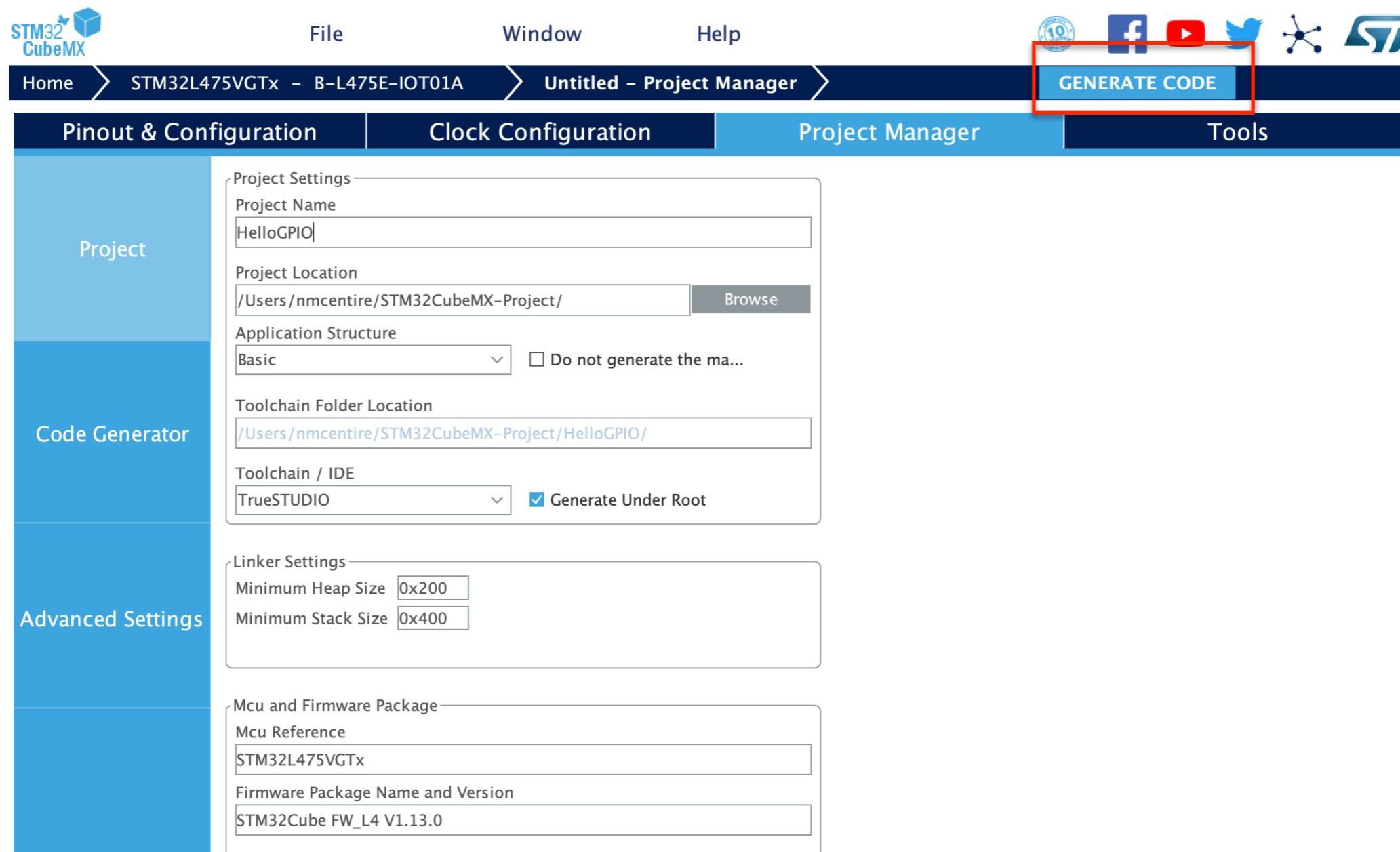
# Step: Enter “HelloGPIO” for Project Name



