

# Developing with Sensors Made Simple

Simplifying Motion MEMS and Environmental Sensors Design  
using the STM32CubeMX and the X-CUBE-MEMS1 Software Pack

## Hands-on Workshop

IoT Systems Development – Ecosystems



Technology Tour 2019

Toronto, Canada | May 29



# Developing with Sensors Made Simple

## Hands-On

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- USB Flash drive with relevant material for the hands-on
- **Please copy** the content of the USB drive on your laptop




**Please return it at the  
end of the workshop**



# Agenda

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- Introduction
  - Products & Ecosystem
  - Hands-on Training Session
    - Installation Process
      - STM32CubeMX libraries installation
      - STM32CubeIDE installation
      - Tera Term installation
    - Hardware Description
    - Lab Examples: 
- **Lab 0** - Read all sensors in polling mode
  - **Lab 1** - LIS2DW12 accelerometer orientation change detection
  - **Lab 2** - LPS22HH barometer read from internal FIFO
  - **Lab 3** - LSM6DSO accelerometer embedded step counter
  - **Lab 4** - LIS2DW12 accelerometer acceleration detection
  - **Lab 5** - LSM6DSO accelerometer single/double tap detection
  - **Lab 6** - LSM6DSO accelerometer 6.6 kHz data rate read at 100 Hz

# ST Addresses Four End Markets

4

Automotive

Industrial

Personal Electronics

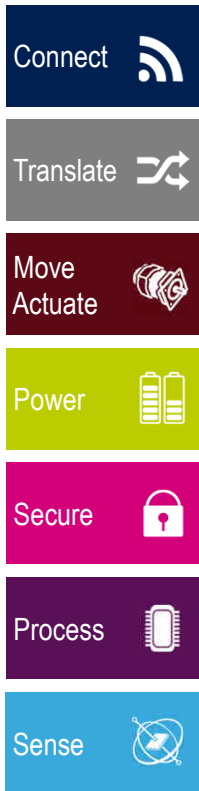
Communications  
Equipment,  
Computers & Peripherals





# ST: Products & Ecosystem

5



  
SensorTile



ProfiMEMS



STM32 Nucleo Development  
& Expansion boards

## Pre-integrated SW for vertical applications



Smart Things



Smart Home



Smart City



Smart Industry

## Development Ecosystem



Code generators



Prototyping  
software



Development  
environments



Debug  
solutions



Simulation  
and analysis tools



On-line  
design tools



# >150 Partners... and Counting

6



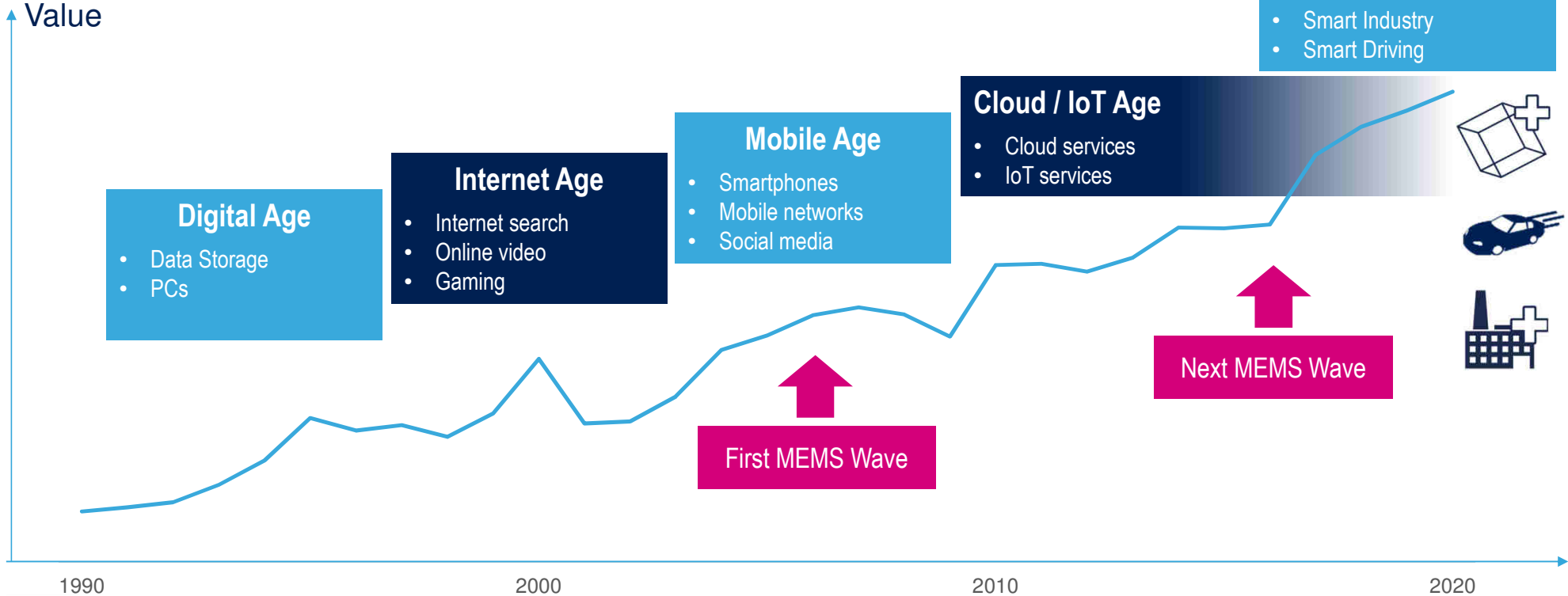


# Sensors Trends

7

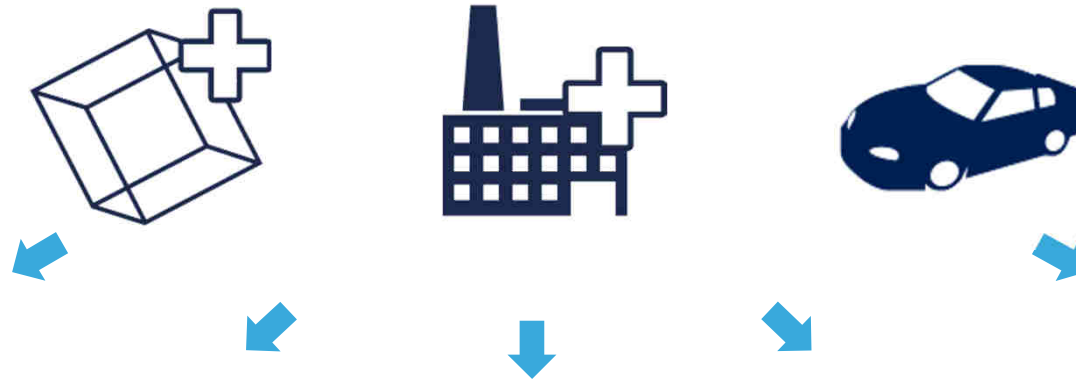
## Growth enablers of the Semiconductor Market

Global Semiconductor Market  
Value



# Sensors Evolution

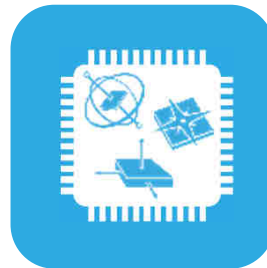
8



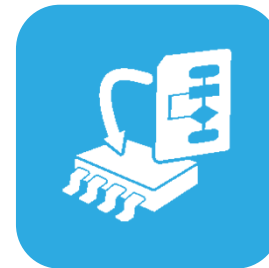
Technologies  
Manufacturing



Accuracy  
Stability



Multi Sensors  
Integration



Embedded  
Smart Functions



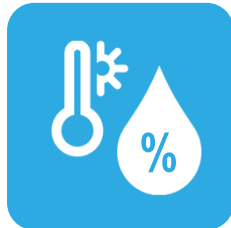
Low Power  
Always ON

# A Broad Sensor Portfolio

9



Motion



Environment



Interactivity



Micro-Actuators



Optical

# Designing with Sensors

10

## Complicated

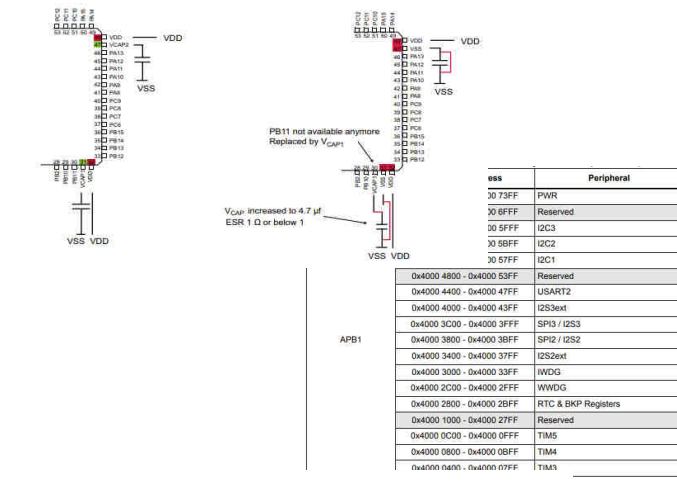


Table 42. CTRL1\_XL register

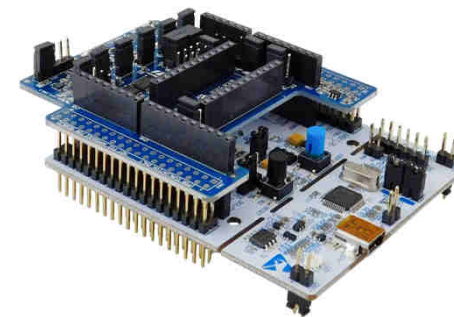
ODR_XL3	ODR_XL2	ODR_XL1	ODR_XL0	FS1_XL	FS0_XL	LPF2_XL_EN	0
---------	---------	---------	---------	--------	--------	------------	---

Table 43. CTRL1\_XL register description

ODR_XL[3:0]	Accelerometer ODR selection (see Table 44)
FS1[1:0]_XL	Accelerometer full-scale selection (see Table 45)
LPF2_XL_EN	Accelerometer high-resolution selection (0: output from first stage digital filtering selected (default); 1: output from LPF2 second filtering stage selected)



## Simple

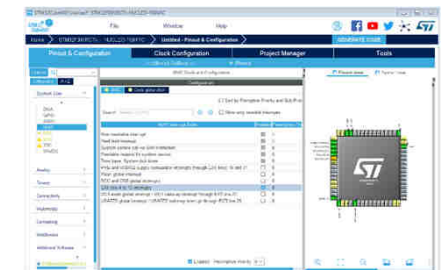


HW

NUCLEO + X-NUCLEO

SW

STM32CubeIDE + STM32CUBEMX + X-CUBE-MEMS1





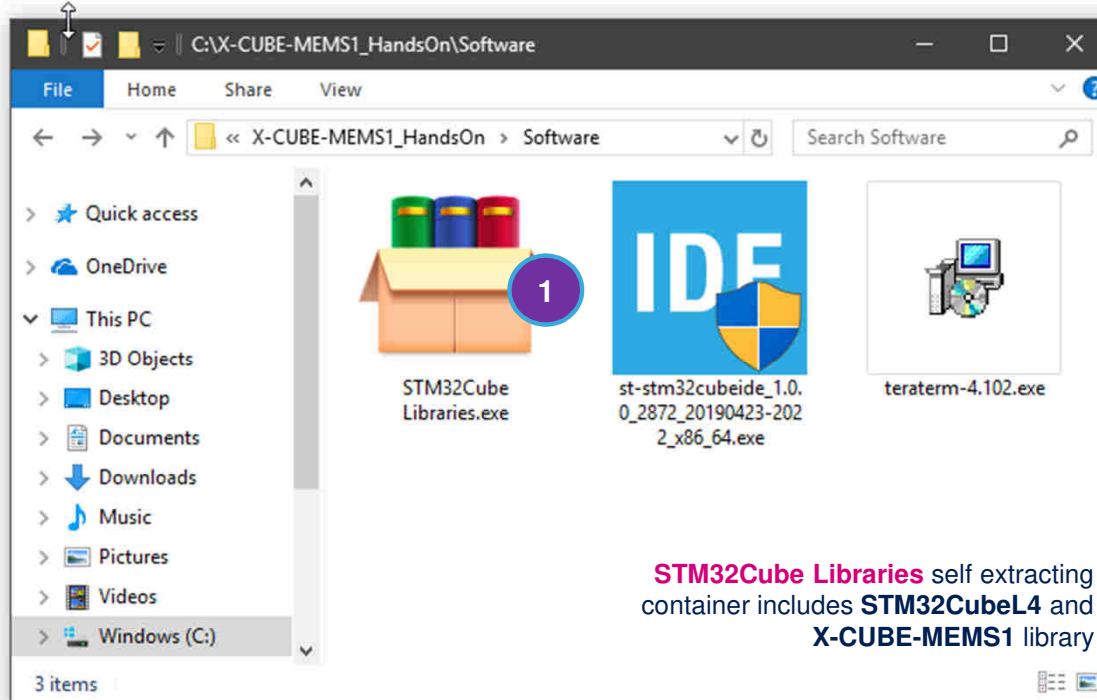
# STM32CubeMX libraries installation



# STM32CubeMX libraries installation

12

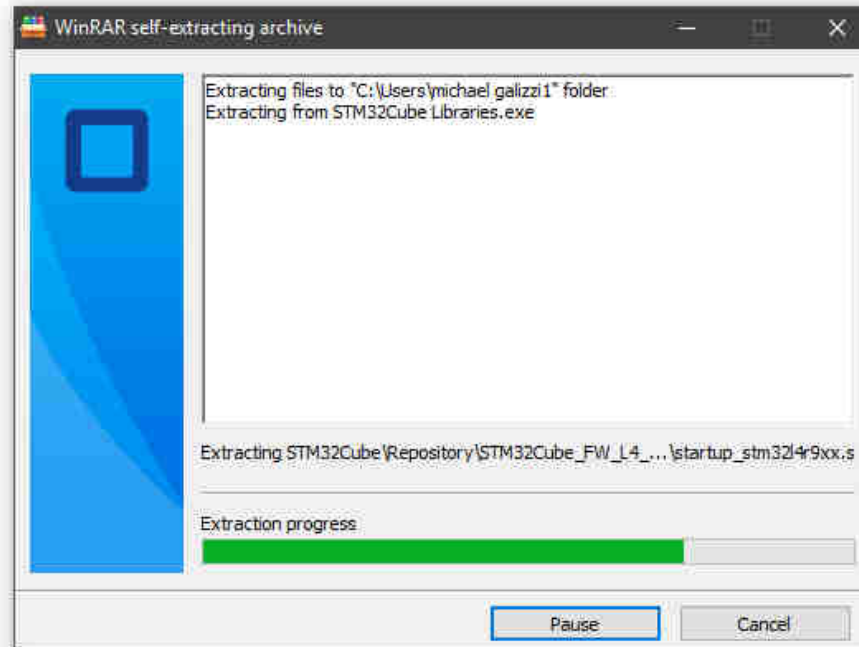
1. Run the **STM32Cube Libraries.exe** self-extracting archive located in **X-CUBE-MEMS1\_HandsOn\Software**



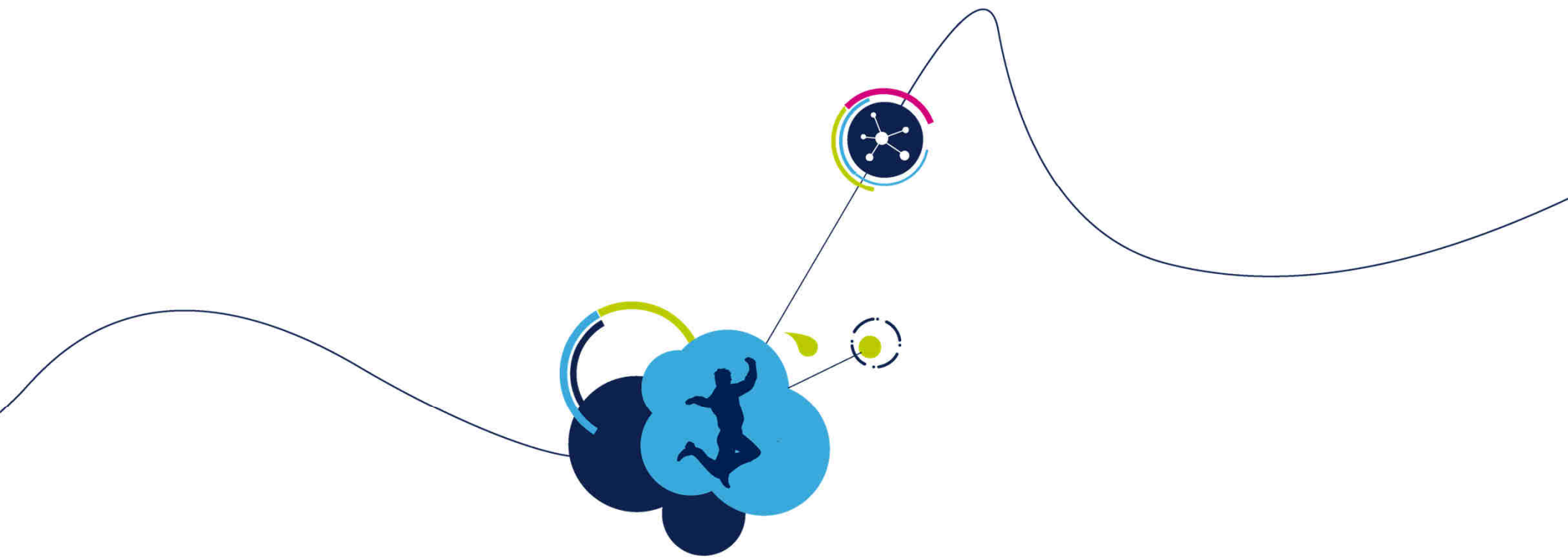
# STM32CubeMX libraries installation

13

1. Library extraction **may take few minutes**.  
Please wait the library to be fully extracted before proceed any further.



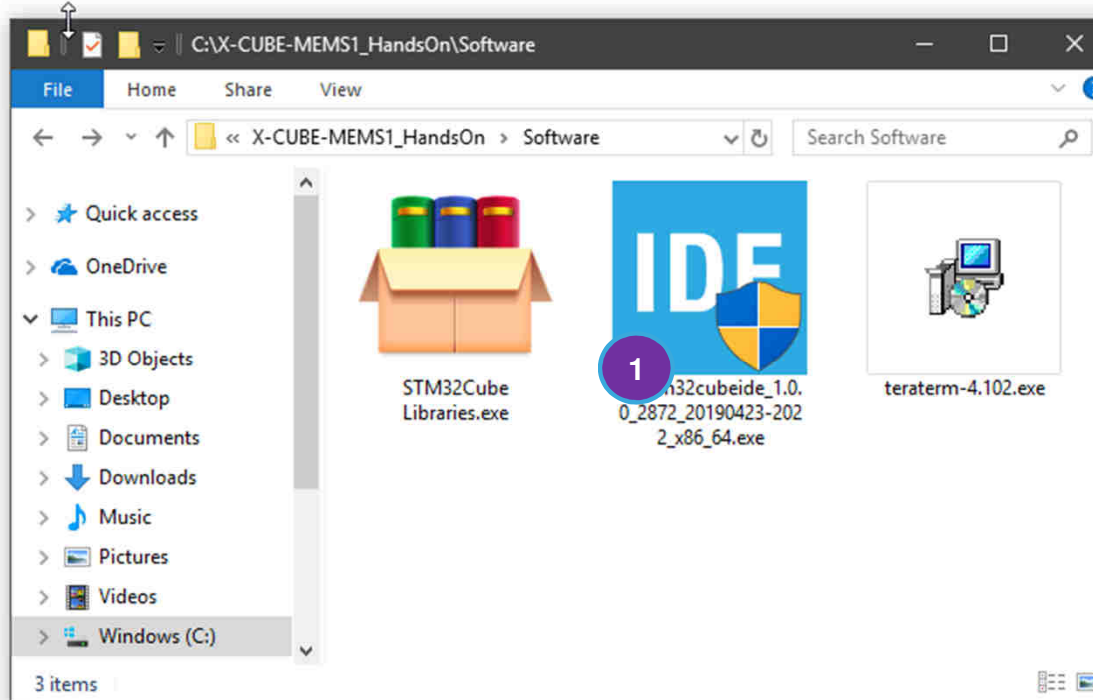
Meantime we'll proceed to install and configure STM32CubeIDE



# STM32CubeIDE installation

# STM32CubeIDE installation 15

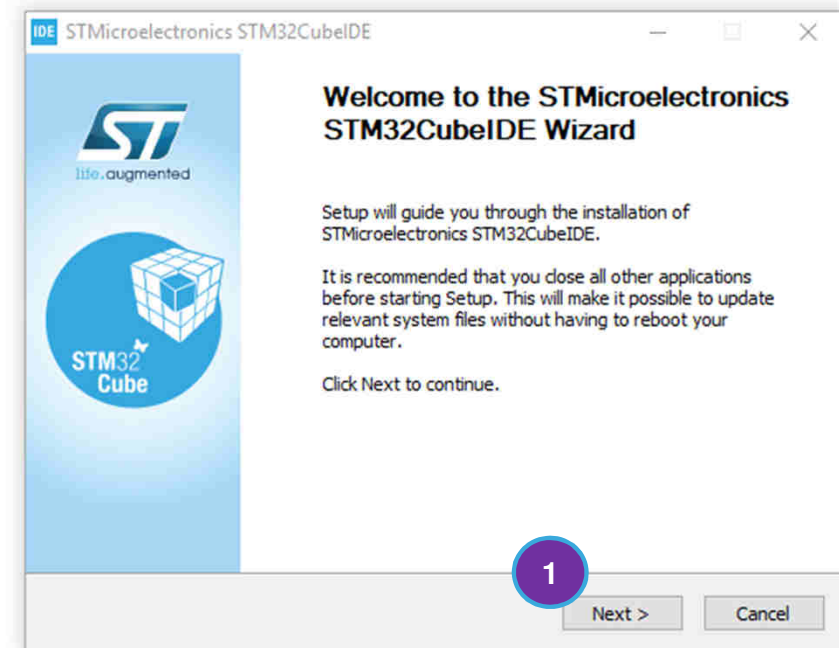
1. Run the **STM32CubeIDE** installer located in **X-CUBE-MEMS1\_HandsOn\Software**



# STM32CubeIDE installation

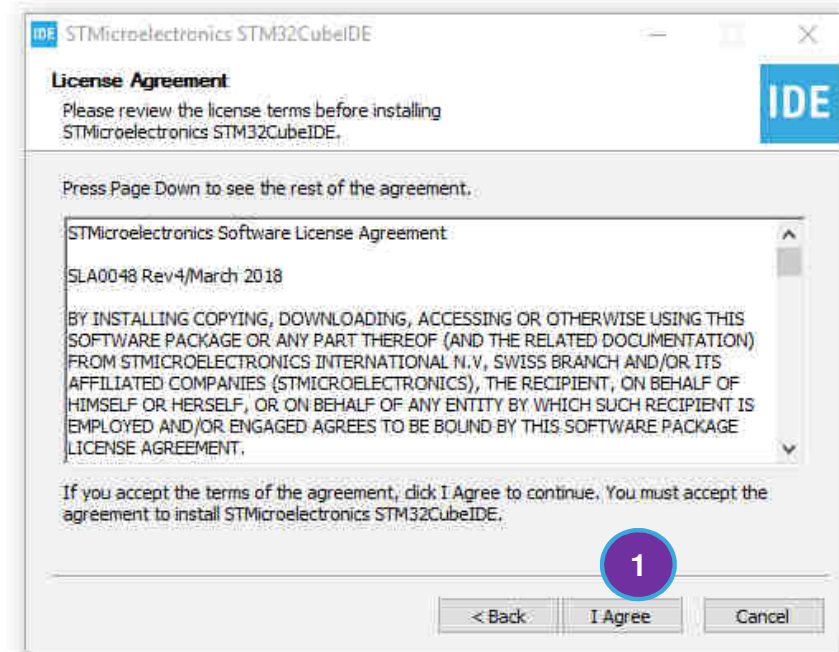
16

1. Click **Next >**



# STM32CubeIDE installation 17

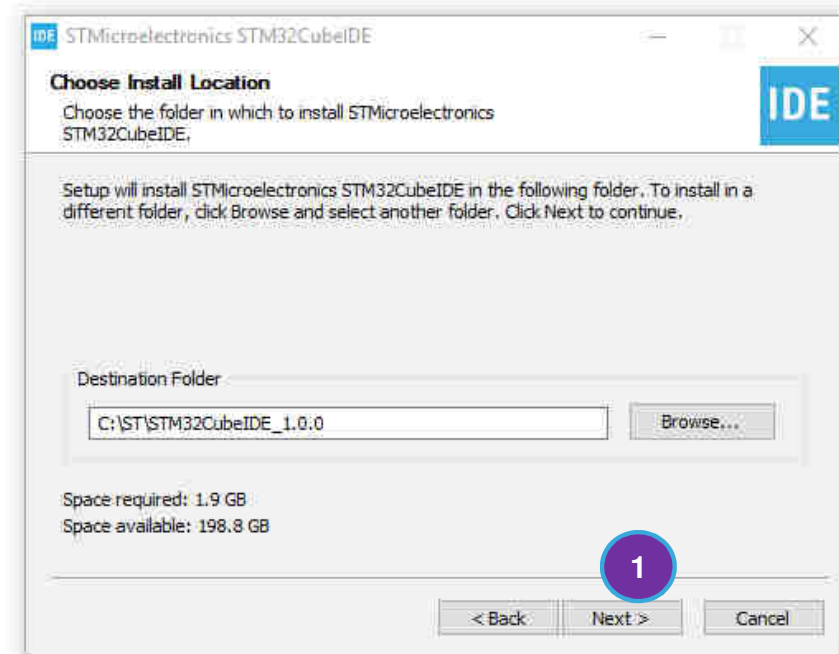
## 1. Click **I Agree**



# STM32CubeIDE installation

18

1. Click **Next >**

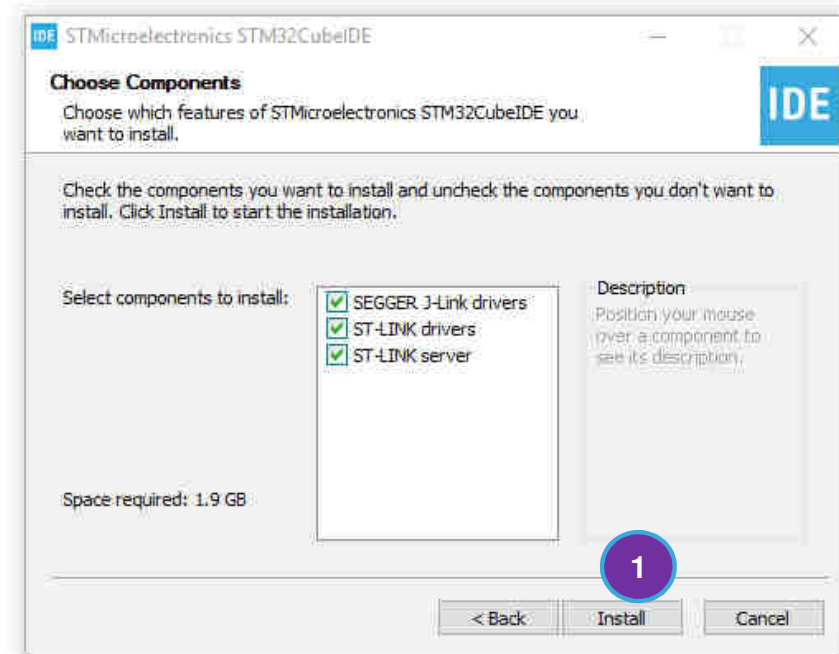




# STM32CubeIDE installation

19

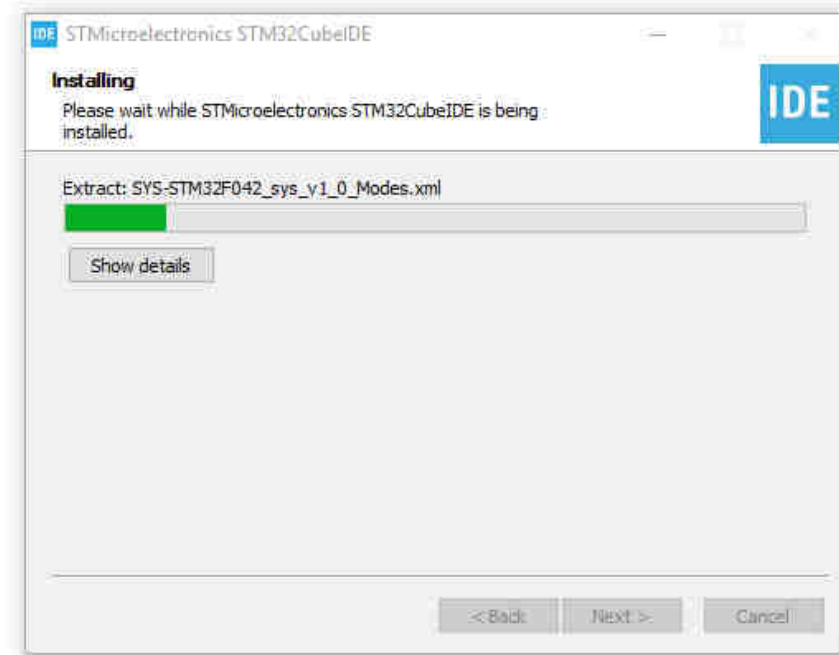
## 1. Click **Install**

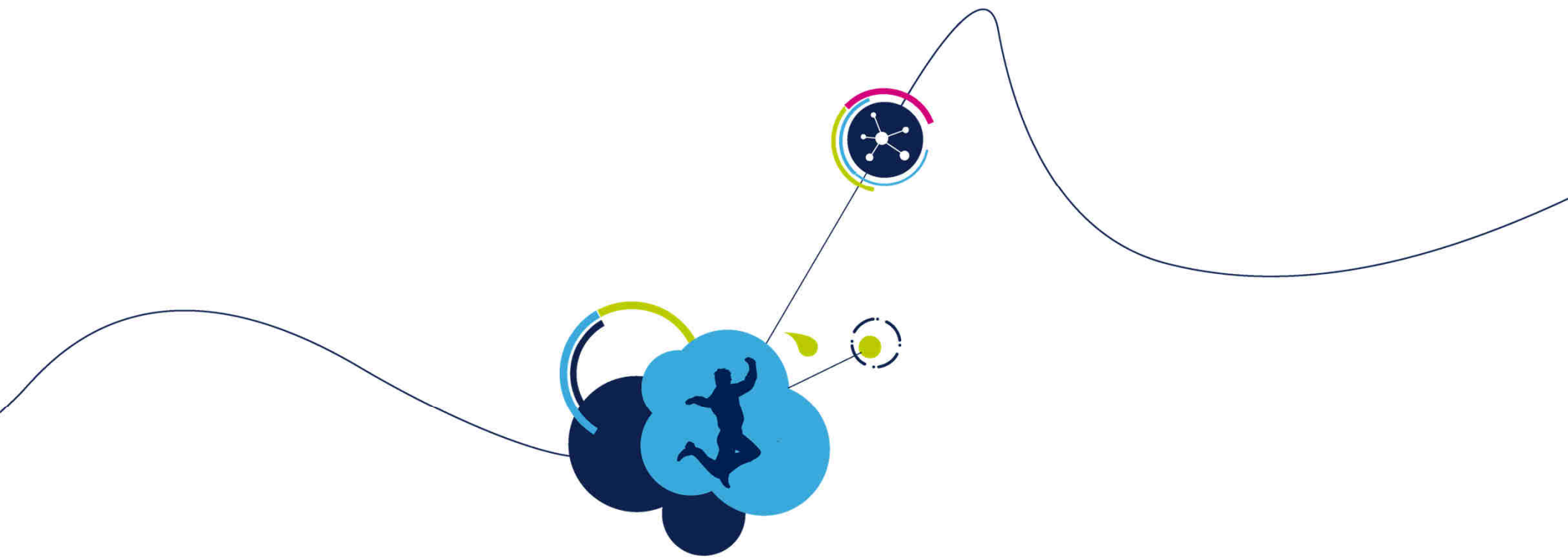


# STM32CubeIDE installation...

20

1. Wait until installation is completed



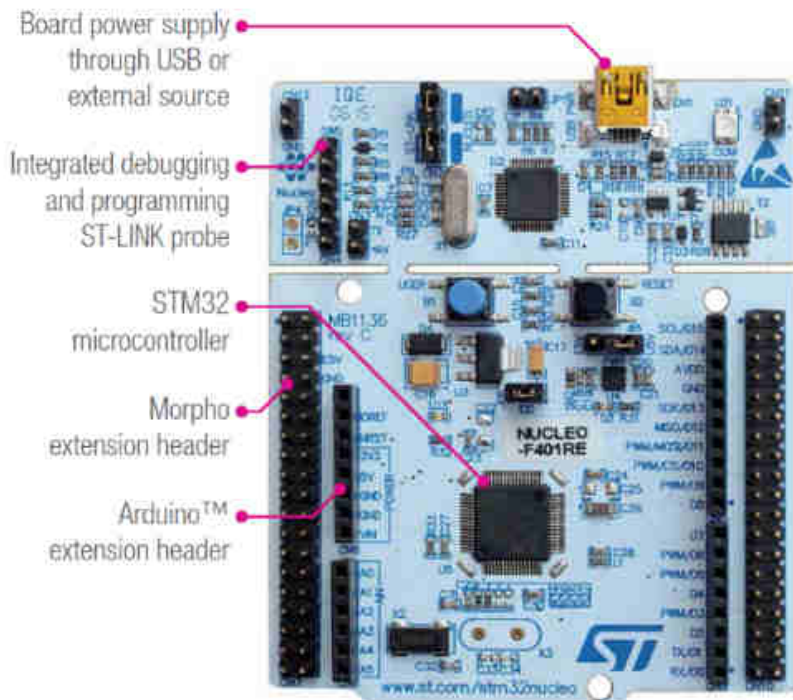


# STM32 Nucleo Expansion

# STM32 Nucleo Development Boards

22

27 development boards and growing... in two flavors (Processing & Security)



STM32 complete product range  
from ultra-low power to high performance

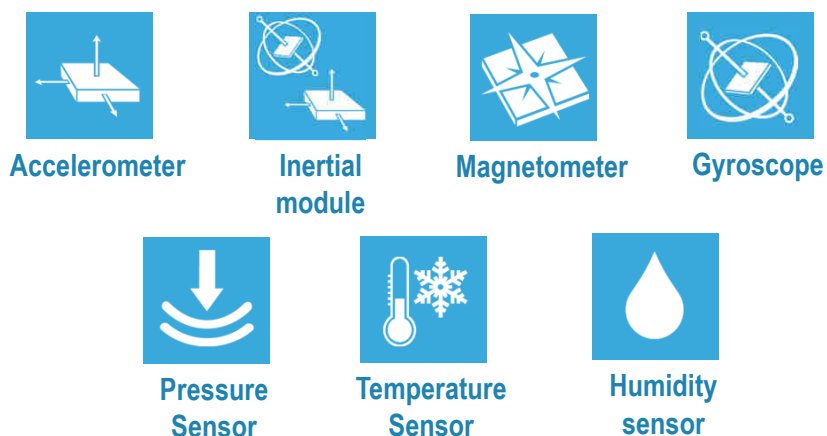




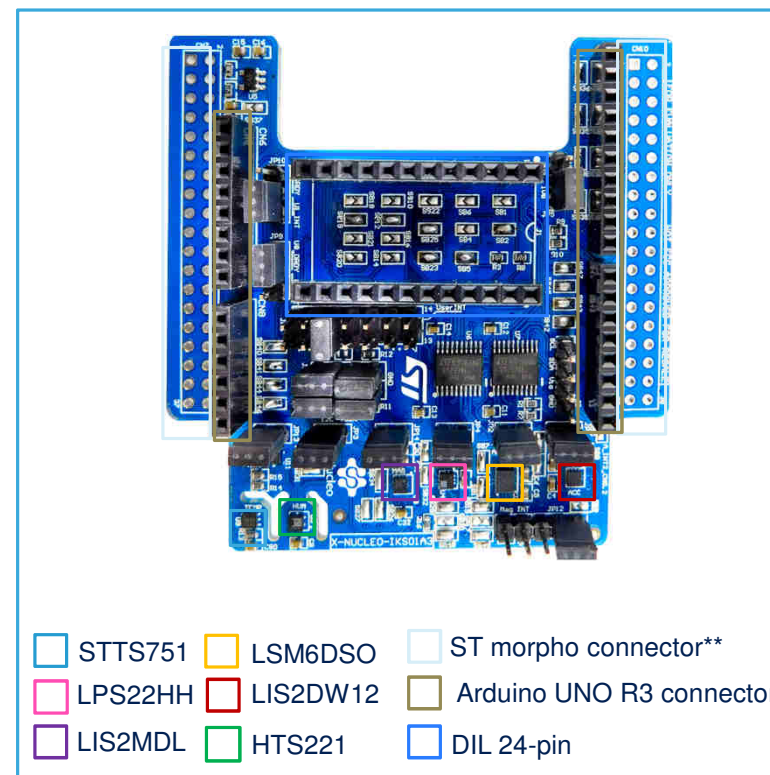
# X-NUCLEO-IKS01A3

## Motion MEMS and environmental sensor expansion board

23

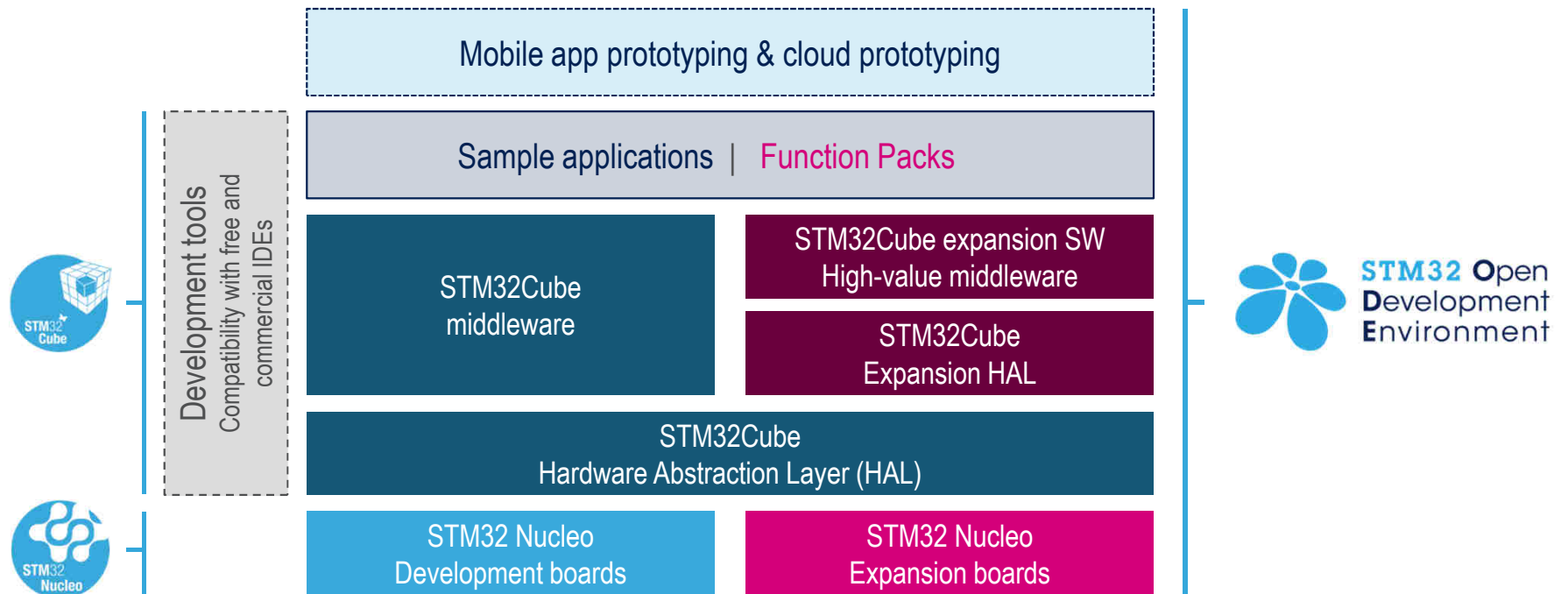


- The X-NUCLEO-IKS01A3 is a motion MEMS and Environmental sensor evaluation board system.
- It is compatible with the Arduino UNO R3 connector layout, and is designed around ST's latest sensors.



# Development Software Architecture

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# STM32 Supported IDEs

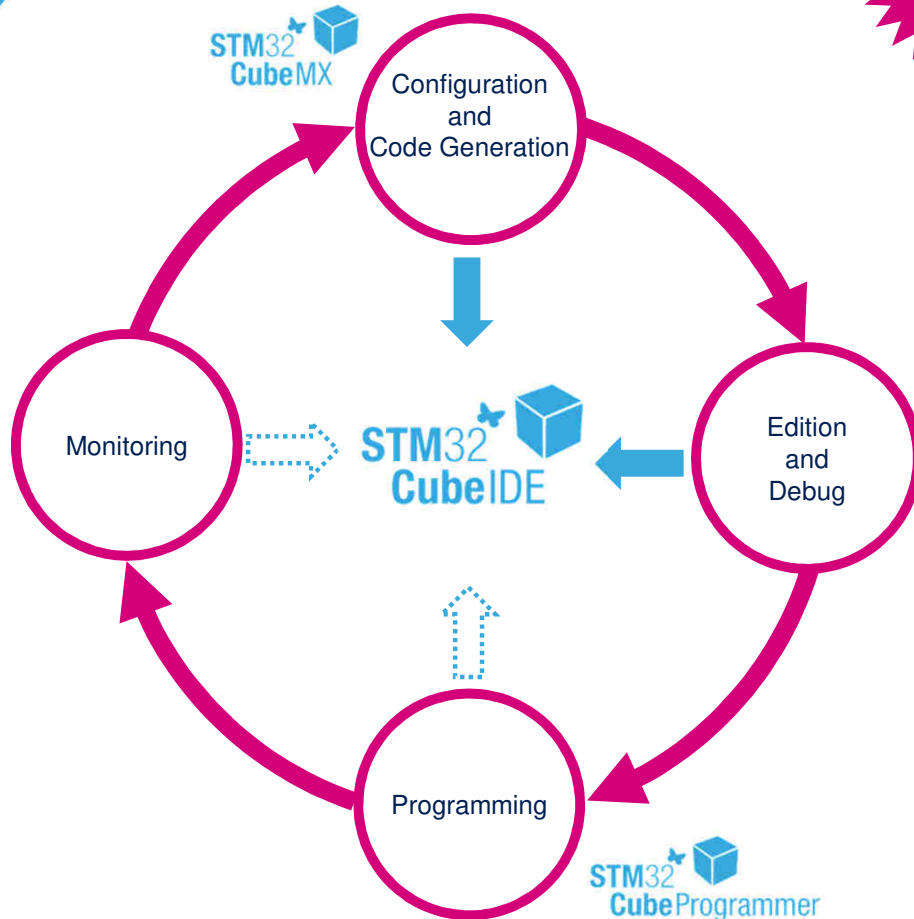
25



STM32 IDEs







# STM32CubeIDE

*an All-in-1 development tool*

26

Complete multi platform family tools

Cover full development cycle

Integrated solution



## 27



## “X-CUBE-MEMS1”

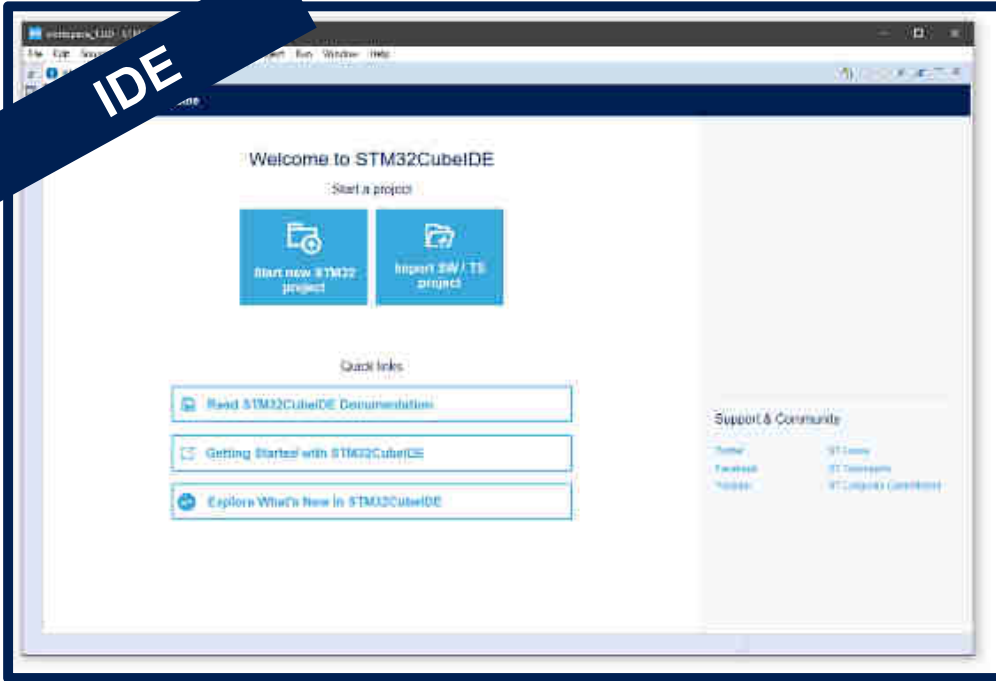
application code and drivers for sensors



# STM32CubeIDE

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*an All-in-1 development tool*



Dedicated IDE for all STM32 microcontrollers

**STM32CubeMX** is natively integrated as code generator

Based on Eclipse (Text editor), GCC (compiler) and GDB (debugger)



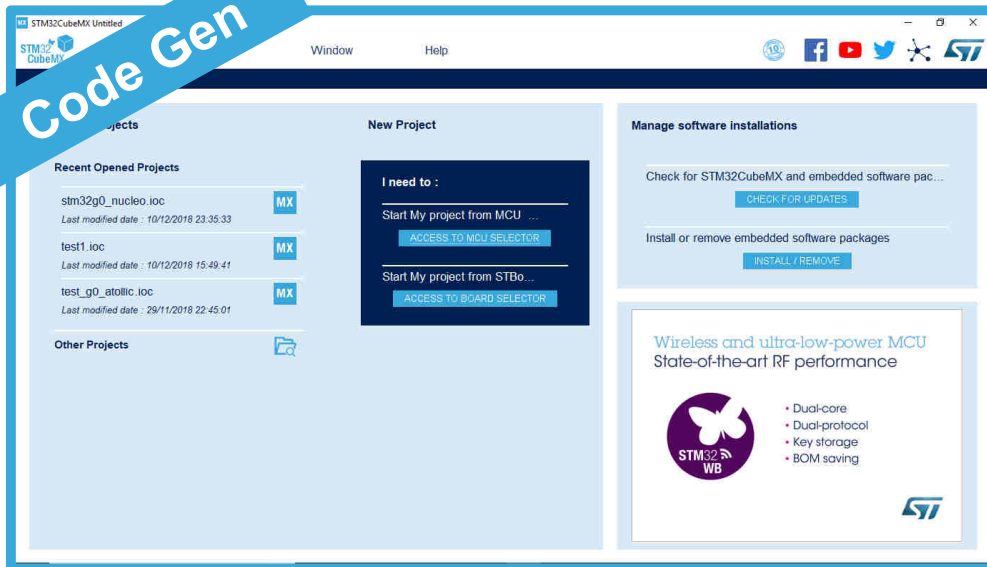


# STM32CubeMX

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*an All-in-1 development tool*

Code Gen



Very powerful configuration and code generation

Support all STM32 MCU and MPU, with integrated powerful Finder

Pinouts, clock tree, peripherals and middleware configuration.

Expandable to support wireless connectivity, sensors and much more!



STM32CubeL0



STM32CubeL1



STM32CubeL4



STM32CubeF1



STM32CubeF3



STM32CubeF2



STM32CubeF4



STM32CubeG0



STM32CubeF0



STM32CubeF7



STM32CubeH7



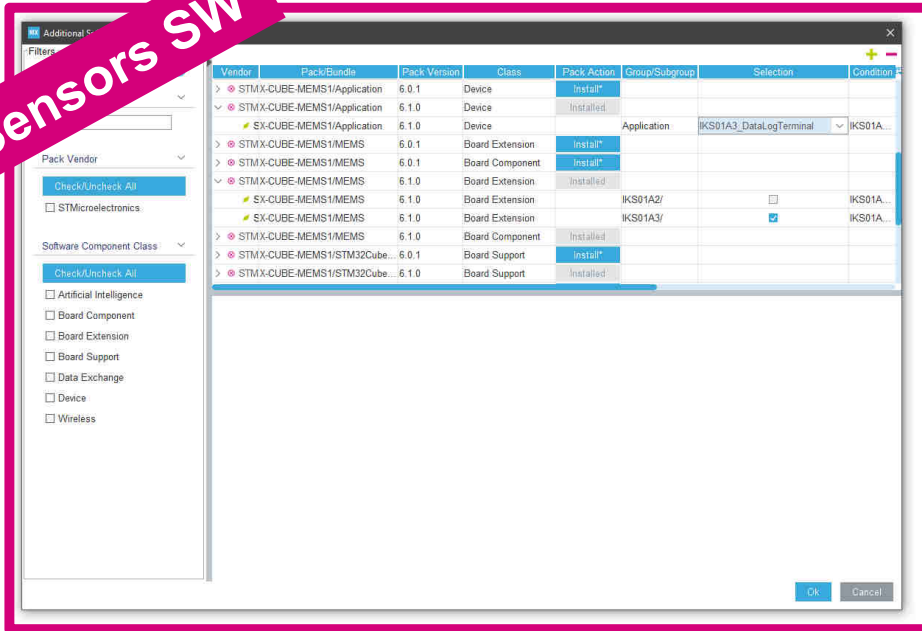


# X-CUBE-MEMS1

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*an All-in-1 development tool*

Sensors SW



Drivers for sensors

Board Support Package firmware architecture

Include Sample Applications



Accelerometer



Inertial module



Magnetometer



Gyroscope



Pressure Sensor



Temperature Sensor



Humidity sensor

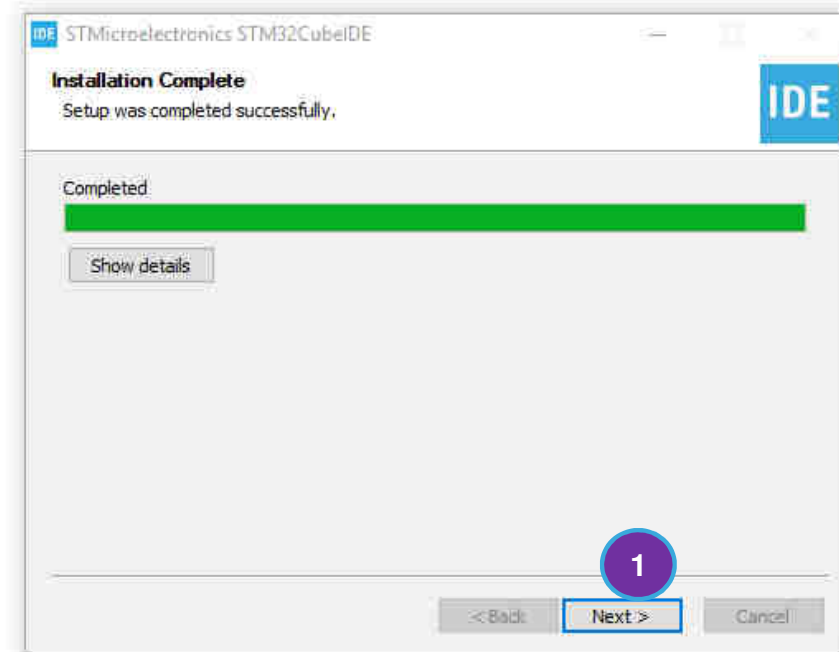


life.augmented

# ...STM32CubeIDE installation

31

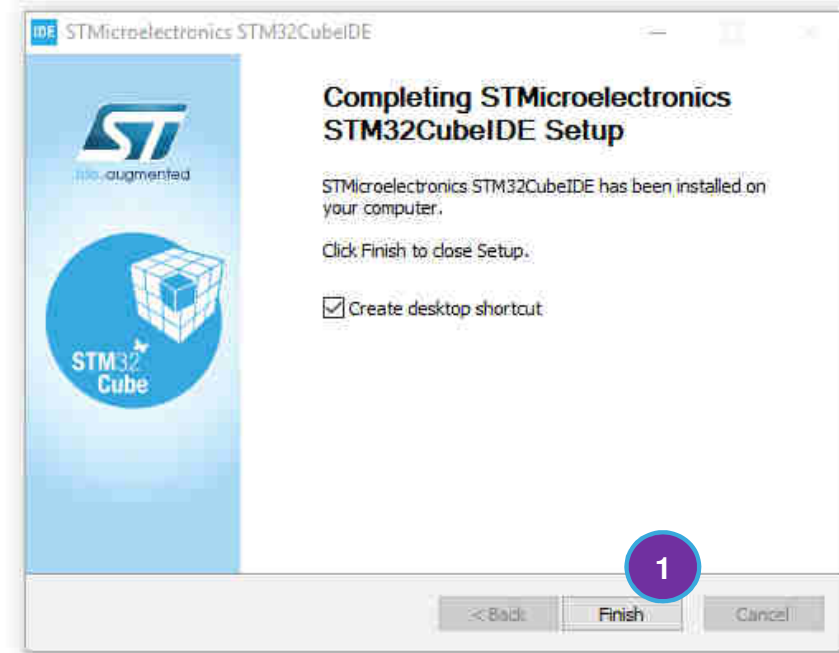
1. Click **Next >**



# STM32CubeIDE installation

32

1. Click **Finish**





# STM32CubeIDE configuration

33

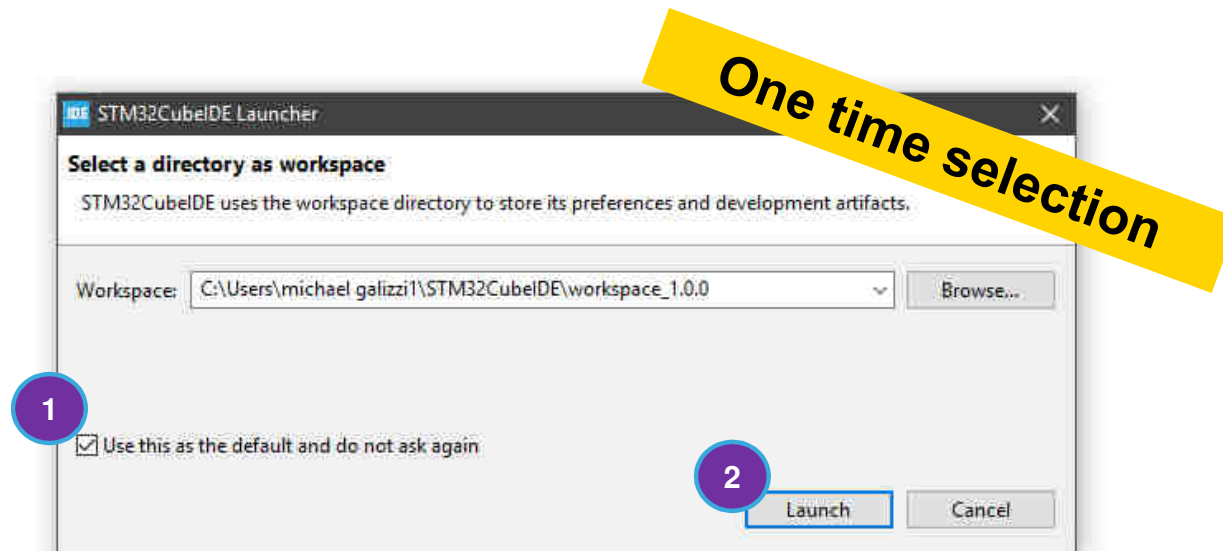
1. Open **STM32CubeIDE** by double clicking the icon on your desktop
2. Wait until **STM32CubeIDE** is loading



# STM32CubeIDE configuration

34

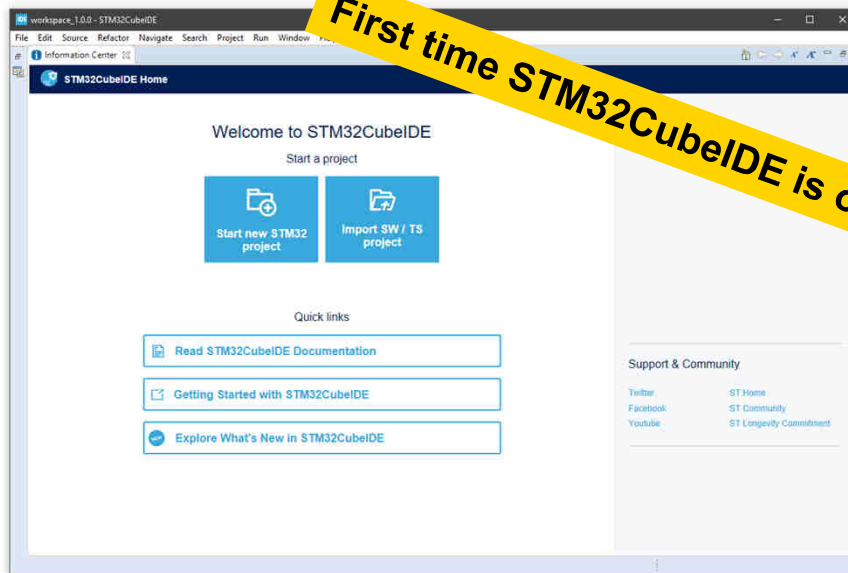
1. Check **Use this as the default and do not ask again**
2. Click **Launch**



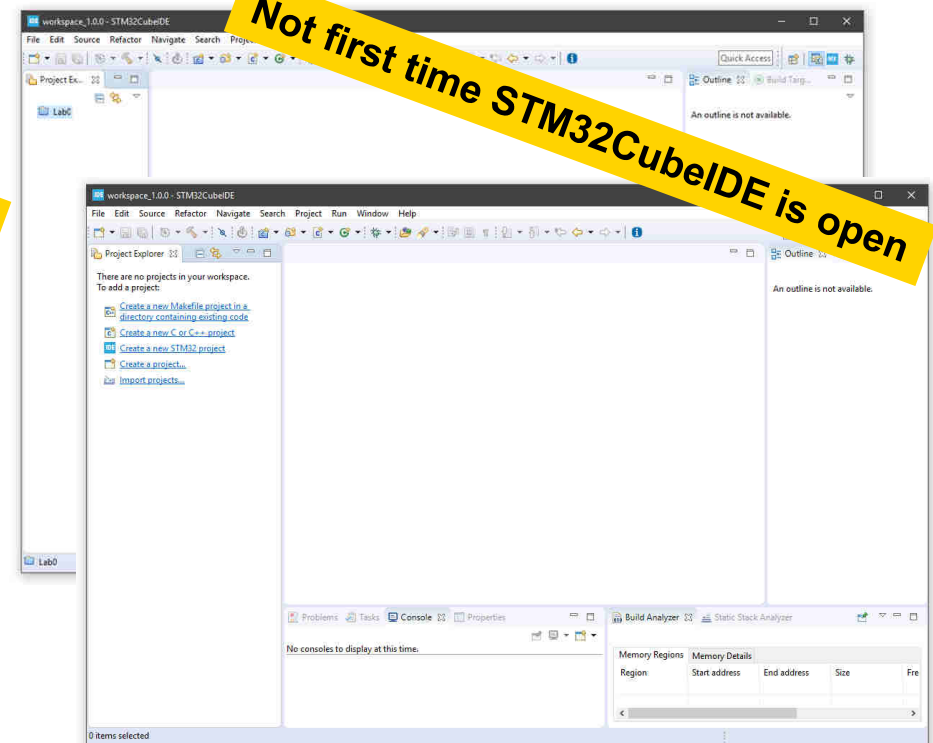
# STM32CubeIDE configuration

35

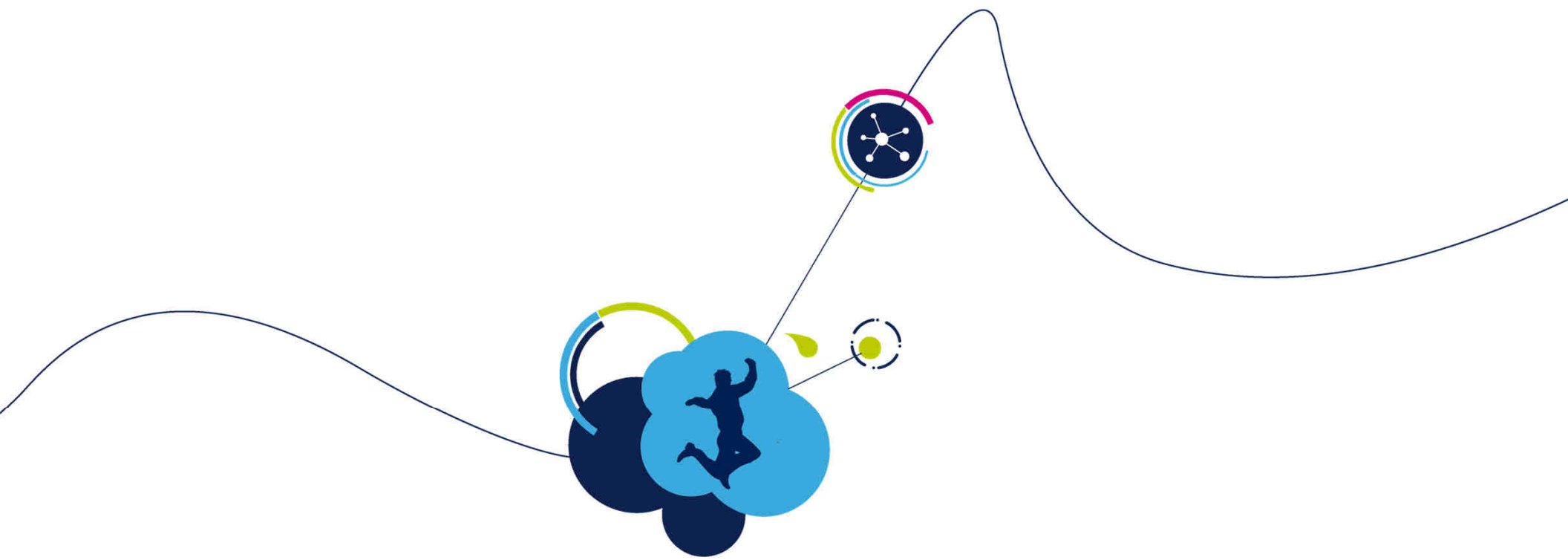
The main interface of STM32CubeIDE will appear differently, depending if it is the first time it has been run or not:



First time STM32CubeIDE is open



Not first time STM32CubeIDE is open

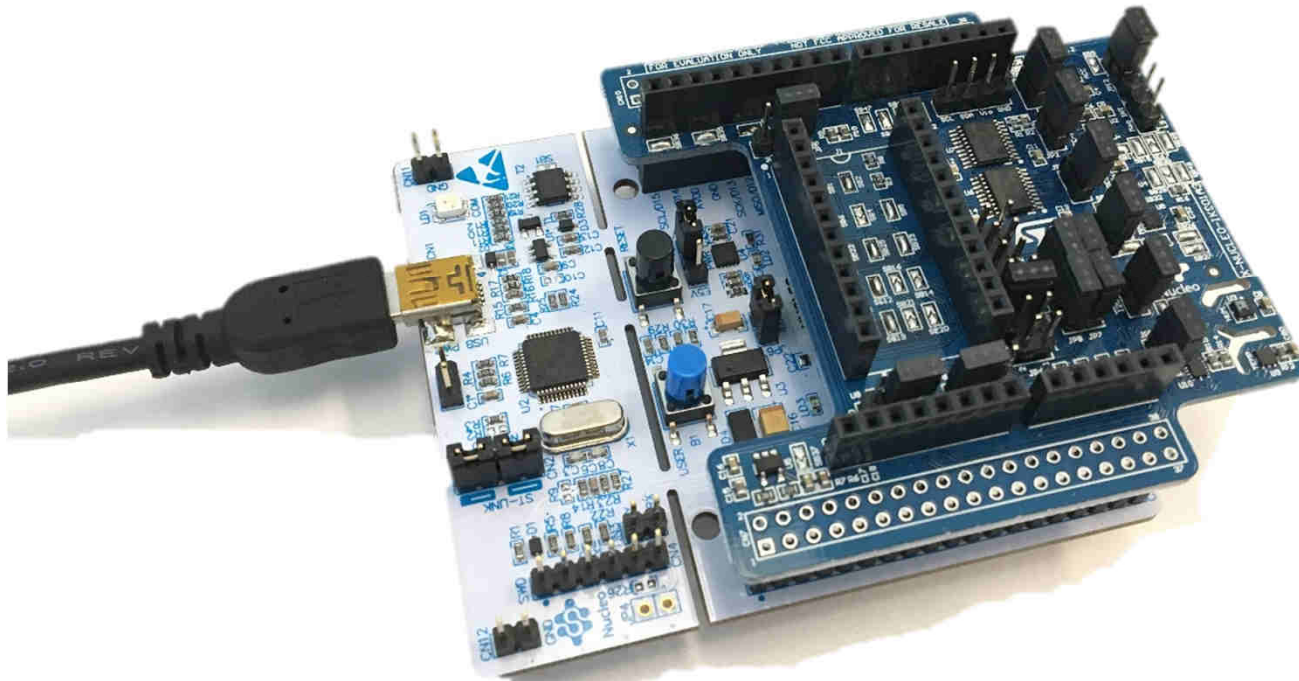


# Preparing the hardware

# Preparing the Hardware 1/3

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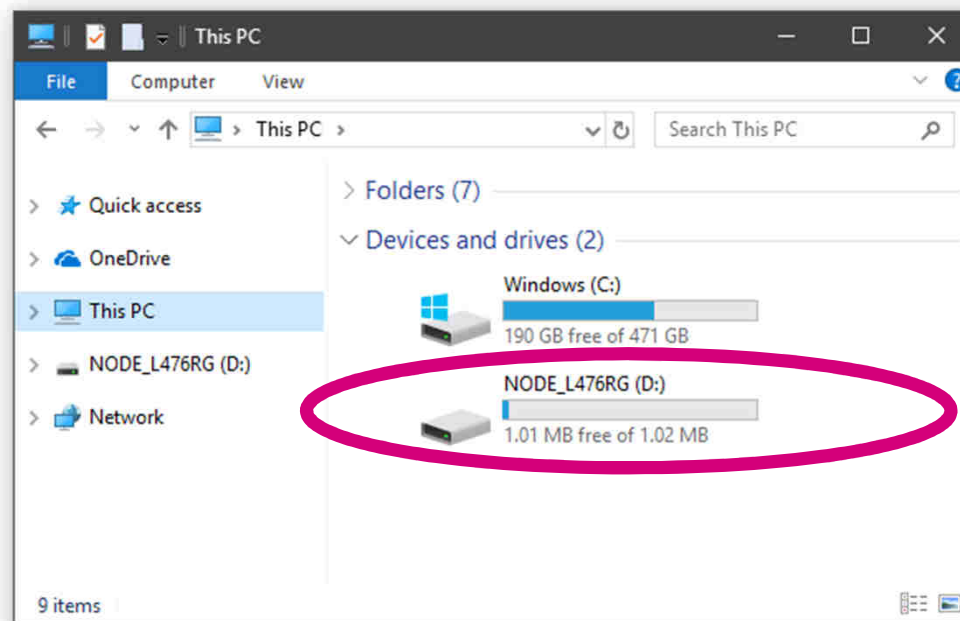
1. Stack **NUCLEO-L476RG** and **X-NUCLEO-IKS001A3** and connect it to the PC



# Preparing the Hardware 2/3

38

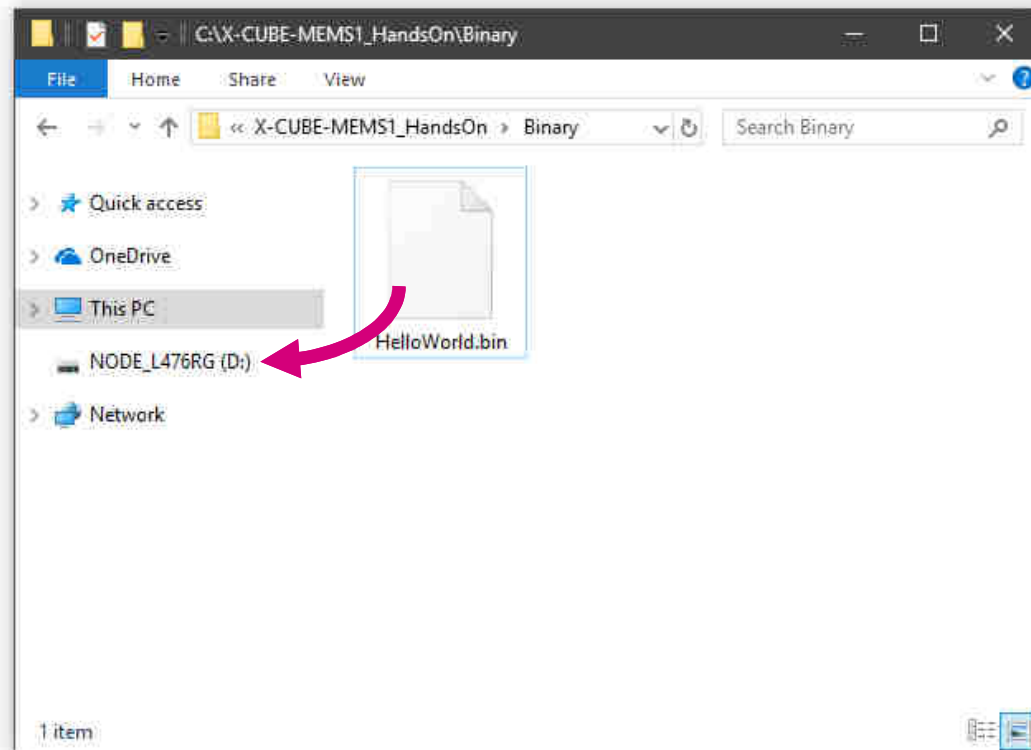
1. Once the hardware is connected to the PC a new drive named **“NODE\_L476RG”** should appear on your File Explorer

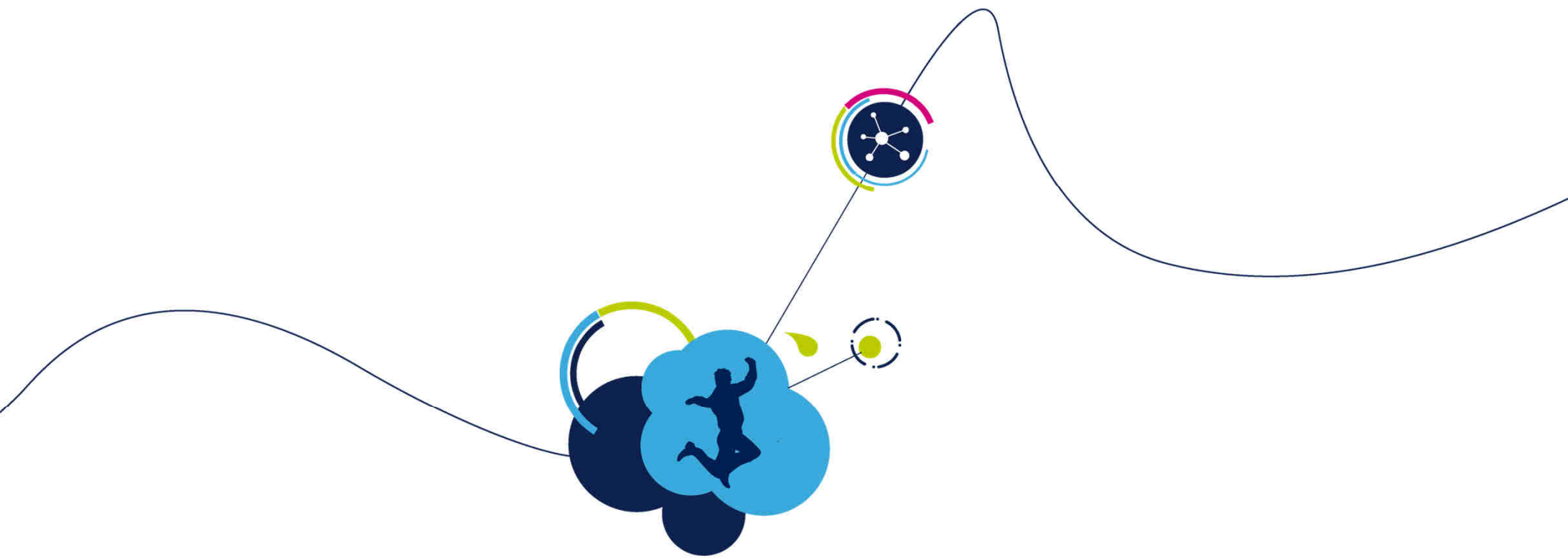


# Preparing the Hardware 3/3

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1. Drag and Drop the **X-CUBE-MEMS1\_HandsOn\Binary\HelloWorld.bin** in the “**NODE\_L476RG**” drive





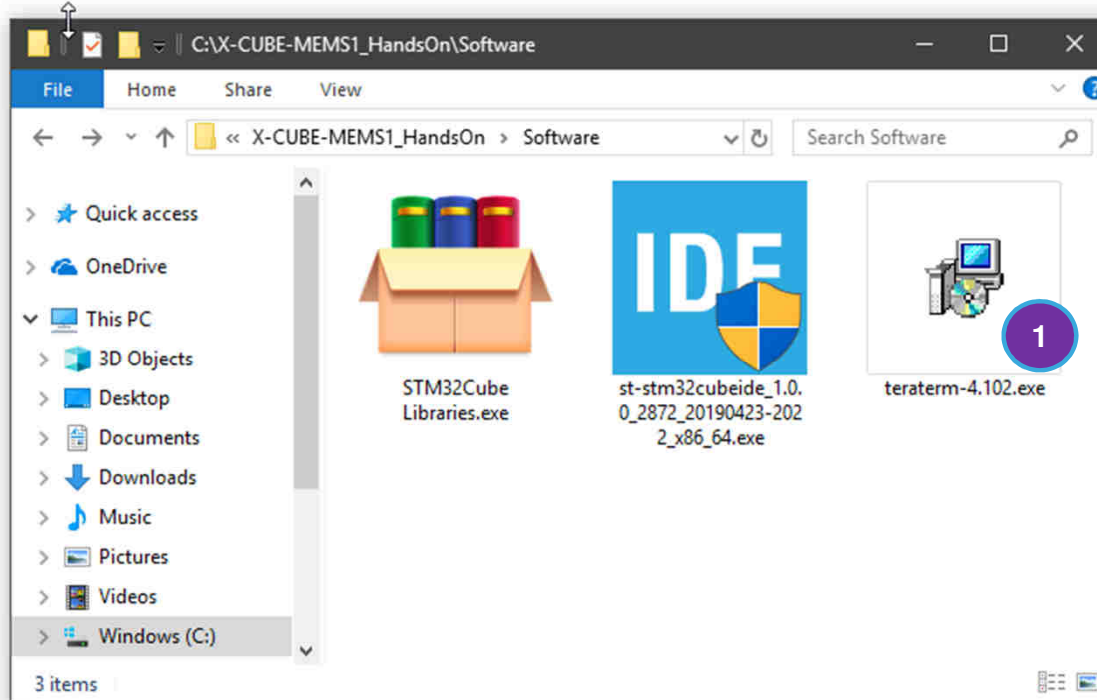
# Tera Term installation



# Tera Term setup 1/9

41

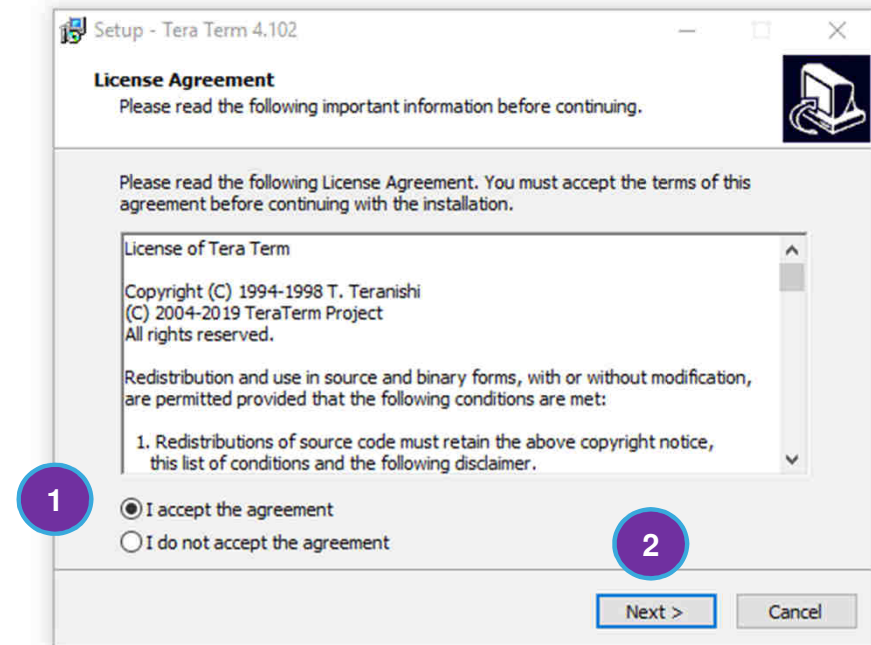
1. Launch the **teraterm-4.102.exe** installer inside the **X-CUBE-MEMS1\_HandsOn\Software** directory



# Tera Term setup 2/9

42

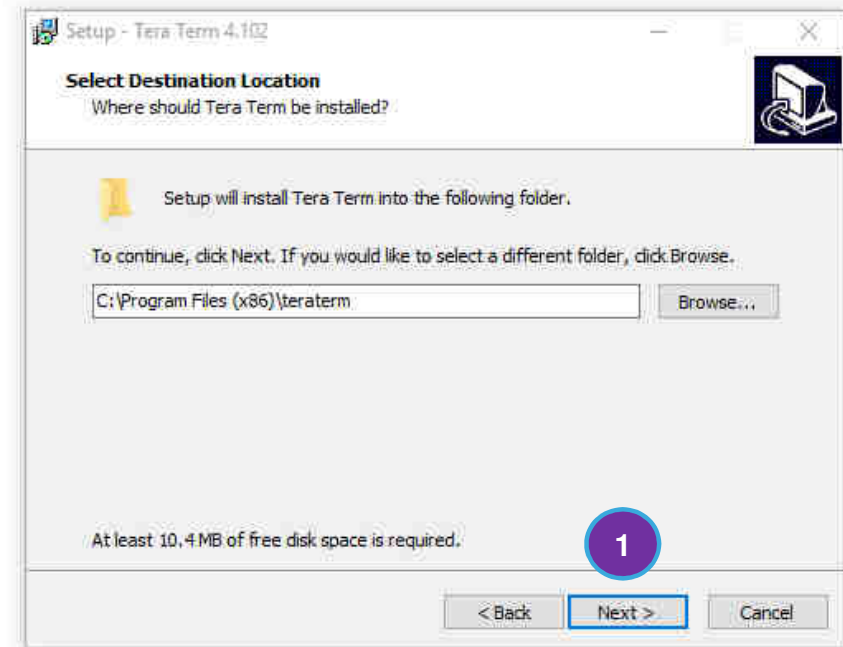
1. Accept the agreement
2. Click on **Next**



# Tera Term setup 3/9

43

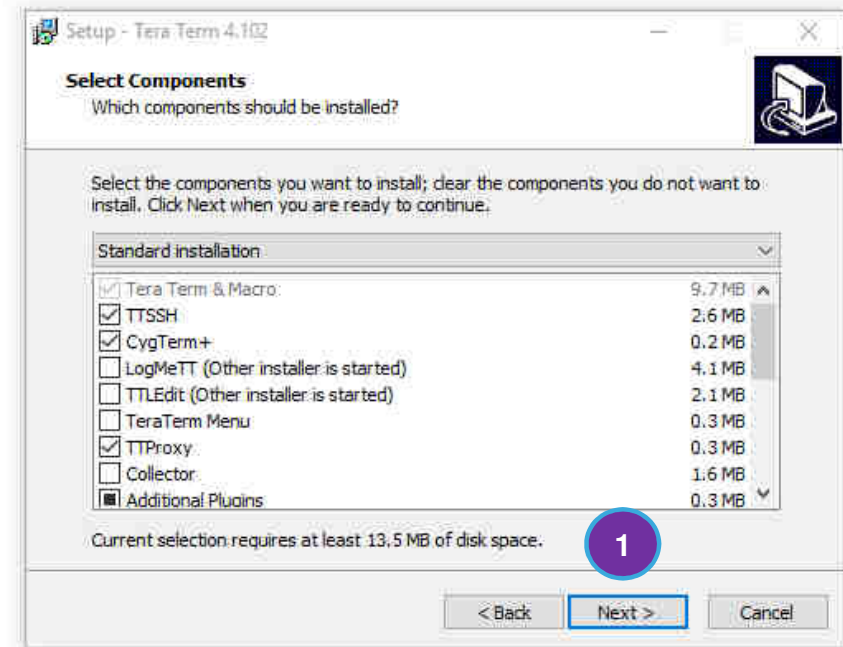
1. Click on **Next**



# Tera Term setup 4/9

44

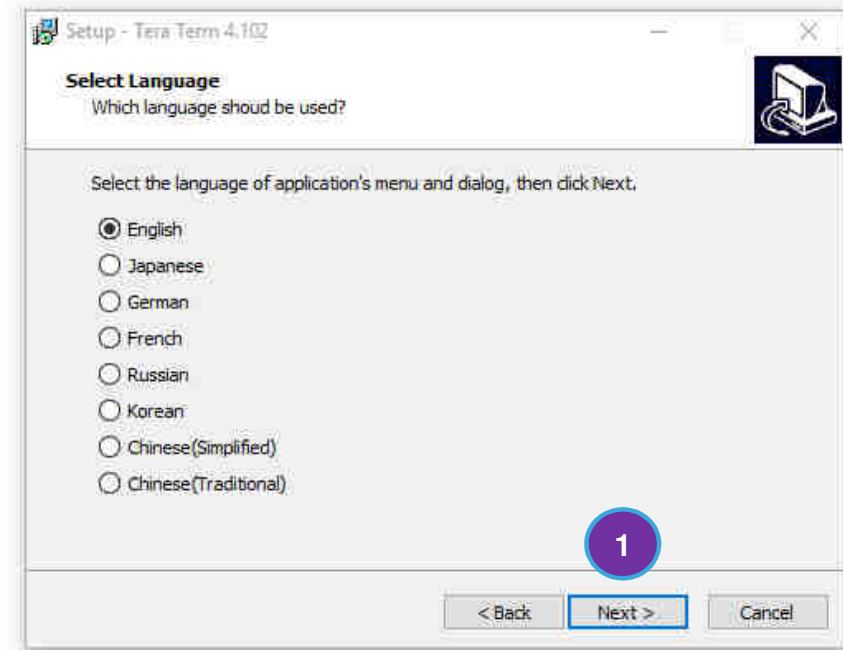
1. Click on **Next**



# Tera Term setup 5/9

45

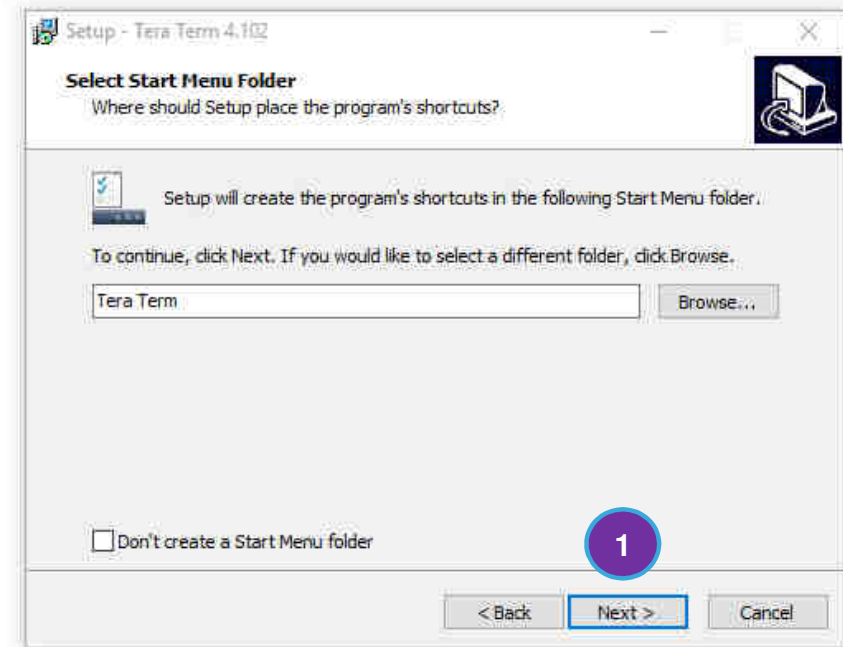
1. Click on **Next**



# Tera Term setup 6/9

46

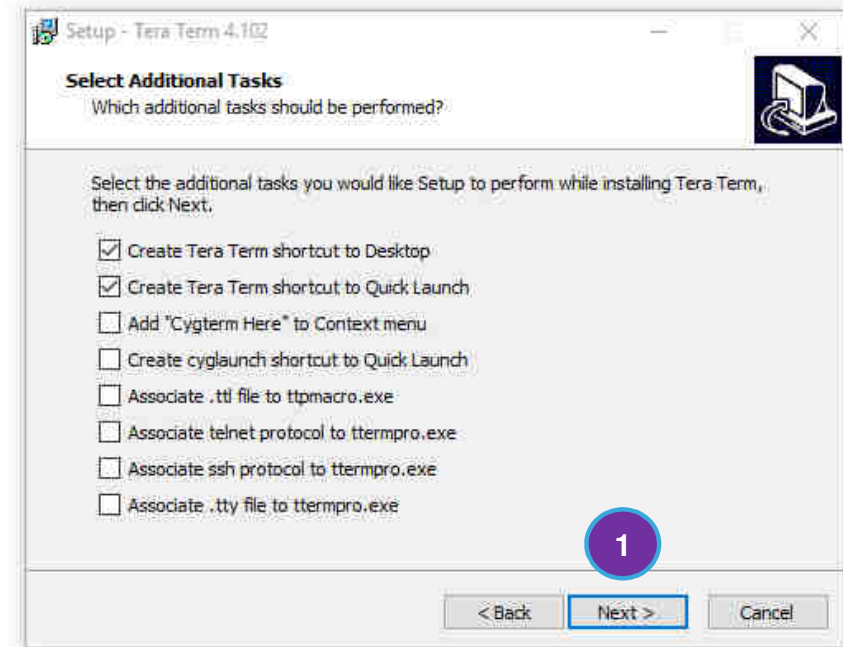
1. Click on **Next**



# Tera Term setup 7/9

47

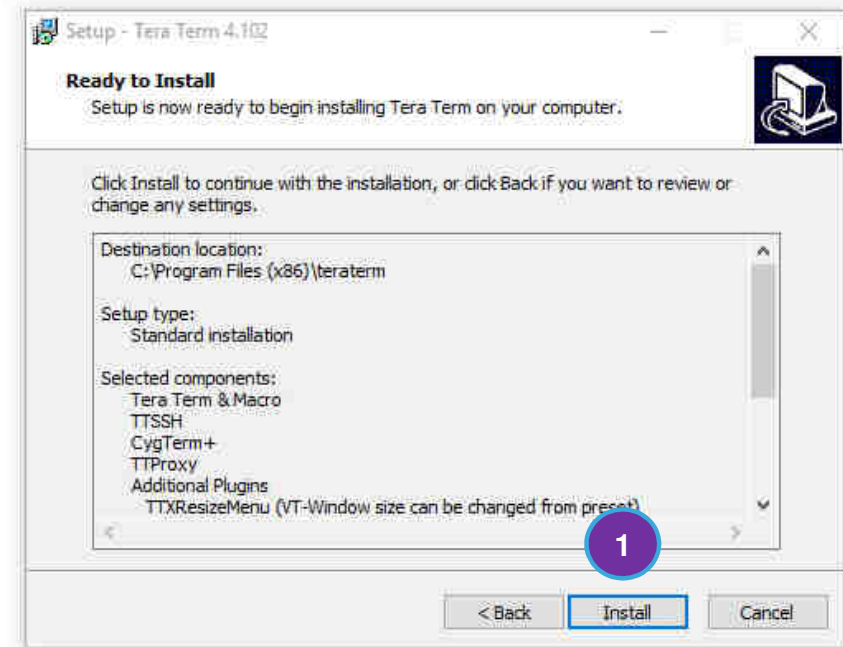
1. Click on **Next**



# Tera Term setup 8/9

48

1. Click on **Install**

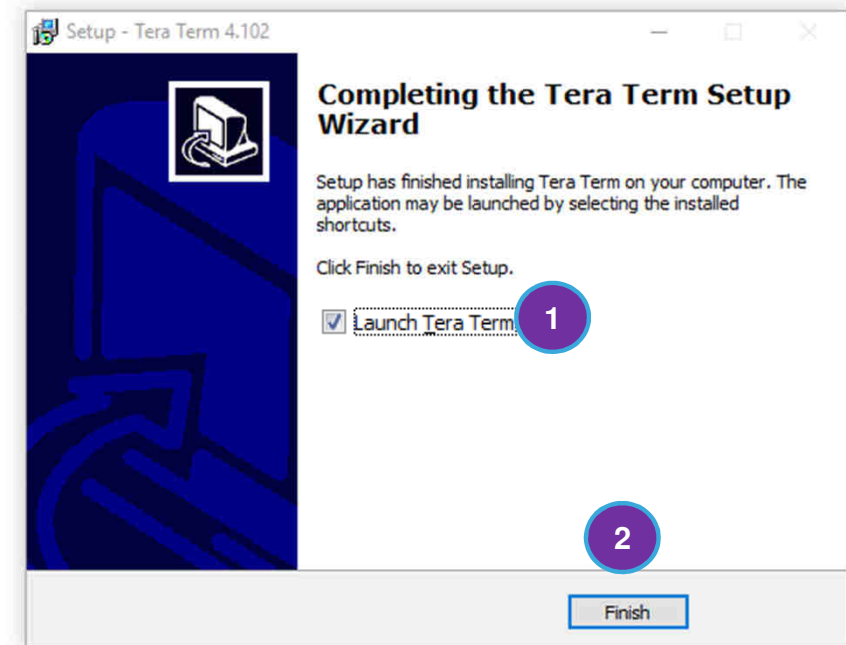


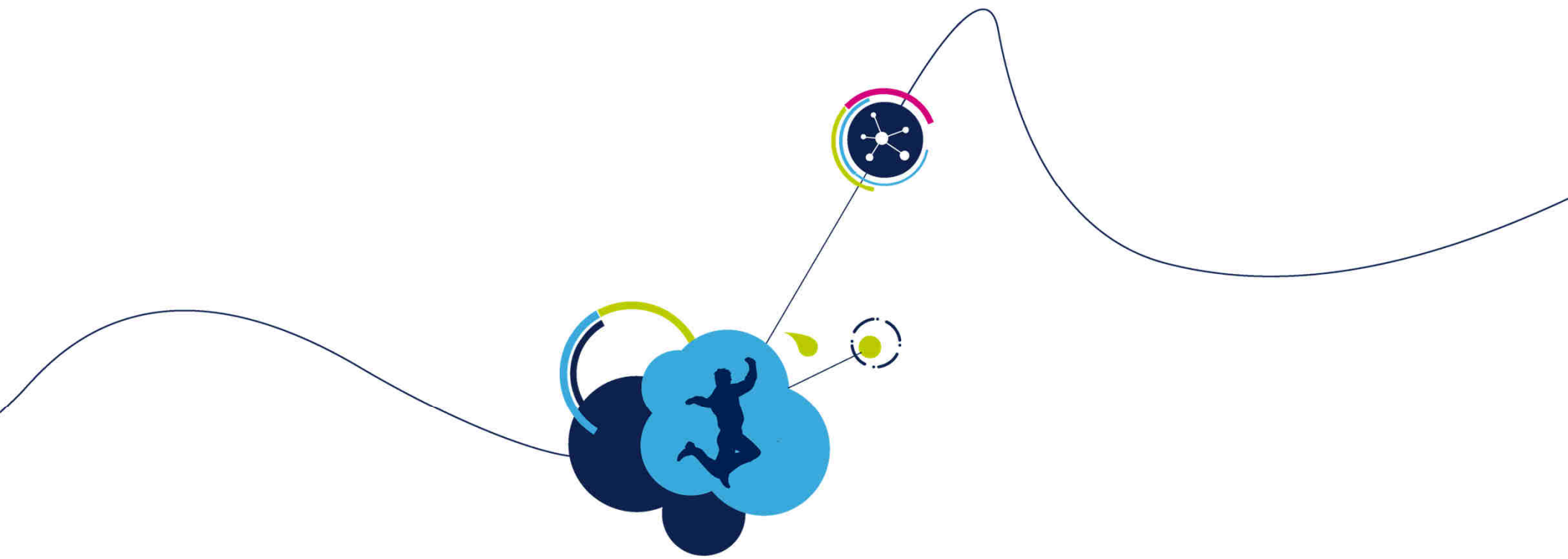


# Tera Term setup 9/9

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1. Select **Launch Tera Term**
2. Click on **Finish**





# Tera Term configuration

# Tera Term configuration 1/6

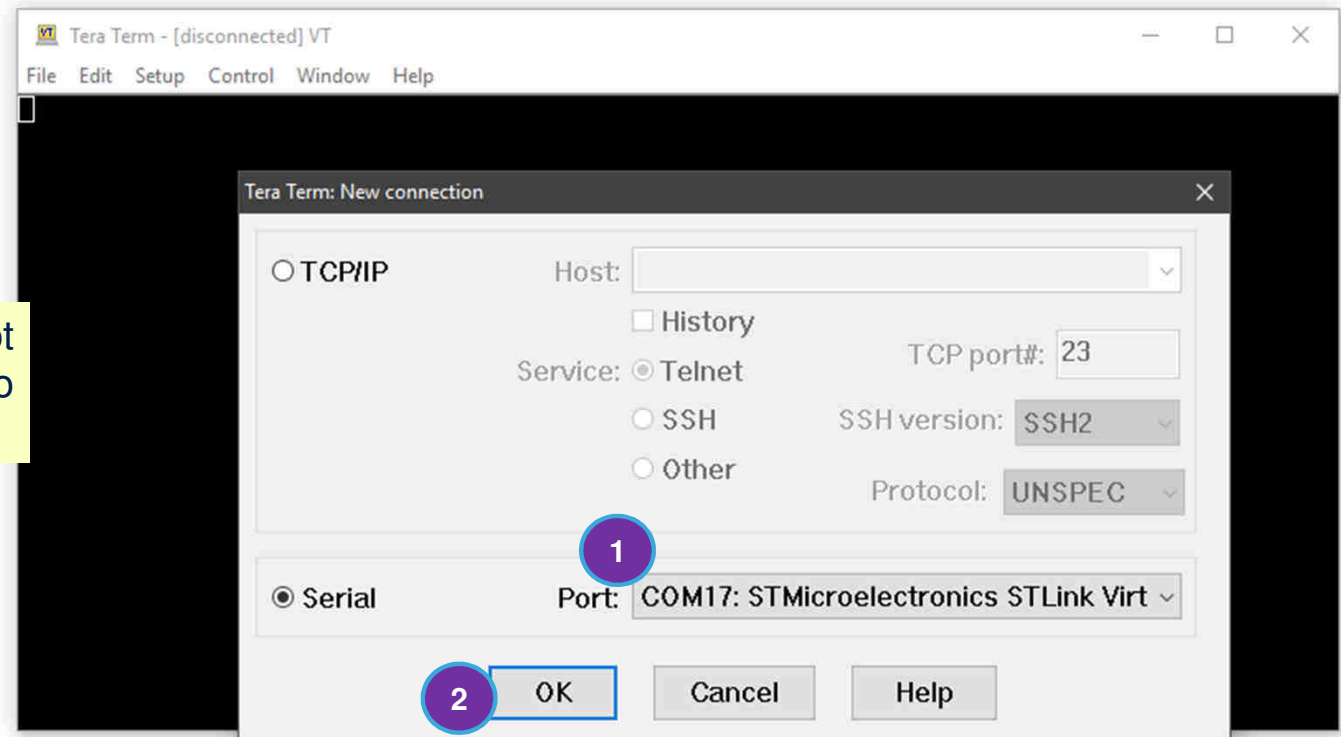
51

Plug the board to the PC using the mini USB cable provided



1. Select the **STMicroelectronics STLink Virtual COM Port**
2. Click **OK**

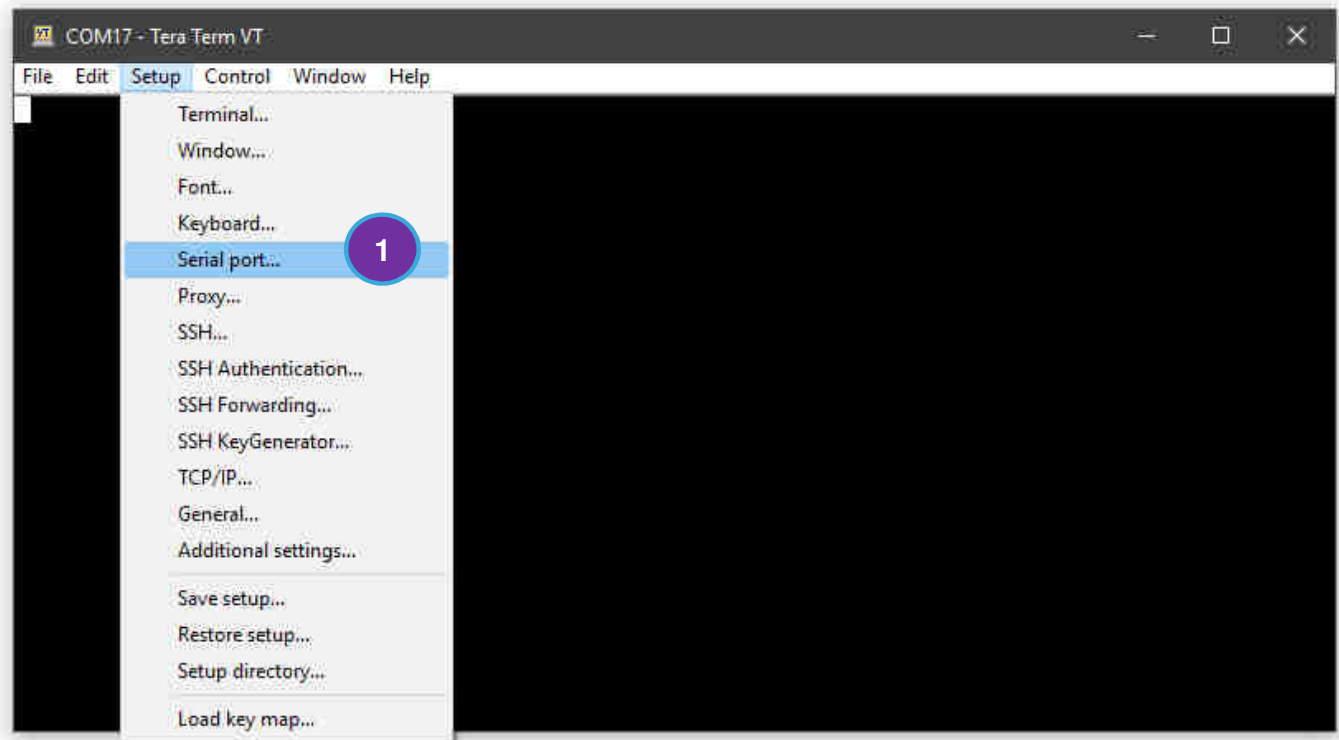
If ST-LINK Virtual COM port is not detected please go to [troubleshooting solution #2](#)