# Step: Select “TrueStudio” for Toolchain / IDE



# Step: Click on “Generate Code”

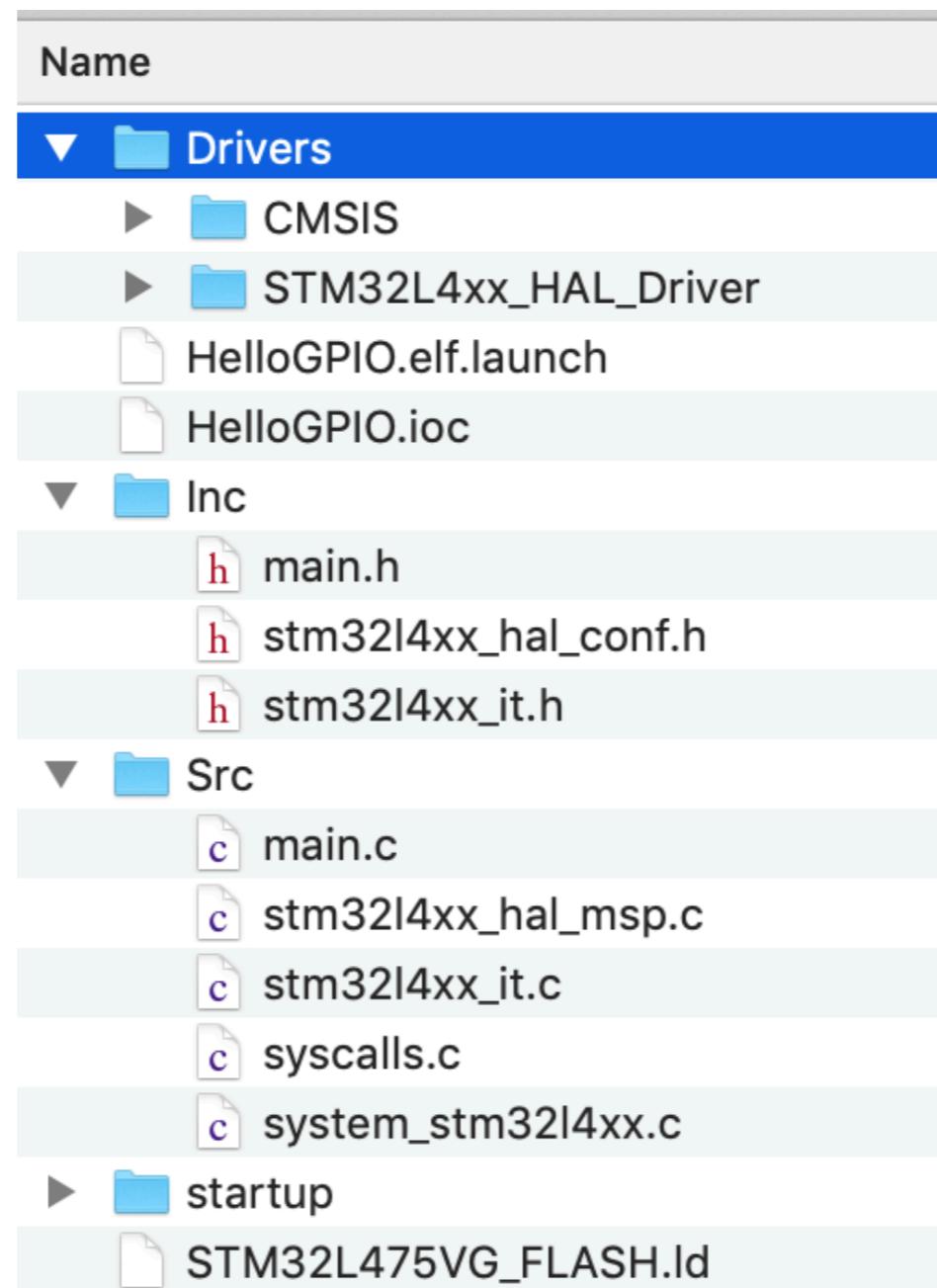


# Step: Select “Open Folder”

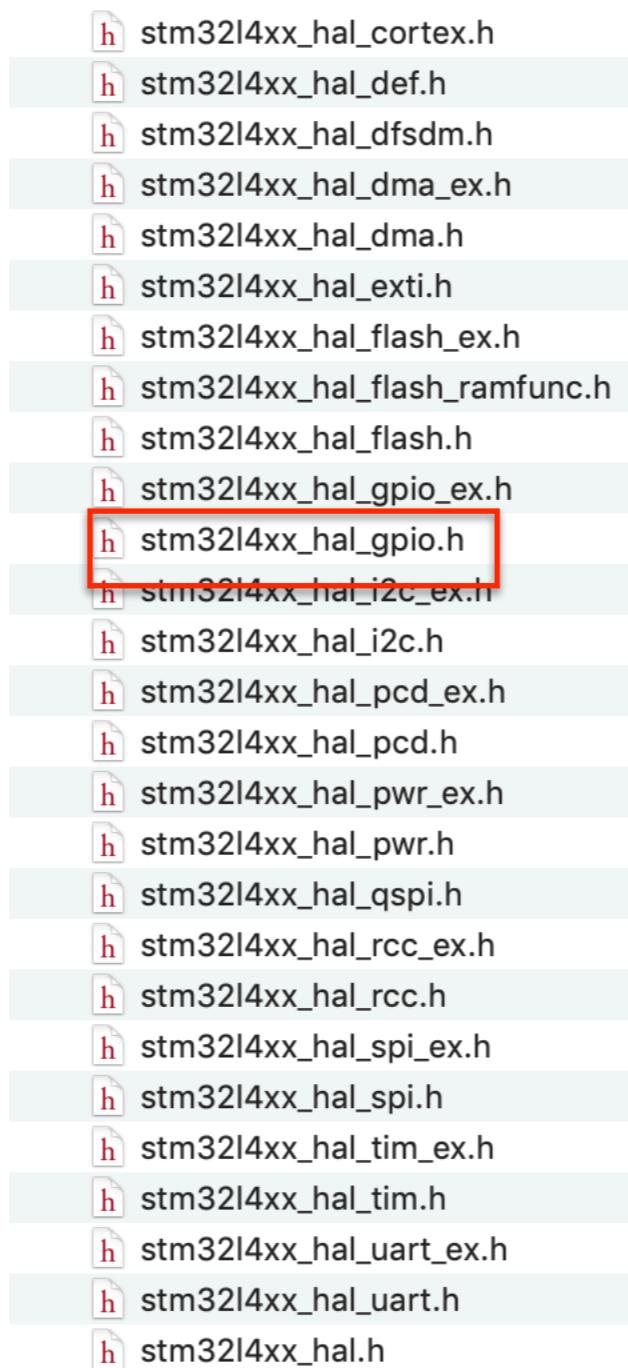


# Tour of Generated Project

# Step: View Open Folder

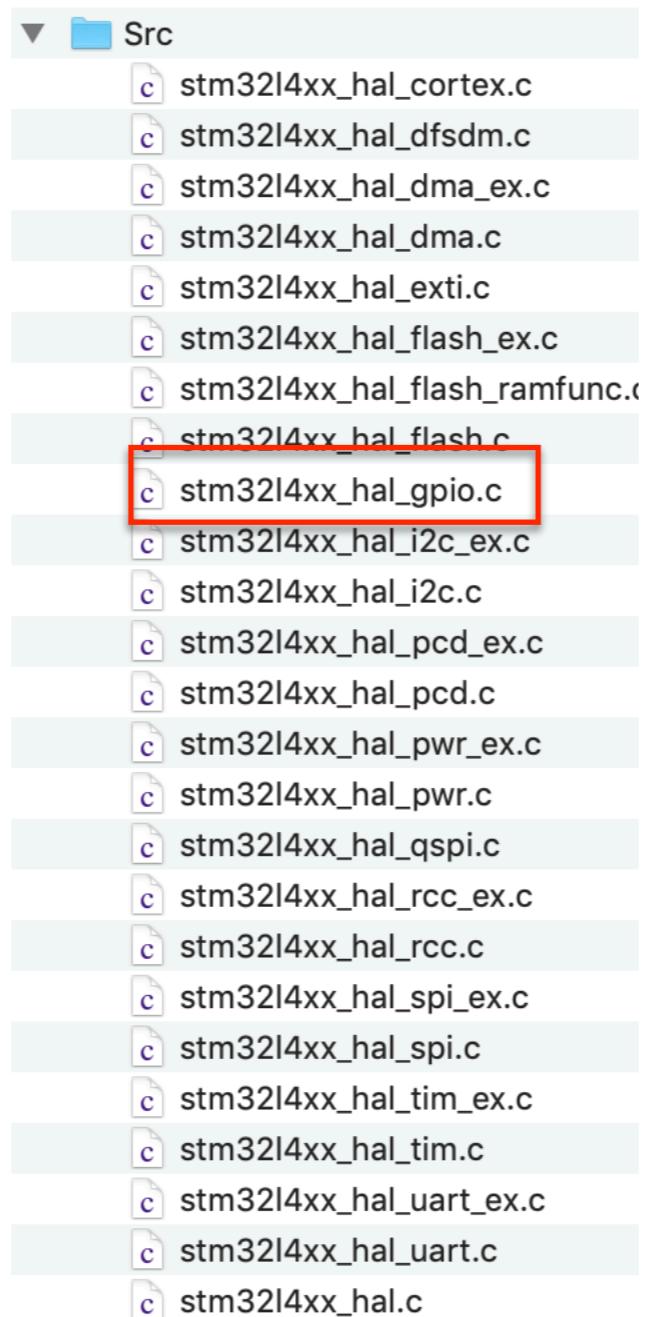


# Step: View “Drivers/STM32L4xx\_HAL\_Driver/Inc” directory



Observe  
stm32l4xx\_hal\_gpio.h

# Step: View “Drivers/STM32L4xx\_HAL\_Driver/Src” directory



Observe  
stm32l4xx\_hal\_gpio.c

# main.c - Part 1

```
85 int main(void)
86 {
87 /* USER CODE BEGIN 1 */
88
89 /* USER CODE END 1 */
90
91 /* MCU Configuration-----*/
92
93 /* Reset of all peripherals,
94 HAL_Init();
95
96
97 /* Initialize all configured peripherals */
98 MX_GPIO_Init();
99 }
```

# main.c - Part 2

```
473 static void MX_GPIO_Init(void)
474 {
475 GPIO_InitTypeDef GPIO_InitStruct = {0};
476
477 /* GPIO Ports Clock Enable */
478 __HAL_RCC_GPIOE_CLK_ENABLE();
479 __HAL_RCC_GPIOC_CLK_ENABLE();
480 __HAL_RCC_GPIOA_CLK_ENABLE();
481 __HAL_RCC_GPIOB_CLK_ENABLE();
482 __HAL_RCC_GPIOD_CLK_ENABLE();
```

# main.c - Part 3

# main.c - Part 4

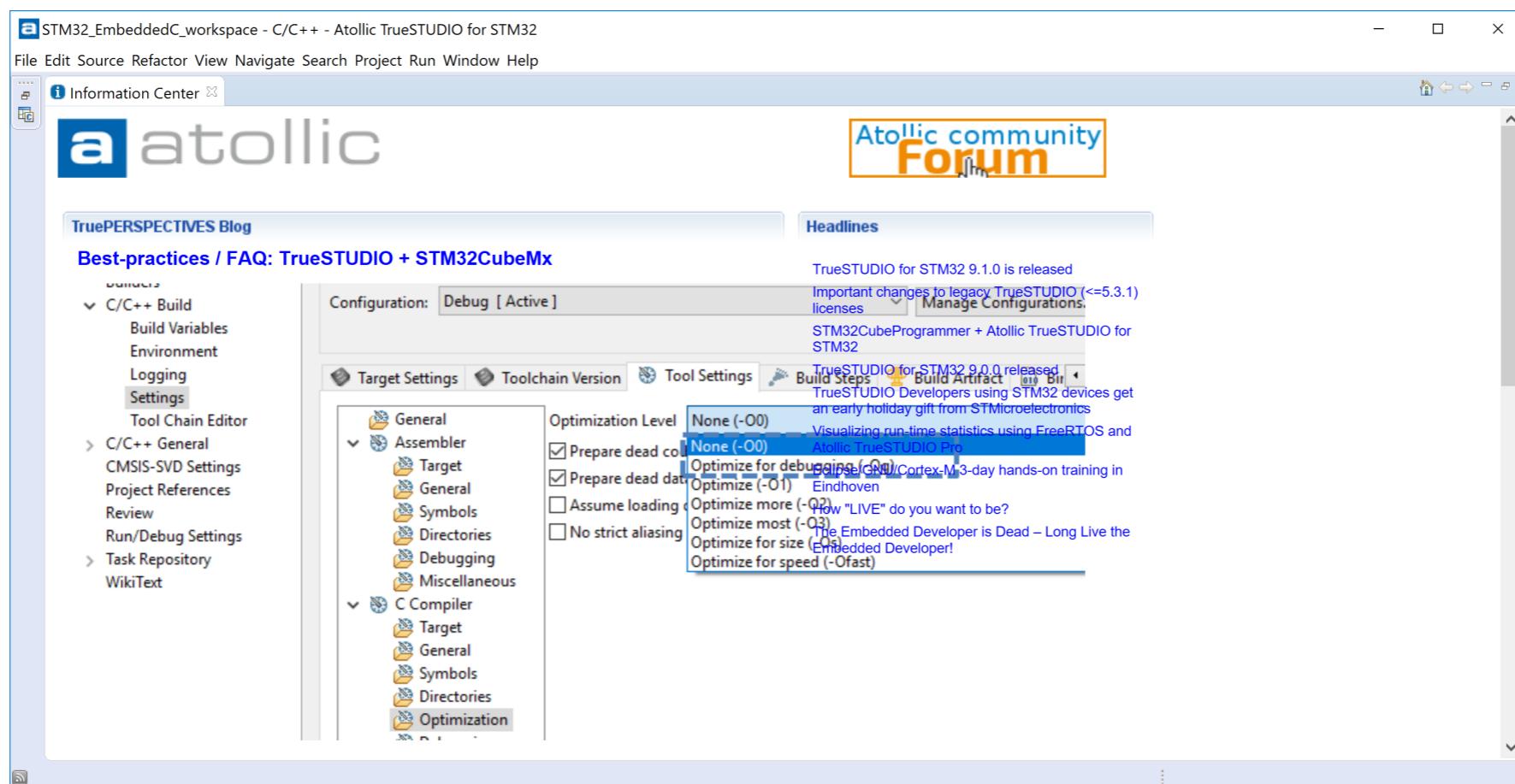
```
510
511 /*Configure GPIO pins : M24SR64_Y_RF_DISABLE_Pin M24SR64_Y_GPIO_Pin ISM43362_RST_Pin ISM4
512 GPIO_InitStruct.Pin = M24SR64_Y_RF_DISABLE_Pin|M24SR64_Y_GPIO_Pin|ISM43362_RST_Pin|
513 ||||||| ISM43362_SPI3_CSN_Pin;
514 GPIO_InitStruct.Mode = GPIO_MODE_OUTPUT_PP;
515 GPIO_InitStruct.Pull = GPIO_NOPULL;
516 GPIO_InitStruct.Speed = GPIO_SPEED_FREQ_LOW;
517 HAL_GPIO_Init(GPIOE, &GPIO_InitStruct);
518
519 /*Configure GPIO pins : USB_OTG_FS_OVRCR_EXTI3_Pin SPSGRF_915_GPIO3_EXTI5_Pin SPBTLE_RF_
520 GPIO_InitStruct.Pin = USB_OTG_FS_OVRCR_EXTI3_Pin|SPSGRF_915_GPIO3_EXTI5_Pin|
521 ||||| SPBTLE_RF_IRQ_EXTI6_Pin|ISM43362_DRDY_EXTI1_Pin;
522 GPIO_InitStruct.Mode = GPIO_MODE_IT_RISING;
523 GPIO_InitStruct.Pull = GPIO_NOPULL;
524 HAL_GPIO_Init(GPIOE, &GPIO_InitStruct);
525
526 /*Configure GPIO pin : BUTTON_EXTI13_Pin */
527 GPIO_InitStruct.Pin = BUTTON_EXTI13_Pin;
528 //GPIO_InitStruct.Mode = GPIO_MODE_IT_FALLING;
529 GPIO_InitStruct.Pull = GPIO_NOPULL;
530 HAL_GPIO_Init(BUTTON_EXTI13_GPIO_Port, &GPIO_InitStruct);
531
```