# Tera Term configuration 2/6

52

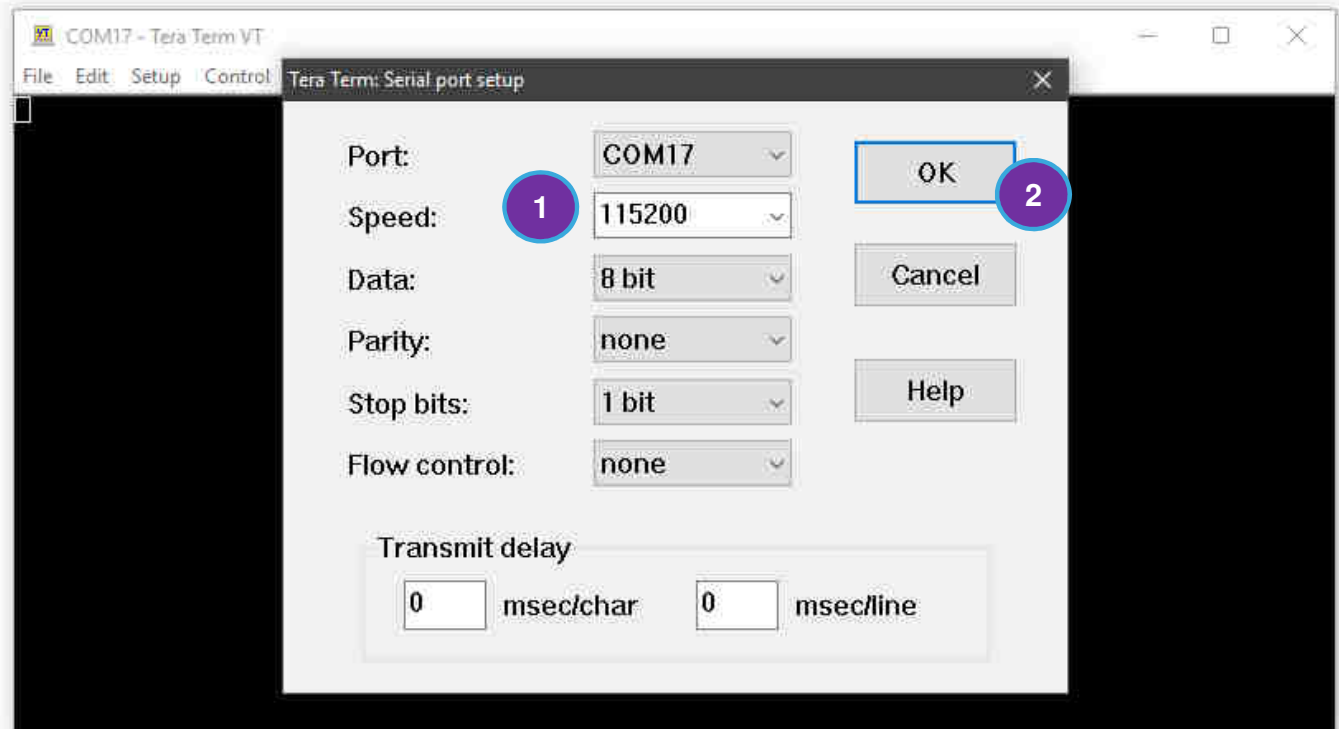
1. Click **Setup** -> **Serial port...**



# Tera Term configuration 3/6

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1. Set the following:  
Baud Rate: **115200**  
Data: **8 bit**  
Parity: **none**  
Stop: **1 bit**  
Flow control: **none**
2. Click **OK**



# Tera Term configuration 4/6

54

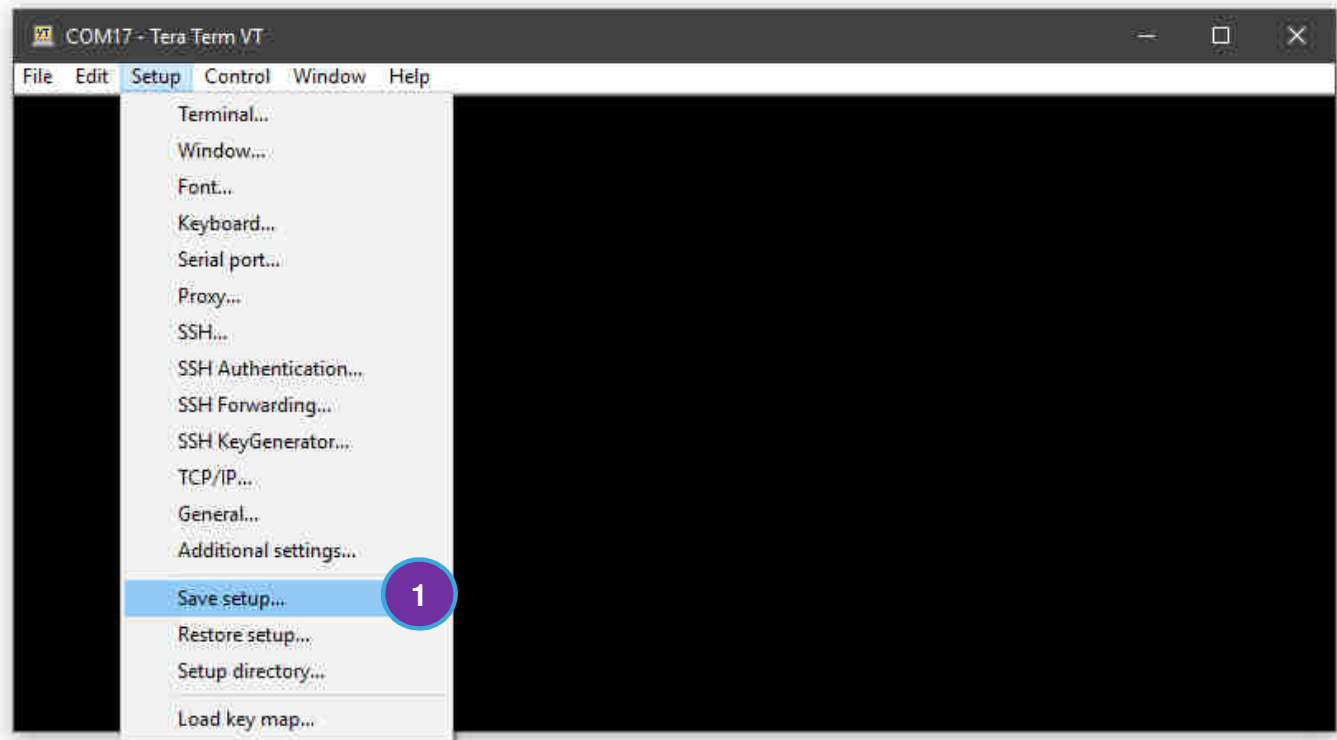
1. Check if on the Tera Term is printed “Hello world” every second



# Tera Term configuration 5/6

55

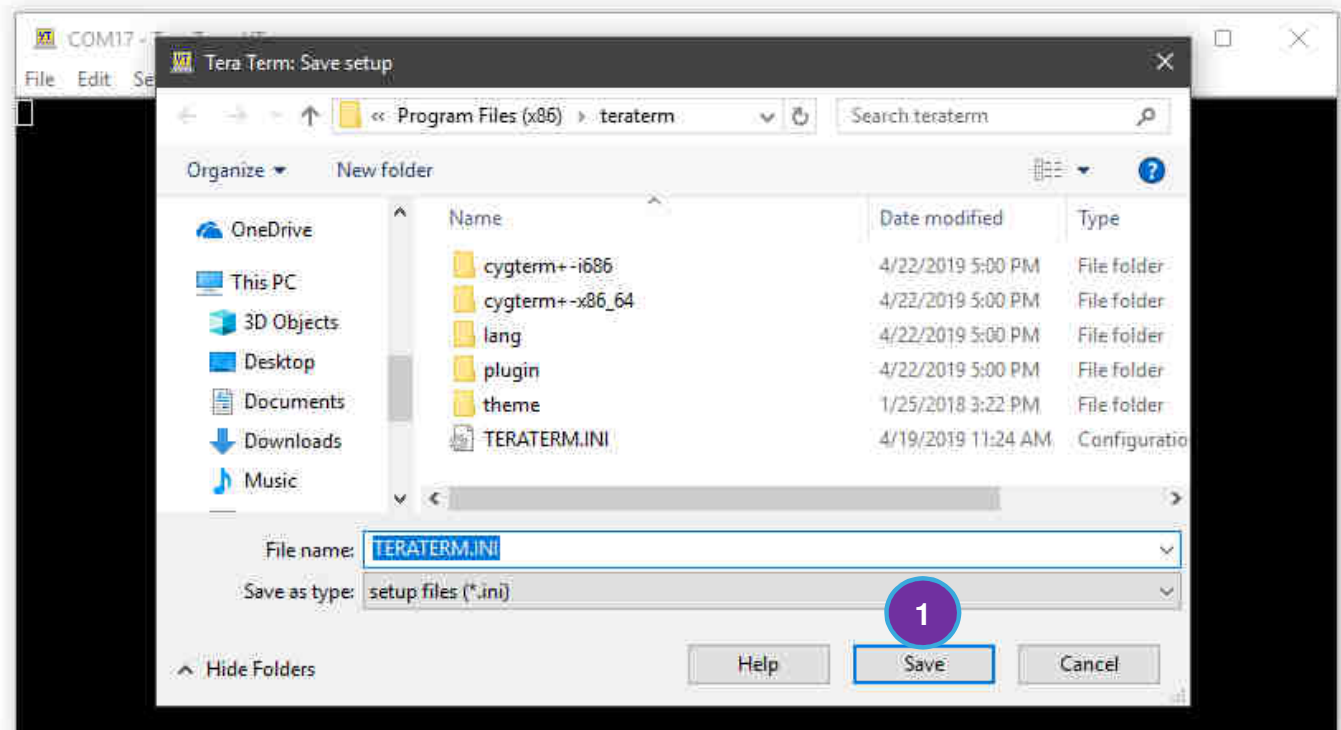
1. Click **Setup** -> **Save setup...**



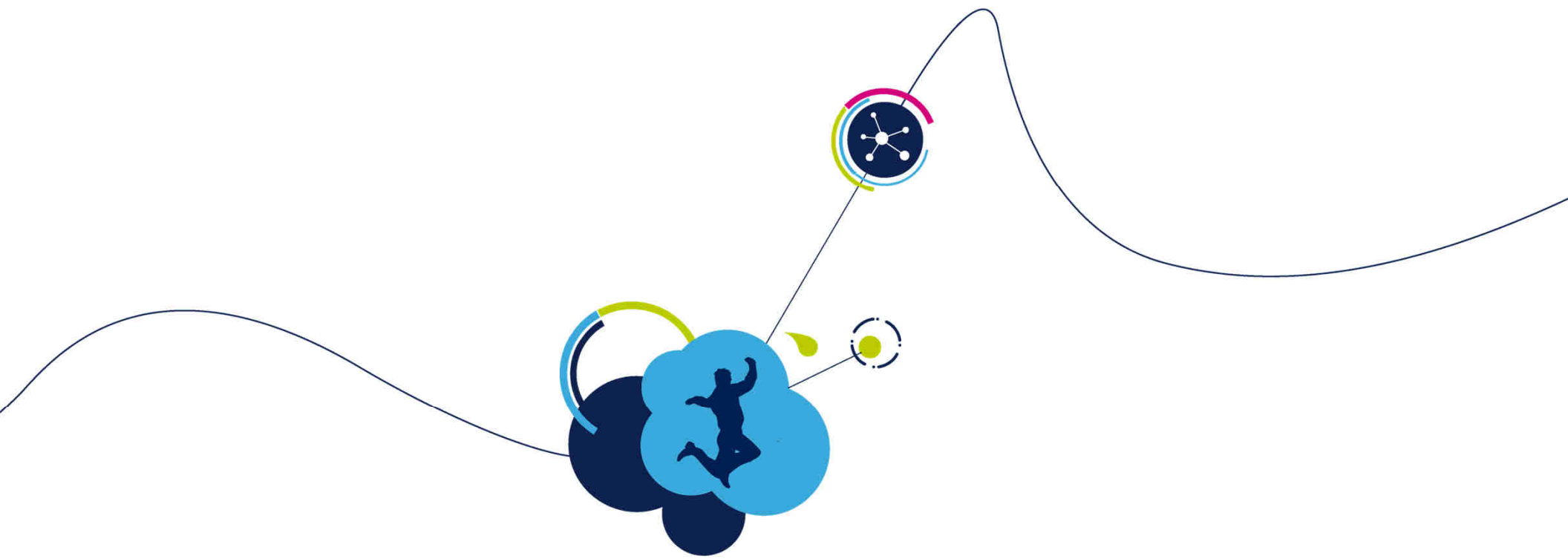
# Tera Term configuration 6/6

56

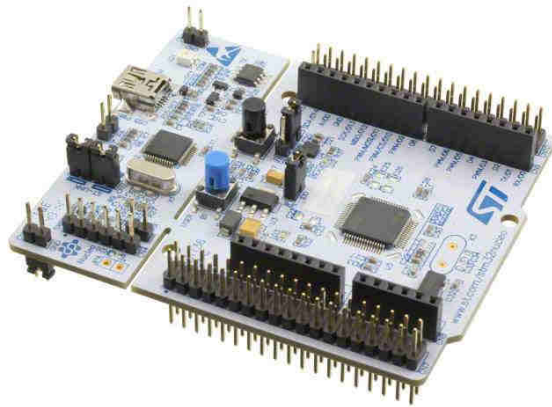
1. Click **Save**





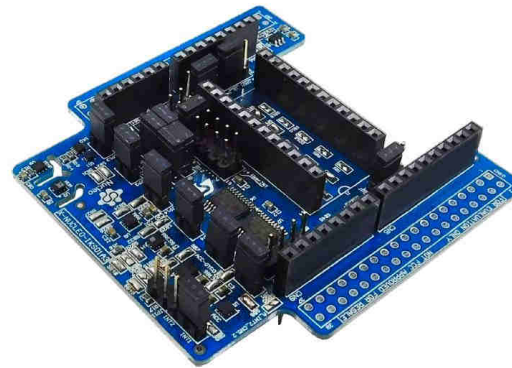


# Hardware



**NUCLEO-L476RG**

Development board with  
STM32L476RG MCU, supports  
Arduino and ST morpho connectivity



**X-NUCLEO-IKS01A3**

Motion MEMS and environmental  
sensor evaluation board system



**MINI USB CABLE**

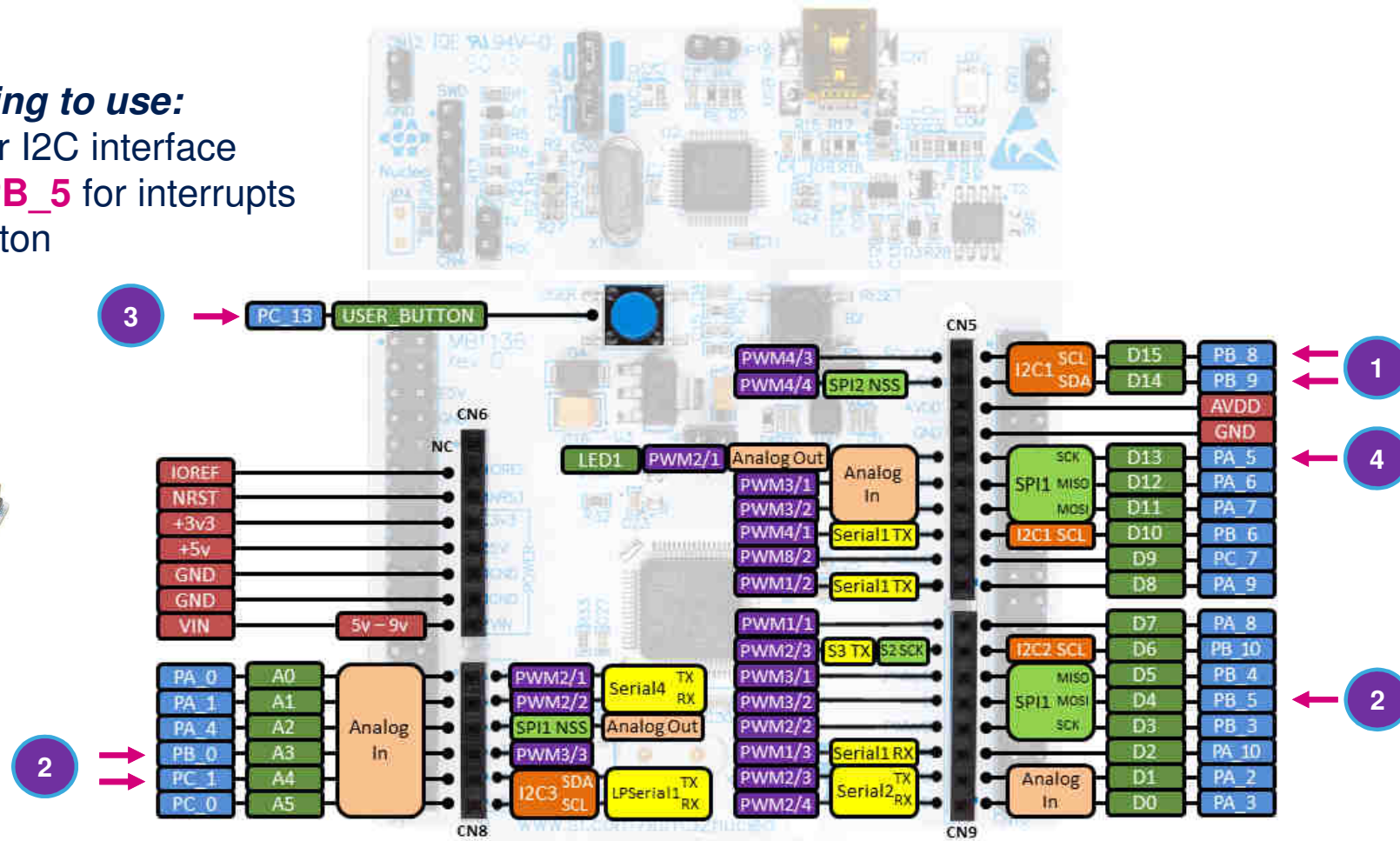
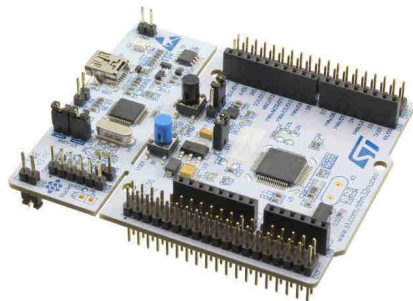
Enable USB communication  
to the laptop

# NUCLEO-L476RG header pinout

59

*In our labs we are going to use:*

1. **PB\_8** and **PB\_9** for I2C interface
2. **PB\_0**, **PC\_1** and **PB\_5** for interrupts
3. **PC\_13** for user button
4. **PA\_5** for the LED

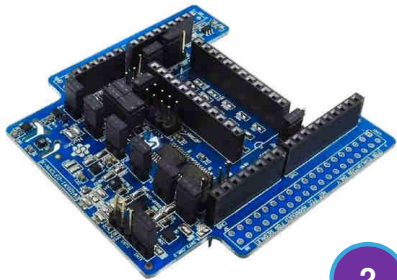


# X-NUCLEO-IKS01A3 header pinout

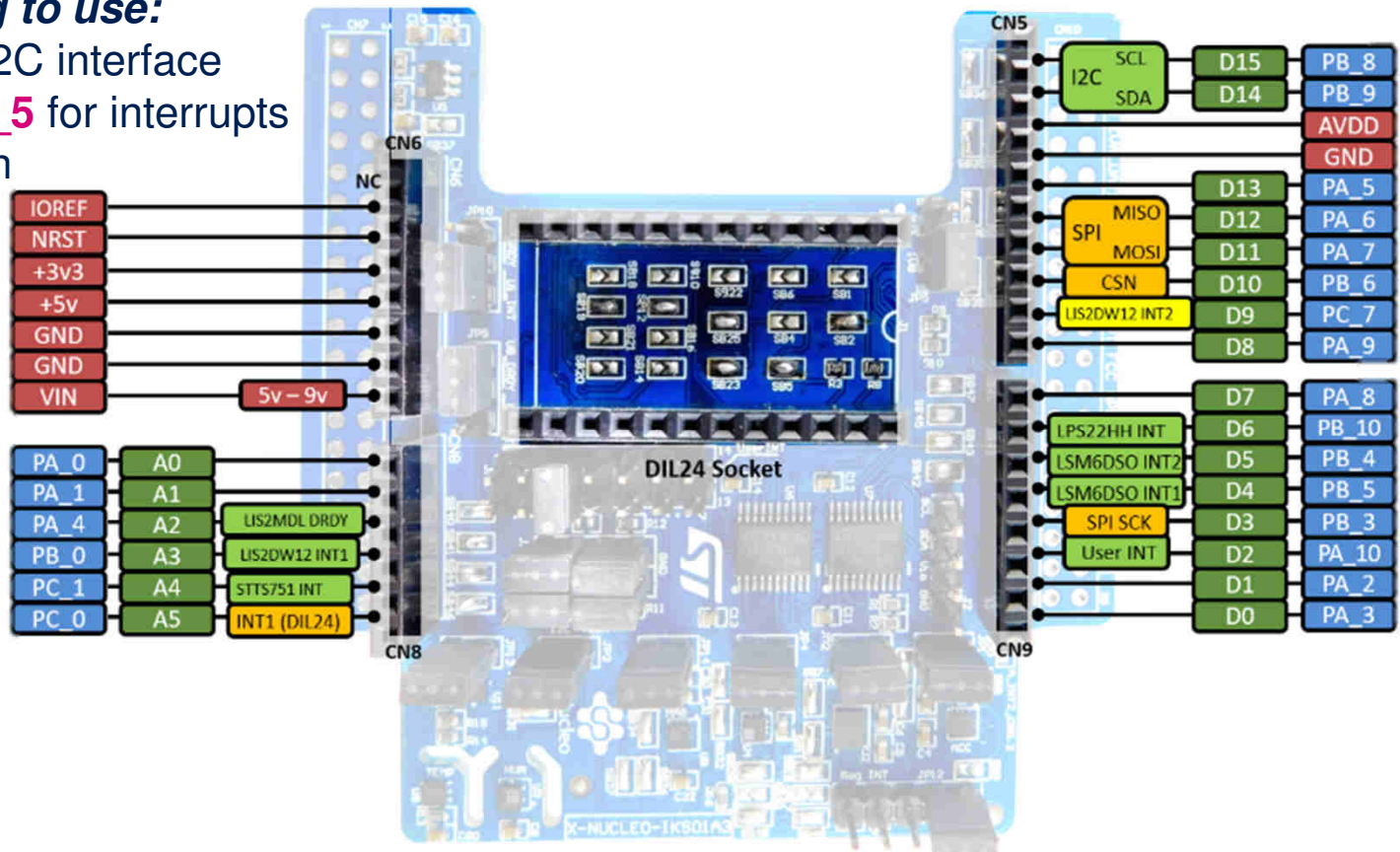
60

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3. **PC\_13** for user button
4. **PA\_5** for the LED



2

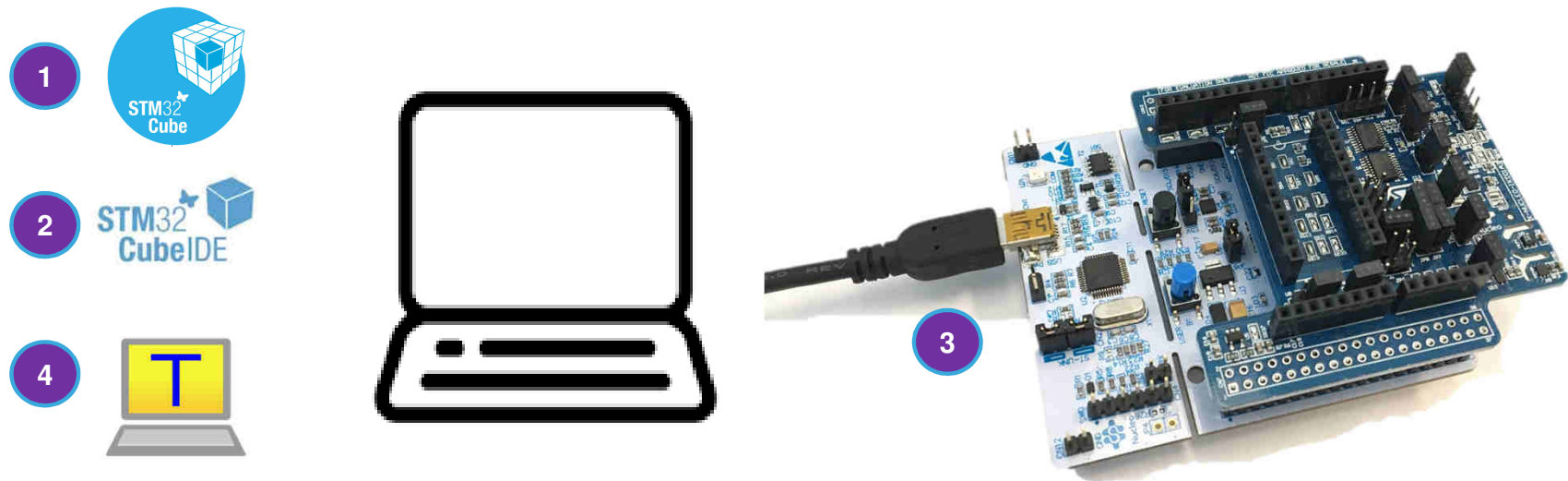


1

2

# Hardware and Software check

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- At this point you should all have:
  1. *Installed* STM32Cube libraries
  2. *Installed* STM32CubeIDE
  3. *Stacked* the Nucleo-L476 with X-Nucleo-IKS01A3 and plug it to the PC
  4. *Installed and configured* Tera Term



# LAB0

## Goals:

- Configure a new project using X-CUBE-MEMS1
- **Configure all sensors and read data in polling mode**
- Visualizing sensor data on Tera Term

# Leading Sensors for IoT

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## ACCELEROMETER & GYROSCOPE **6-AXIS IMU**

**LSM6DSO**

Wearables,  
Smartphones, IoT,  
AR/VR



- Best in class for Power/Noise
- Embedded Digital Features including: New Pedometer, FSM
- High speed I3C interface
- Real dual core

## ULTRA LOW POWER **ACCELEROMETER**

**LIS2DW12**

IoT, wearable,  
anti-tampering,  
security



- Flexibility Power Consumption vs. Noise
- Ecosystem (SW, libraries, ref design, Nucleo boards ...)

## HIGH ACCURACY **PRESSURE SENSOR**

**LPS22HH**

Compact, low  
power, water  
resistant



- LPS22HH: high accuracy,
- Low Power Consumption
- Skip One Point Cal. post Soldering

## MAGNETOMETER **COMPASS**

**LIS2MDL**

Accuracy,  
Temperature  
Stability



- Power Consumption
- Thermal Stability & Precision
- The LIS2MDL has a magnetic field dynamic range of  $\pm 50$  gauss.

## LOCAL **TEMPERATURE SENSOR**

**STTS751**

Low Voltage,  
Low Power



- Ultra low power with one shot mode for superior power savings
- SMBus 2.0 compliant supporting ALERT command
- Very small package

## HUMIDITY AND **TEMPERATURE COMBO**

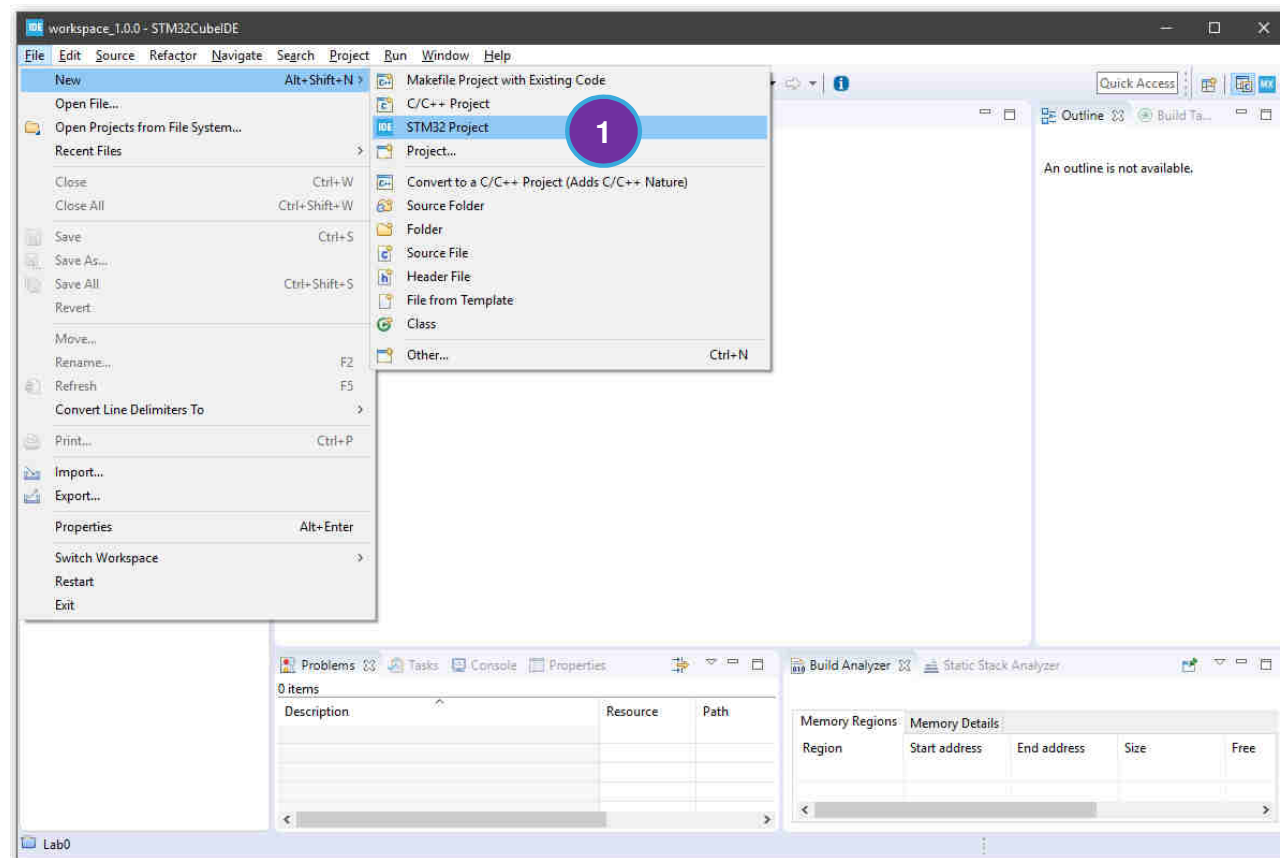
**HTS221**

Compact  
Low Power



- Direct H and T data readout
- Low current consumption (3.5uA)
- Industrial temperature operating range

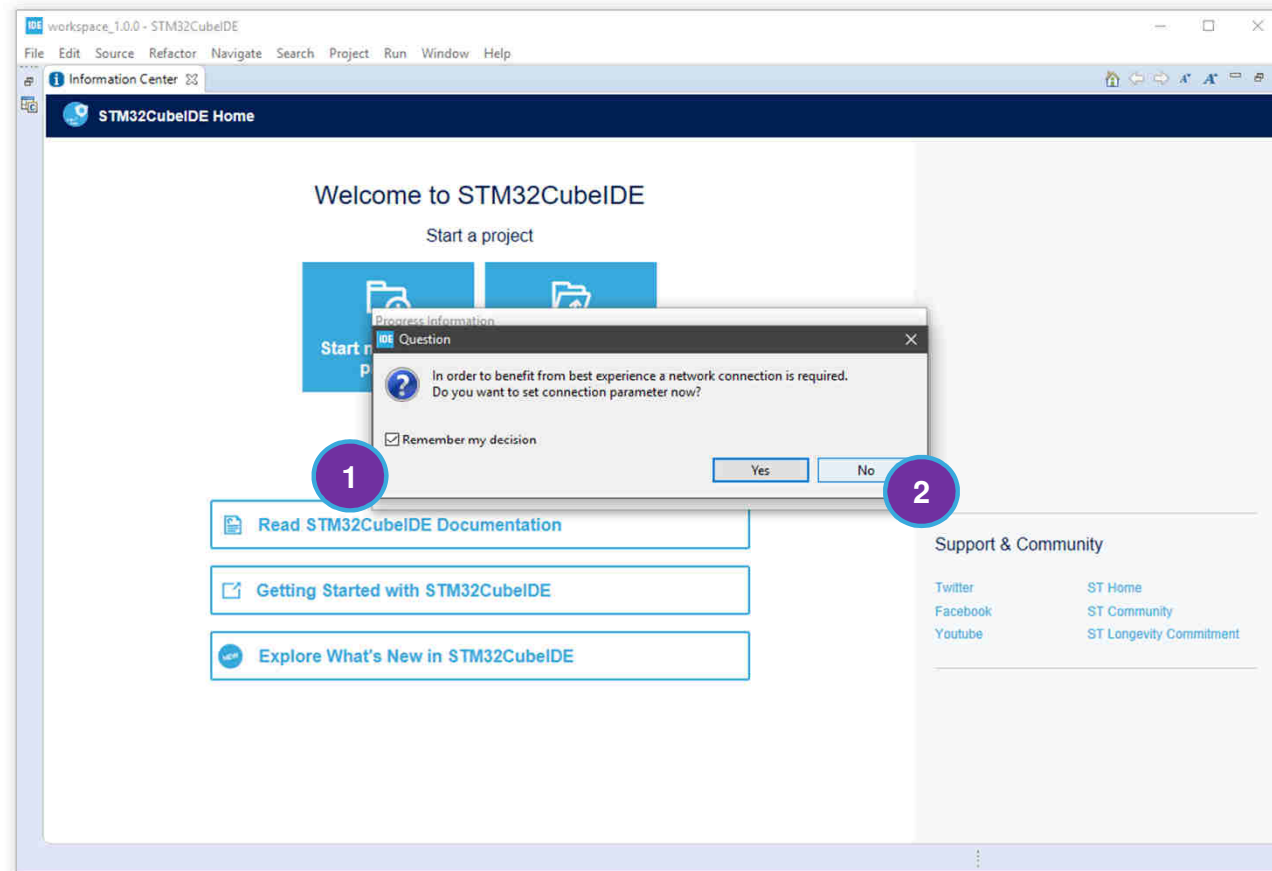
## 1. Click on **File > New > STM32 Project**



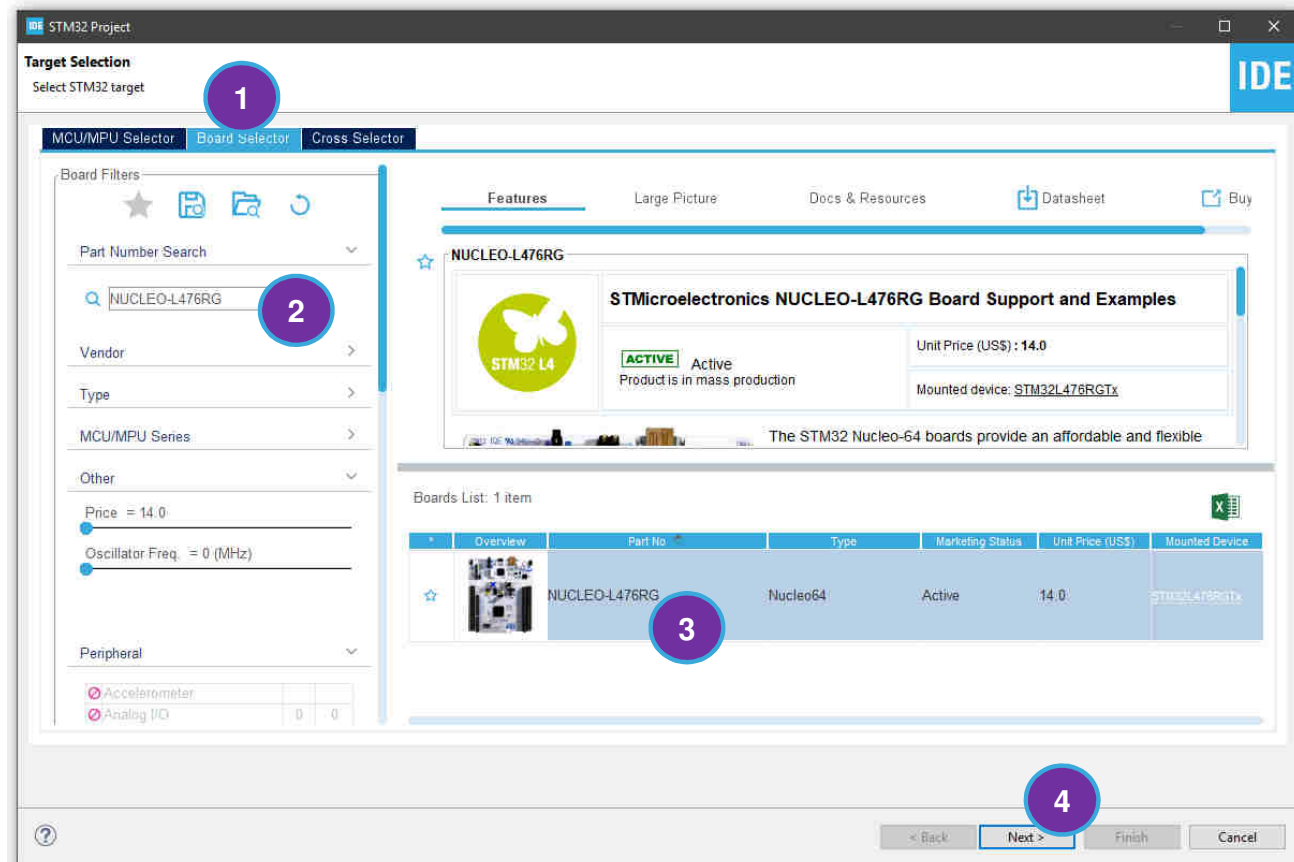


1. Check **Remember my decision\***
2. Click on **No**

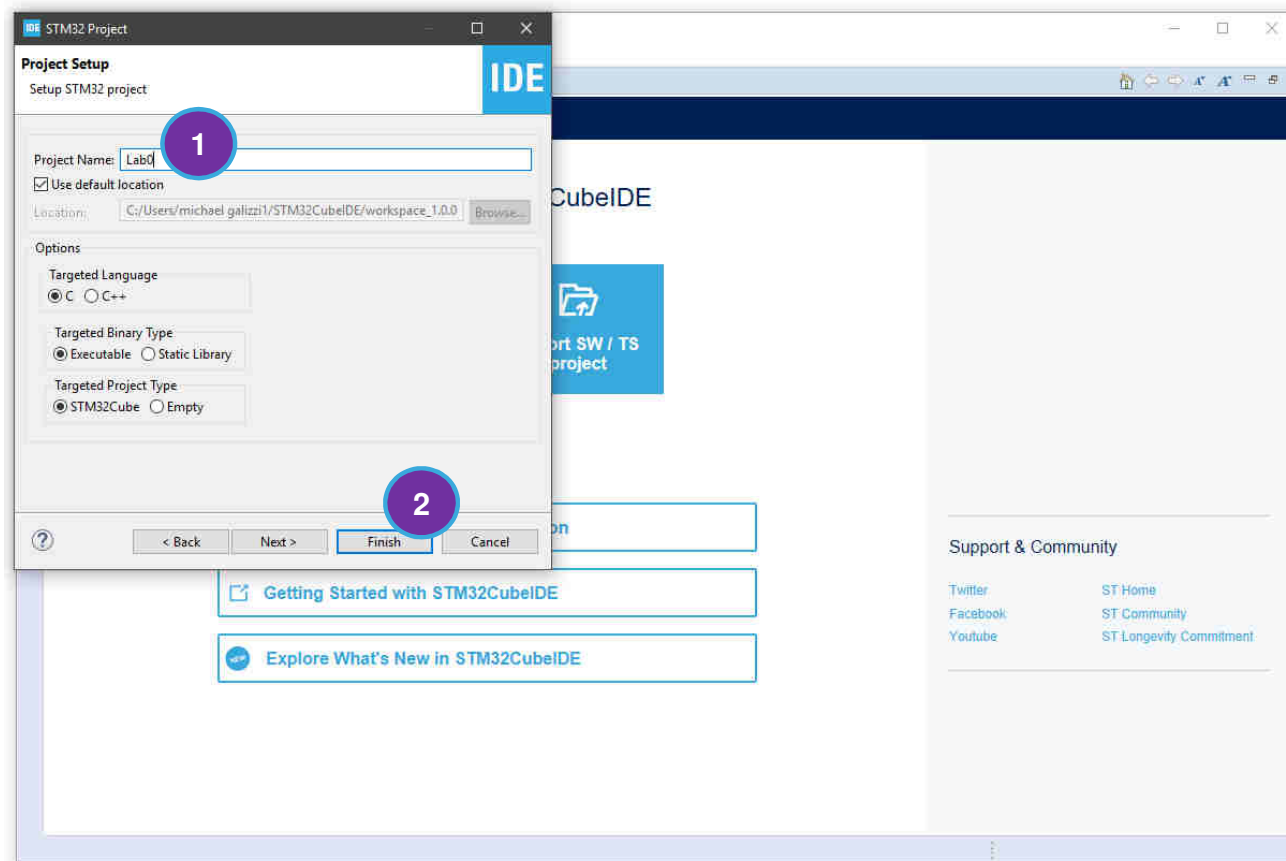
\* It is always possible to reconfigure internet connection parameter in **Window > Preferences** then in **General > Network Connections**



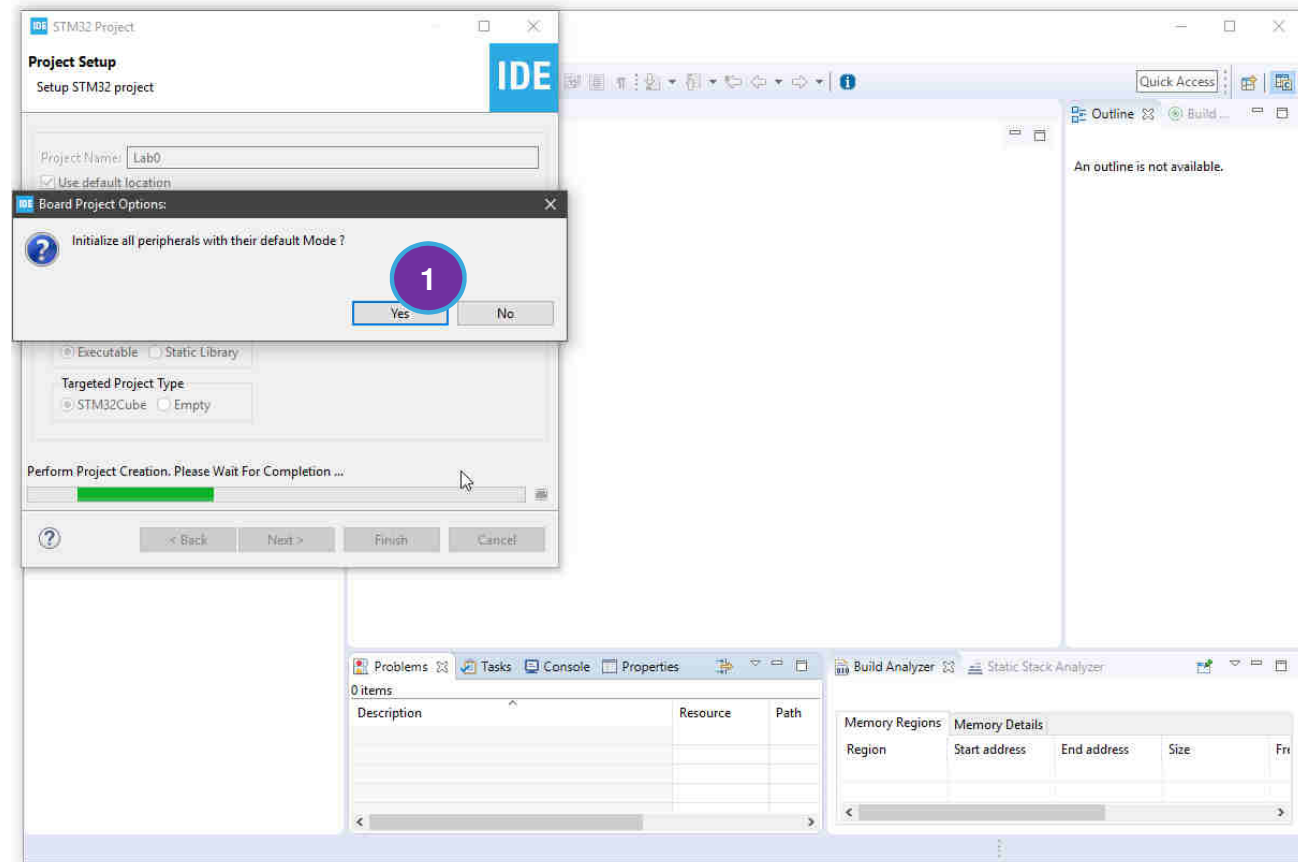
1. Click on **Board Selector**
2. Type **NUCLEO-L476RG**
3. Click on the board
4. Click **Next >**