# Summary so far...

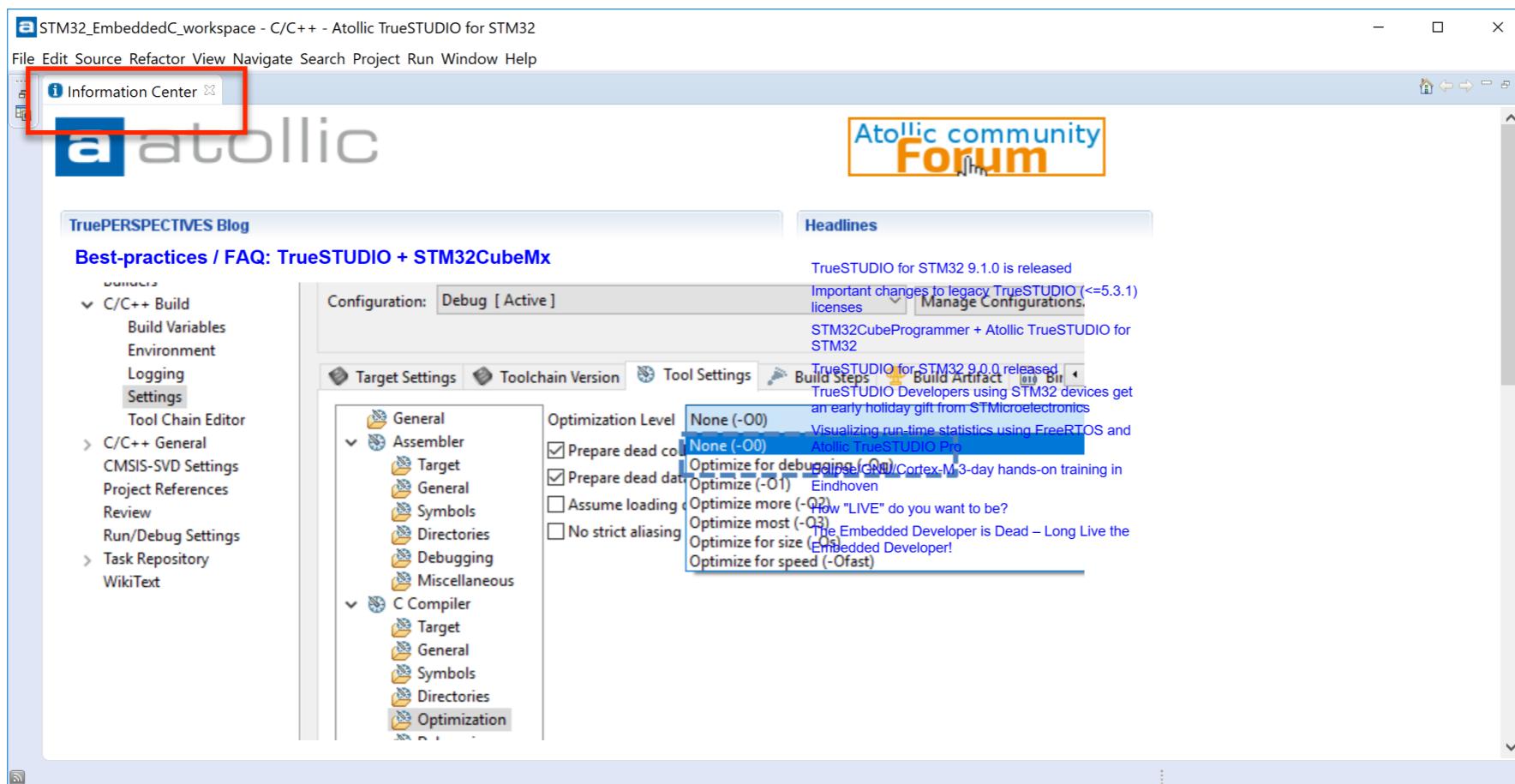
- STM32CubeMX generates GPIO Code
- HAL Driver Code
  - Drivers/STM32L4xx\_HAL\_Driver/Inc
    - stm32l4xx\_hal\_gpio.h
  - Drivers/STM32L4xx\_HAL\_Driver/Src
    - stm32l4xx\_hal\_gpio.c

Use TrueStudio  
To Read Status of Button, then Turn  
on LED2 when button pressed, turn  
off when button released