1. Project Name **Lab0**
2. Click **Finish**

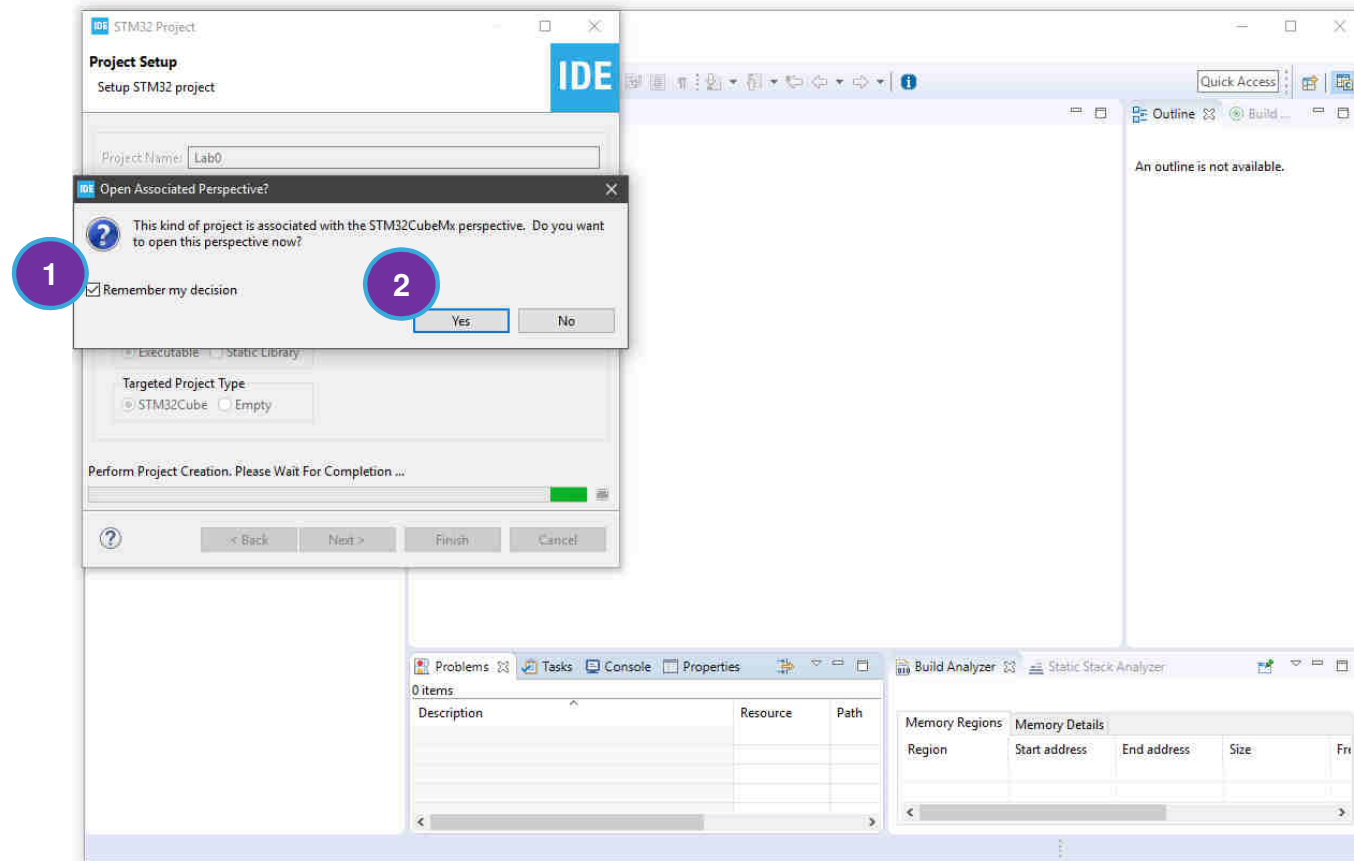


1. Click **Yes** to init peripherals in default mode



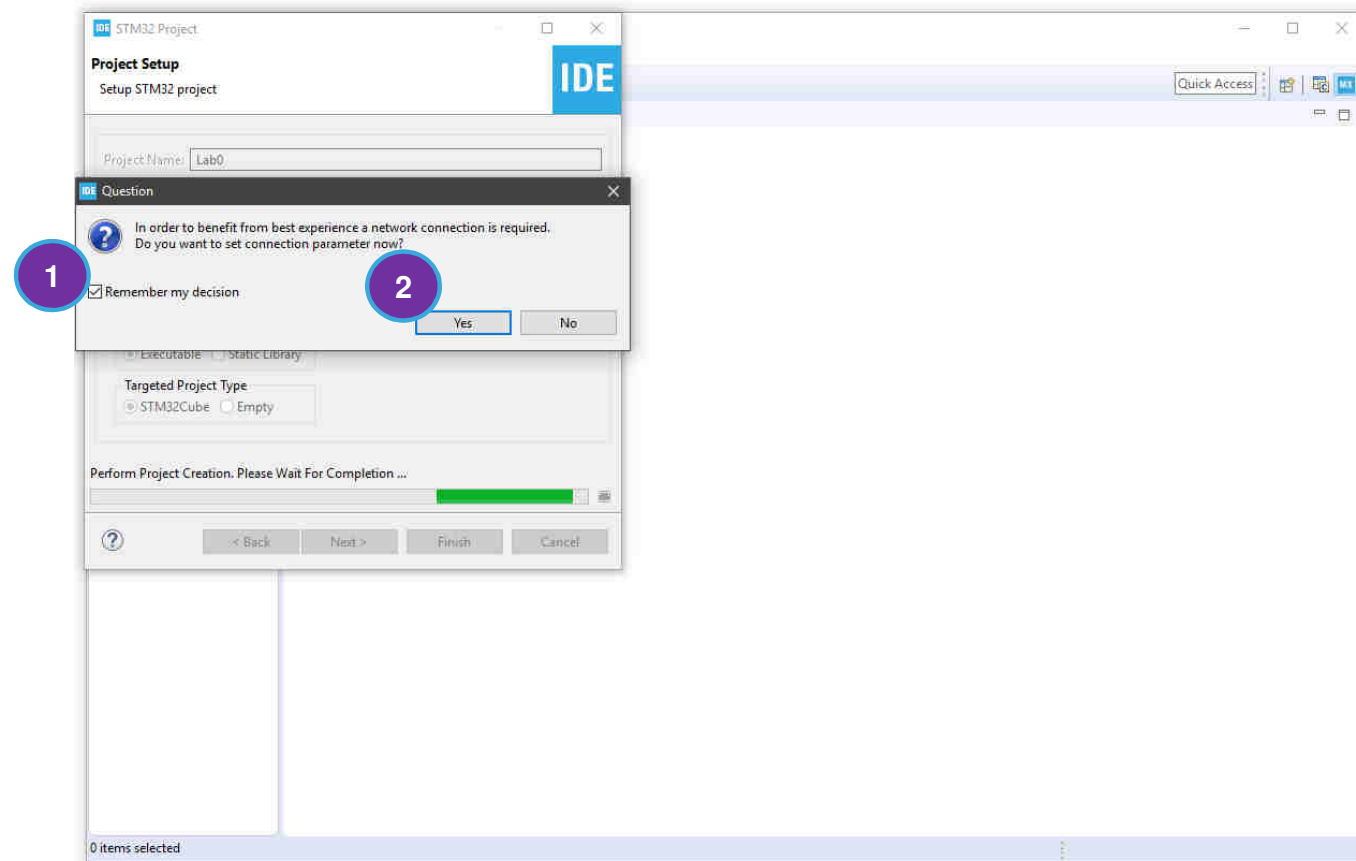
1. Check **Remember my decision**

2. Click **Yes**



1. Check **Remember my decision**
2. Click **No** \*

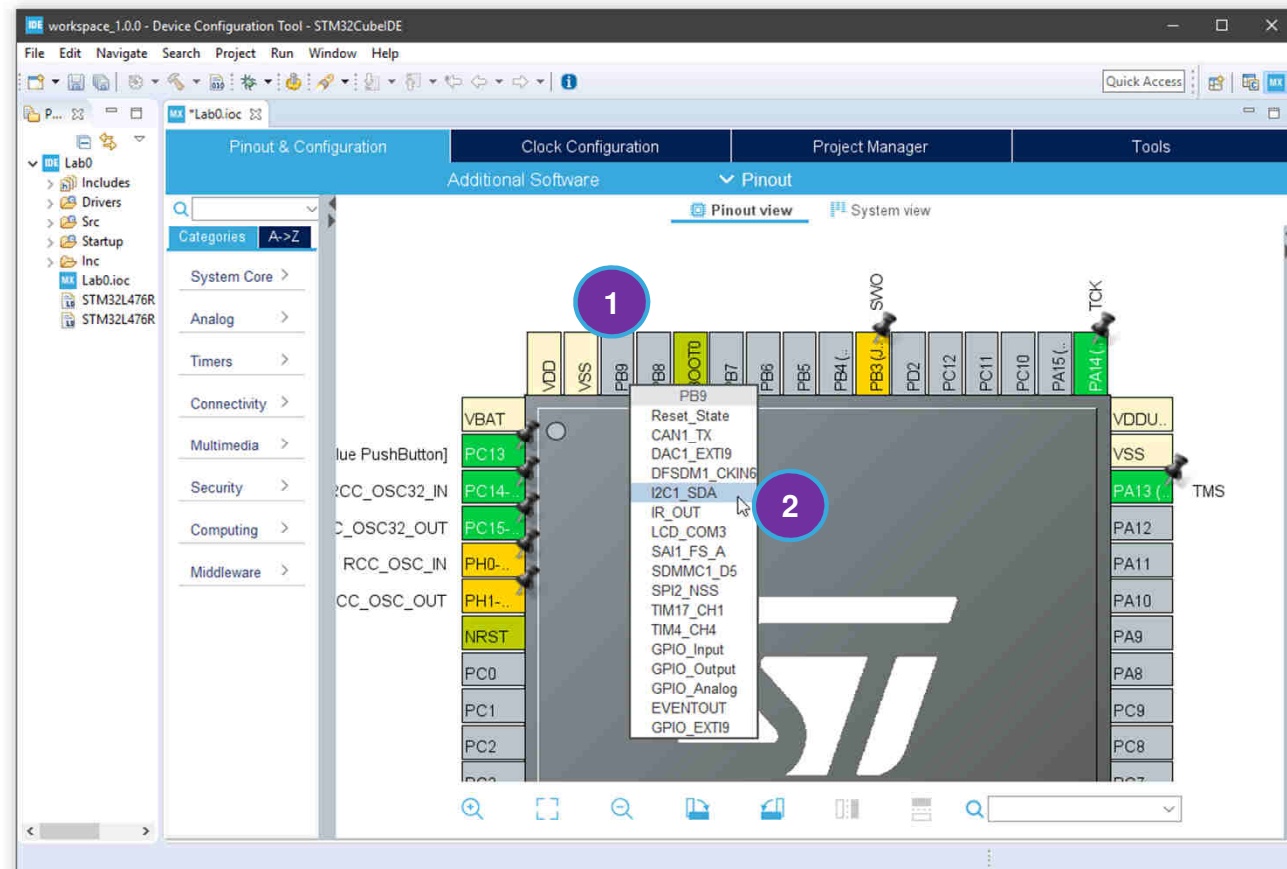
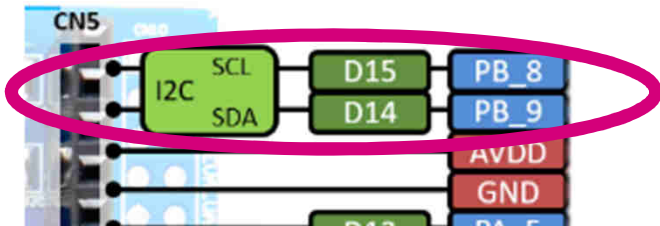
\* We are using all the tools in offline mode, so that internet connection is not strictly needed



# Lab0 – Configure the I2C bus

71

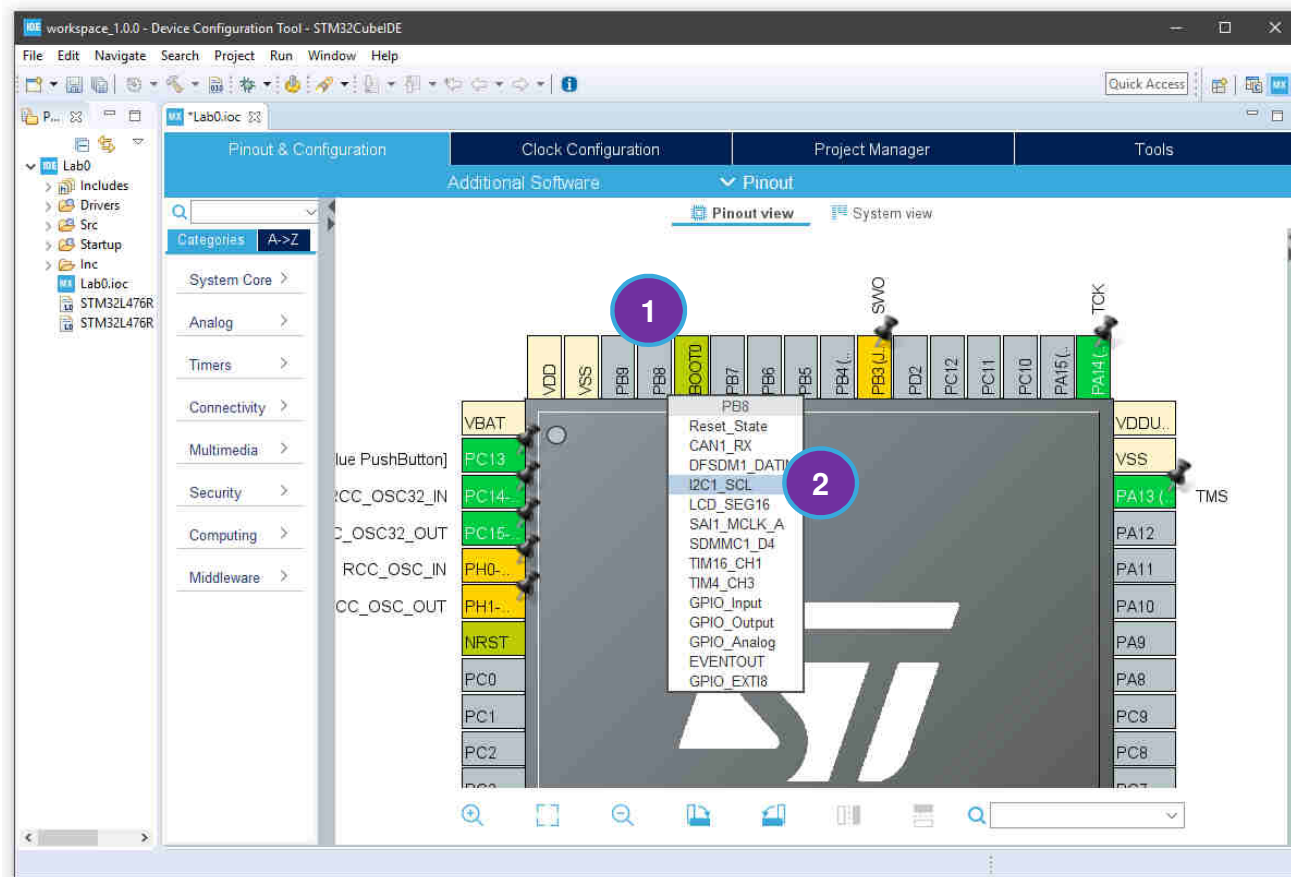
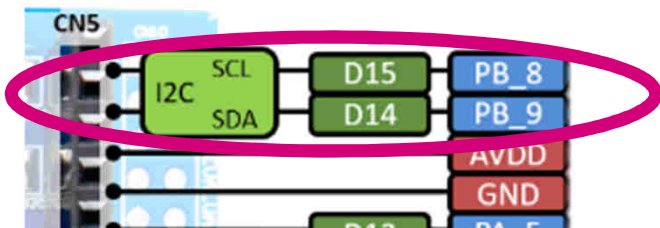
1. Left Click on **PB9** pin
2. Select **I2C1\_SDA**



# Lab0 – Configure the I2C bus

72

1. Left Click on **PB8** pin
2. Select **I2C1\_SCL**

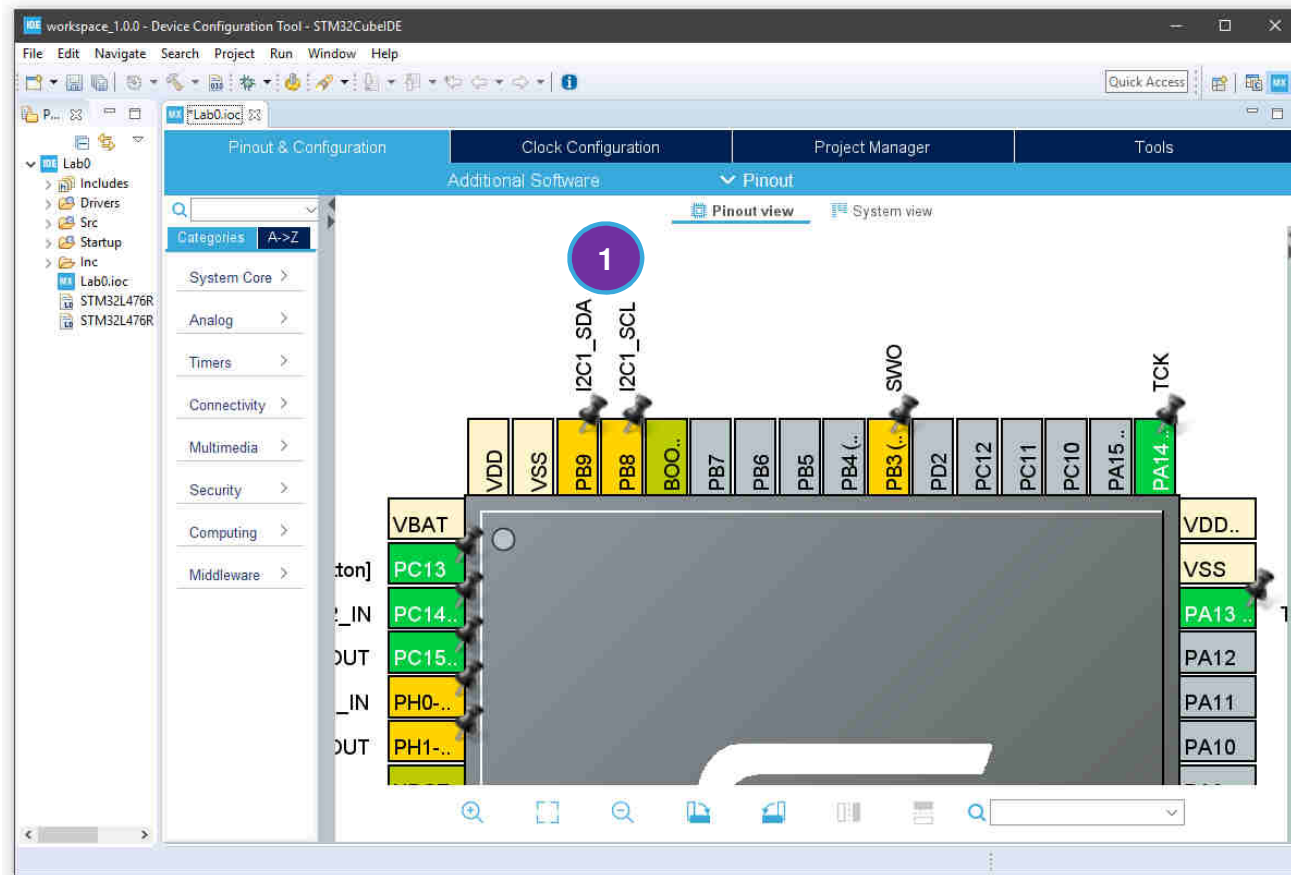
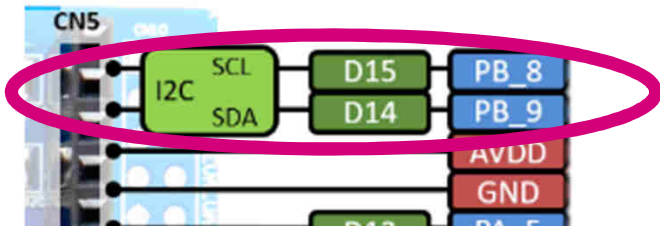




# Lab0 – Configure the I2C bus

73

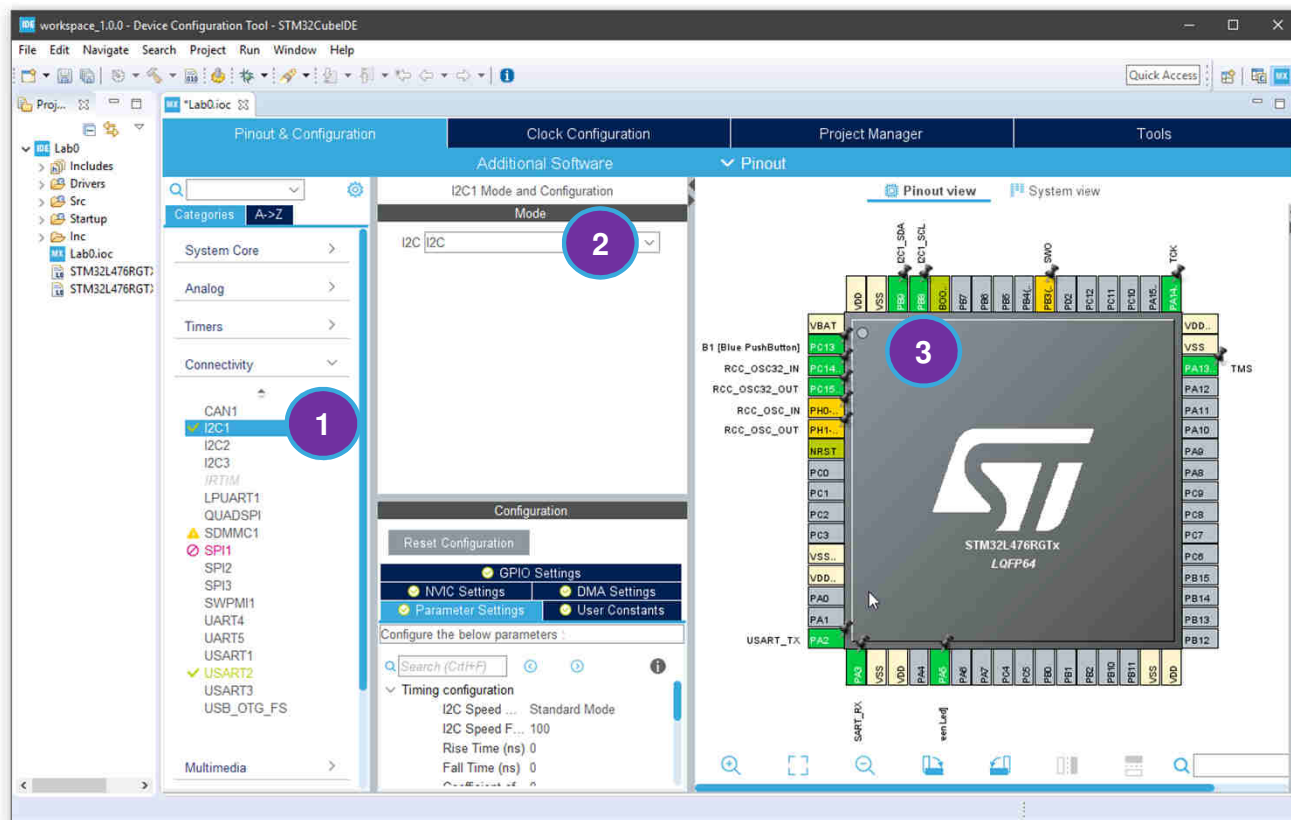
1. At this point I2C1 pins PB9 and PB8 should appear in yellow (selected but not configured)



# Lab0 – Configure the I2C bus

74

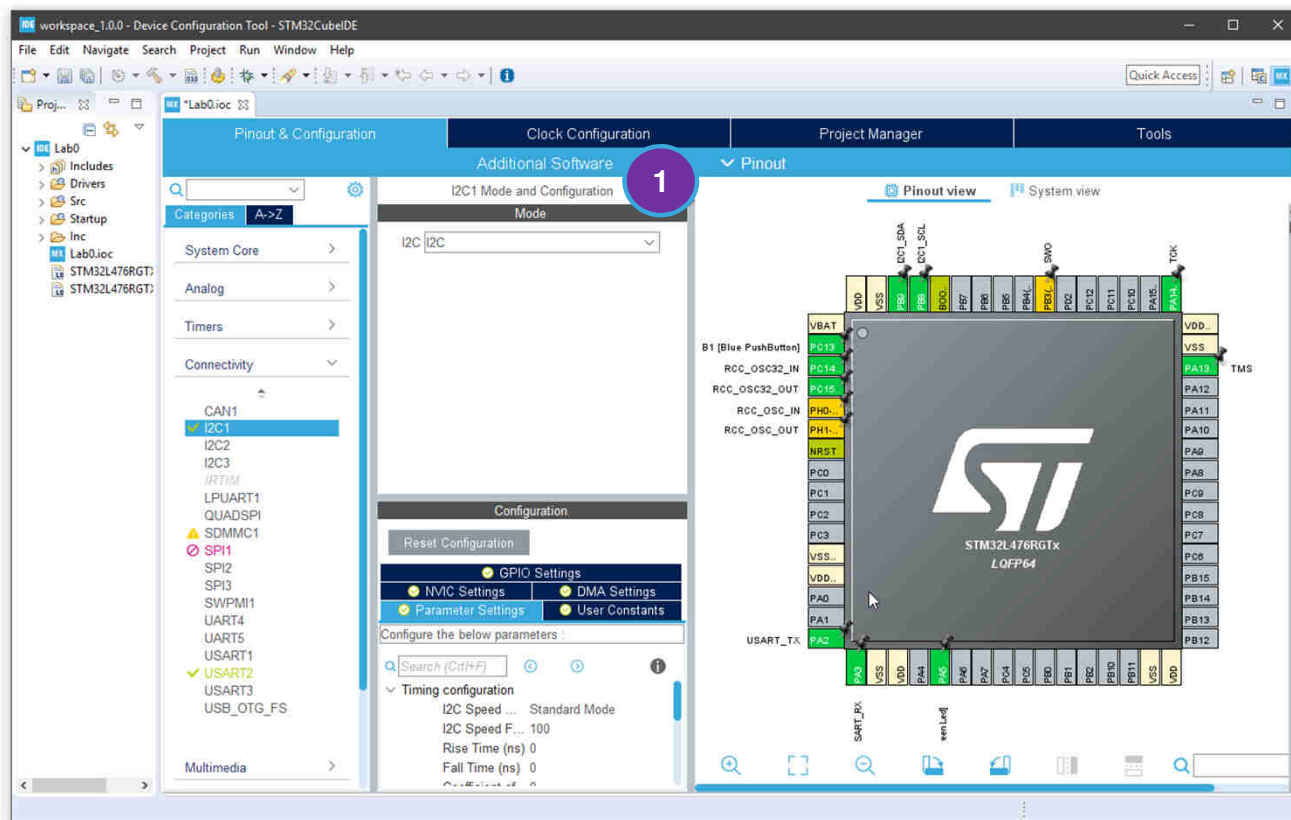
1. Expand *Connectivity* tab and check **I2C1**
2. Select **I2C** in *I2C1 Mode and Configuration*
3. PB8 and PB9 should now become green



# Lab0 – Select the MEMS library

75

1. Click on **Additional Software**



# Additional Software Intro

76

**X-CUBE-MEMS1/...** will be the Pack/Bundle we are going to use in this hands-on

Pack Version to be selected is **6.1.0** (mandatory)

Enlarge the column **Selection** to see the option available

The screenshot shows the 'Additional Software Components selection' window. On the left, there is a 'Filters' panel with a search bar, a 'Pack Vendor' dropdown set to 'STMicroelectronics', and two 'Check/Uncheck All' buttons. The main area is a table with the following columns: Vendor, Pack/Bundle, Pack Version, Class, Pack Action, Group/Subgroup, Selection, and Condition. The table lists various software components, including STMX-CUBE-MEMS1/... and SX-CUBE-MEMS1/... packs. Red boxes highlight the 'Pack/Bundle' and 'Pack Version' columns, and a red arrow points to the 'Selection' column.

Vendor	Pack/Bundle	Pack Version	Class	Pack Action	Group/Subgroup	Selection	Condition
>	STMX-CUBE-MEMS1/Application	6.0.1	Device	Install*			
✓	STMX-CUBE-MEMS1/Application	6.1.0	Device	Installed			
	SX-CUBE-MEMS1/Application	6.1.0	Device		Application	IKS01A3_DataLogTerminal	IKS01A...
>	STMX-CUBE-MEMS1/MEMS	6.0.1	Board Extension	Install*			
>	STMX-CUBE-MEMS1/MEMS	6.0.1	Board Component	Install*			
✓	STMX-CUBE-MEMS1/MEMS	6.1.0	Board Extension	Installed			
	SX-CUBE-MEMS1/MEMS	6.1.0	Board Extension		IKS01A2/		IKS01A...
	SX-CUBE-MEMS1/MEMS	6.1.0	Board Extension		IKS01A3/		IKS01A...
>	STMX-CUBE-MEMS1/MEMS	6.1.0	Board Component	Installed			
>	STMX-CUBE-MEMS1/STM32Cube...	6.0.1	Board Support	Install*			
>	STMX-CUBE-MEMS1/STM32Cube...	6.1.0	Board Support	Installed			

# Additional Software Intro

77

There are two way to use the X-CUBE-MEMS1 Pack/Bundle:

	X-NUCLEO board	Custom board	
<b>Pack/Bundle class required</b>	Device	Device	(Application)
	Board Extension	Board Support	(STM32Cube BSP Drivers)
		Board Component	(MEMS)

Additional Software Components selection

Filters

Search

Pack Vendor

Check/Uncheck All

☐ STMicroelectronics

Vendor	Pack/Bundle	Pack Version	Class	Pack Action	Group/Subgroup	Selection	Condition
> STMX-CUBE-MEMS1/	Application	6.0.1	Device	Install*			
> STMX-CUBE-MEMS1/	Application	6.1.0	Device	Installed			
> SX-CUBE-MEMS1/	Application	6.1.0	Device		Application	IKS01A3_DataLogTerminal	IKS01A...
> STMX-CUBE-MEMS1/	MEMS	6.0.1	Board Extension	Install*			
> STMX-CUBE-MEMS1/	MEMS	6.0.1	Board Component	Install*			
> STMX-CUBE-MEMS1/	MEMS	6.1.0	Board Extension	Installed			
> SX-CUBE-MEMS1/	MEMS	6.1.0	Board Extension		IKS01A2/	<input type="checkbox"/>	IKS01A...
> SX-CUBE-MEMS1/	MEMS	6.1.0	Board Extension		IKS01A3/	<input checked="" type="checkbox"/>	IKS01A...

# Additional Software Intro

78

Lab0 to Lab5 will be based on **X-NUCLEO board**, Lab6 on a **Custom board**

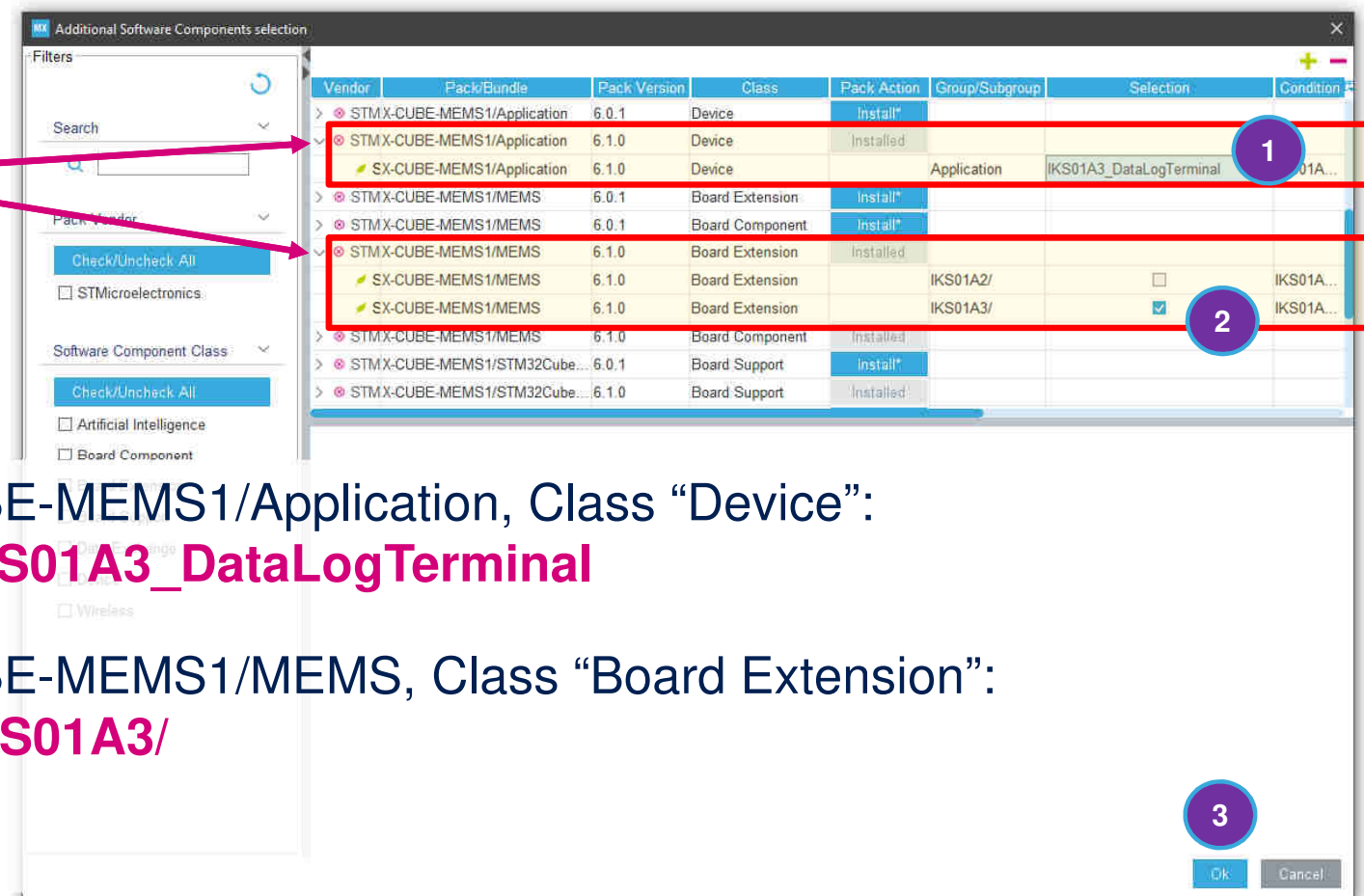
	X-NUCLEO board	Custom board	
Pack/Bundle class required	Device	Device	(Application)
	Board Extension	Board Support	(STM32Cube BSP Drivers)
		Board Component	(MEMS)

Lab0 - Lab 5      Lab6

# Lab0 – Select the MEMS library

79

Click to  
expand tree



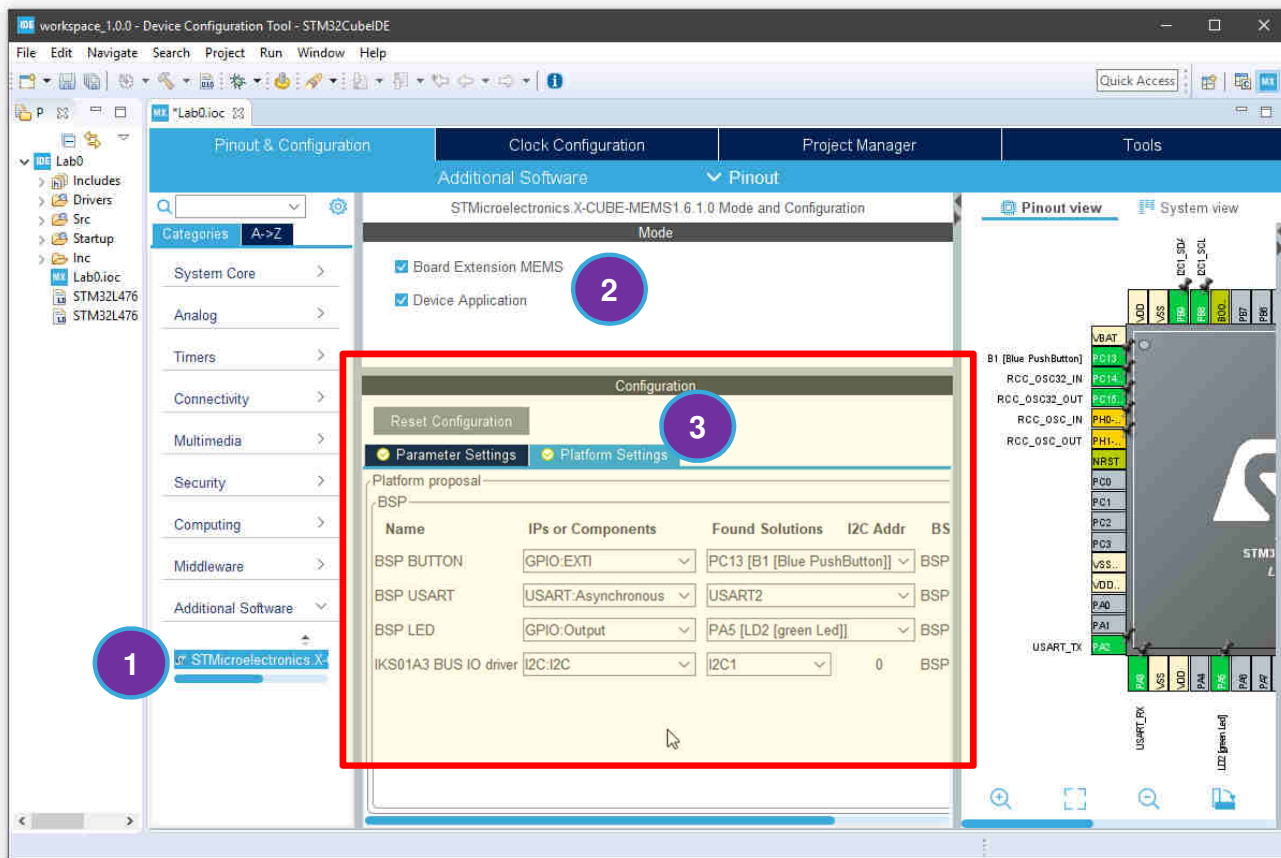
1. In X-CUBE-MEMS1/Application, Class “Device”:  
Select **IKS01A3\_DataLogTerminal**
2. In X-CUBE-MEMS1/MEMS, Class “Board Extension”:  
Check **IKS01A3/**
3. Click **OK**



# Lab0 – Configure the MEMS library

80

1. Expand Additional Software and select the X-CUBE-MEMS1
2. Check both:  
**Board Extension MEMS**  
**Device Application**
3. Configure Platform Settings as in picture (details in next page)





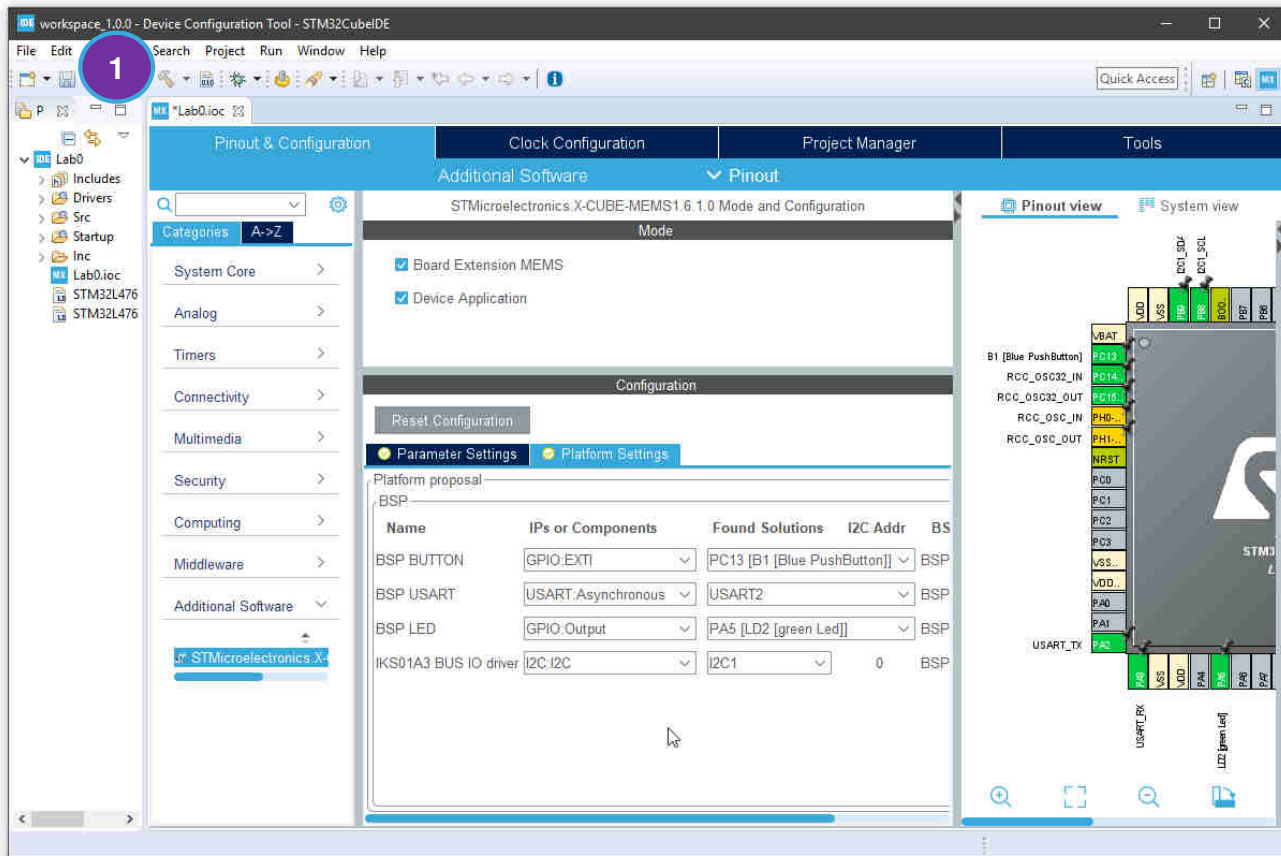
## 81



# Lab0 – Save the project

82

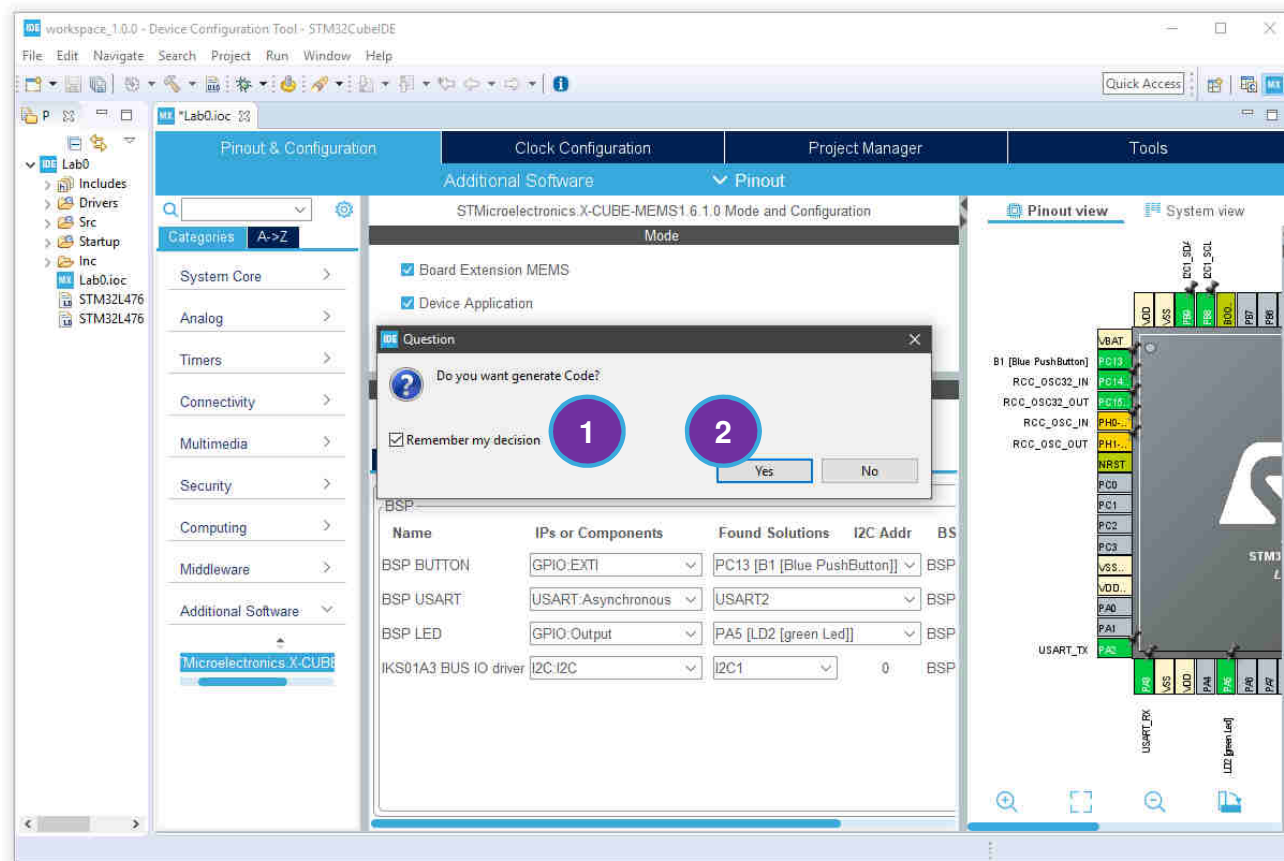
1. Click the save button



# Lab0 – Code Generation

83

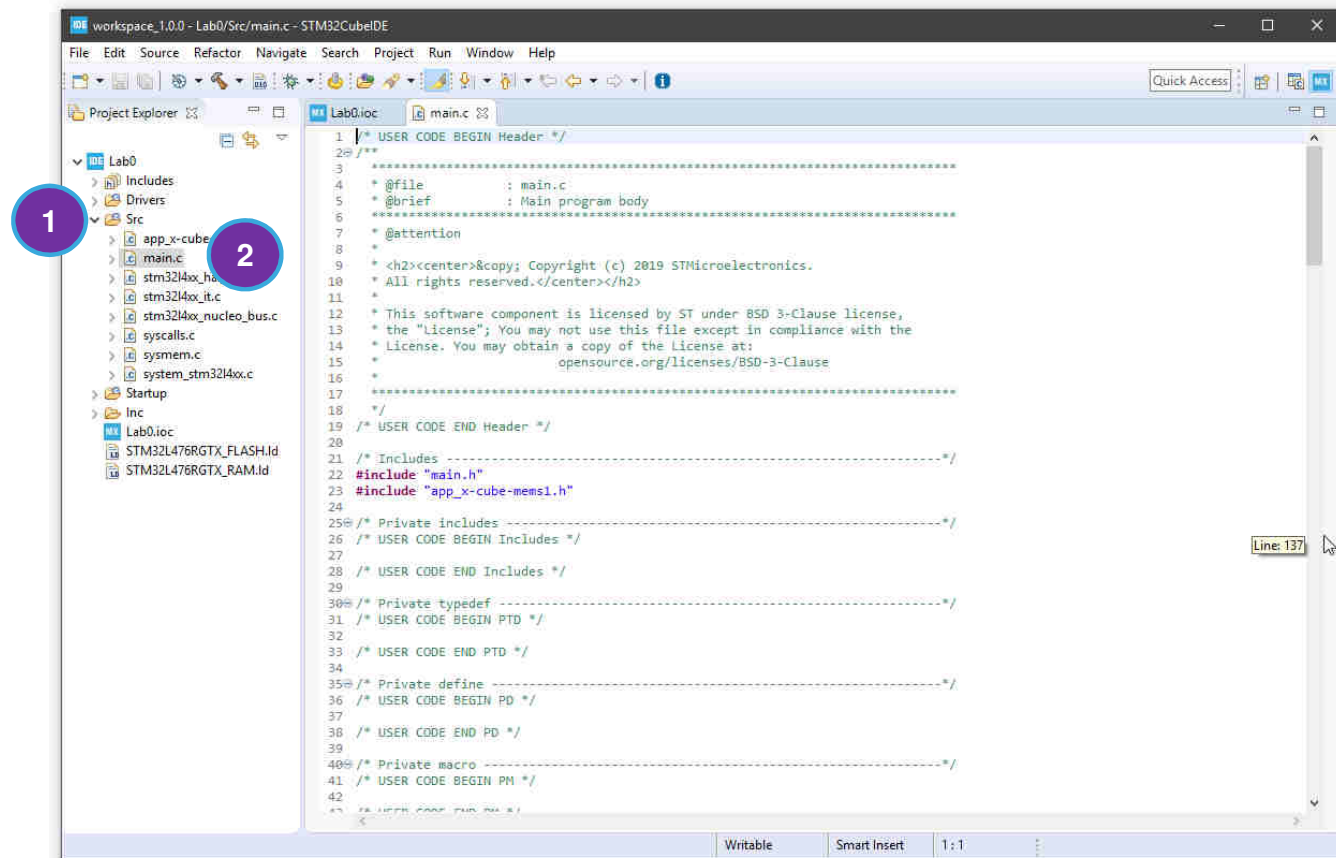
1. Check **Remember my decision**
2. Click **Yes**



# Lab0 – Code Editing


84

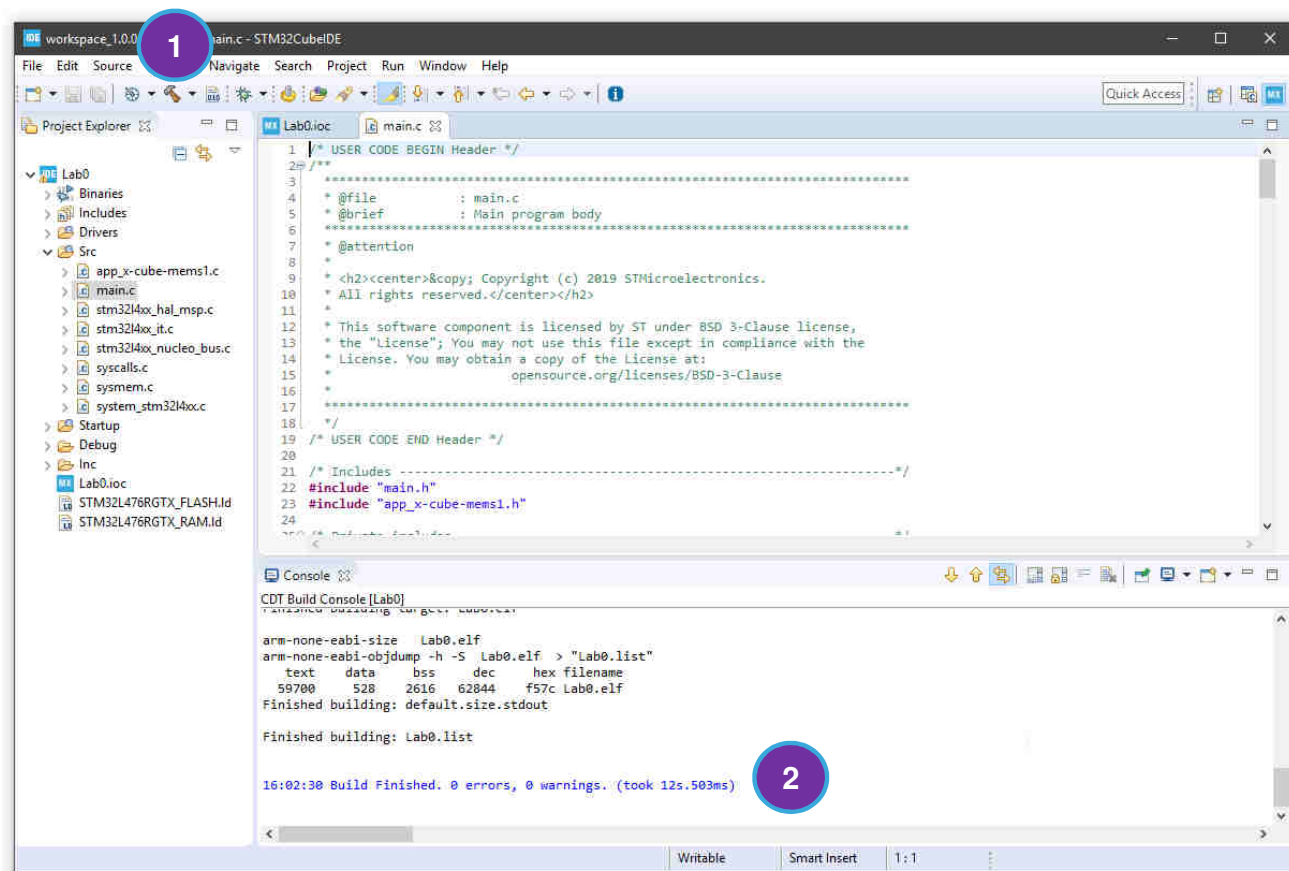
1. Expand **Src**
2. Double click on **main.c**



# Lab0 - Compiling

85

1. Click on the hammer  to begin compilation, or press **CTRL+B**
2. Compilation should terminate with 0 errors and 0 warning



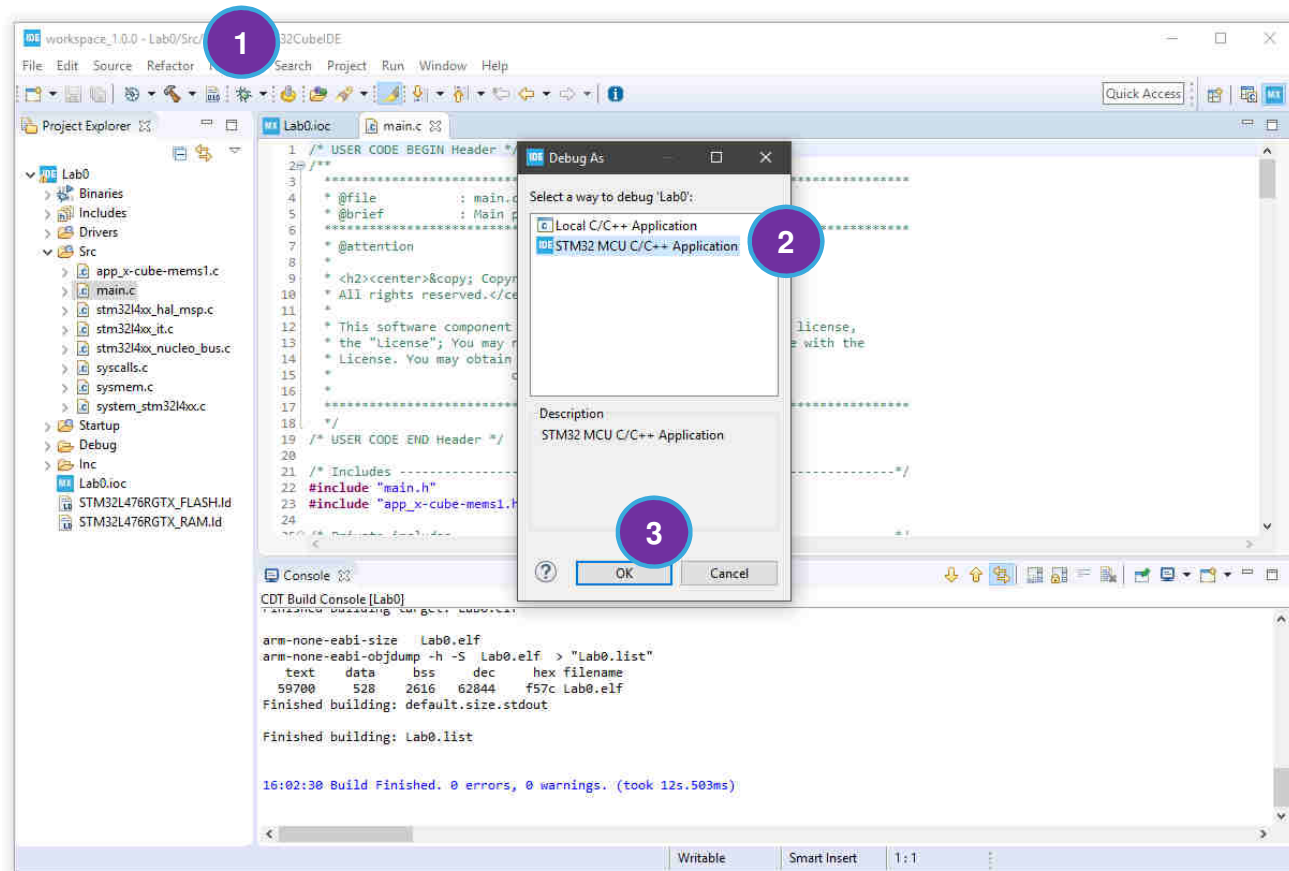
# Lab0 - Debugging

86

1. Click on the bug  to begin debugging

2. Select **STM32 MCU C/C++ App**

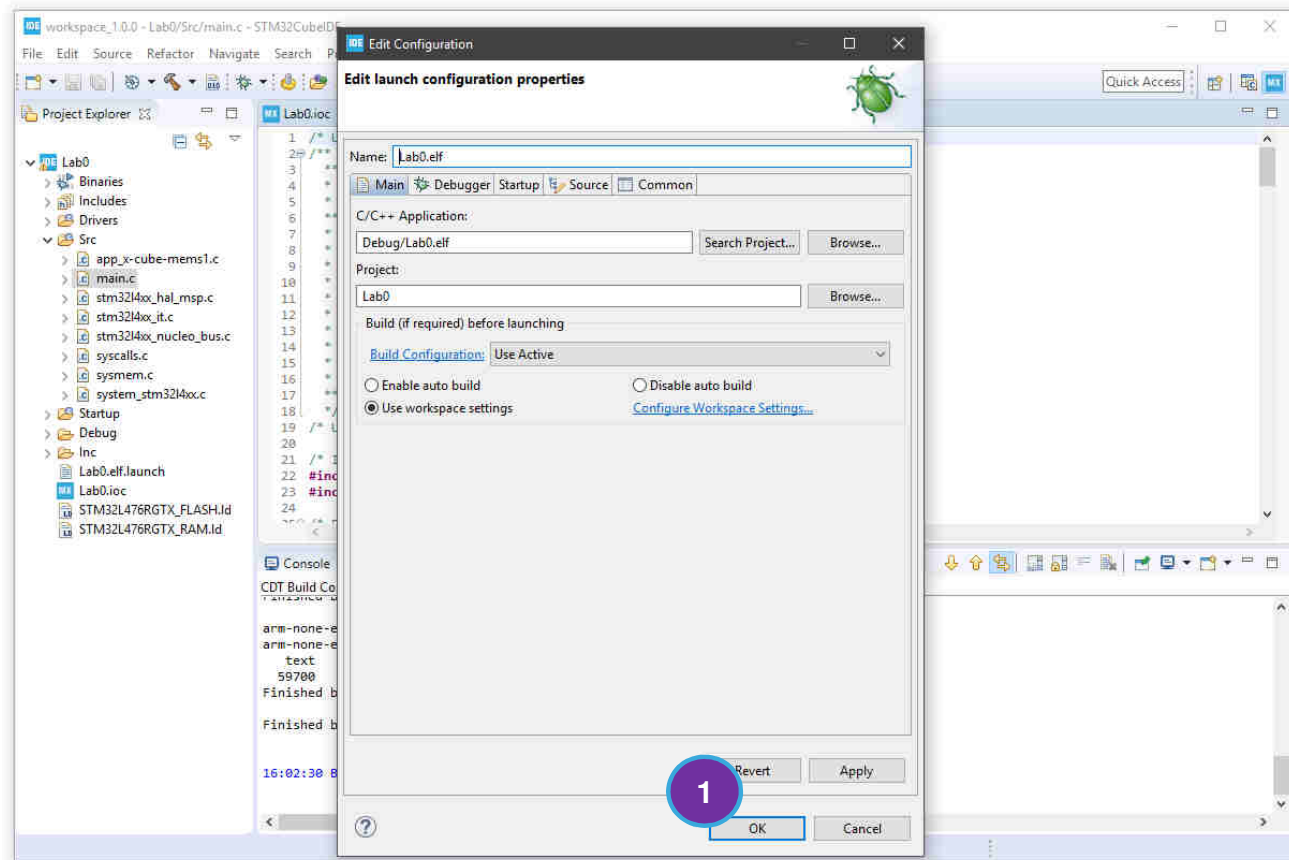
3. Click **OK**



# Lab0 - Debugging

87

1. Click **OK**

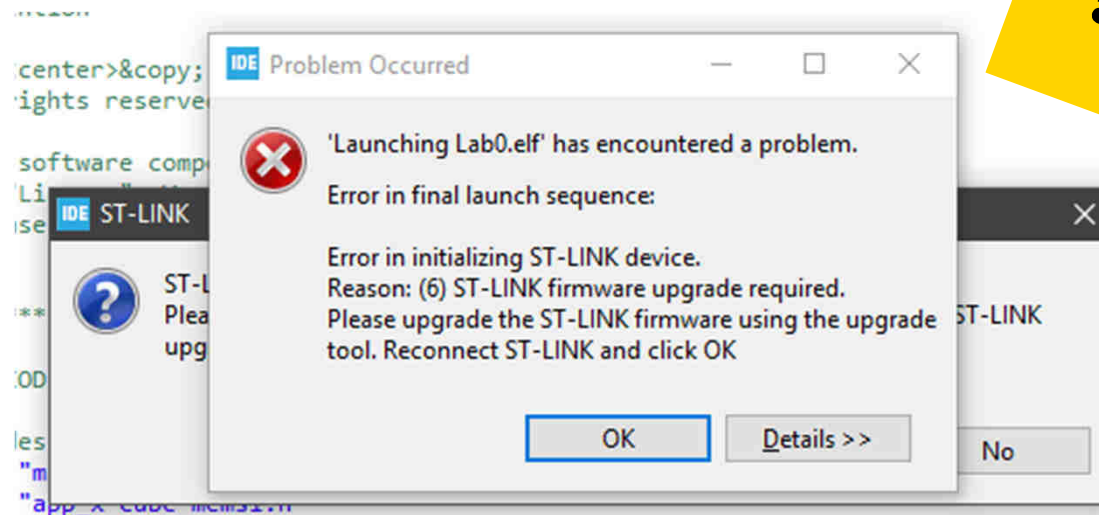




# Lab0 - Debugging

88

- The first time you debug the board by pressing , a **Problem Occurred** because ST-LINK needs to be upgraded

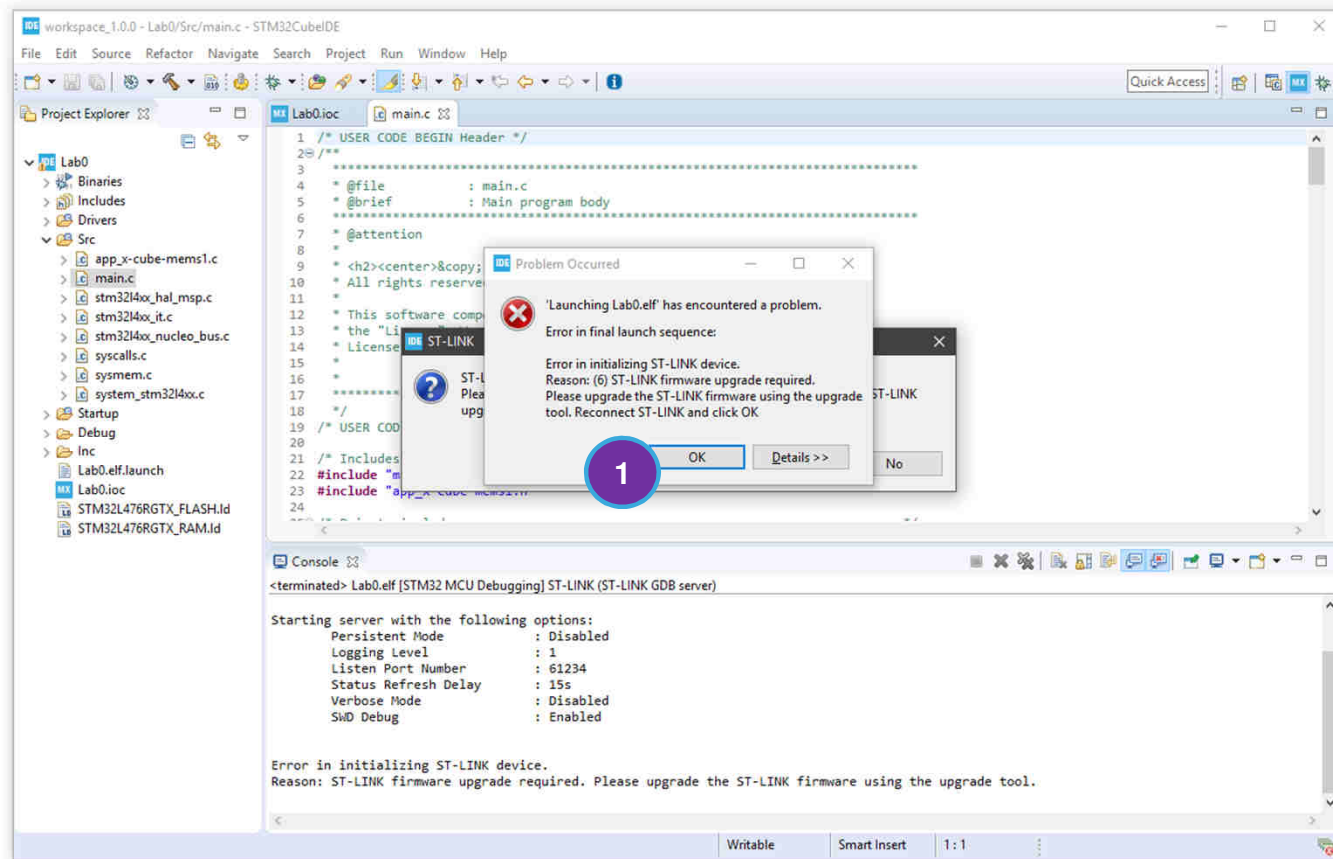


**New NUCLEO boards  
always need to be  
upgraded**



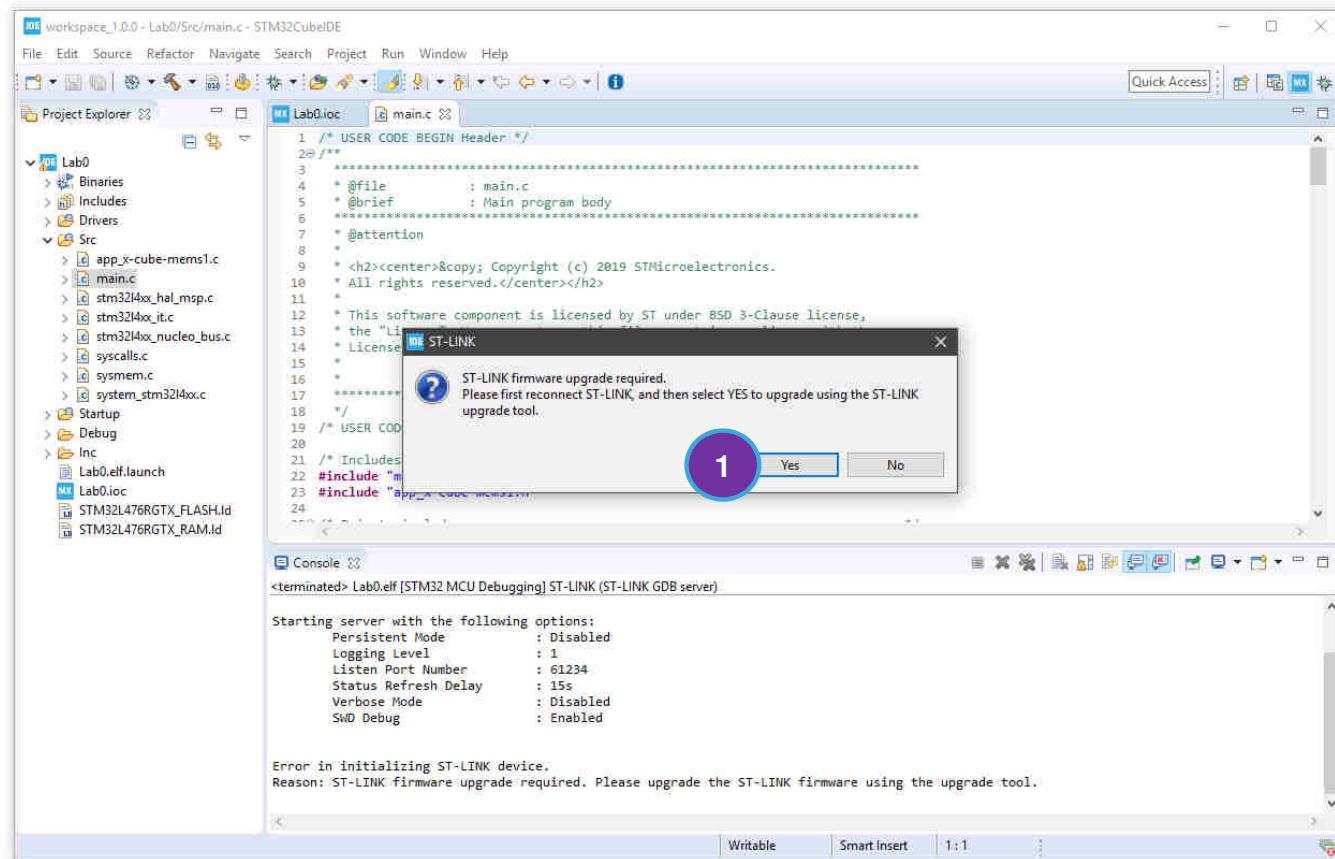
# Lab0 – Updating ST-LINK 89

1. Click **OK** to run upgrade to latest firmware



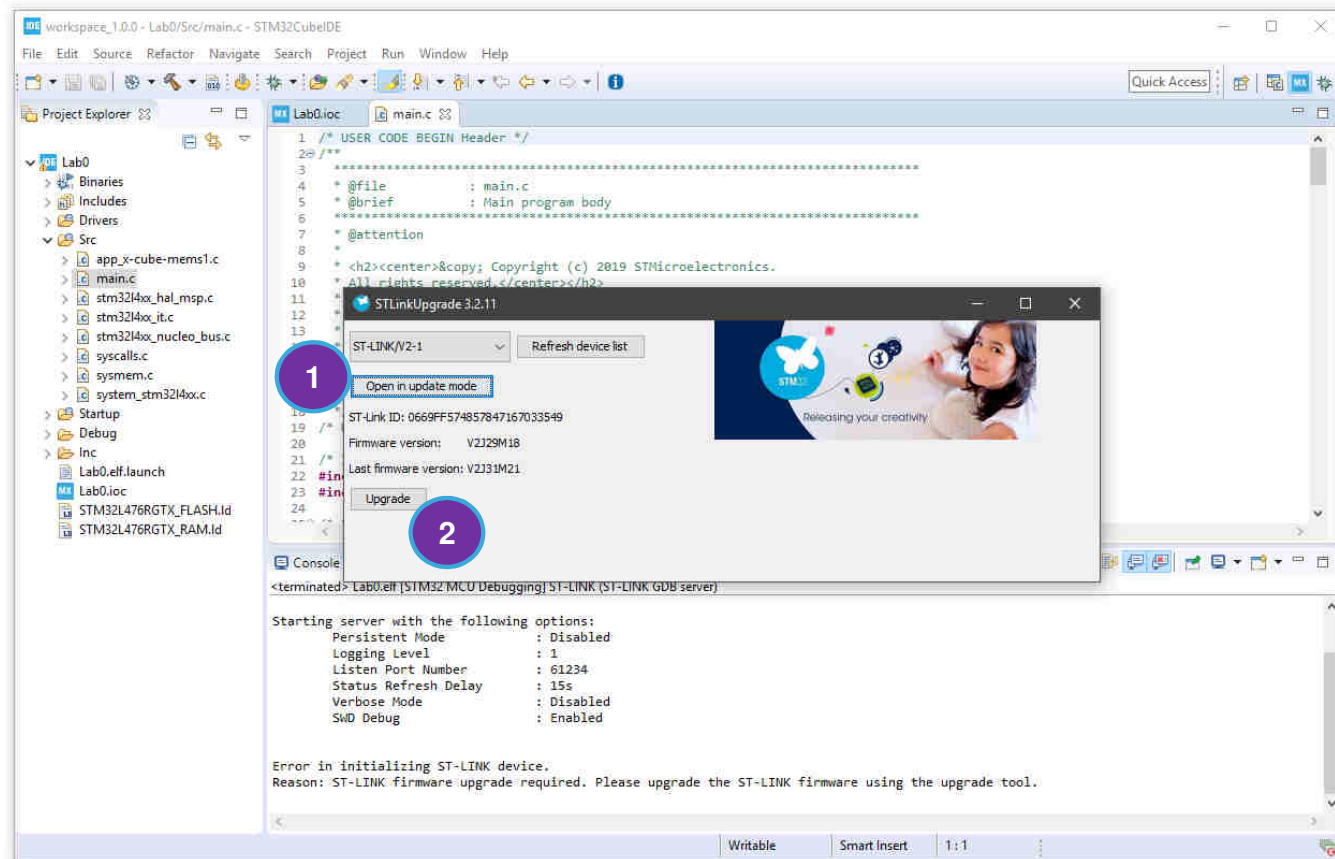
# Lab0 – Upgrading ST-LINK 90

1. Click **Yes** when is asked to upgrade the ST-LINK



# Lab0 – Upgrading ST-LINK 91

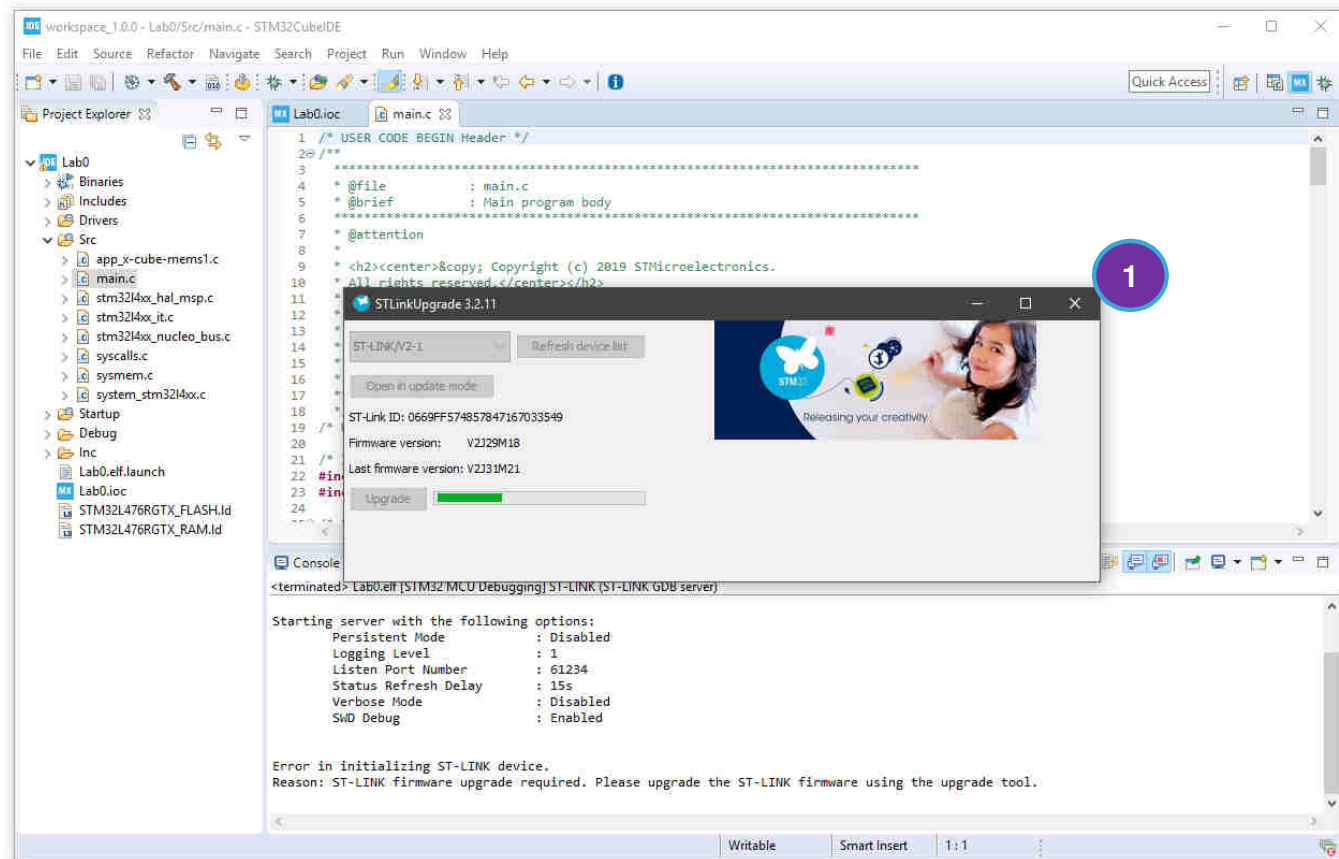
1. Click **Open in update mode** to force ST-LINK
2. Click on **Upgrade**



# Lab0 – Upgrading ST-LINK 92

Wait until update is finished and then close the window.

1. Click on **X** when finished



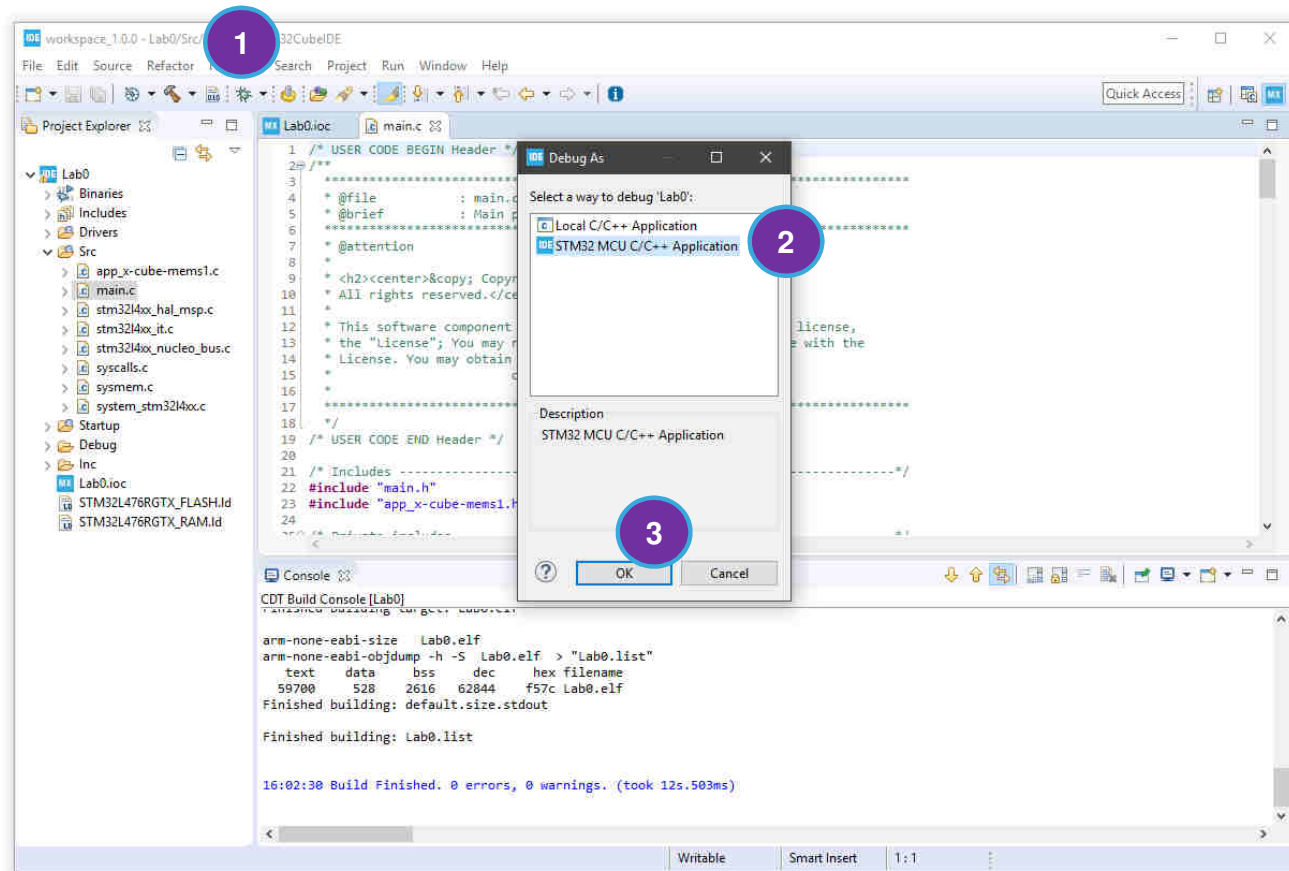
# Lab0 - Debugging

93

1. Click again on the bug  to begin debugging

2. Select **STM32 MCU C/C++ App**

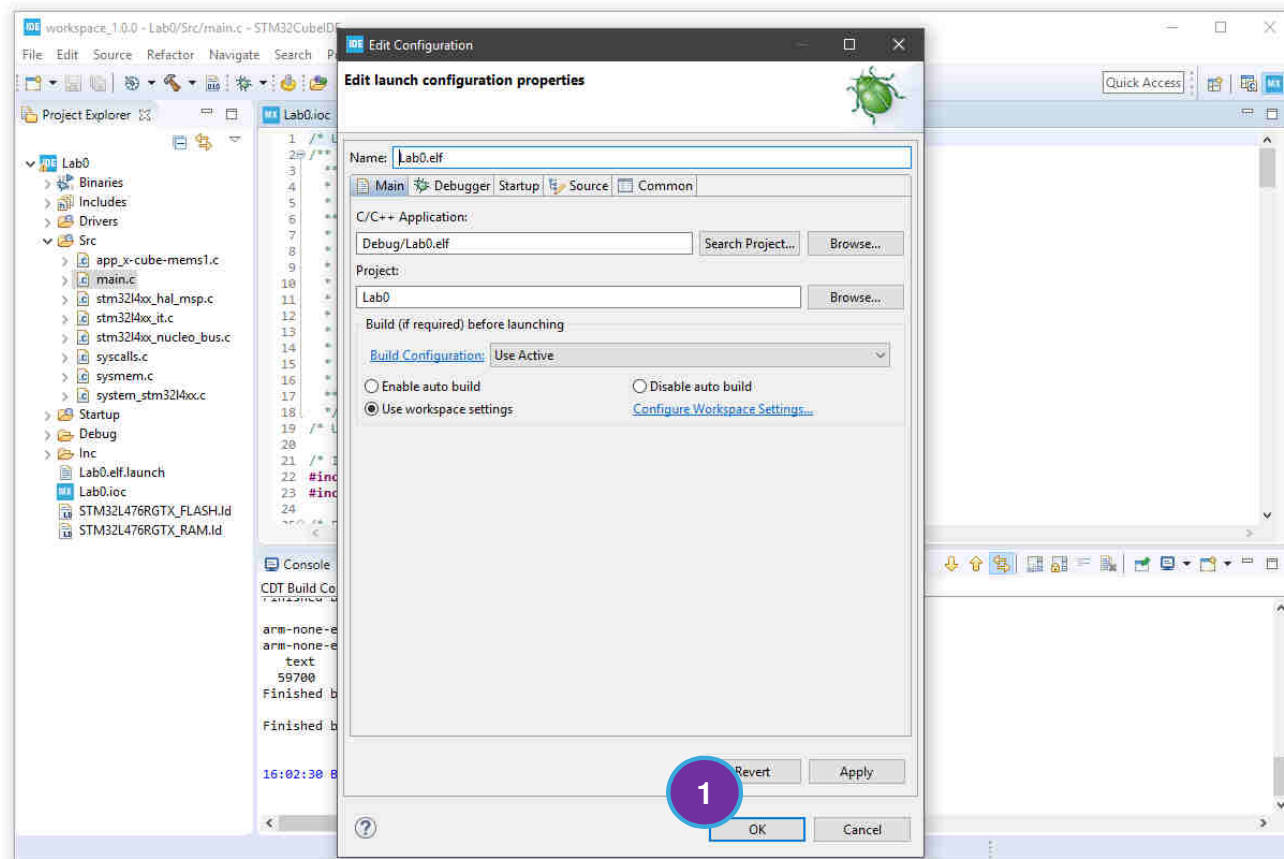
3. Click **OK**



# Lab0 - Debugging

94


1. Click **OK**

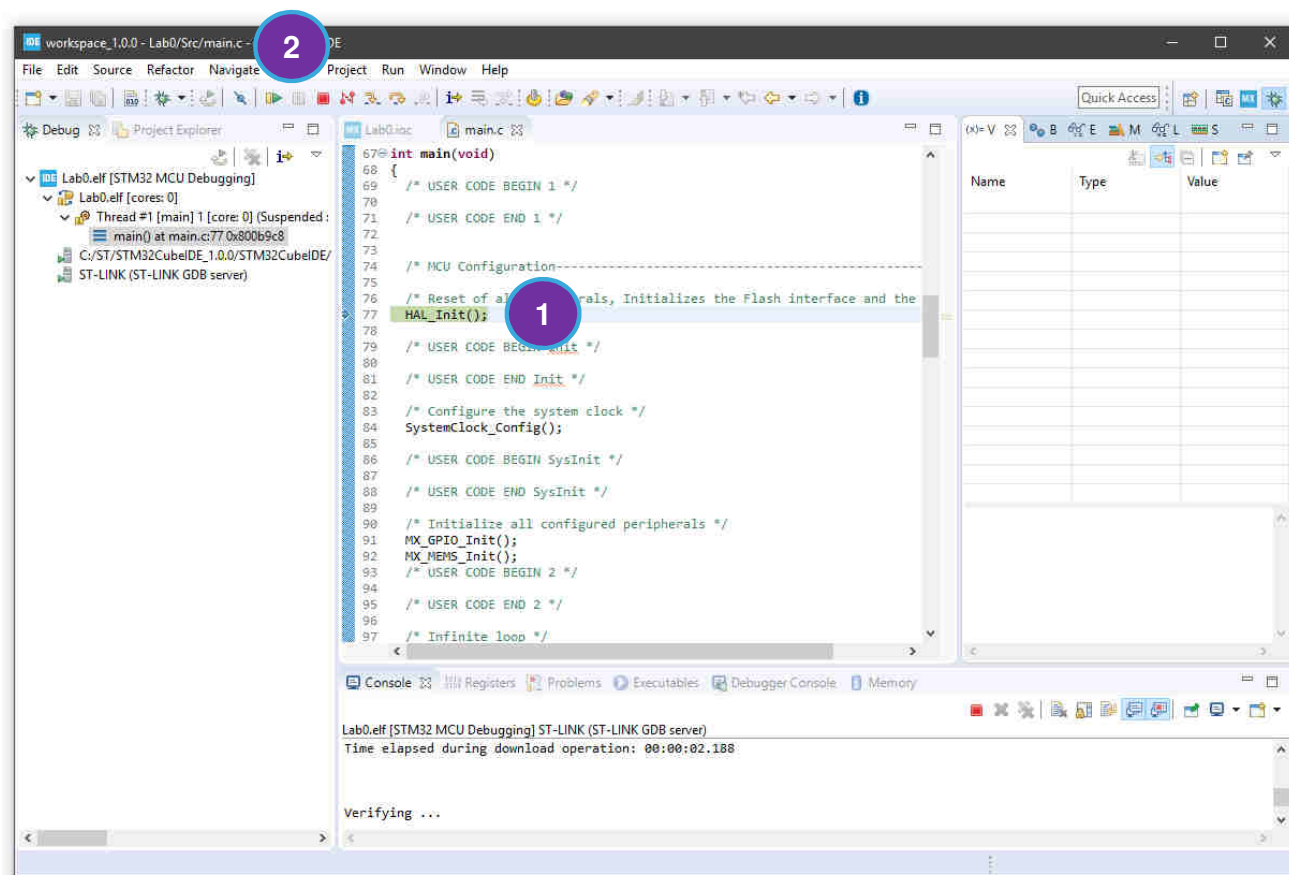


# Lab0 - Debugging

95

1. Code start at the first line of the main function

2. Click play  button to run the code

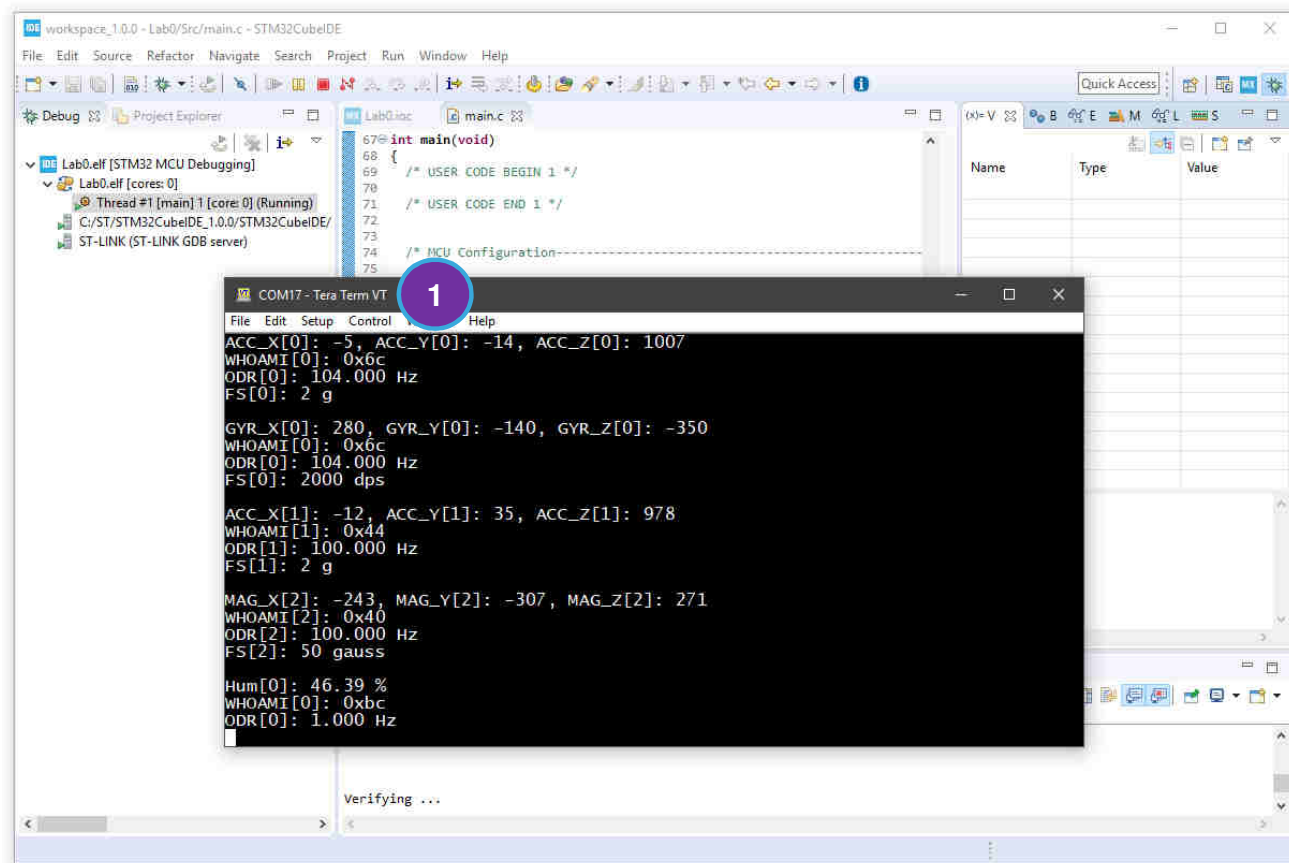




# Lab0 - Debugging

96

1. Open Tera Term to view the output

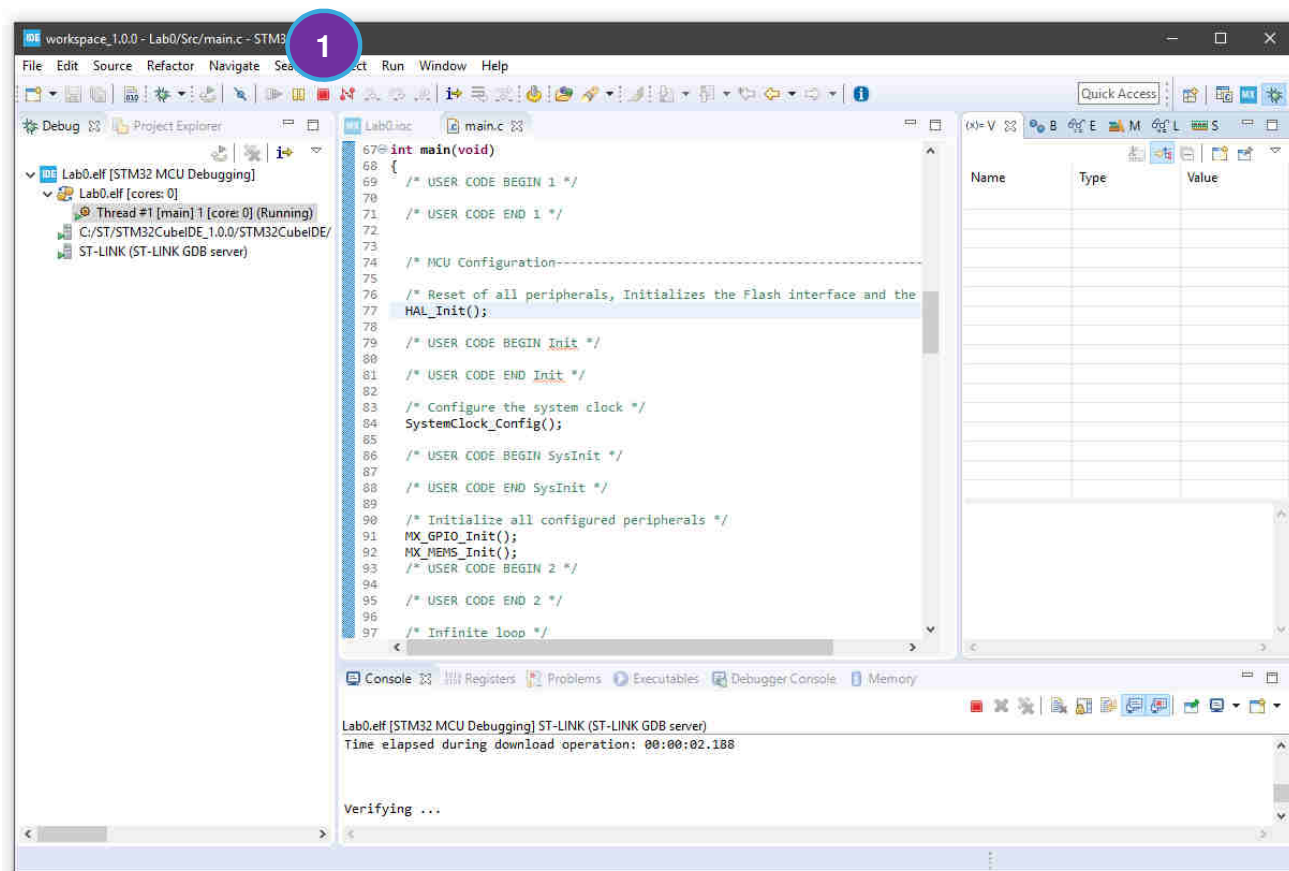




# Lab0 - Debugging

97

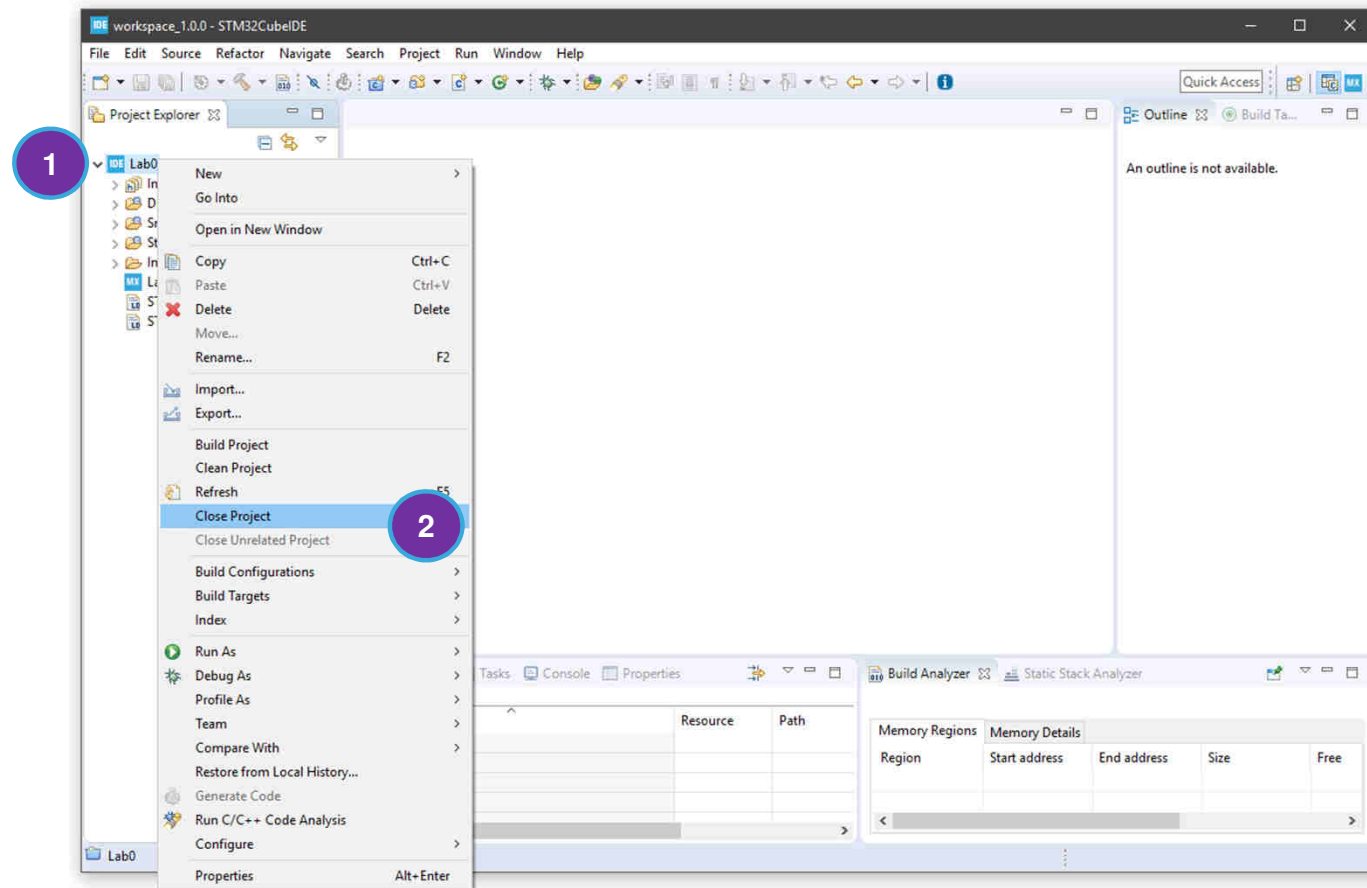
1. Click stop  button to interrupt the debugging