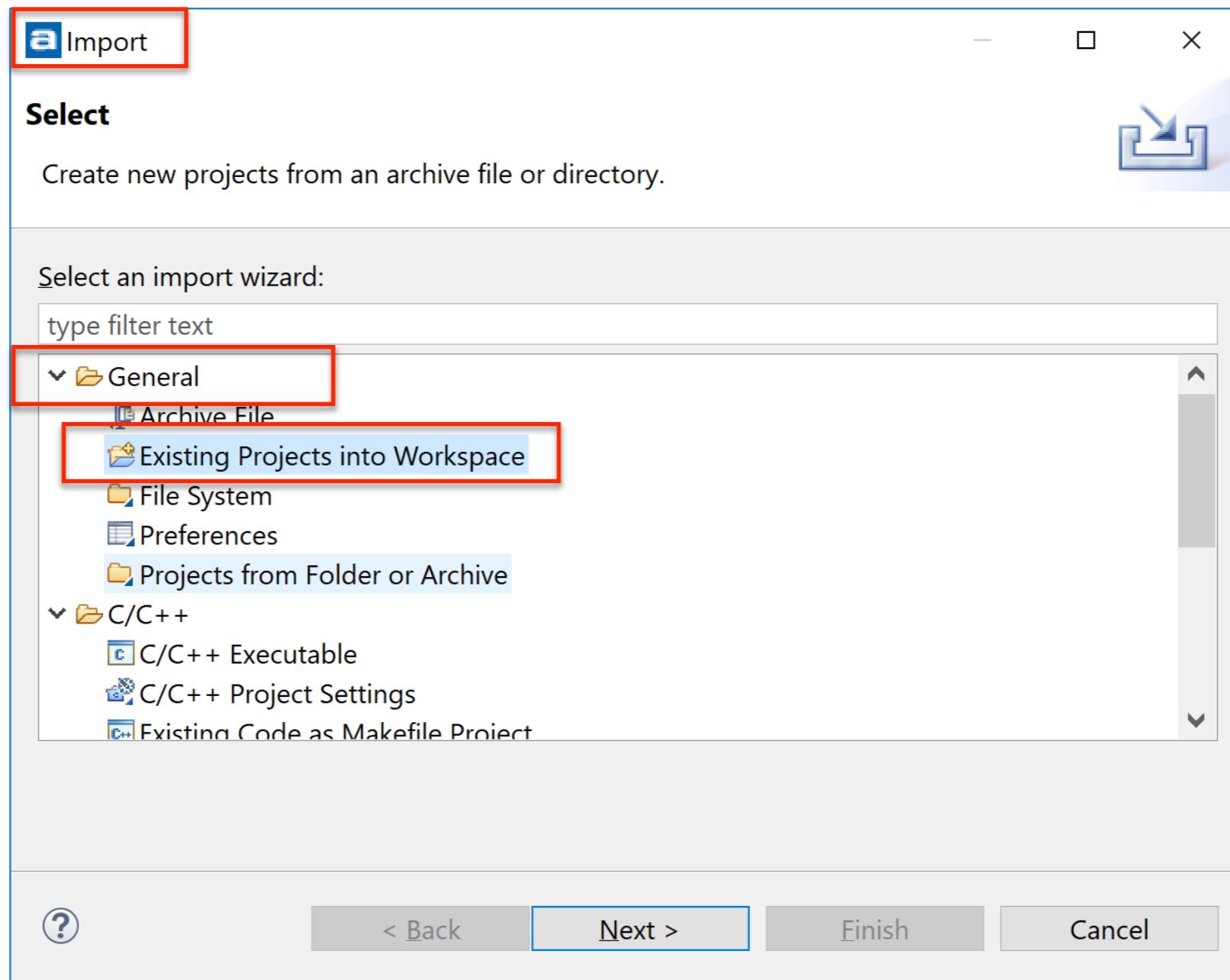
# Step: Startup TrueStudio



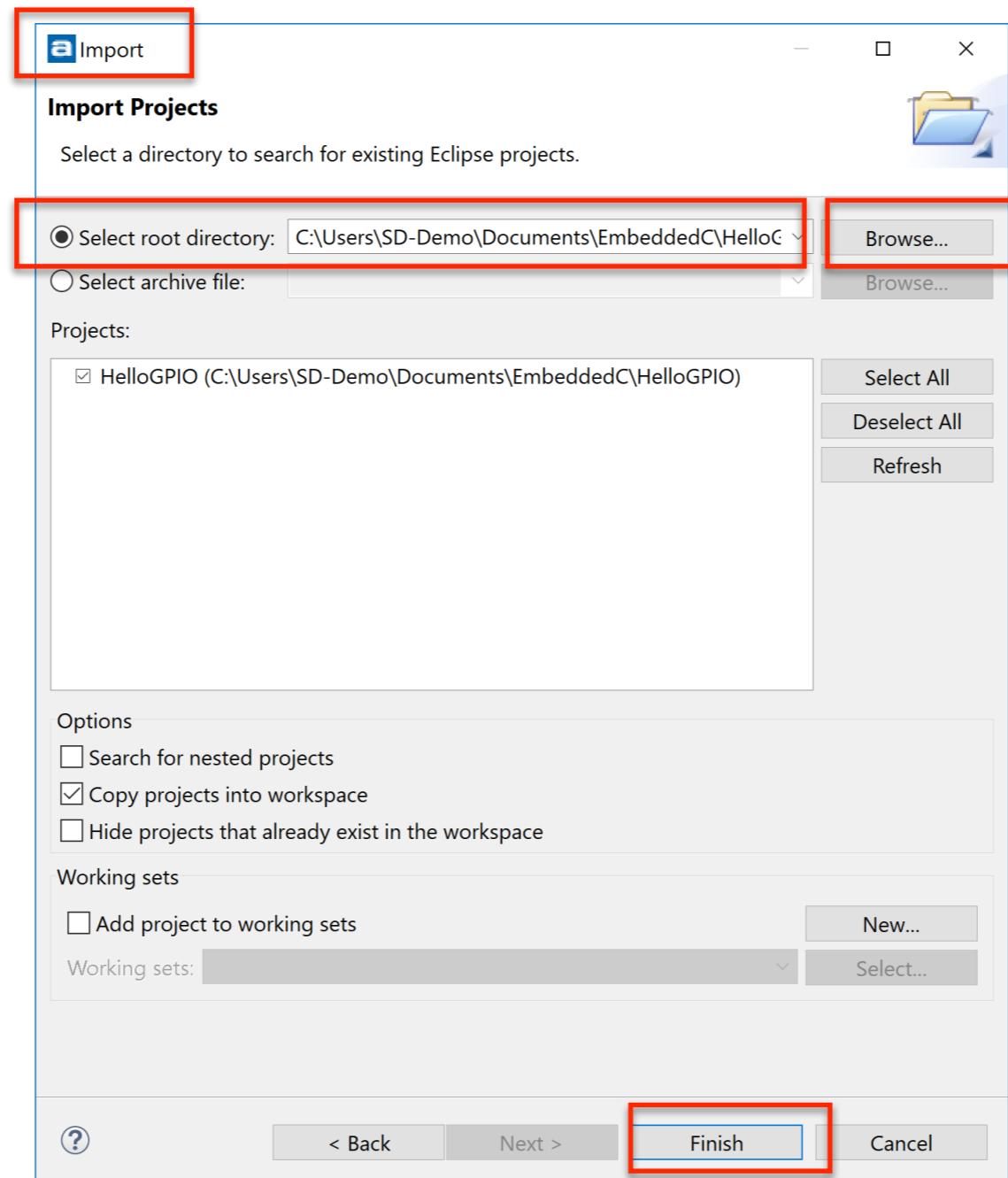
# Step: Click to Close “Information Center”



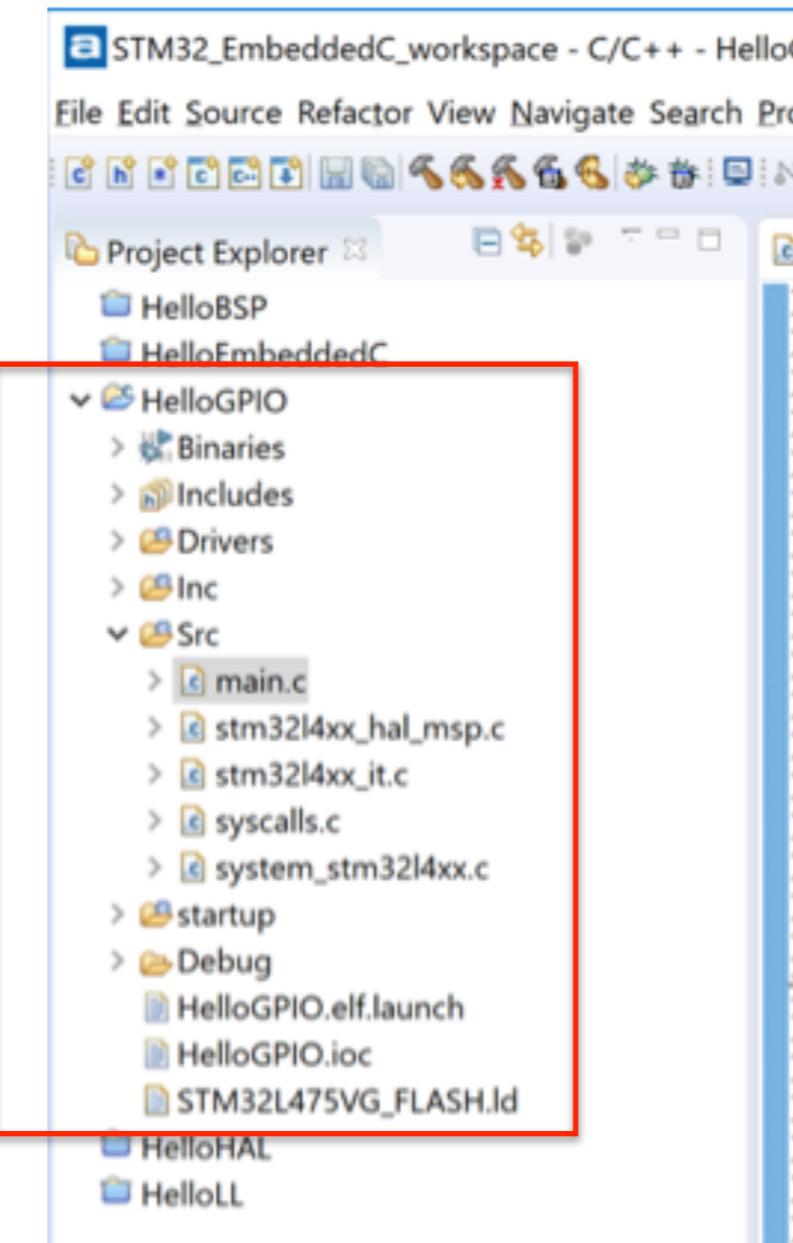
# Step: File, Import, General, Existing Projects into Workspace



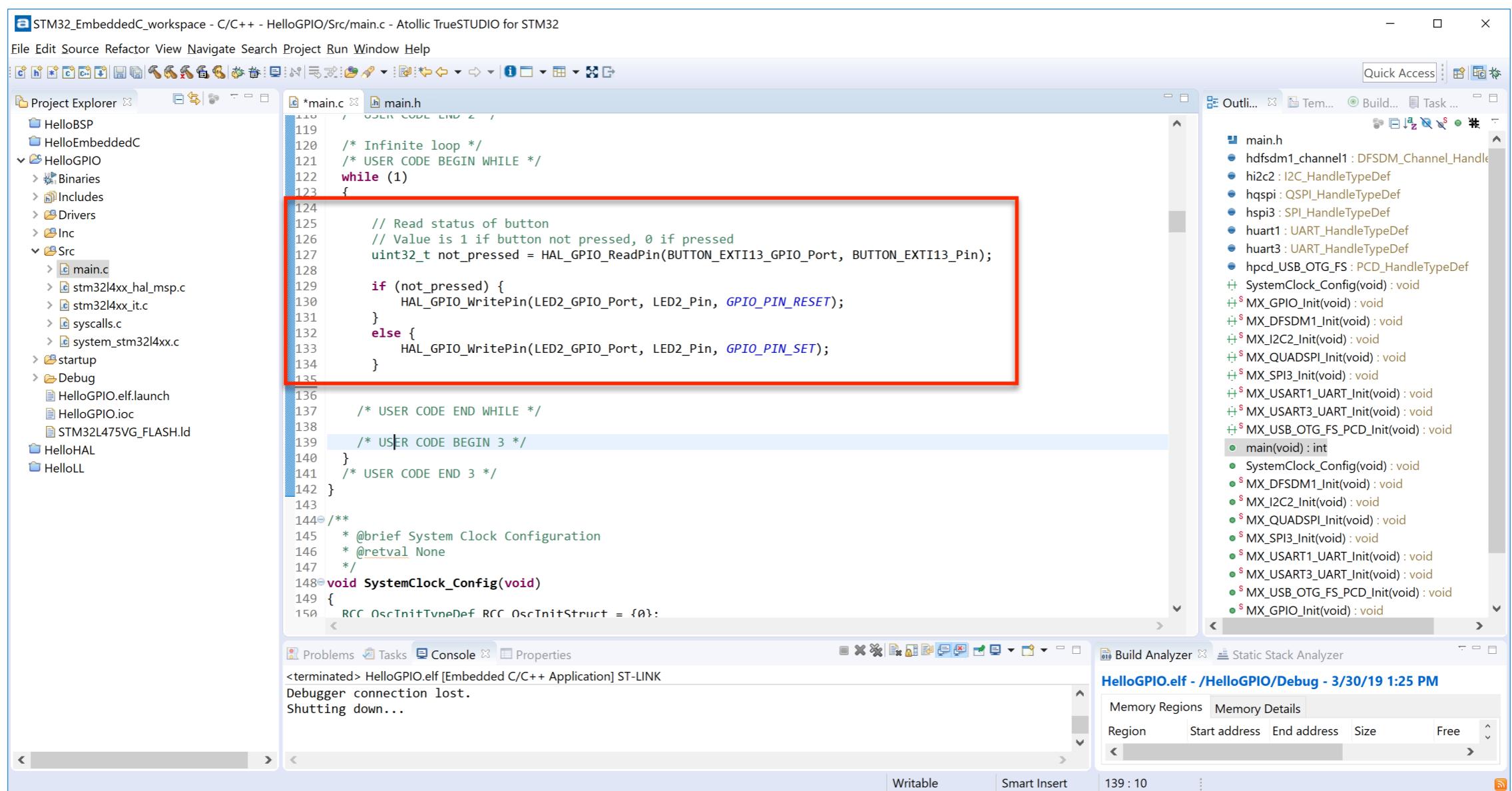
# Step: Select Root Directory (Browse to directory as needed)