# Lab0 – Closing the project

98

1. Right-Click on **Lab0** project
2. Click on **Close Project**



# LAB1



## Goals:

- Configure a new project using X-CUBE-MEMS1
- **Configure LIS2DW12 accelerometer in order to generate an interrupt at every orientation change**
- Enable interrupts in STM32CubeIDE
- Visualizing the new orientation on Tera Term

## Power saving and flexible Accelerometer

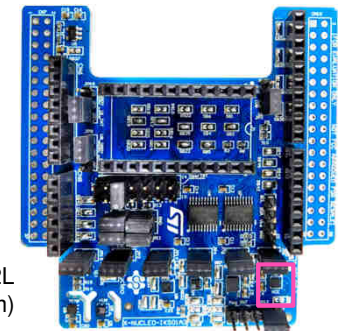
- Down to 0.38  $\mu\text{A}$  power consumption (1.6Hz ODR)
- High Perf. mode: up to 1600Hz with noise density 90  $\mu\text{g}/\sqrt{\text{Hz}}$
- 5 Power Modes + 2 Noise Modes
- 32-level FIFO buffer
- Digital Features
  - Free fall
  - Wake-up
  - 6D / 4D
  - Stationary/Motion detection
  - Double Tap

Enabling battery saving

Accuracy

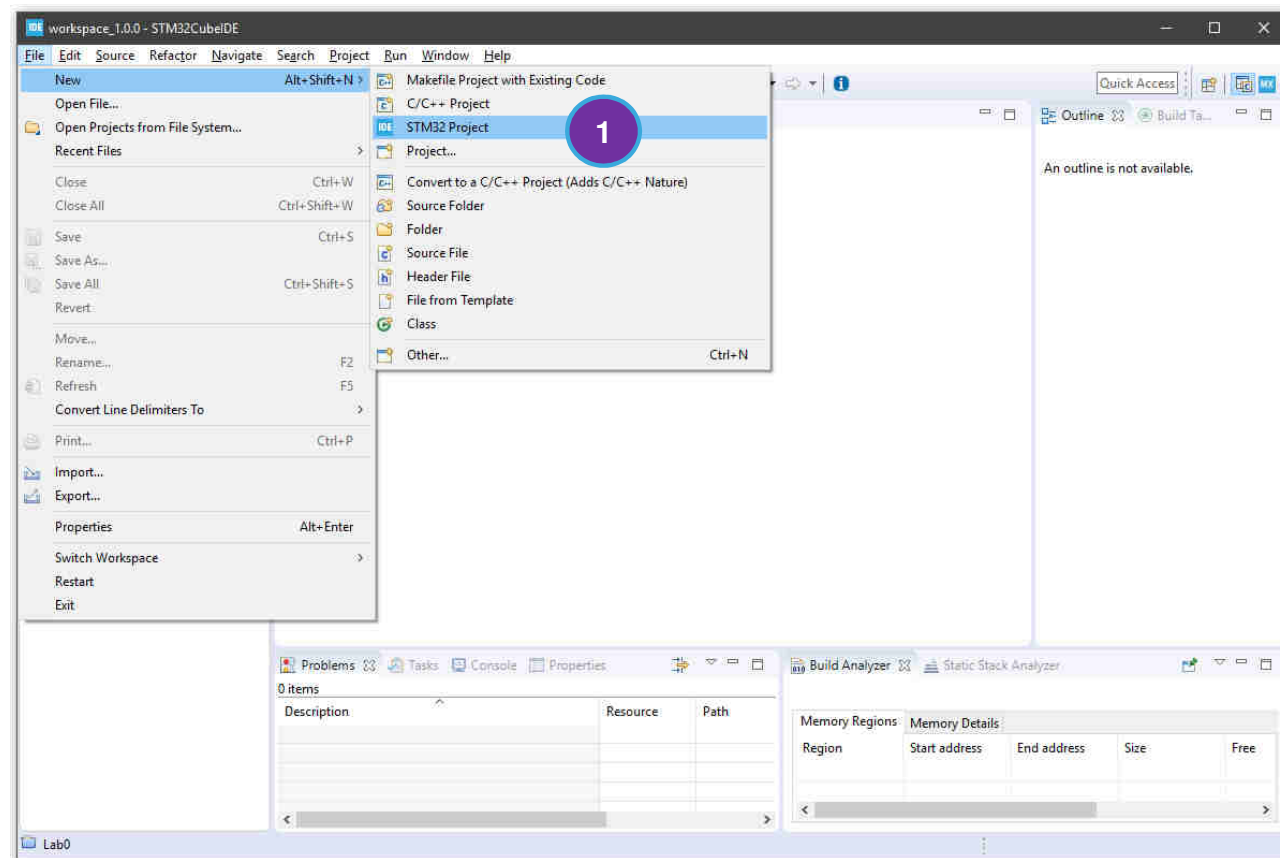
High Flexibility

System Power Saving & Smart Functions

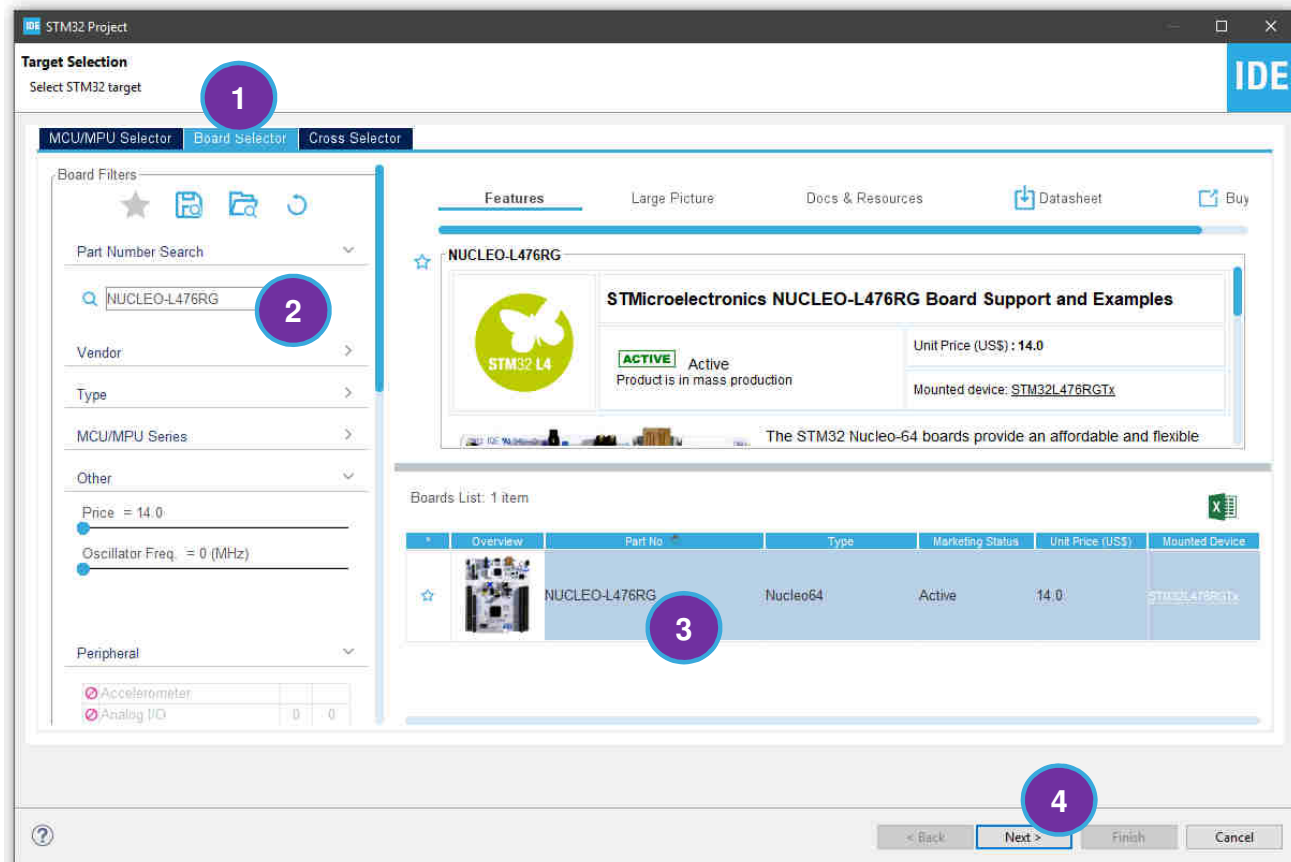


LGA-12L  
(2.0 x 2.0 x 0.7 mm)

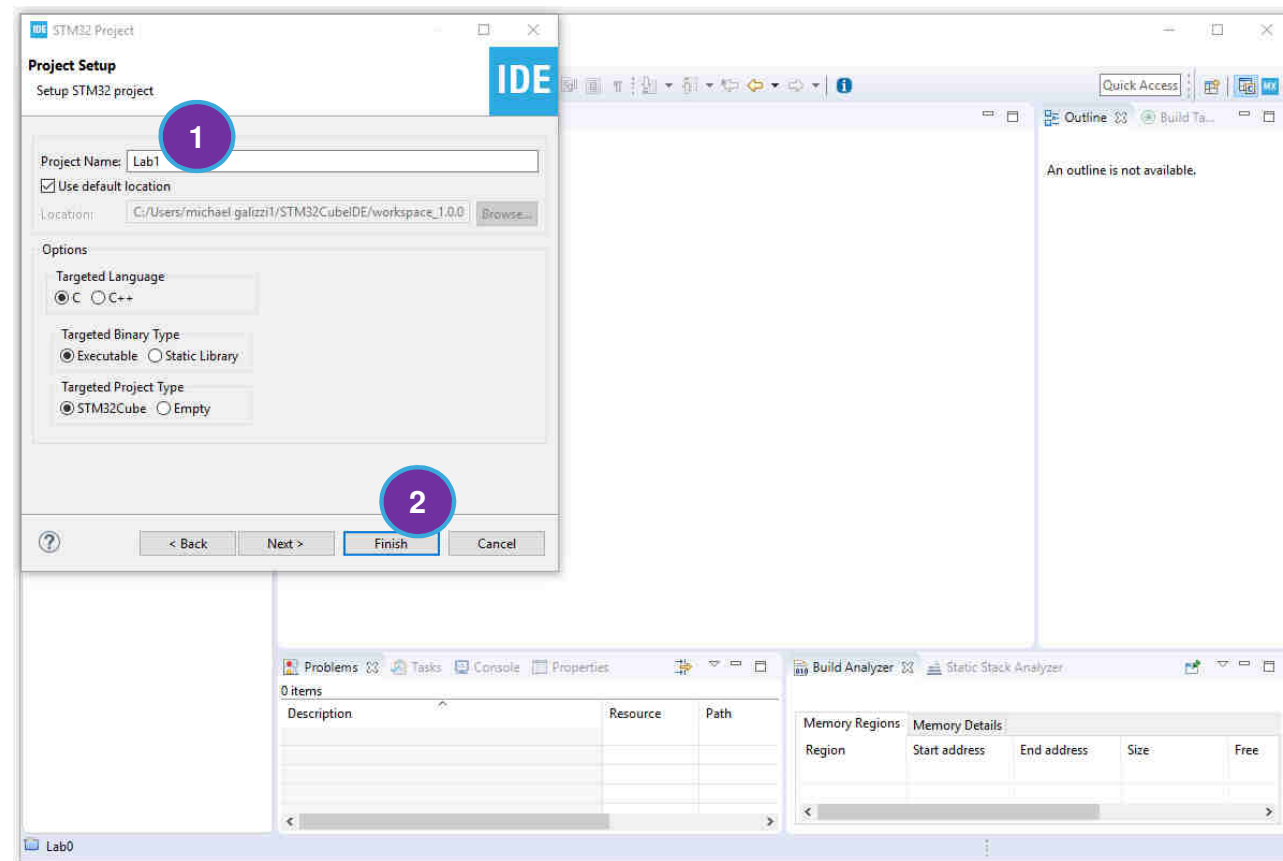
## 1. Click on **File > New > STM32 Project**



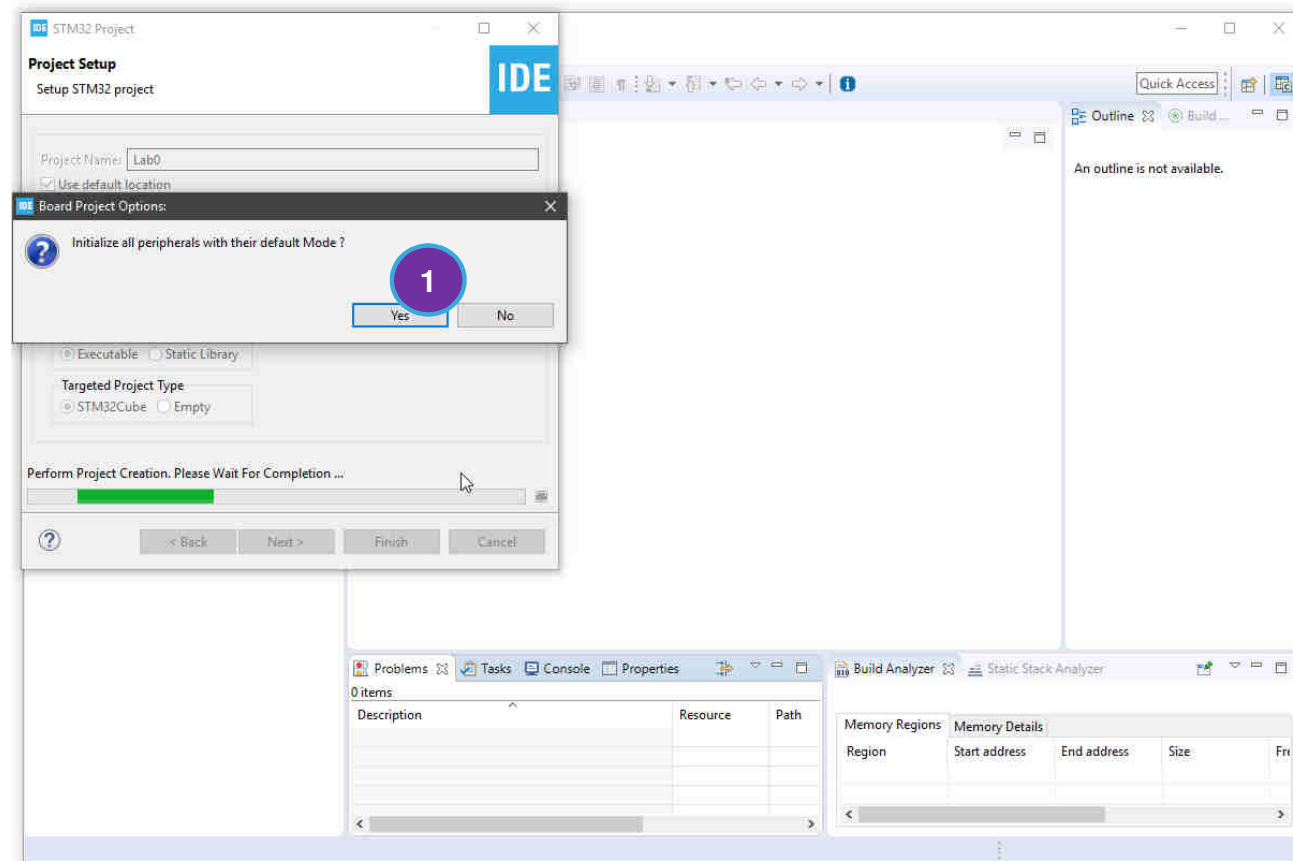
1. Click on **Board Selector**
2. Type **NUCLEO-L476RG**
3. Click on the board
4. Click **Next >**



1. Project Name **Lab1**
2. Click **Finish**



1. Click **Yes** to init peripherals in default mode

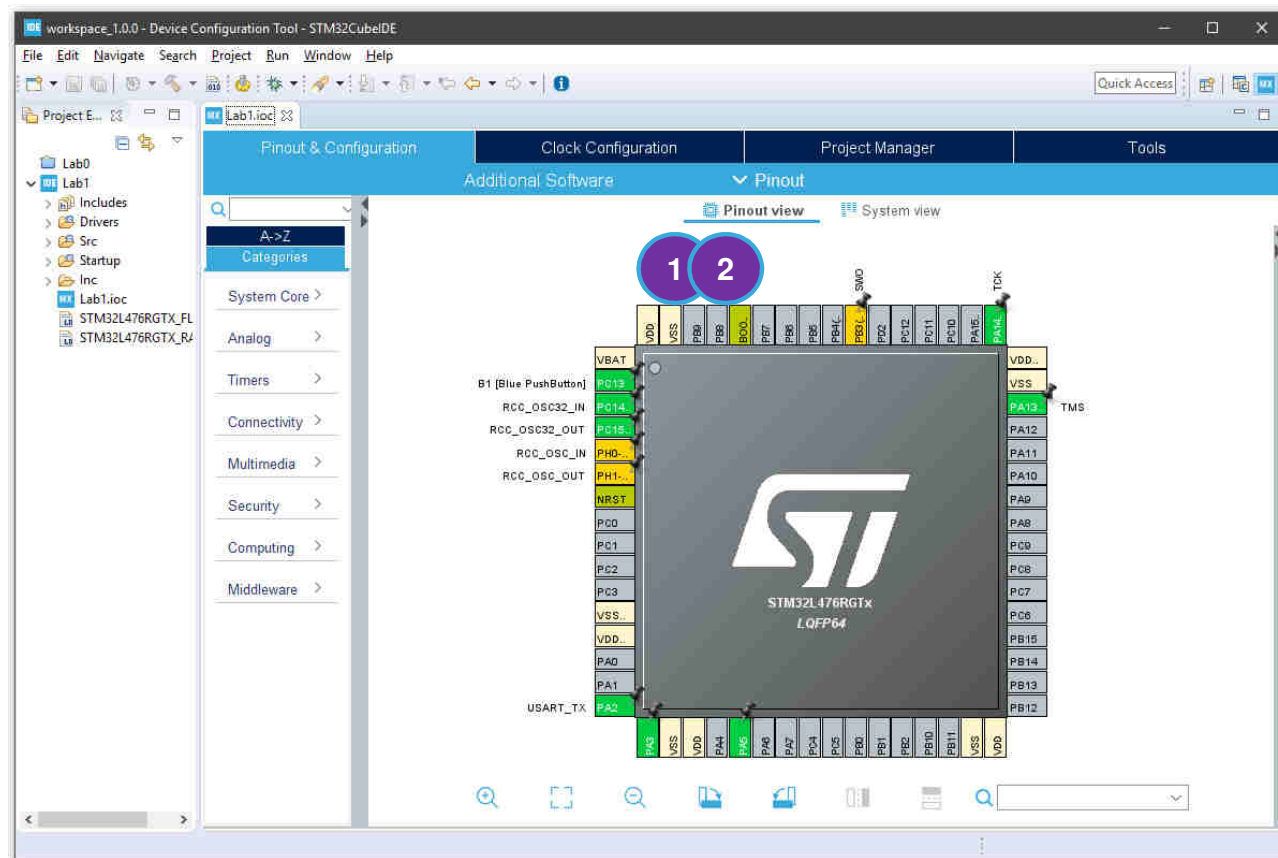
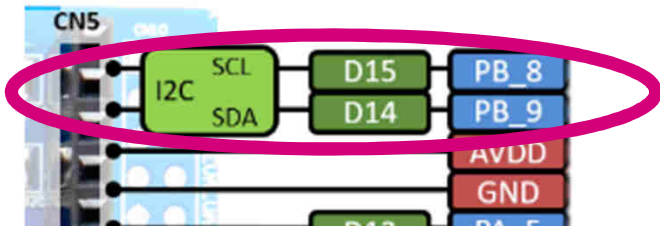




# Lab1 – Configure the I2C bus

105

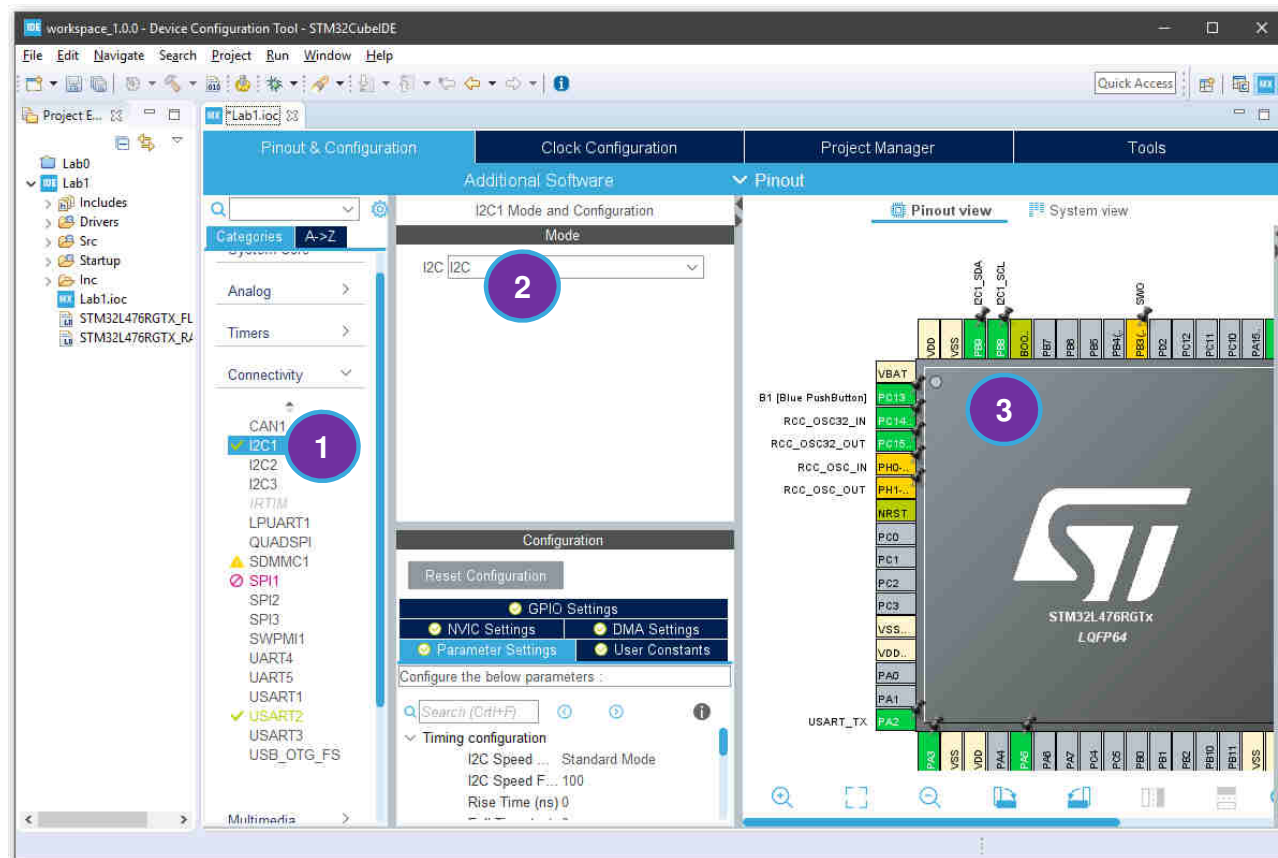
1. Left Click on **PB9** and select I2C1\_SDA
2. Left Click on **PB8** and select I2C1\_SCL



# Lab1 – Configure the I2C bus

106

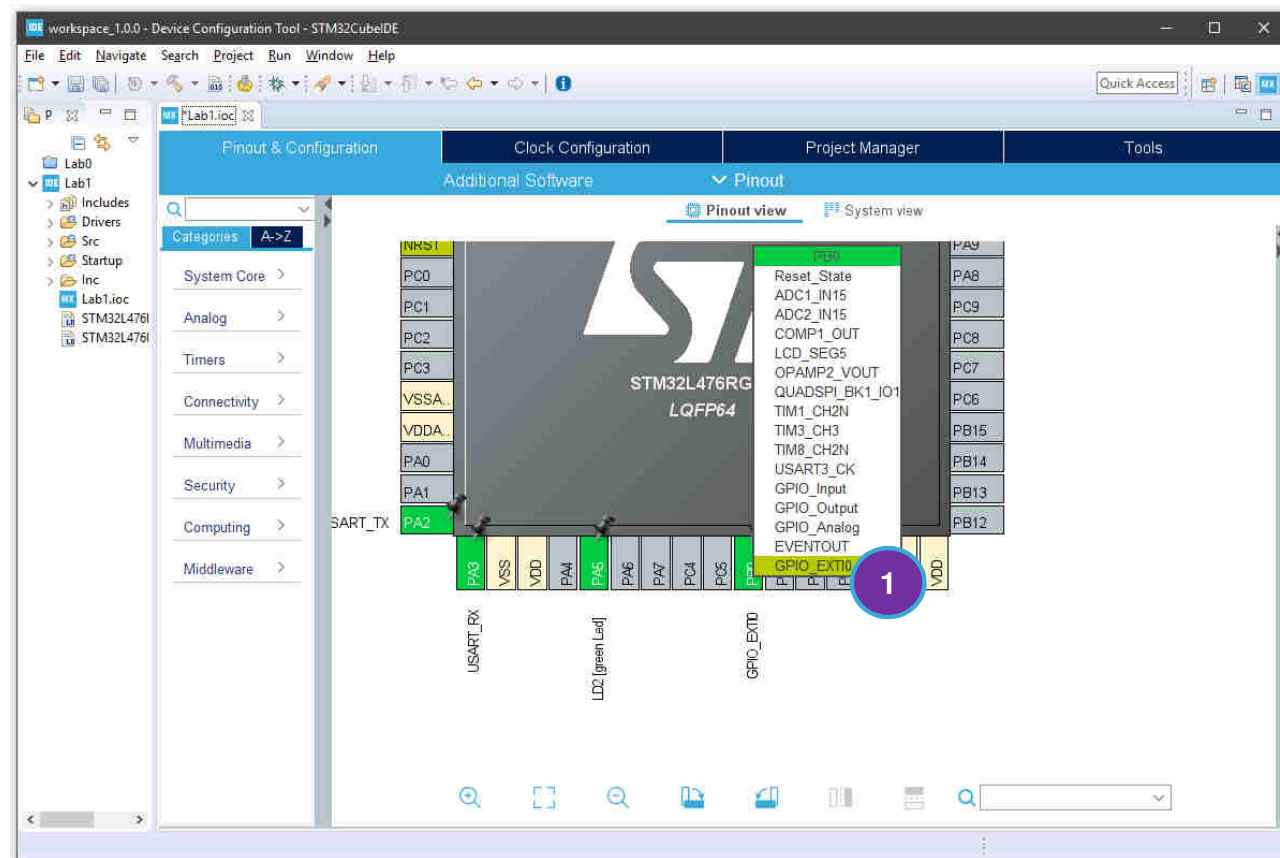
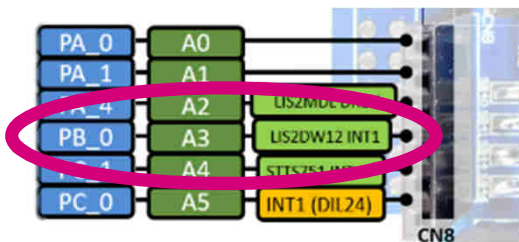
1. Expand *Connectivity* tab and check **I2C1**
2. Select **I2C** in *I2C1 Mode and Configuration*
3. PB8 and PB9 should now become green



# Lab1 – Configure LIS2DW12 interrupt

107

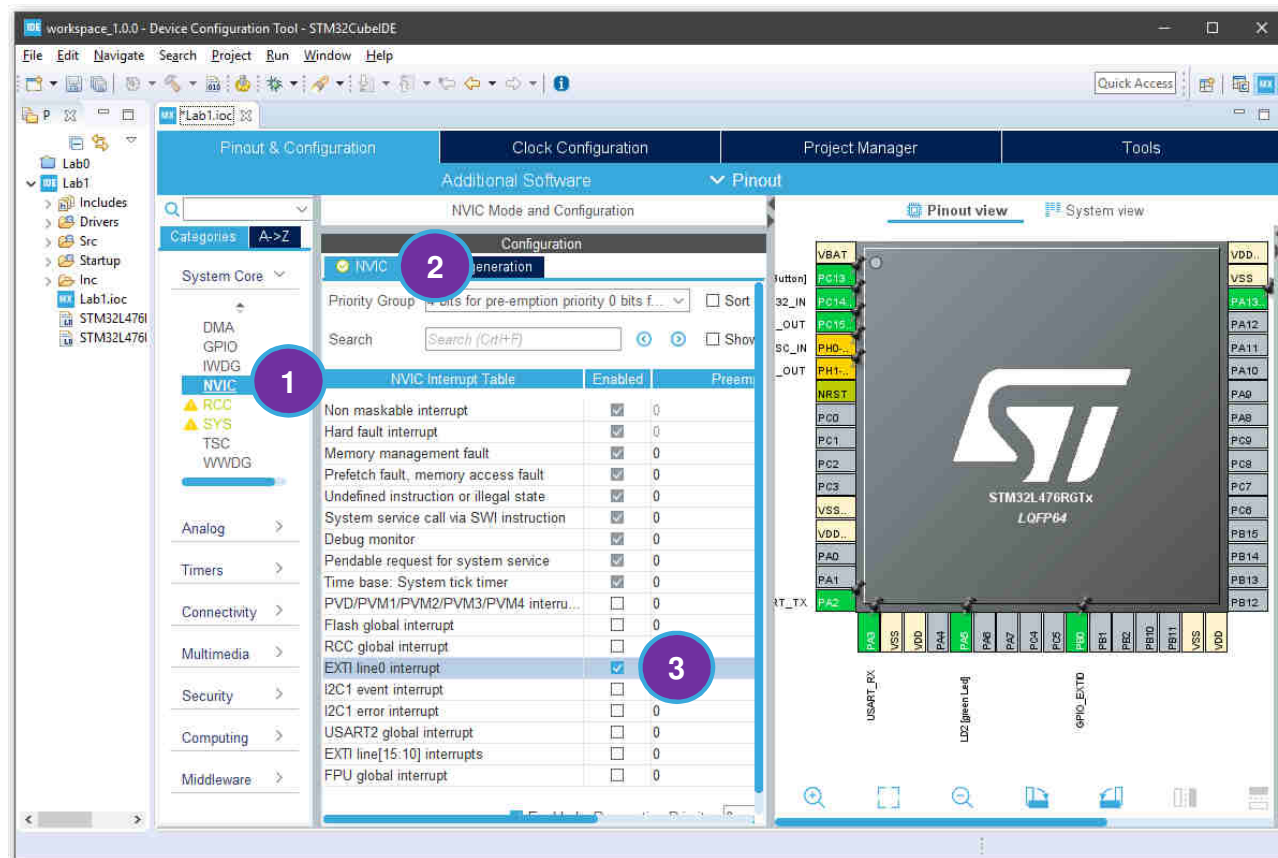
1. Left Click on **PB0** and select **GPIO\_EXTIO**



# Lab1 – Configure LIS2DW12 interrupt

108

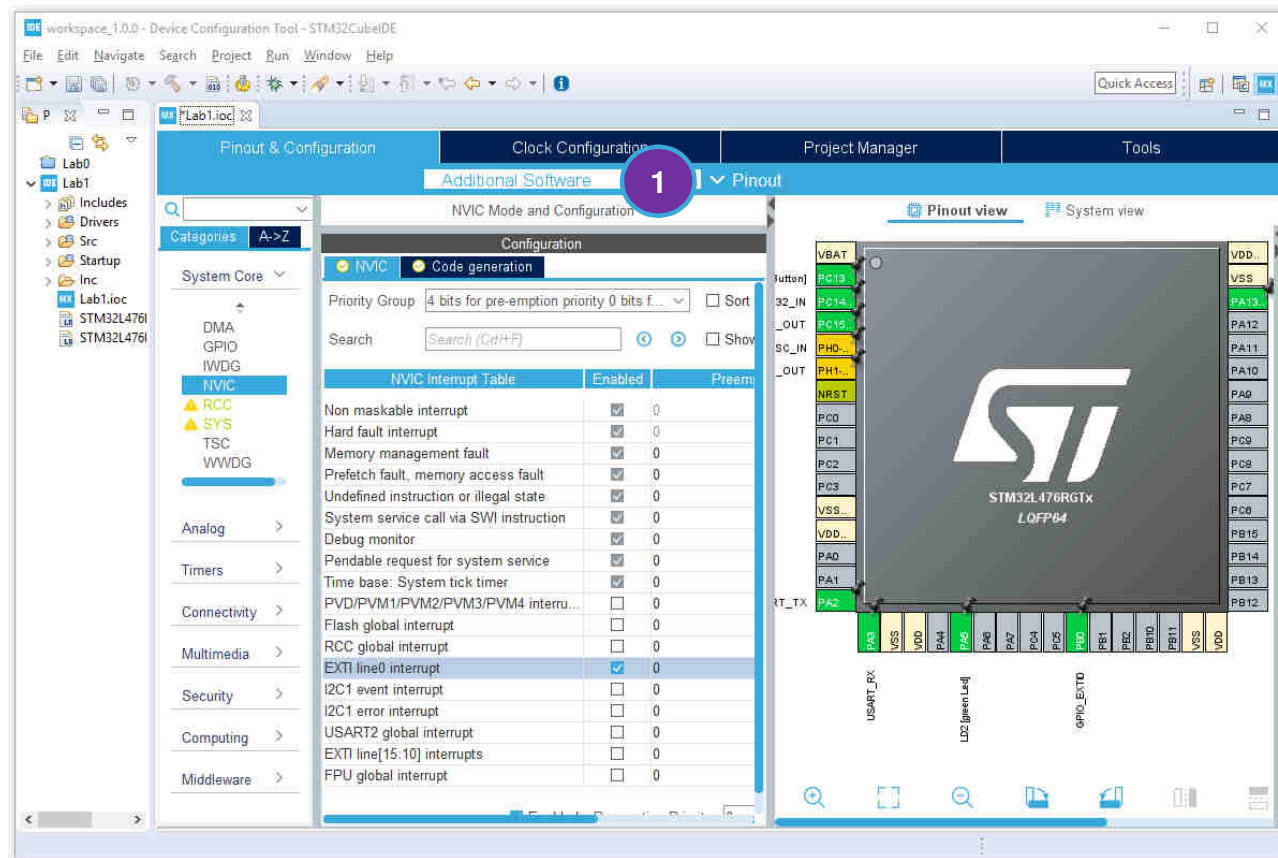
1. Check **NVIC** in tab System Core
2. Select **NVIC** in NVIC Mode and Configuration
3. Enable **EXTI line0 interrupt**



# Lab1 – Select the MEMS library

109

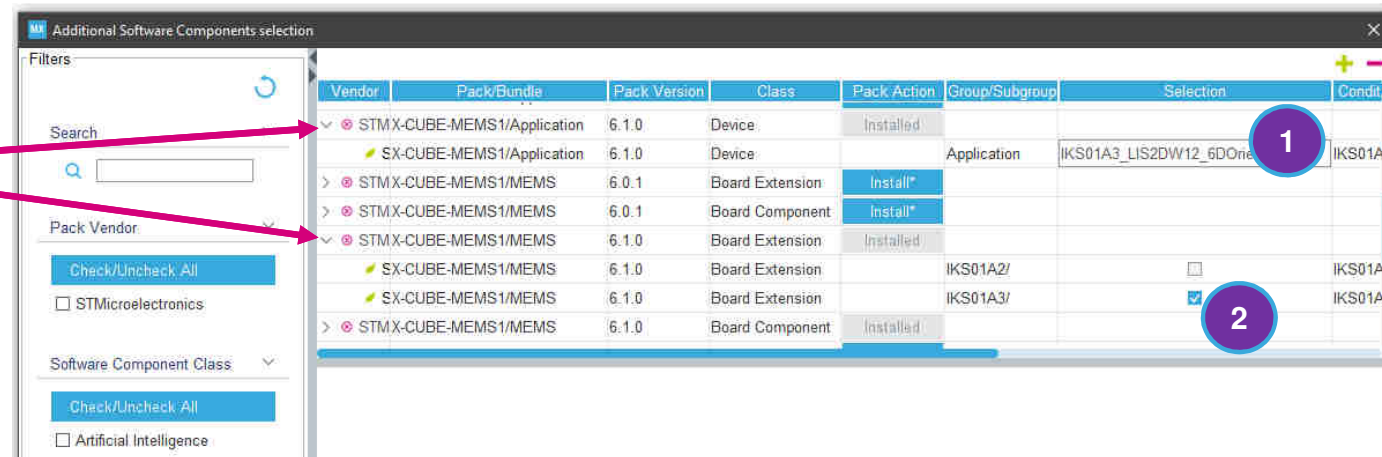
1. Click on **Additional Software**



# Lab1 – Select the MEMS library

110

Click to  
expand tree



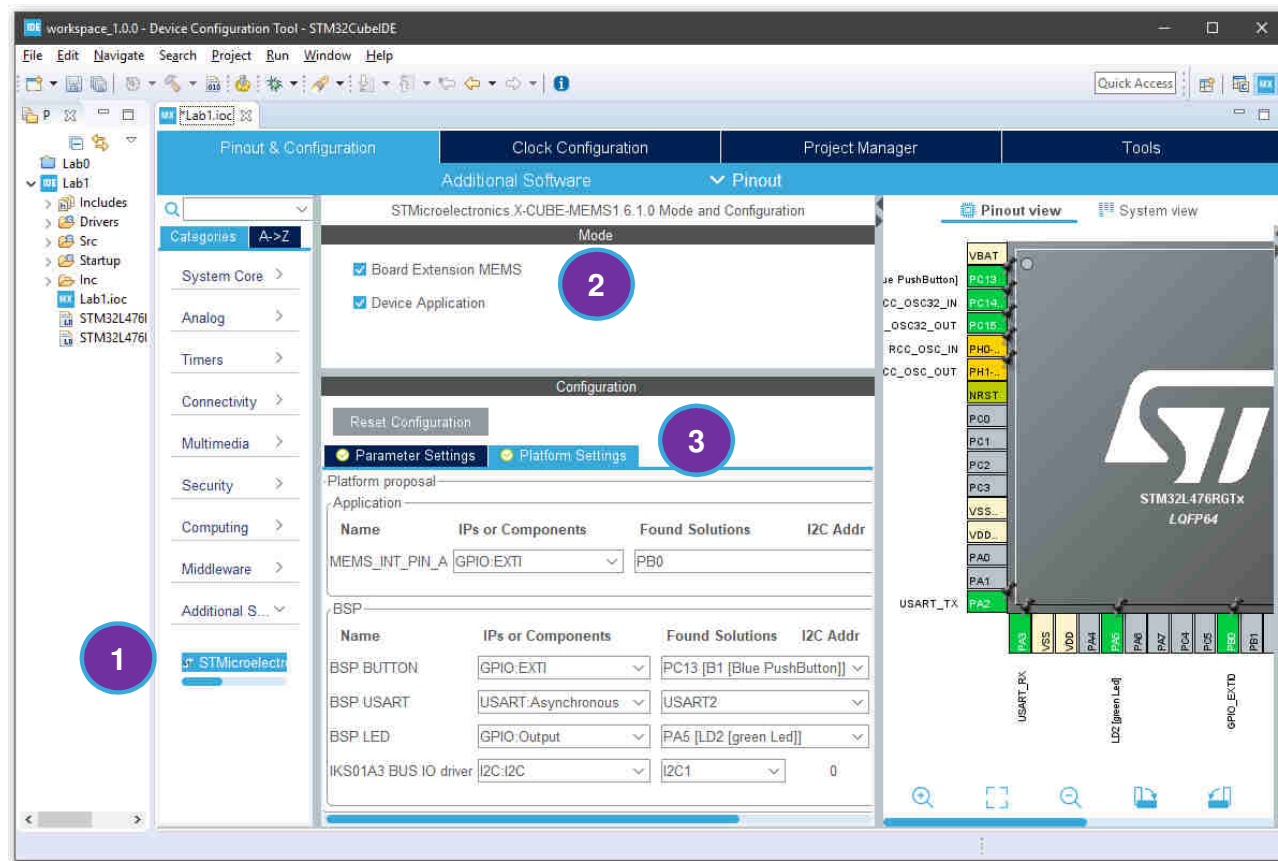
1. In X-CUBE-MEMS1/Application, Class “Device”:  
Select **IKS01A3\_LIS2DW12\_6DOrientation**
2. In X-CUBE-MEMS1/MEMS, Class “Board Extension”:  
Check **IKS01A3/**
3. Click **OK**



# Lab1 – Configure the MEMS library

111

1. Expand Additional Software and select the X-CUBE-MEMS1
2. Check both:  
**Board Extension MEMS**  
**Device Application**
3. Configure Platform Settings as in picture



## 112

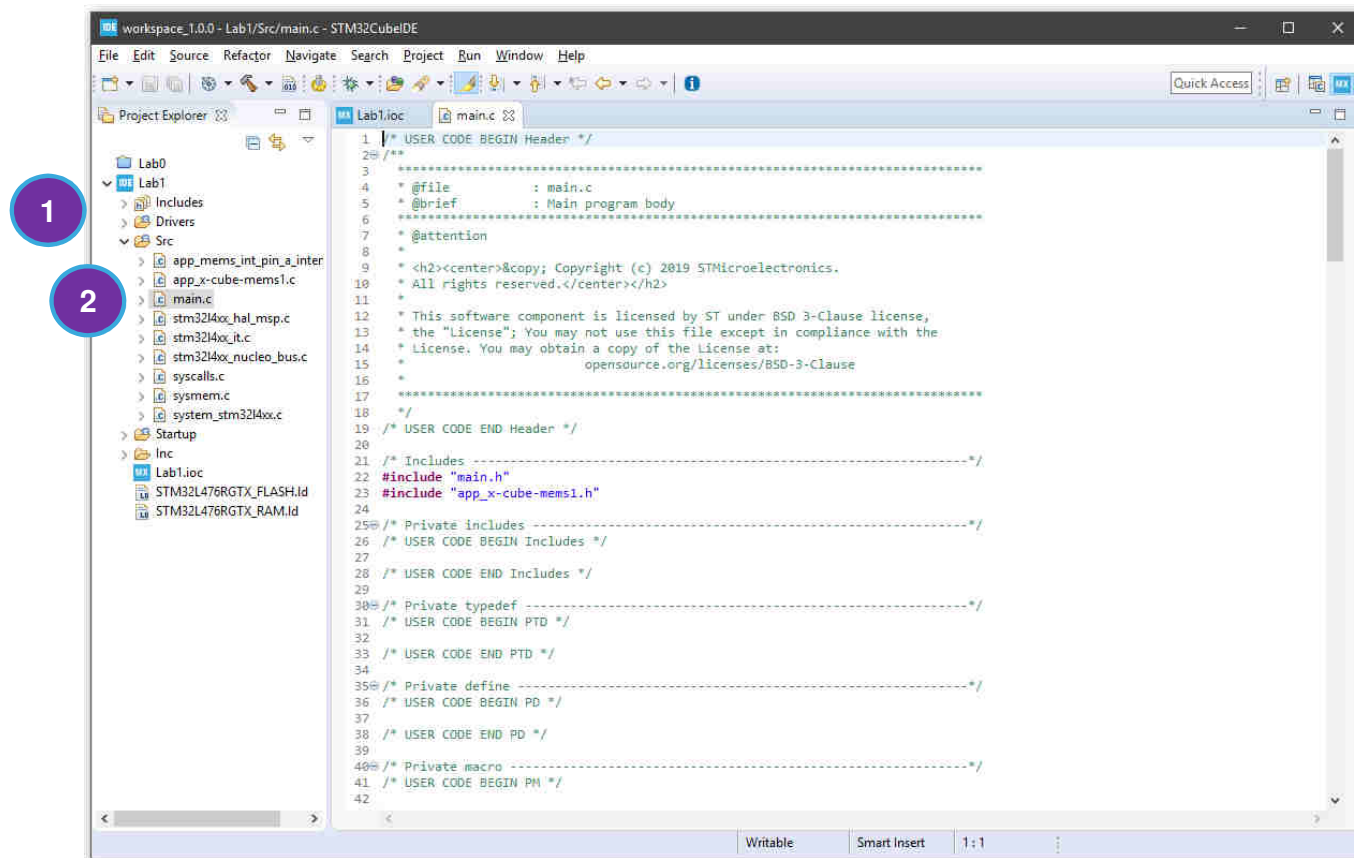




# Lab1 – Code Editing


114

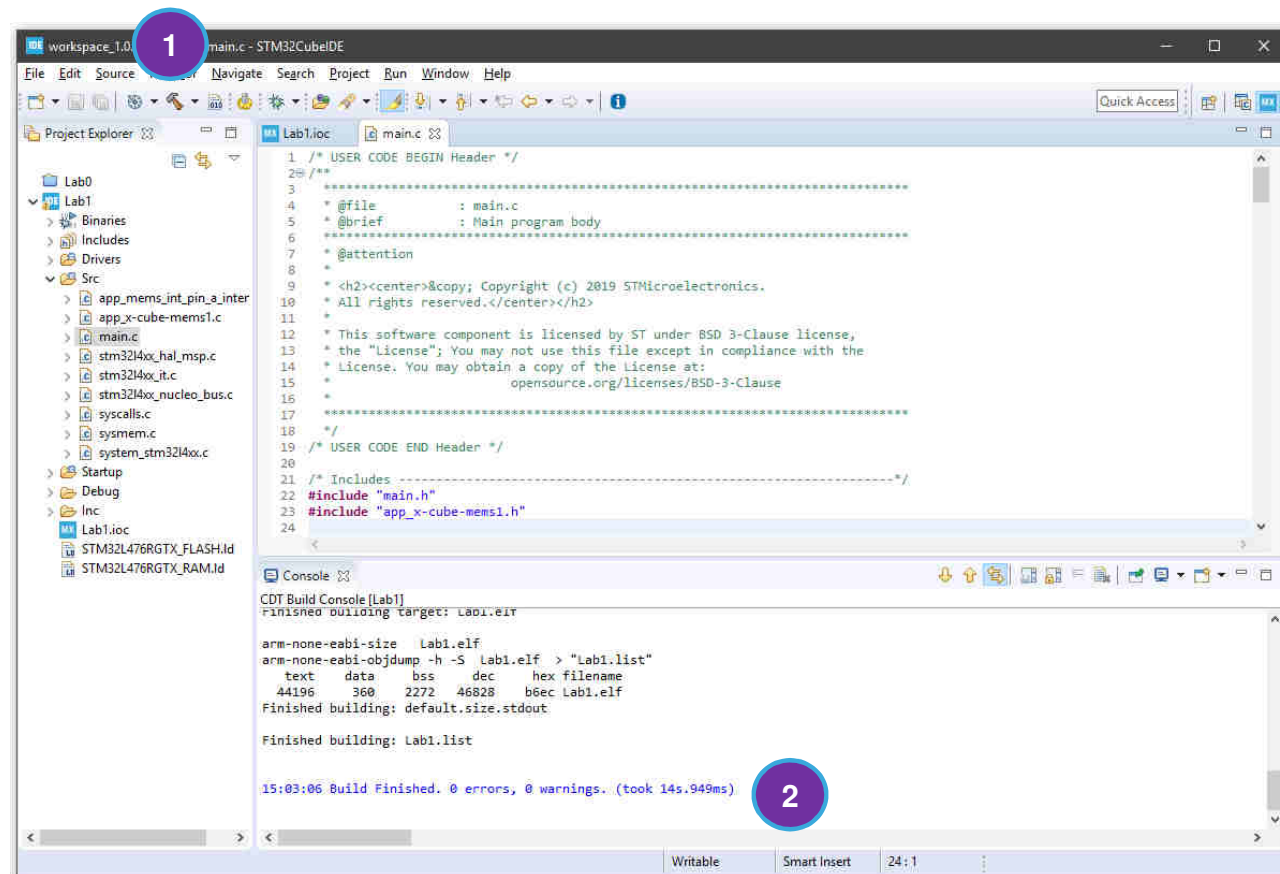
1. Expand **Src** in folder **Lab1**
2. Double click on **main.c**