# Step: Observe Results



# Step: Edit main.c



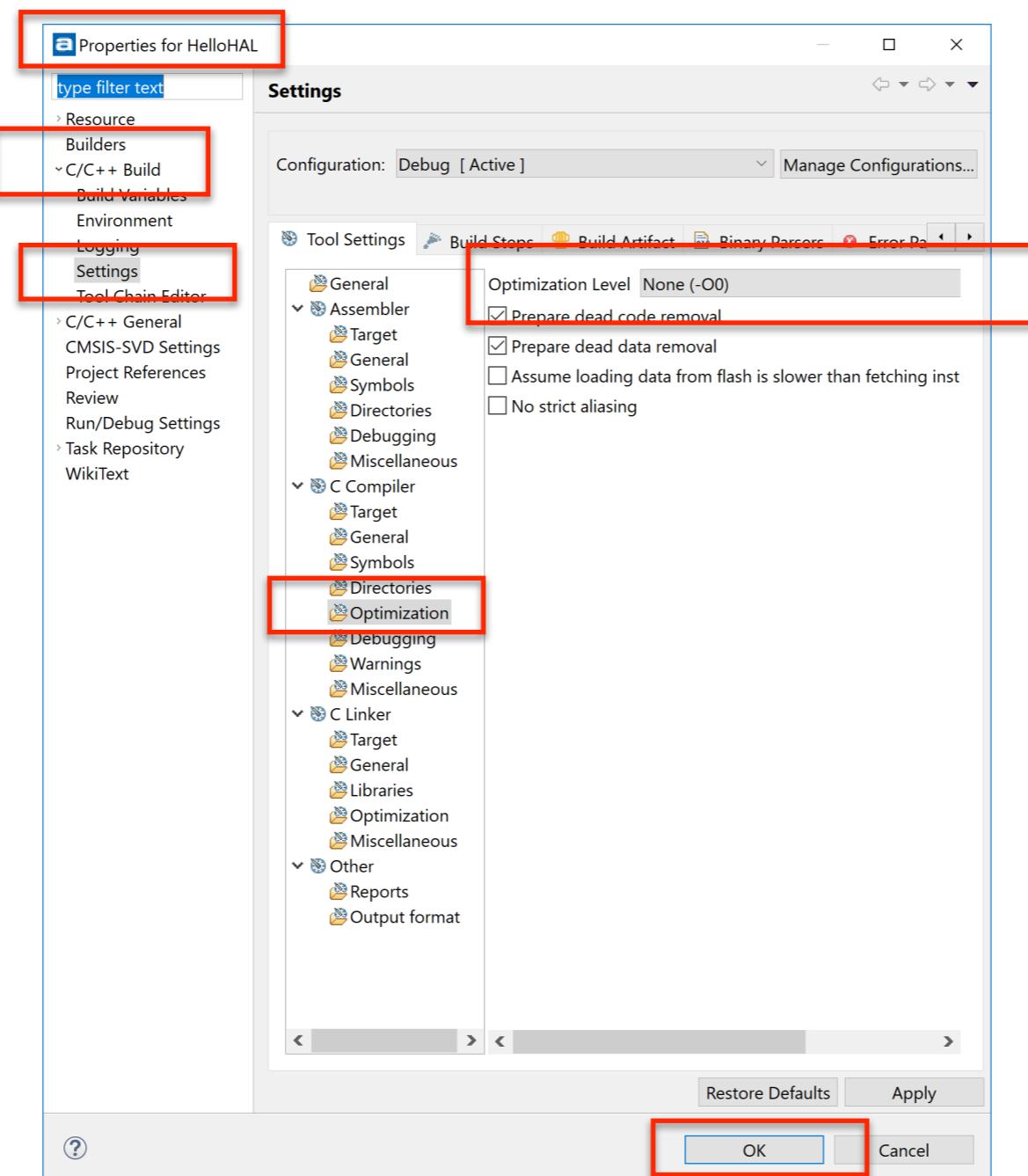
The screenshot shows the Atollic TrueSTUDIO for STM32 IDE interface. The main window displays the `main.c` file with the following code:

```
119 /* Infinite loop */
120 /* USER CODE BEGIN WHILE */
121 while (1)
122 {
124 // Read status of button
125 // Value is 1 if button not pressed, 0 if pressed
126 uint32_t not_pressed = HAL_GPIO_ReadPin(BUTTON_EXTI13_GPIO_Port, BUTTON_EXTI13_Pin);
128
129 if (not_pressed) {
130 HAL_GPIO_WritePin(LED2_GPIO_Port, LED2_Pin, GPIO_PIN_RESET);
131 }
132 else {
133 HAL_GPIO_WritePin(LED2_GPIO_Port, LED2_Pin, GPIO_PIN_SET);
134 }
136
137 /* USER CODE END WHILE */
138
139 /* USER CODE BEGIN 3 */
140 }
141 /* USER CODE END 3 */
142 }
```

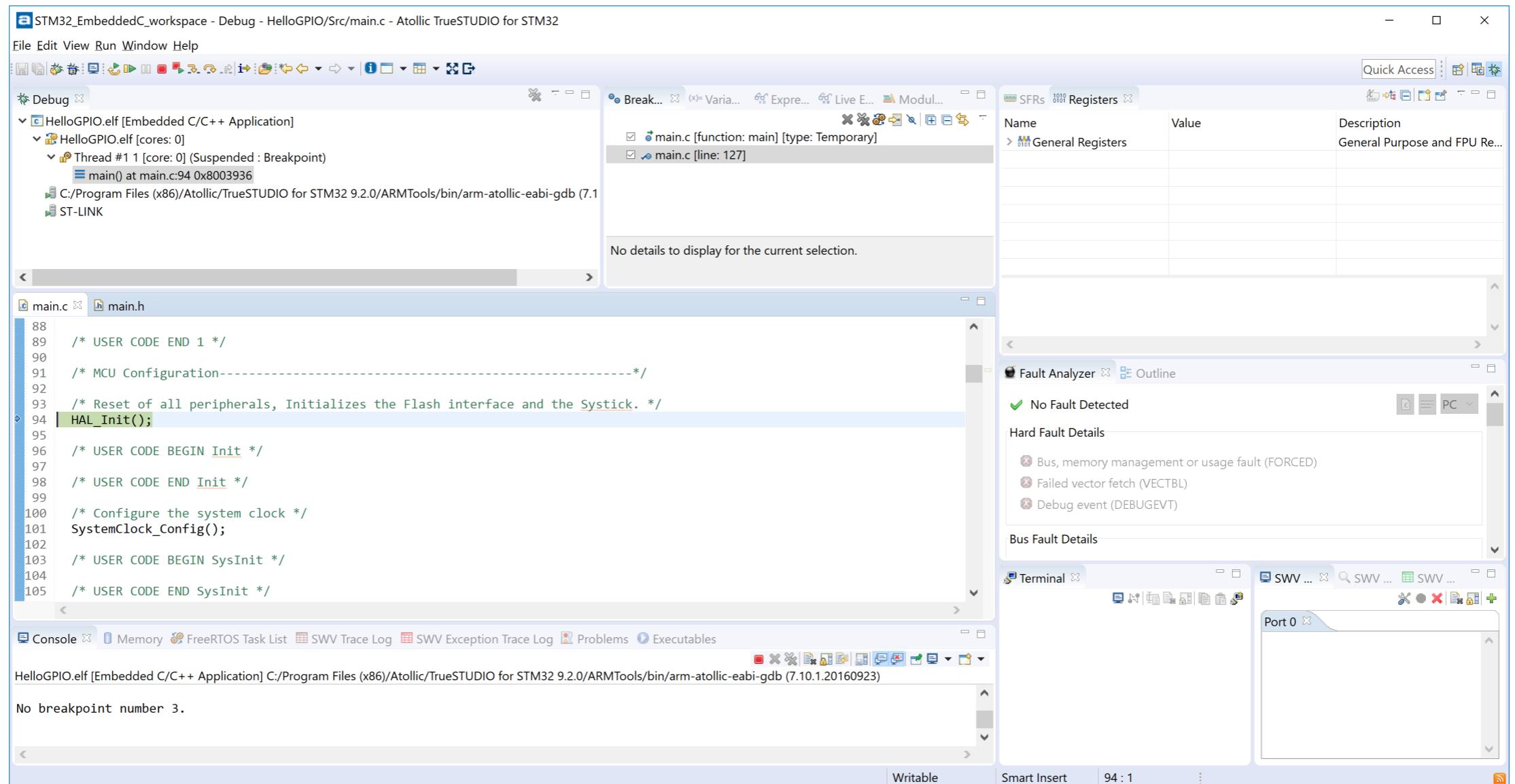
A red box highlights the code from line 124 to 134, which reads the button status and toggles the LED. The code is annotated with comments explaining its purpose.

The Project Explorer on the left shows the project structure, including files like `main.c`, `stm32l4xx_hal_msp.c`, and `SystemClock_Config(void)`. The Outliner on the right lists various handles and functions defined in the project.

# Step: Project, Properties, C/C++ Build, Settings, C Compiler, Optimization, None

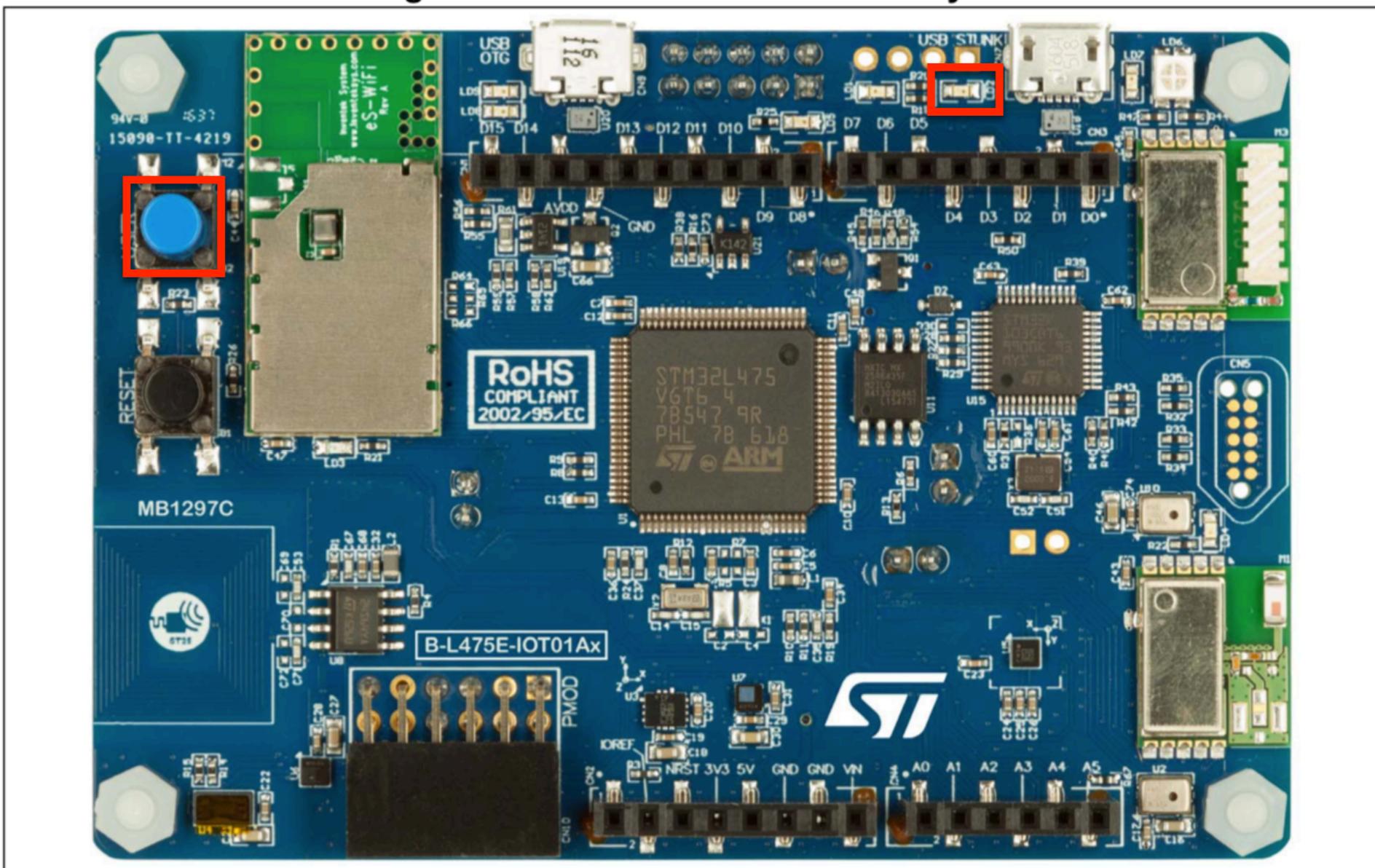


# Step: Build and Run Project in Debug Mode



Step: Press Button to turn on LED.  
Release Button to turn LED off

Figure 1. B-L475E-IOT01A Discovery kit



# Summary

- Introduction to GPIO and Embedded C
- STM32CubeMX and GPIO Code Generation
- Tour of GPIO
- TrueStudio and GPIO
  - Touch Button to turn LED On/Off