# Lab1 - Compiling

115

1. Click on the hammer  to begin compilation, or press **CTRL+B**
2. Compilation should terminate with 0 errors and 0 warning



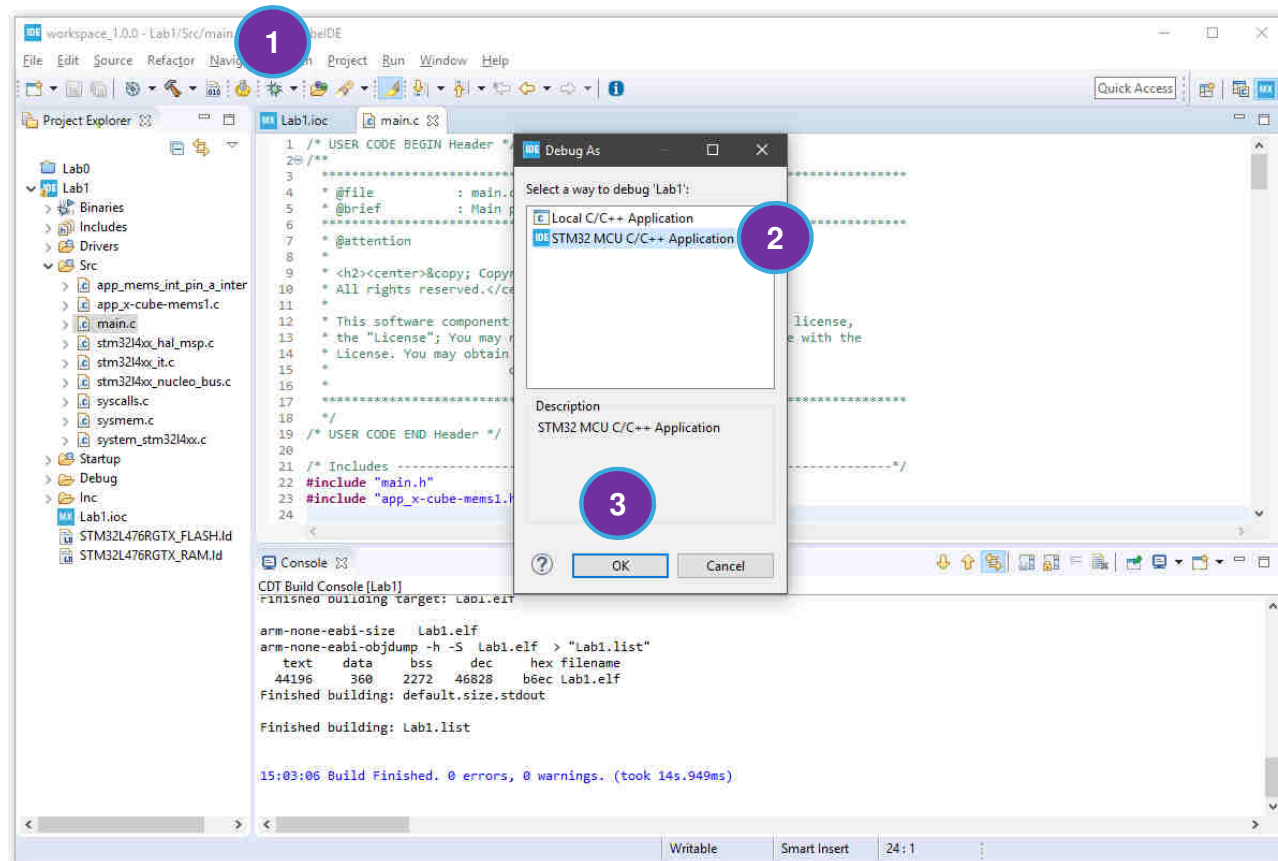
# Lab1 - Debugging

116

1. Click on the bug  to begin debugging

2. Select **STM32 MCU C/C++ App**

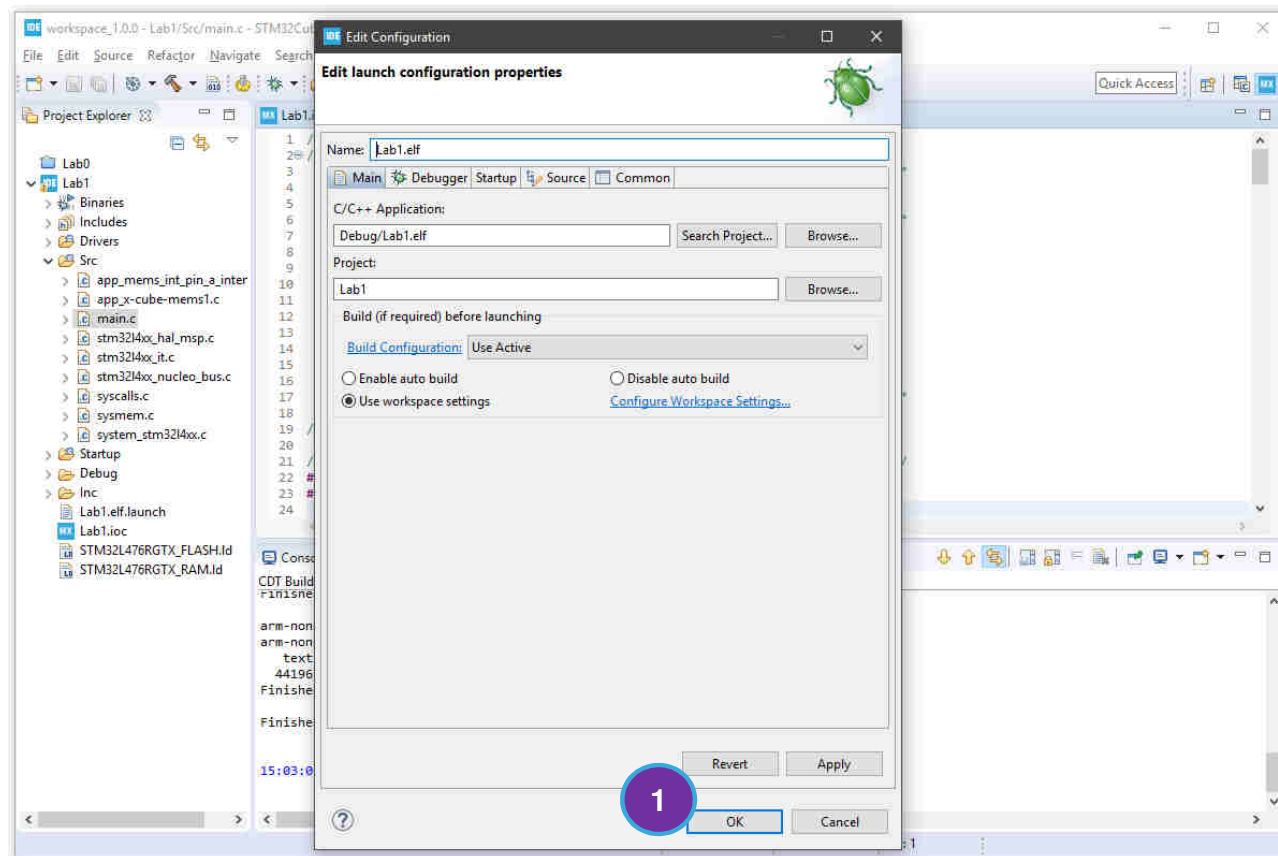
3. Click **OK**



# Lab1 - Debugging

117


1. Click **OK**

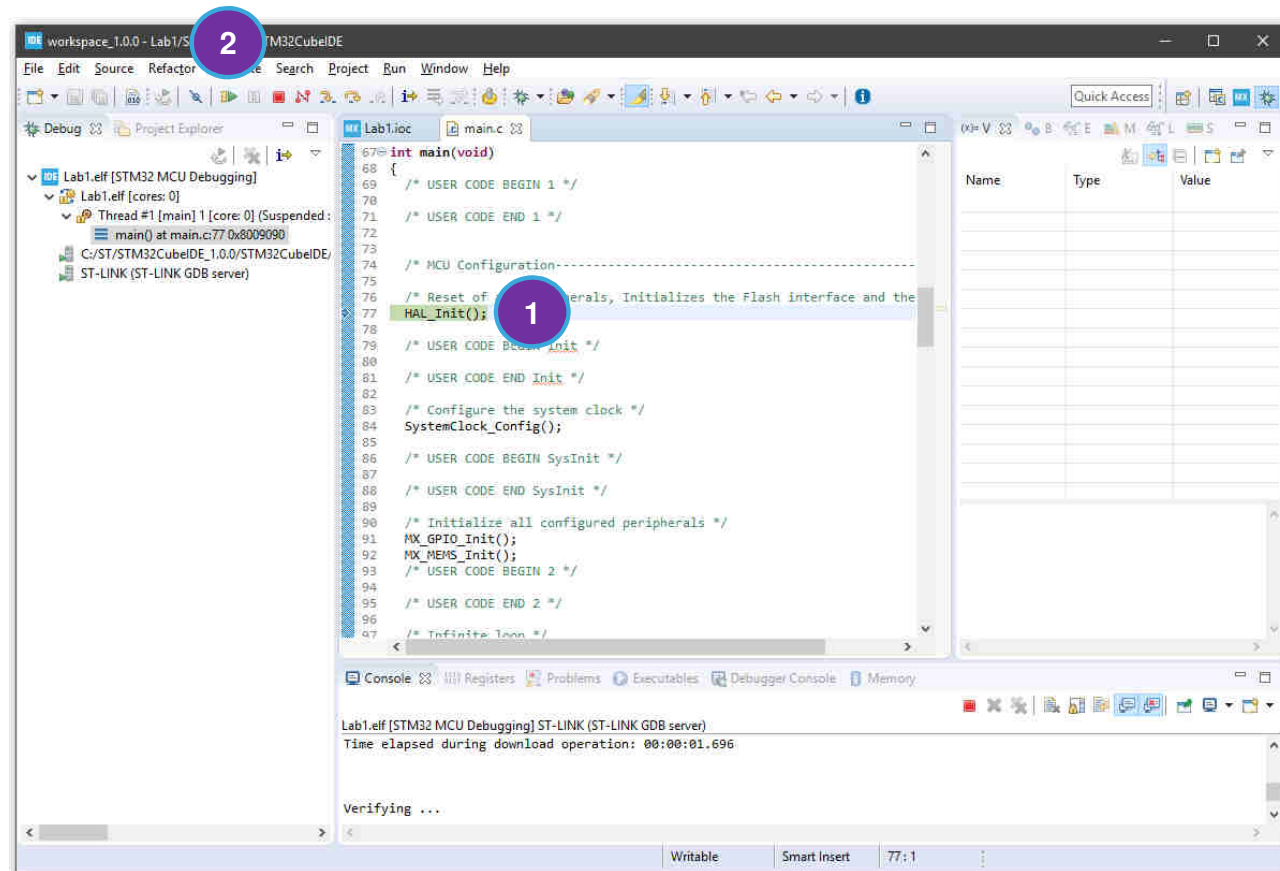


# Lab1 - Debugging

118

1. Code start at the first line of the main function

2. Click play  button to run the code



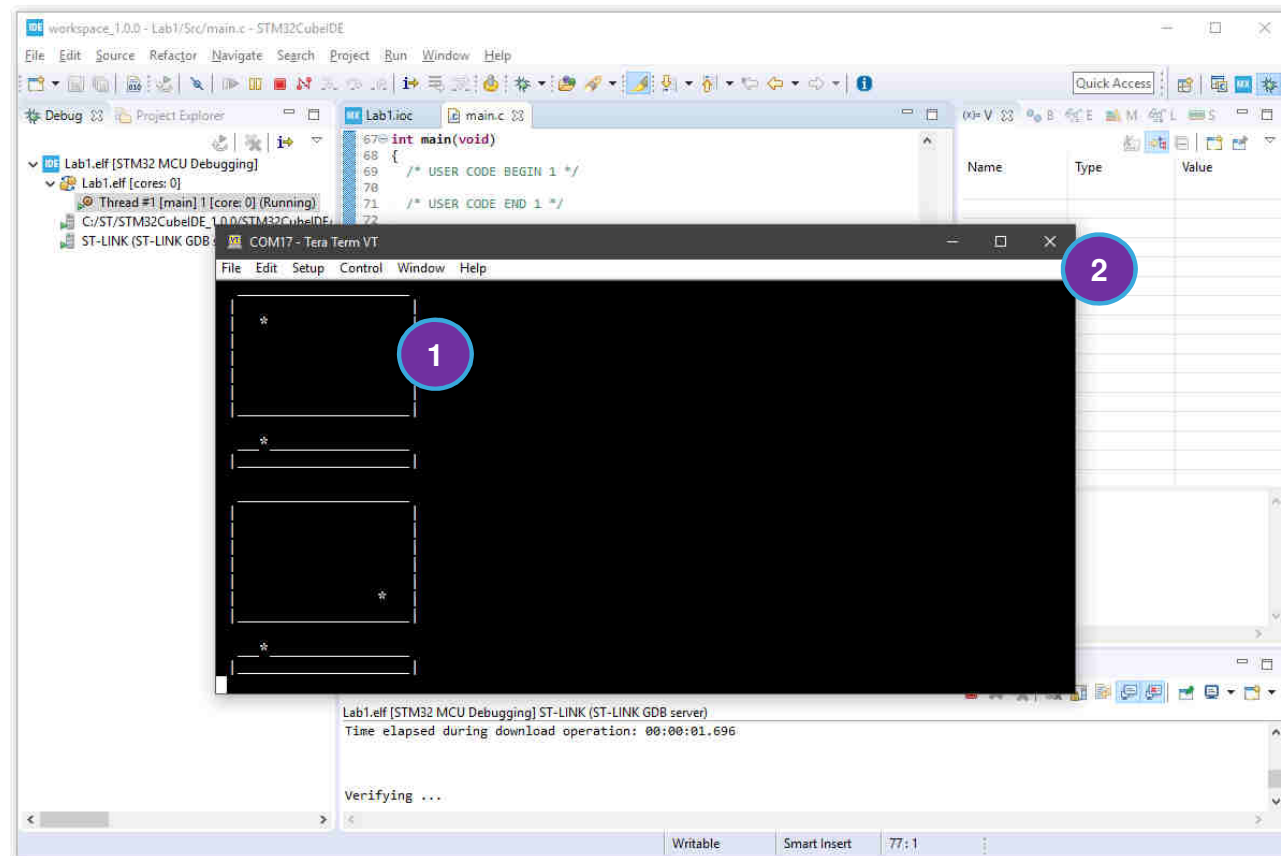
# Lab1 - Testing

119

1. Open Tera Term to view the output

Rotate the board to see the output changing

2. After testing close Tera Term by clicking **X**

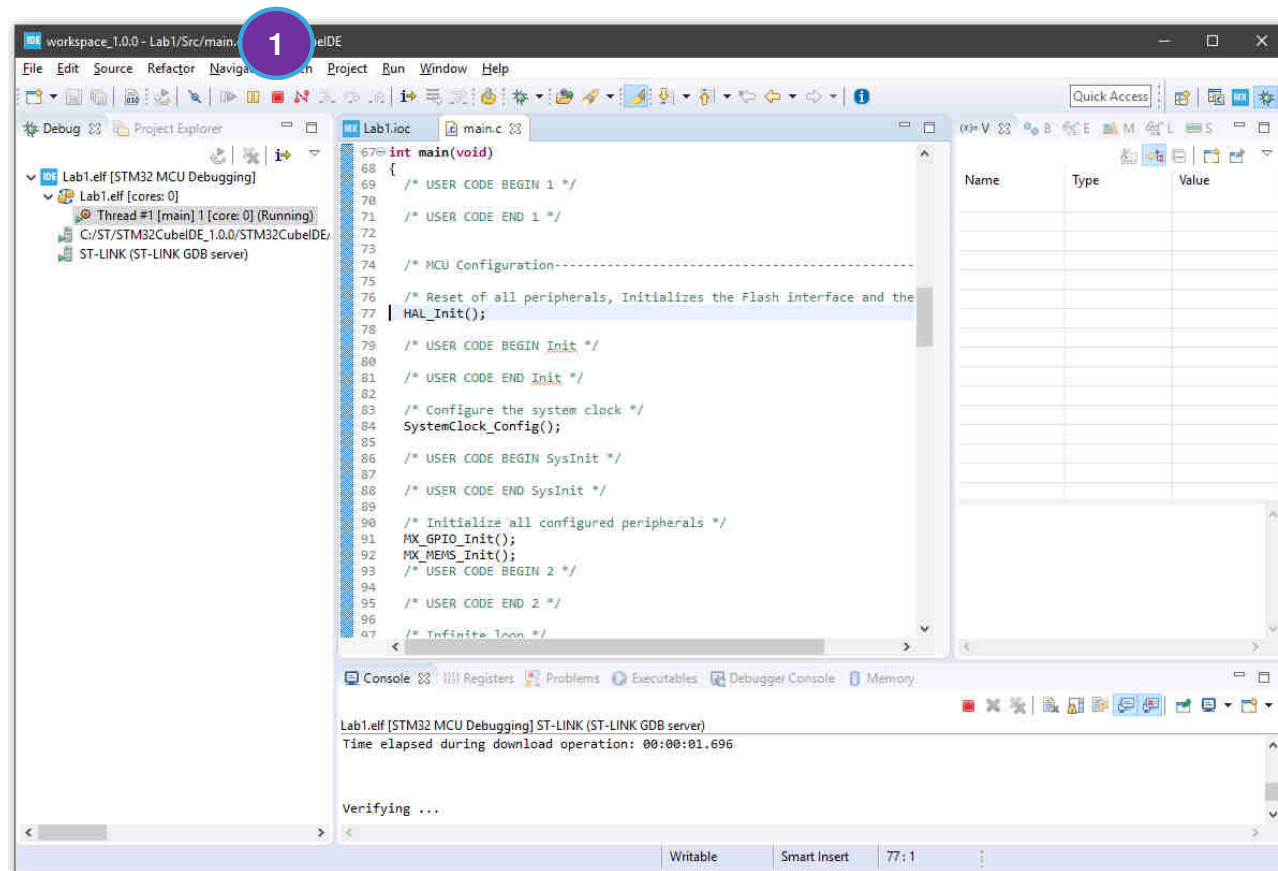




# Lab1 - Debugging

120

1. Click stop  button to interrupt the debugging

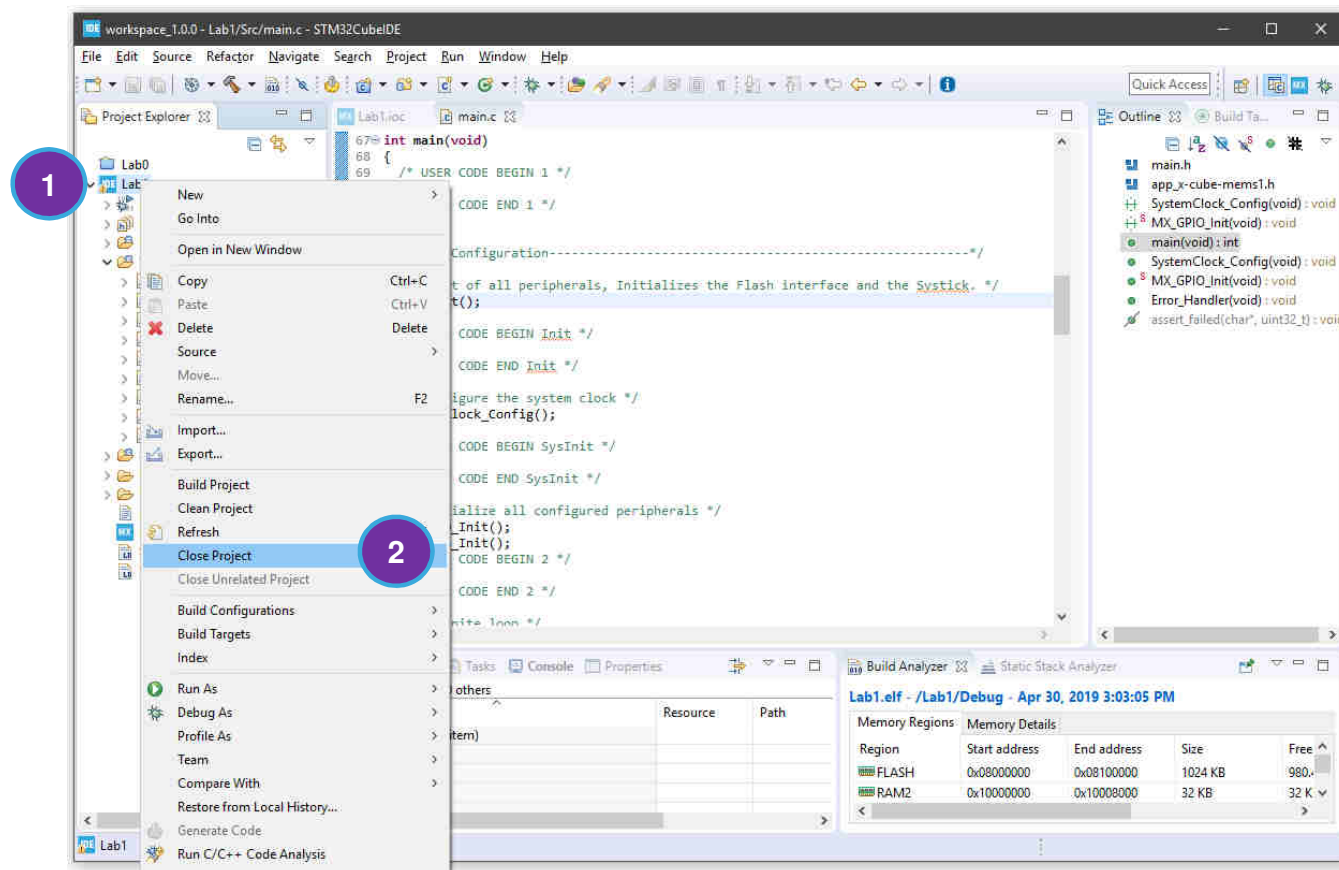




# Lab1 – Closing the project

121

1. Right-Click on **Lab1** project
2. Click on **Close Project**



# LAB2



The graphic features a thin, dark blue wavy line that starts from the left, dips, rises to a peak, and then dips again towards the right. Three circular icons are connected to this line. The first icon, located below the first peak, is a dark blue circle with a white silhouette of a person jumping. It has a yellow arc above it and a blue arc to its left. The second icon, located on the downward slope, is a dark blue circle with a white network-like pattern of dots and lines. It has a yellow arc above it and a blue arc to its left. The third icon, located at the bottom of the second dip, is a small dark blue circle with a white dot in the center. It has a yellow arc above it and a blue arc to its left.

## Goals:

- Configure a new project using X-CUBE-MEMS1
- Configure LPS22HH pressure and temperature sensor to acquire data using internal FIFO
- Enable interrupts in STM32CubeIDE

## High-performance, high-ODR Barometer / Altimeter

- Absolute Accuracy: 0.5hPa
- Relative Accuracy:  $\pm 0.025\text{hPa}$
- RMS Noise:  $\pm 0.65\text{Pa}$  (0.0065hPa)
- ODR up to 200Hz
- Embedded Temperature compensation
- Unique Full Molded Package

High Resolution - ~5cm

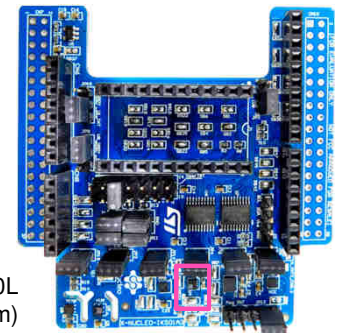
High Performance: excellent noise figure

Fast Response

System Power Saving

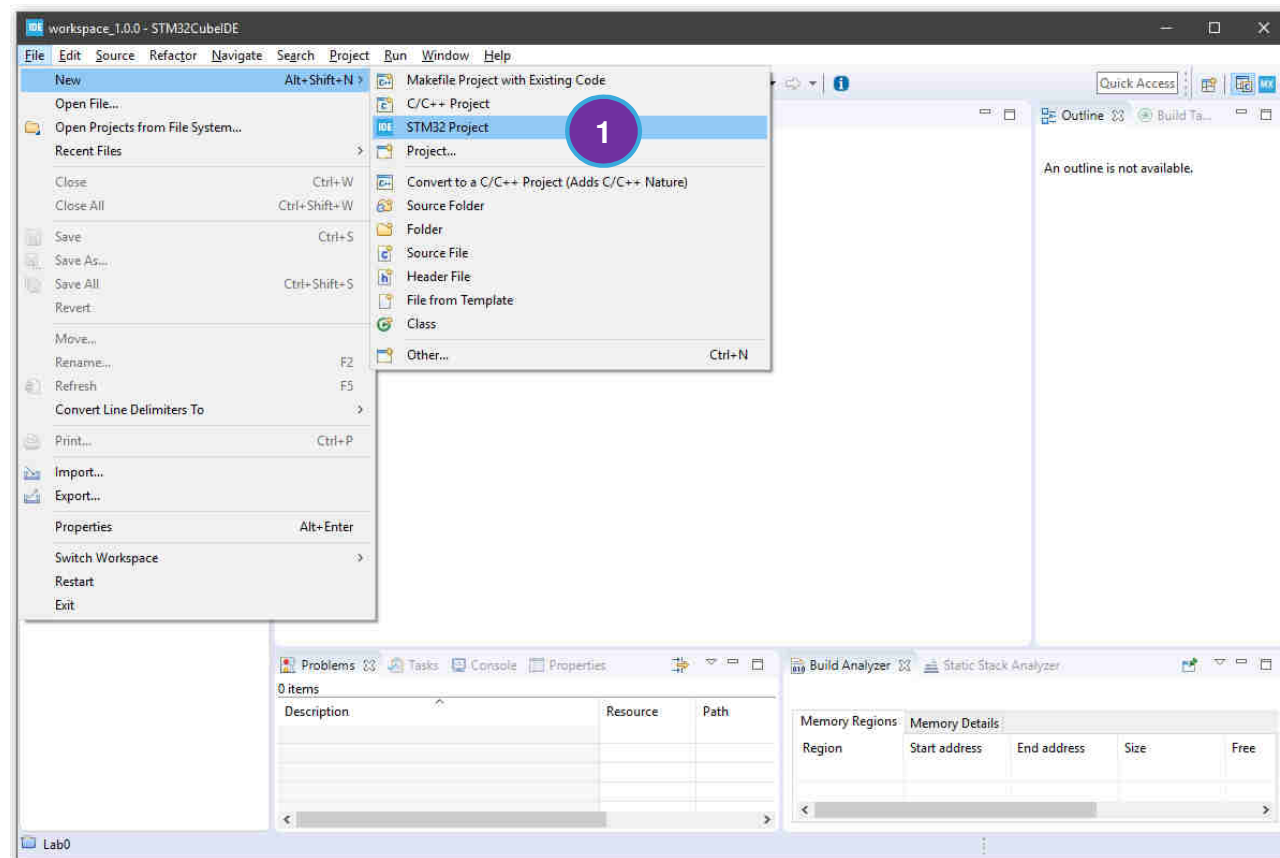
Robustness

Skip One Point Cal.  
post Soldering  
→ Cost Saving

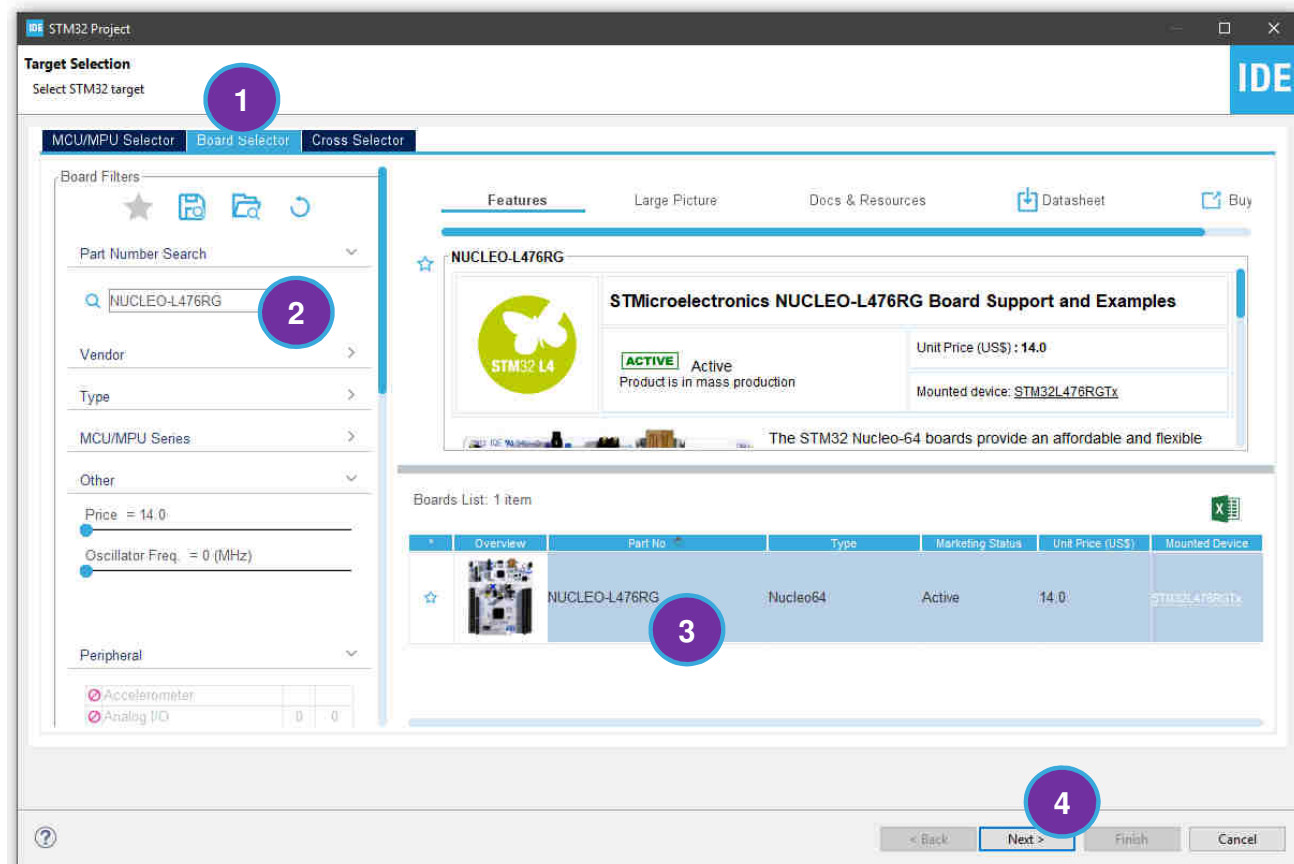


HLGA-10L  
(2 x 2 x 0.73 mm)

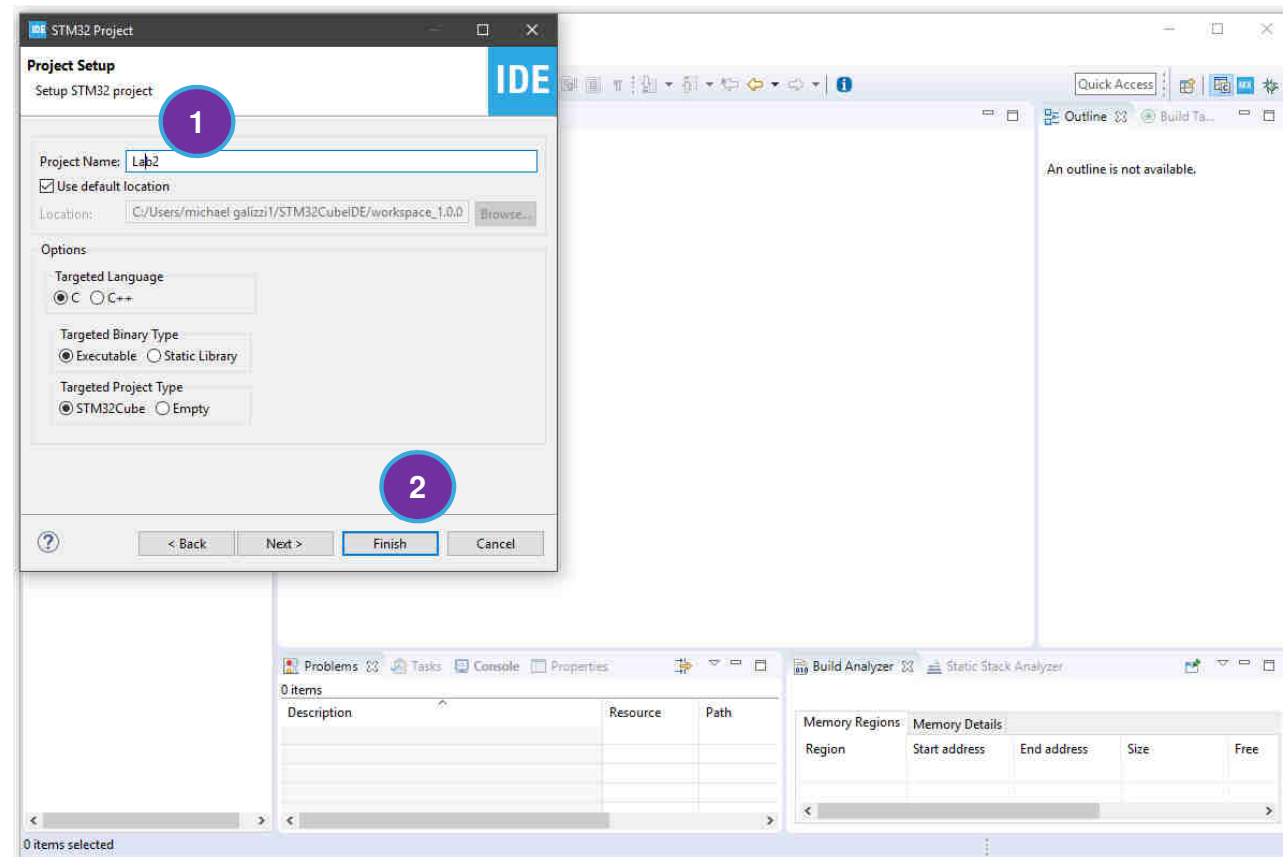
## 1. Click on **File > New > STM32 Project**



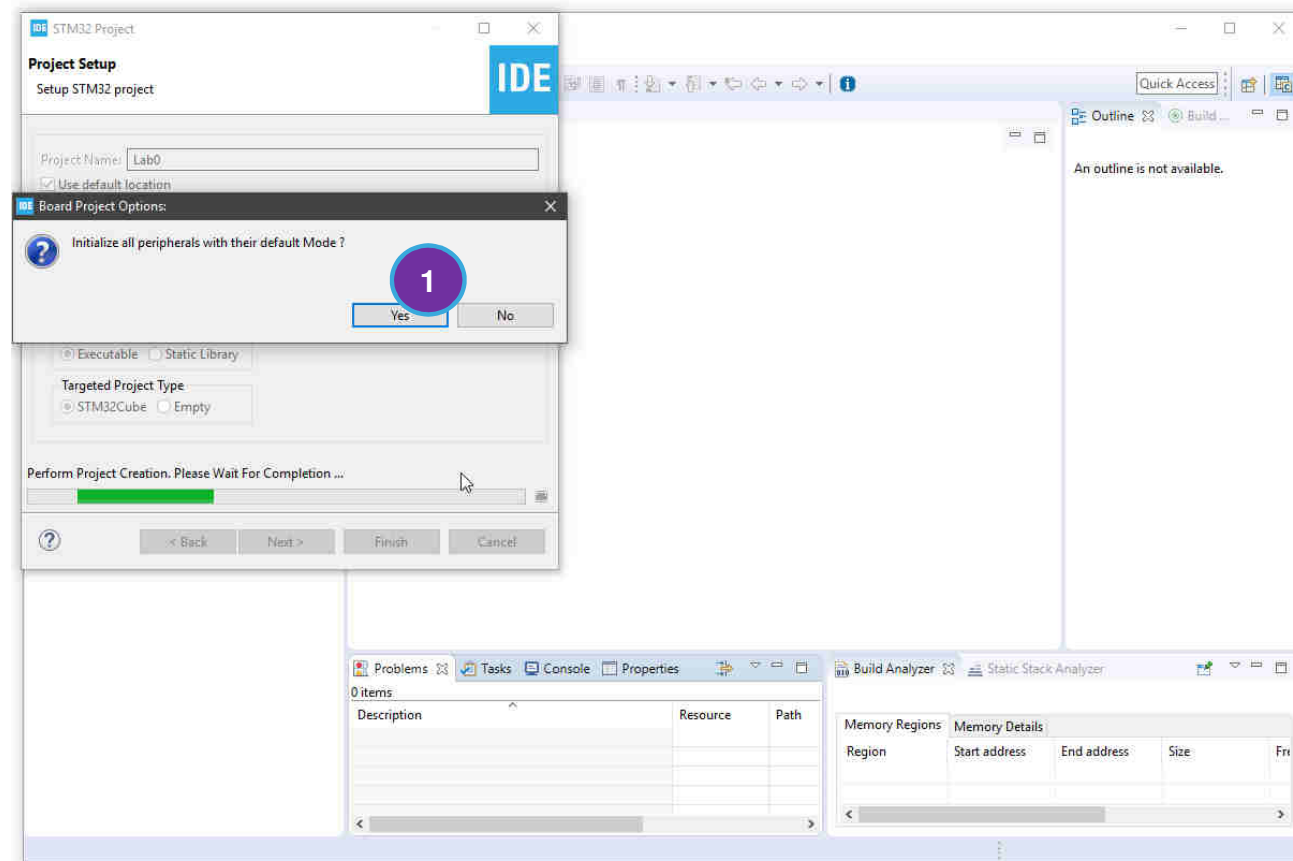
1. Click on **Board Selector**
2. Type **NUCLEO-L476RG**
3. Click on the board
4. Click **Next >**



1. Project Name **Lab2**
2. Click **Finish**



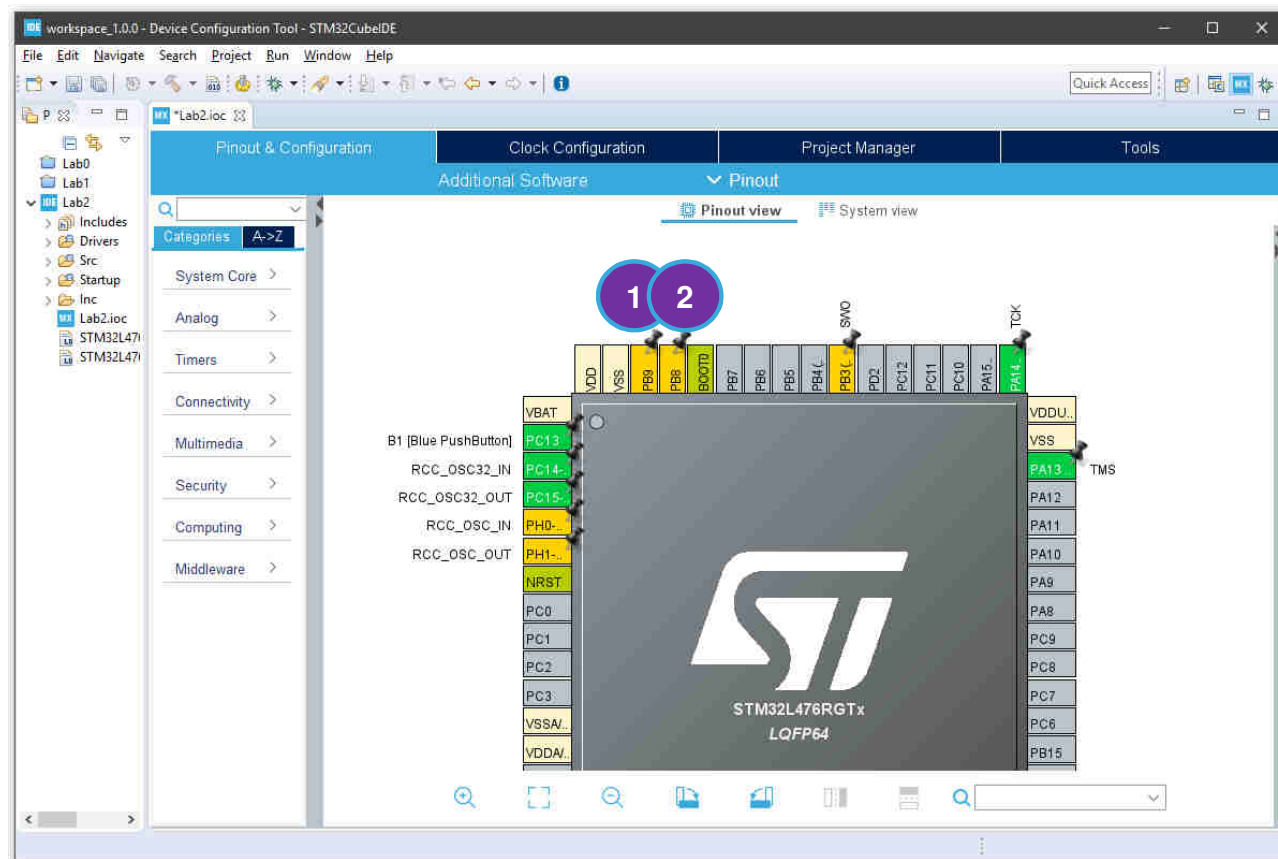
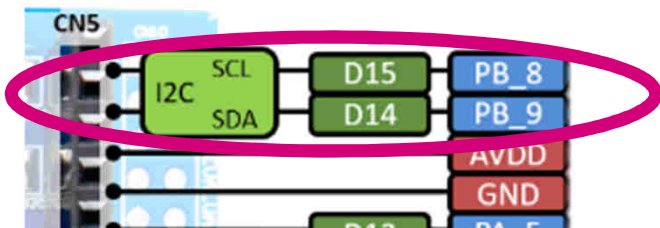
1. Click **Yes** to init peripherals in default mode



# Lab2 – Configure the I2C bus

128

1. Left Click on **PB9** and select I2C1\_SDA
2. Left Click on **PB8** and select I2C1\_SCL

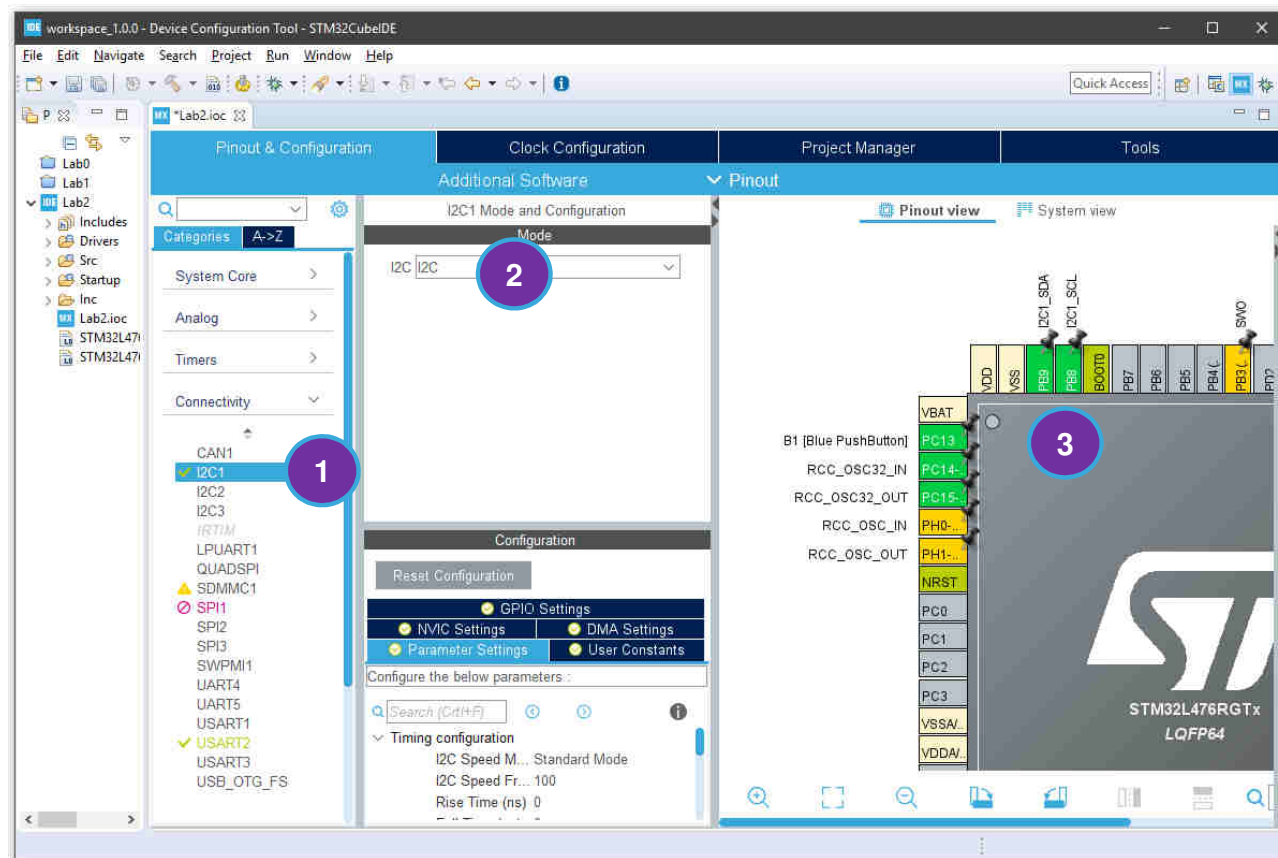




# Lab2 – Configure the I2C bus

129

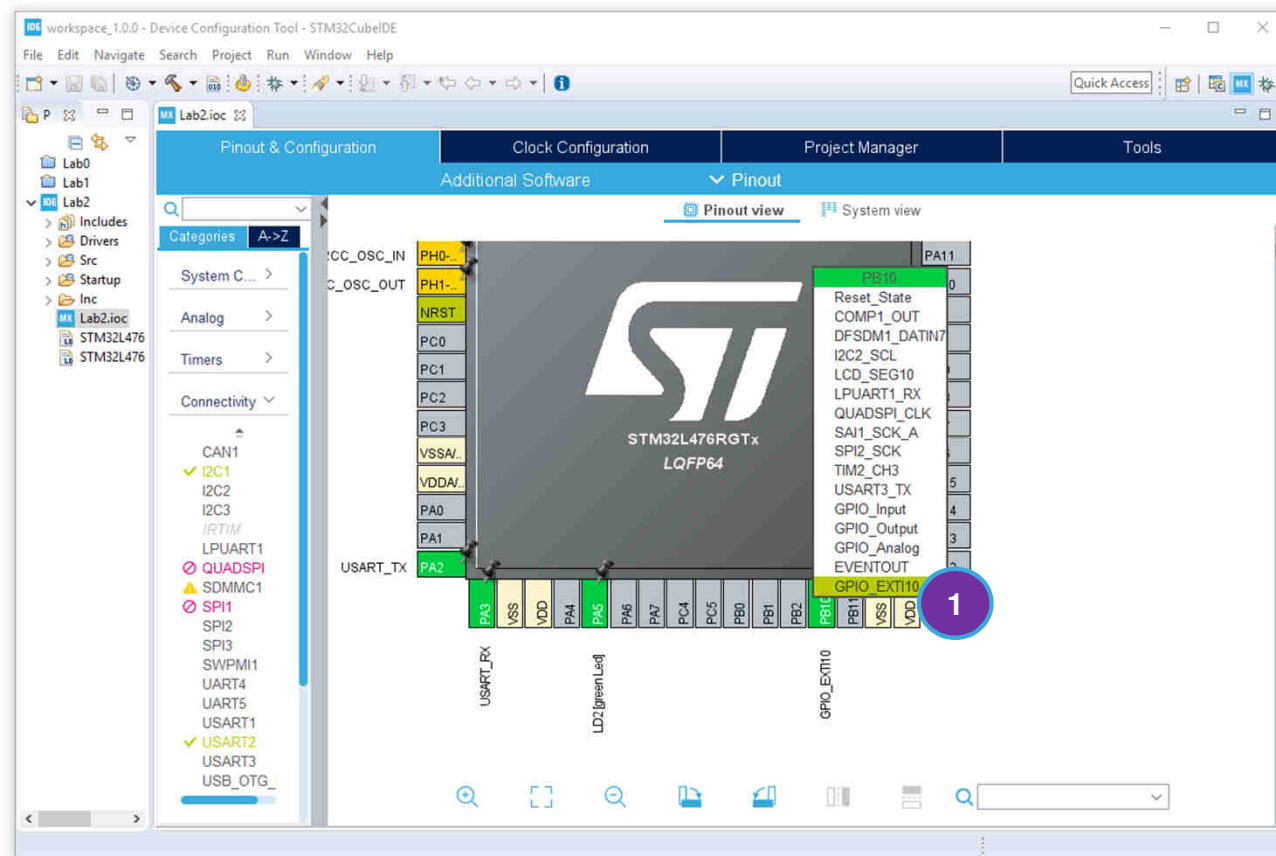
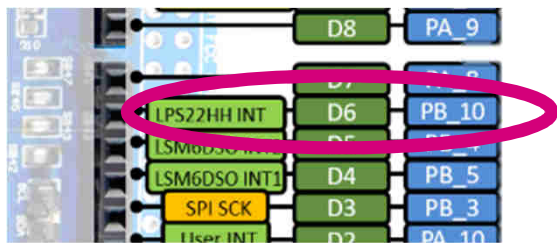
1. Expand *Connectivity* tab and check **I2C1**
2. Select **I2C** in *I2C1 Mode and Configuration*
3. PB8 and PB9 should now become green



# Lab2 – Configure LPS22HH interrupt

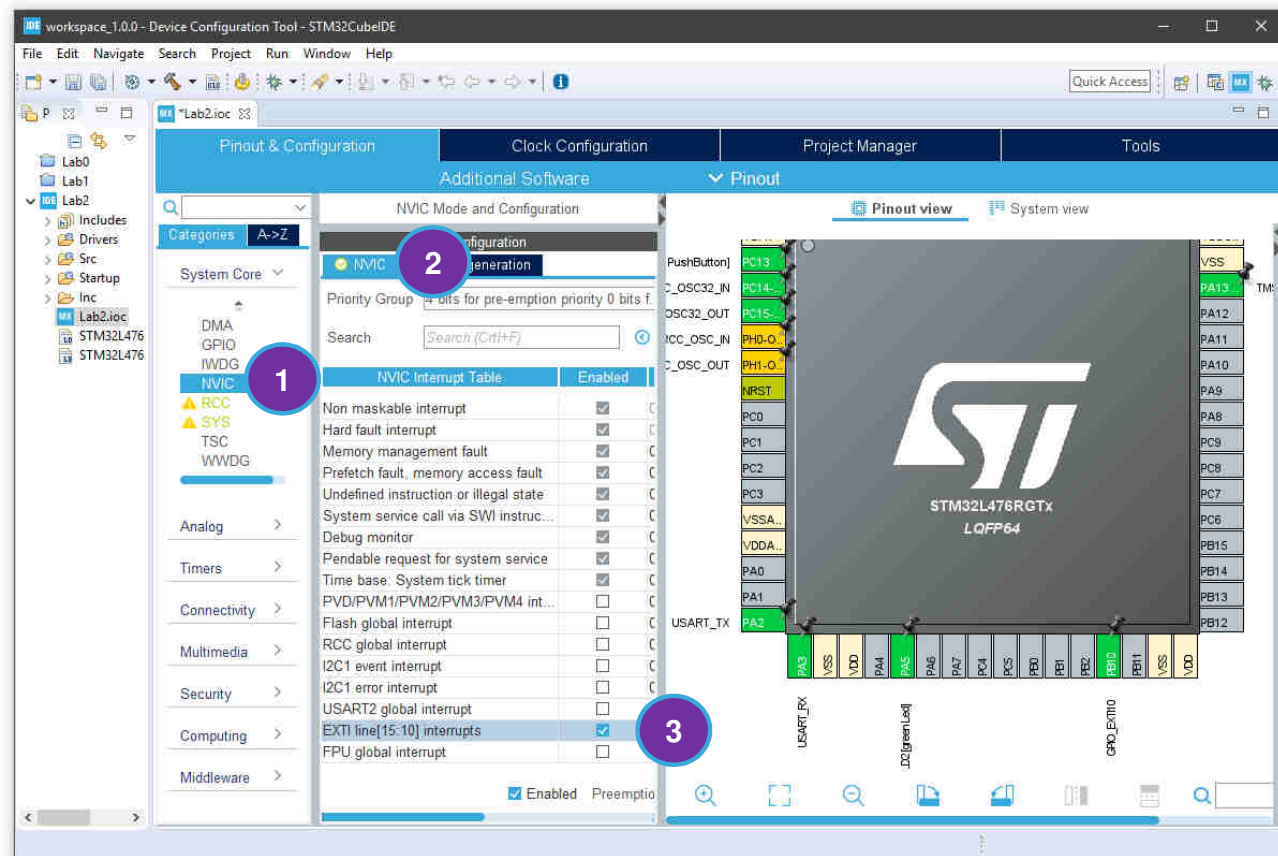
130

1. Left Click on **PB10** and select **GPIO\_EXTI10**



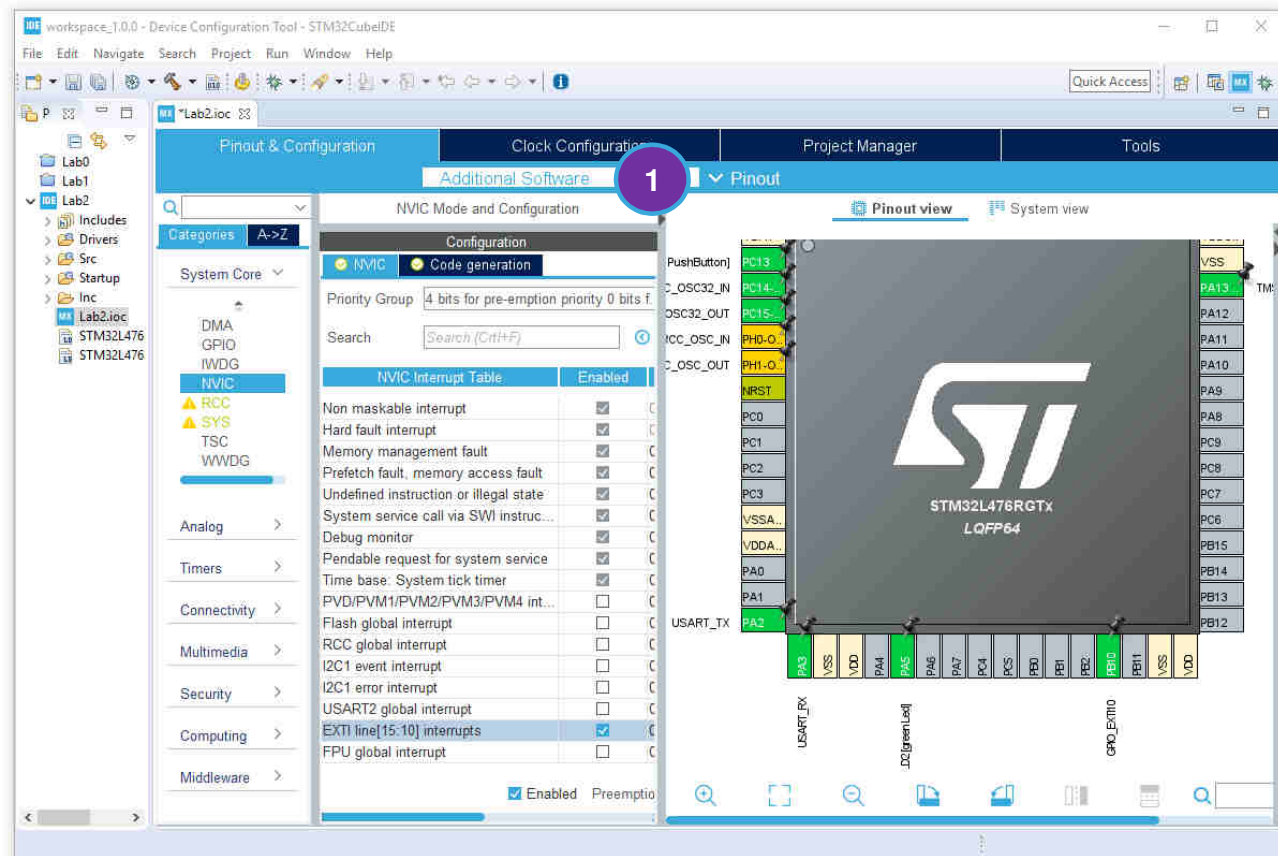
## 131

1. Check **NVIC** in tab  
System Core
2. Select **NVIC** in **NVIC**  
Mode and Configuration
3. Enable  
**EXTI line[15:10] interrupt**



## 132

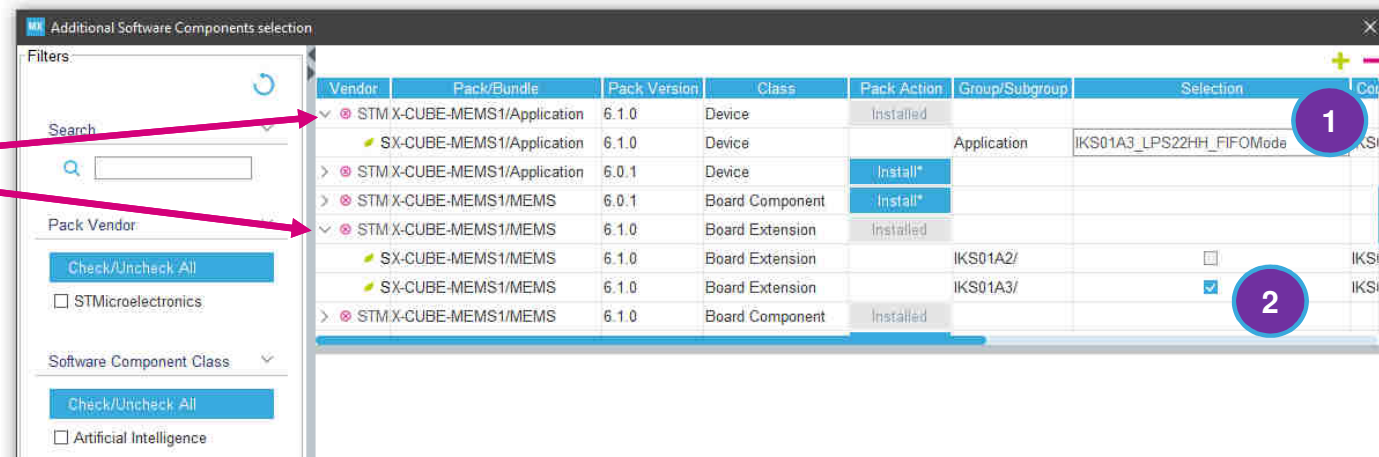
1. Click on **Additional Software**



# Lab2 – Select the MEMS library

133

Click to  
expand tree

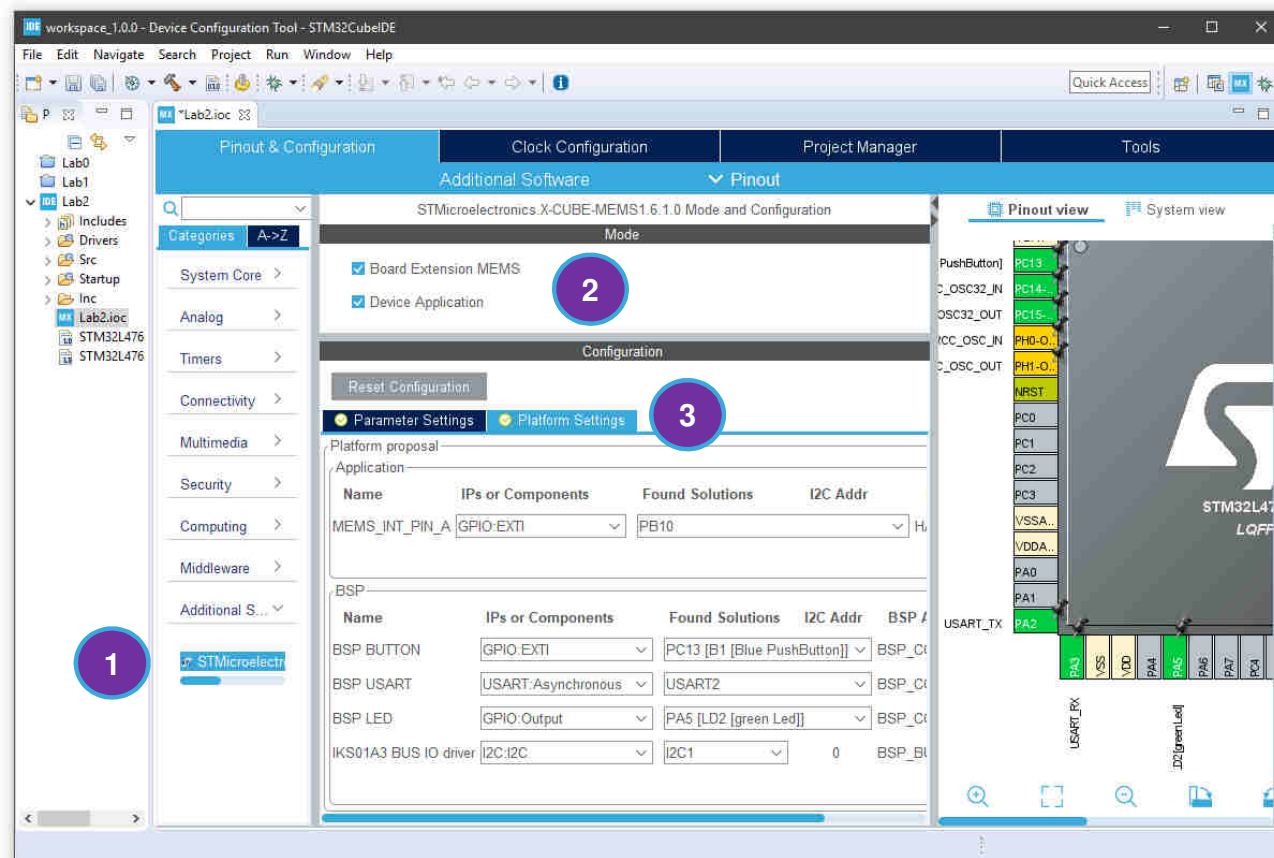


1. In X-CUBE-MEMS1/Application, Class “Device”:  
Select **IKS01A3\_LPS22HH\_FIFOMode**
2. In X-CUBE-MEMS1/MEMS, Class “Board Extension”:  
Check **IKS01A3/**
3. Click **OK**

# Lab2 – Configure the MEMS library

134

1. Expand Additional Software and select the X-CUBE-MEMS1
2. Check both:  
**Board Extension MEMS**  
**Device Application**
3. Configure Platform Settings as in picture





# Lab2 – Configure the MEMS library

135

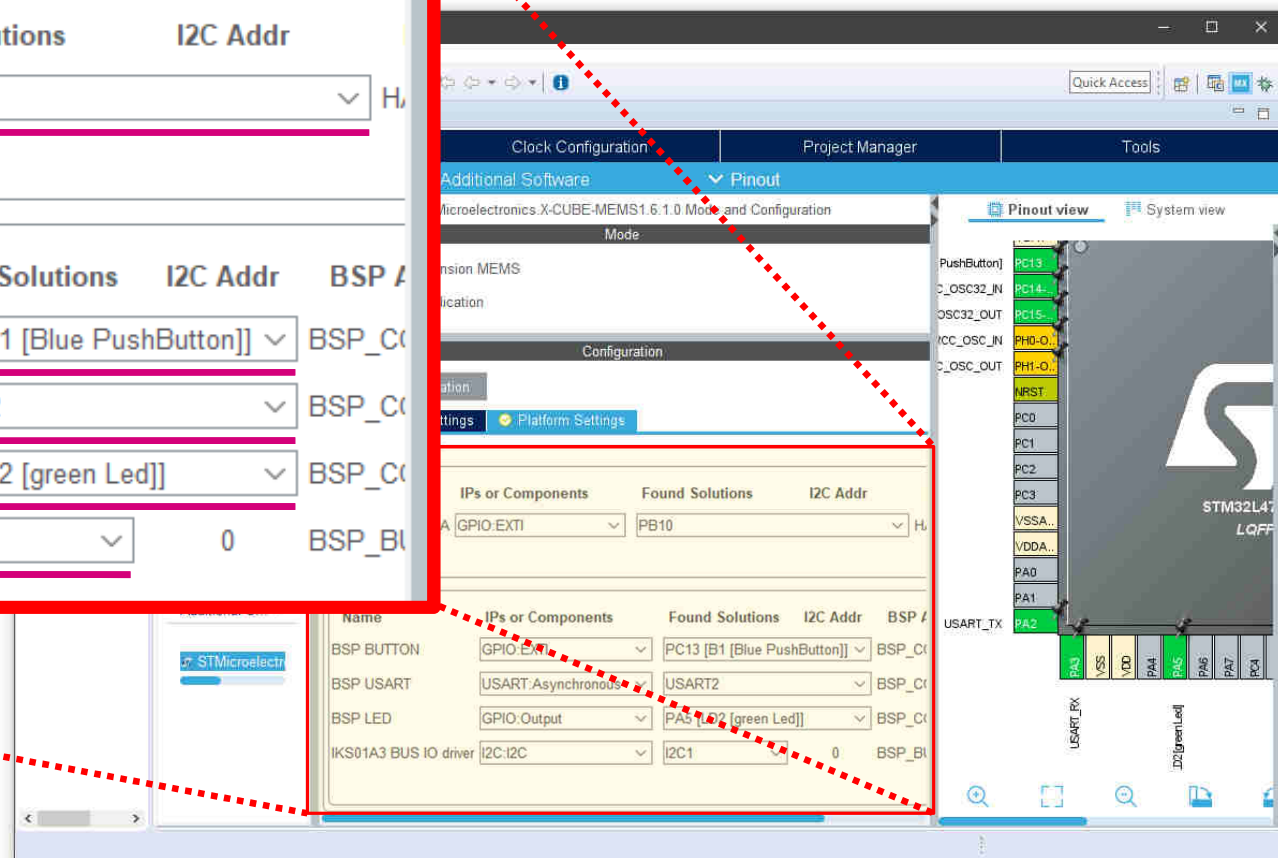
Platform proposal

Application

Name	IPs or Components	Found Solutions	I2C Addr
MEMS_INT_PIN_A	GPIO:EXTI	PB10	

BSP

Name	IPs or Components	Found Solutions	I2C Addr	BSP A
BSP BUTTON	GPIO:EXTI	PC13 [B1 [Blue PushButton]]		BSP_C
BSP USART	USART:Asynchronous	USART2		BSP_C
BSP LED	GPIO:Output	PA5 [LD2 [green Led]]		BSP_C
IKS01A3 BUS IO driver	I2C:I2C	I2C1	0	BSP_B



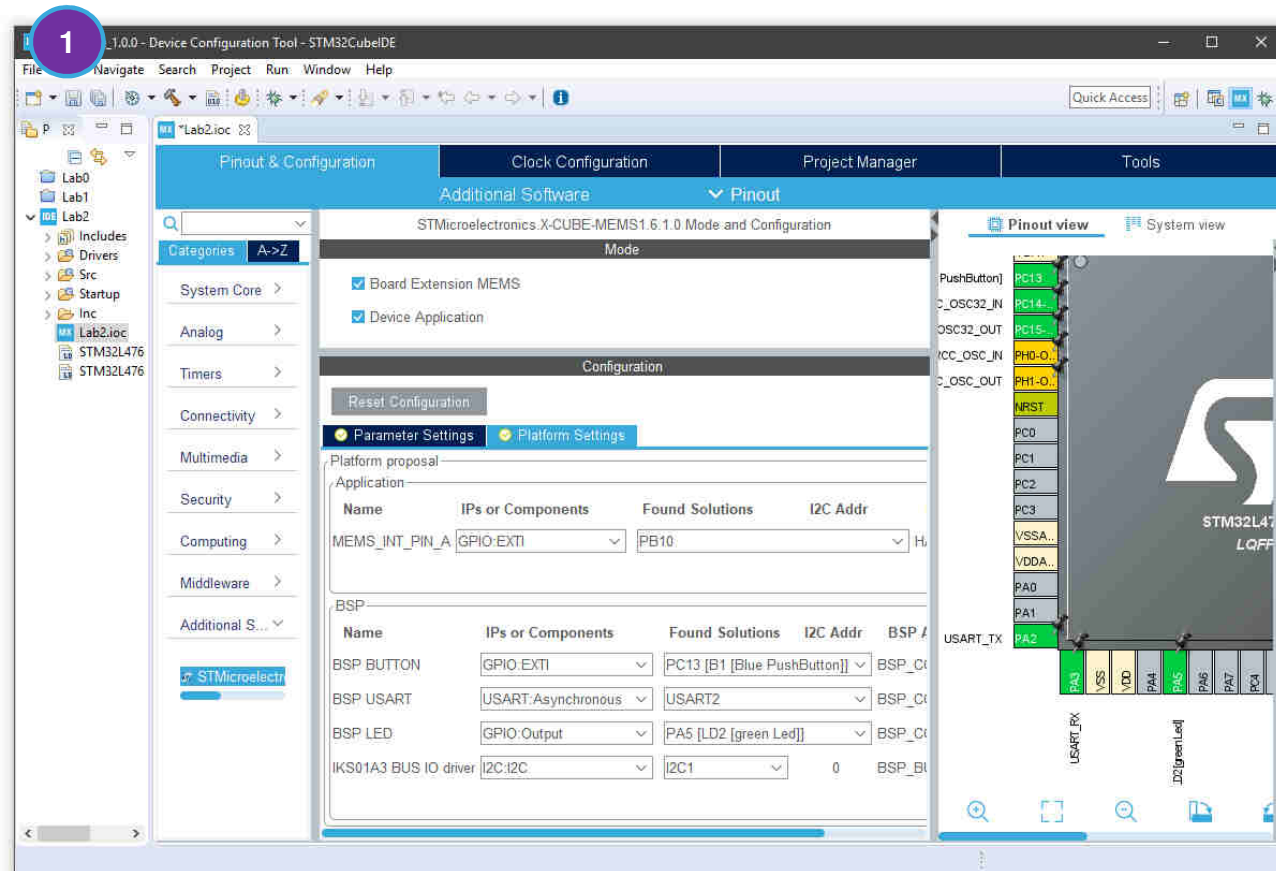
# Lab2 – Save the project

136

1. Click the save button



This action will generate the source code of this lab

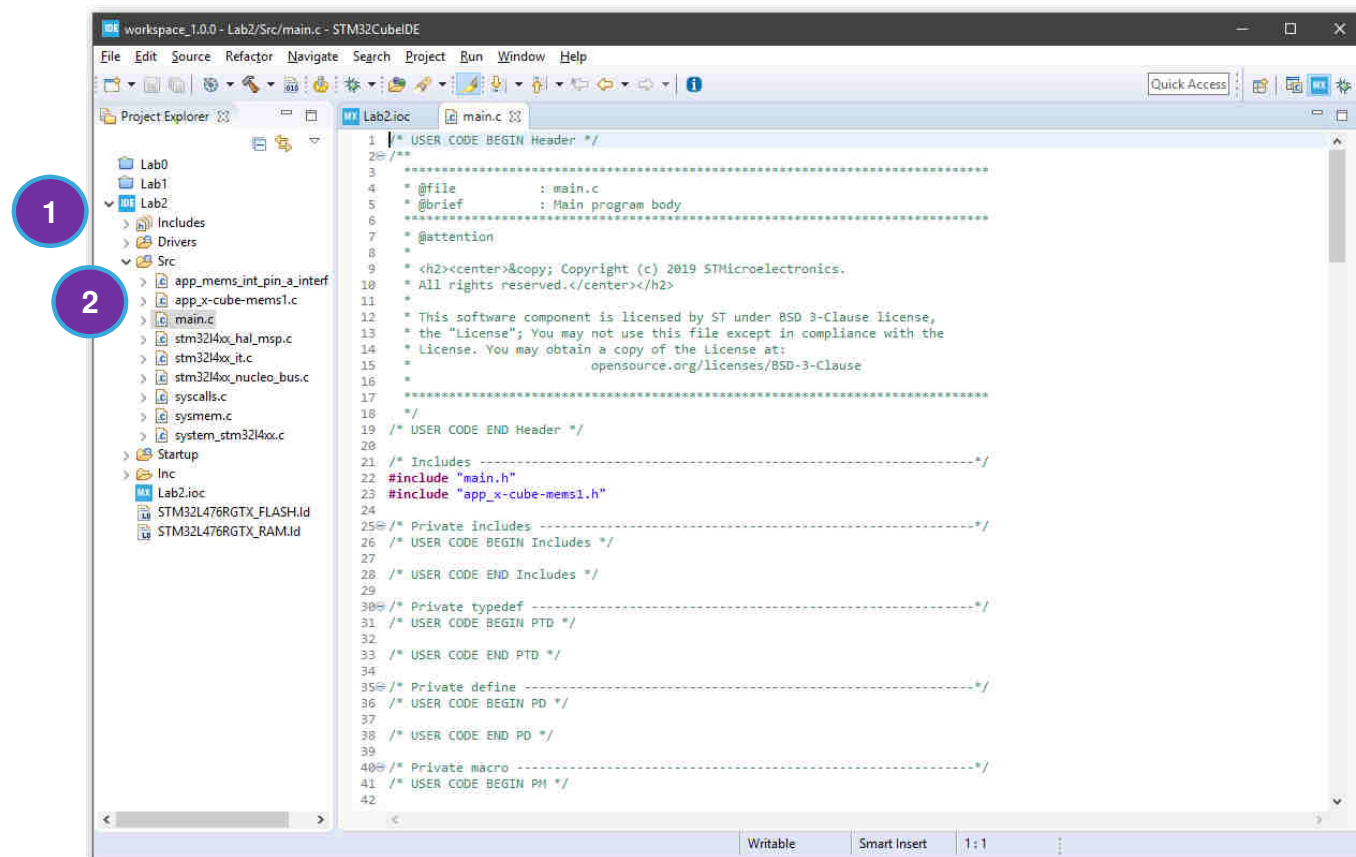




# Lab2 – Code Editing


137

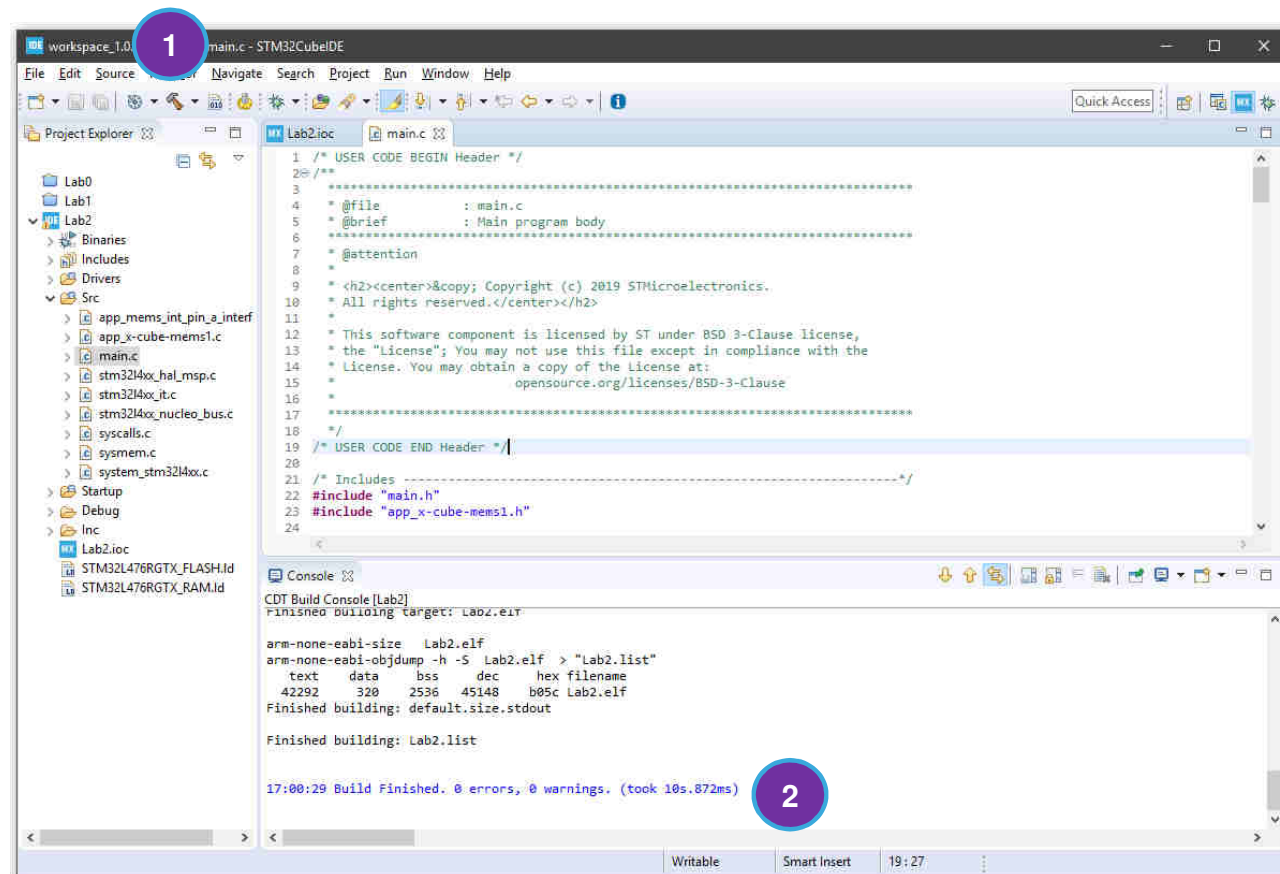
1. Expand **Src** in folder **Lab2**
2. Double click on **main.c**



# Lab2 - Compiling

138

1. Click on the hammer  to begin compilation, or press **CTRL+B**
2. Compilation should terminate with 0 errors and 0 warning



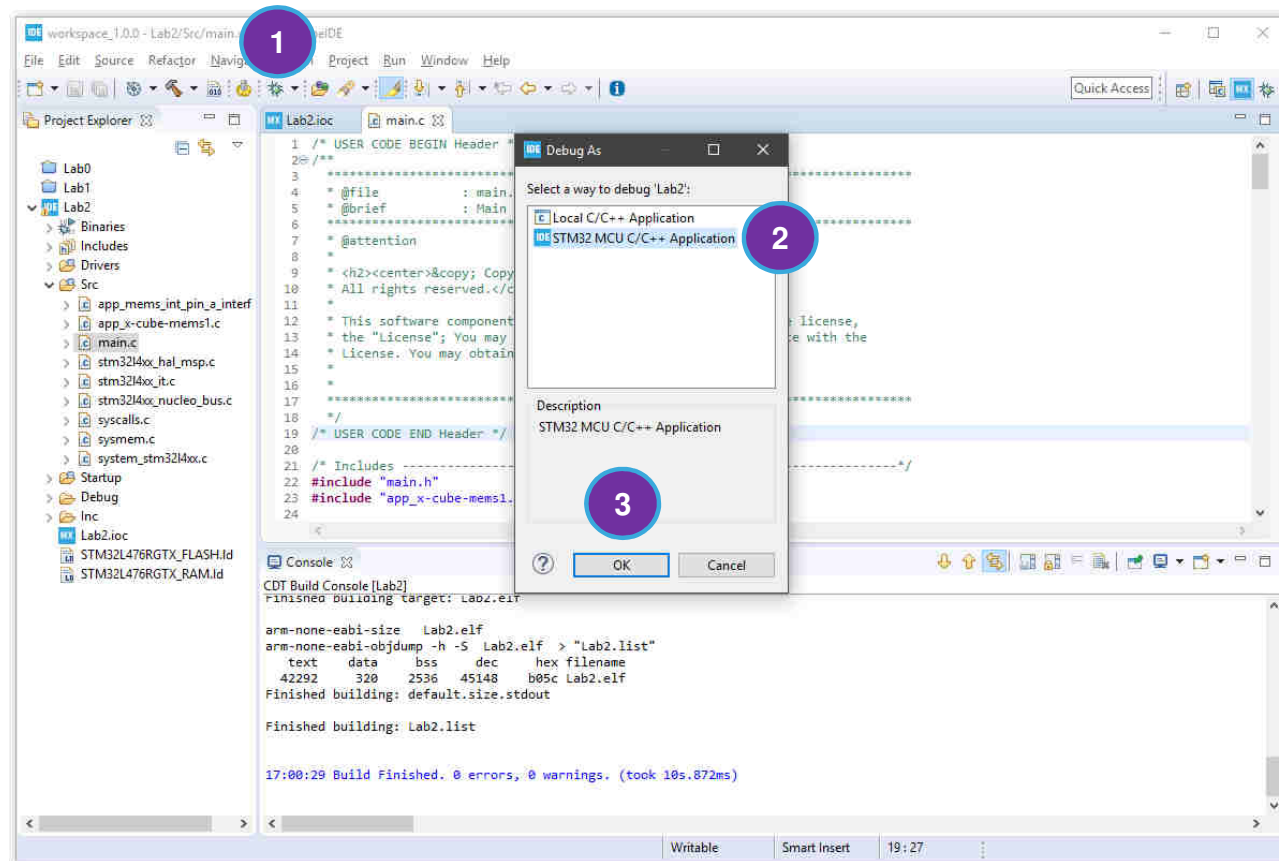
# Lab2 - Debugging

139

1. Click on the bug  to begin debugging

2. Select **STM32 MCU C/C++ App**

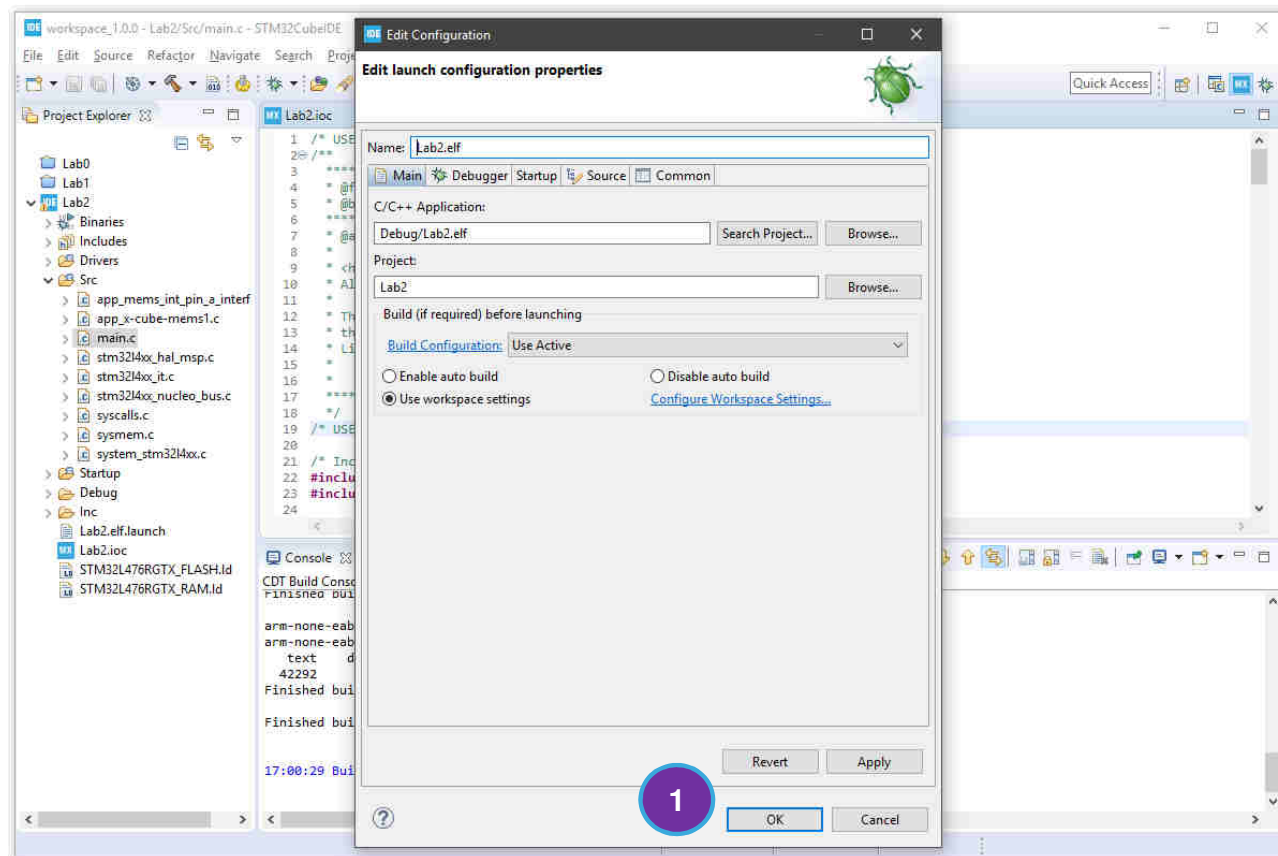
3. Click **OK**



# Lab2 - Debugging

140

1. Click **OK**

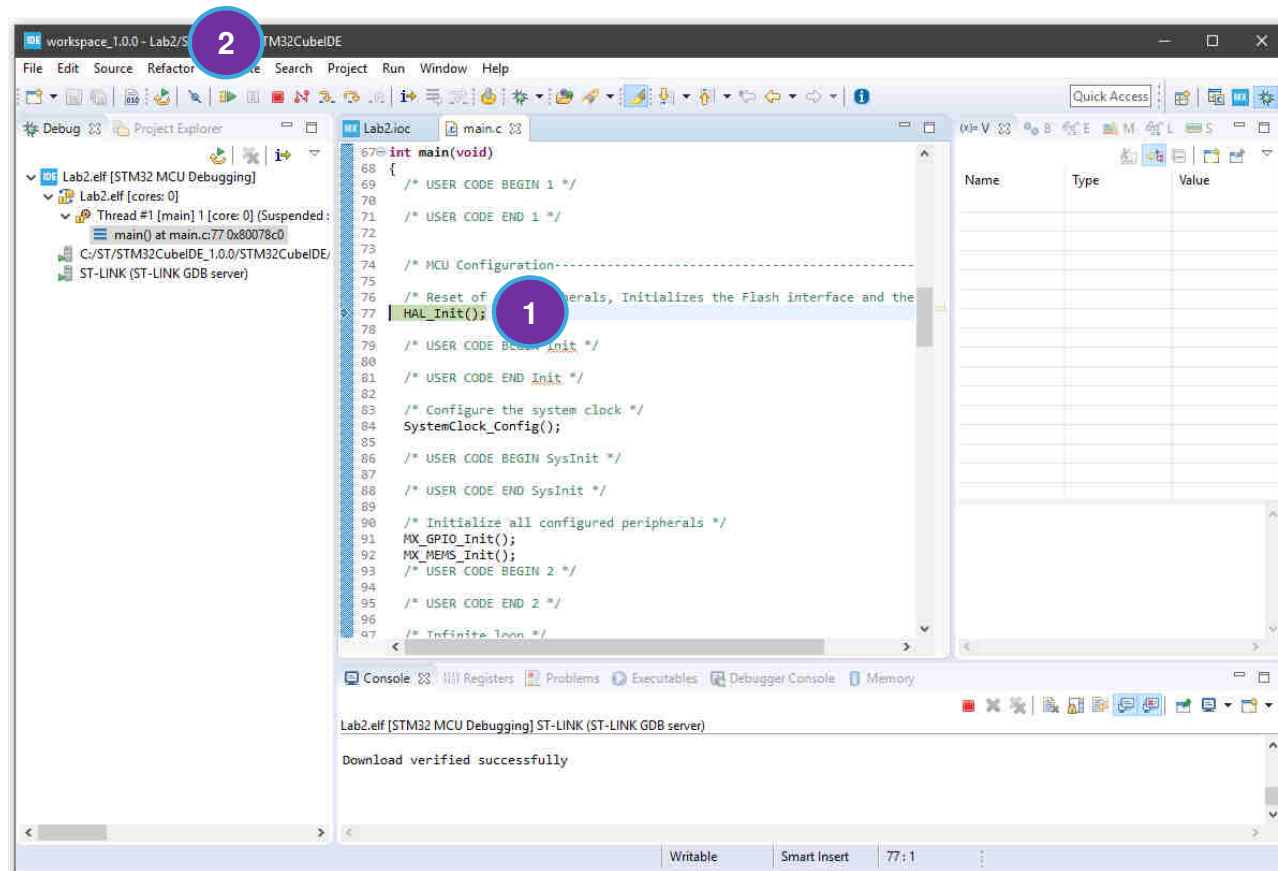


# Lab2 - Debugging

141

1. Code start at the first line of the main function

2. Click play  button to run the code



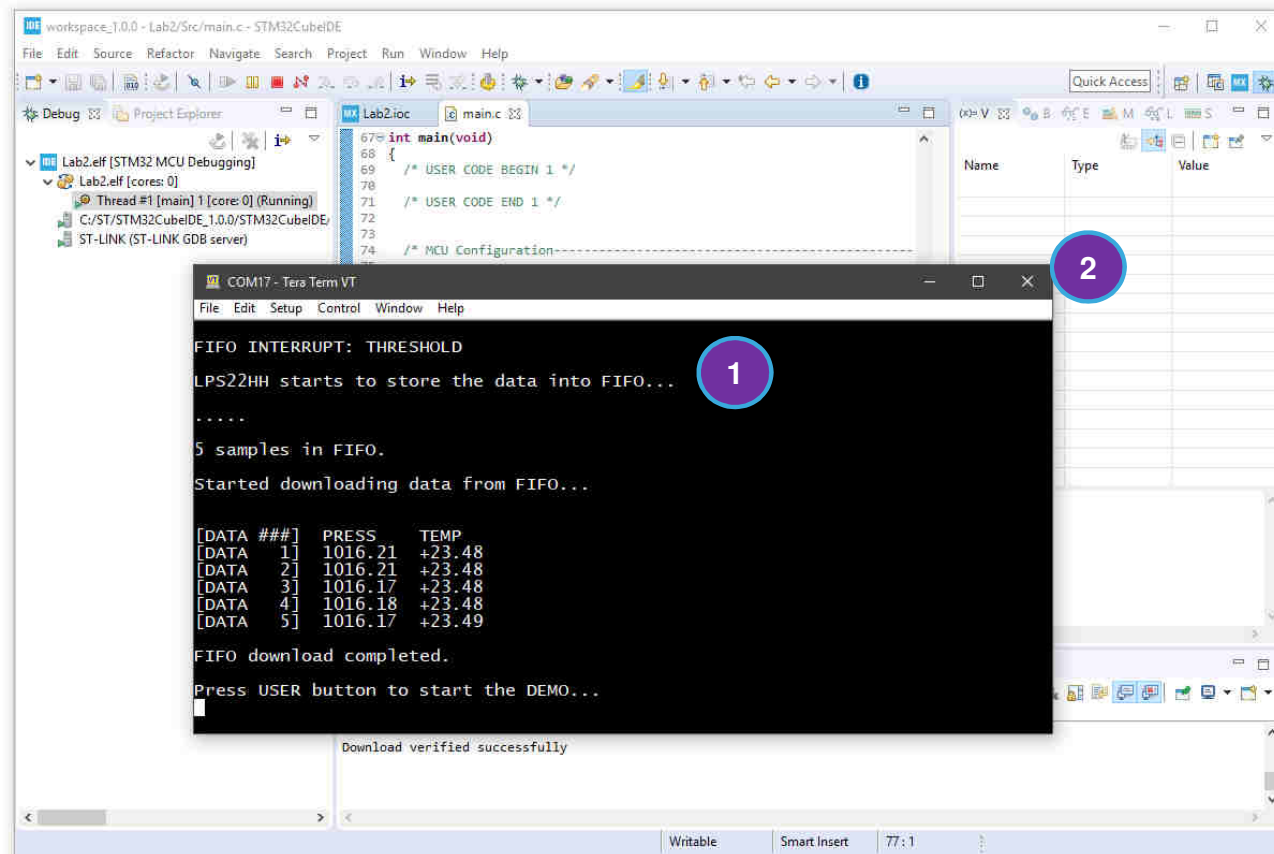
# Lab2 - Testing

142

1. Open Tera Term to view the output

Press User button (blue) on Nucleo board

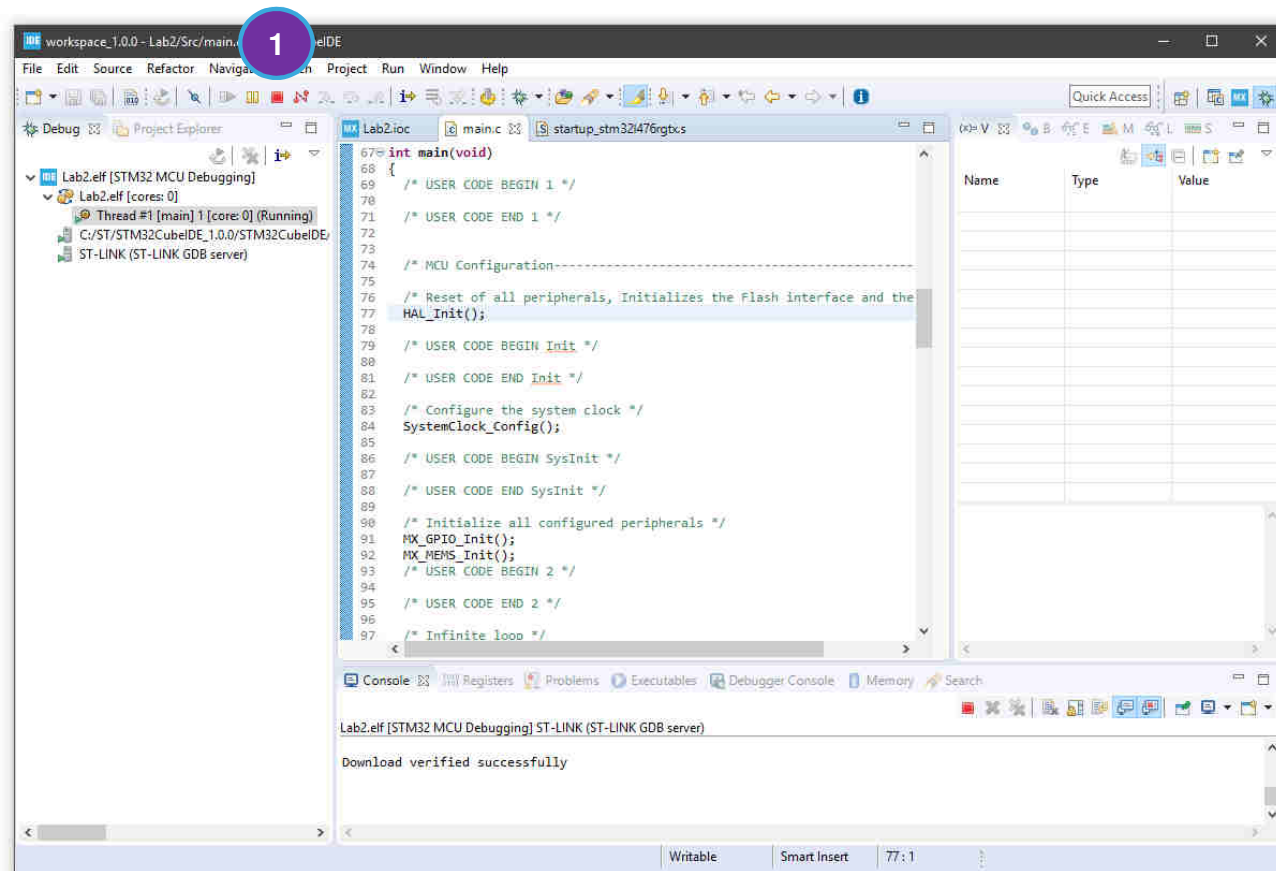
2. After testing close Tera Term by clicking **X**



# Lab2 - Debugging

143

1. Click stop  button to interrupt the debugging

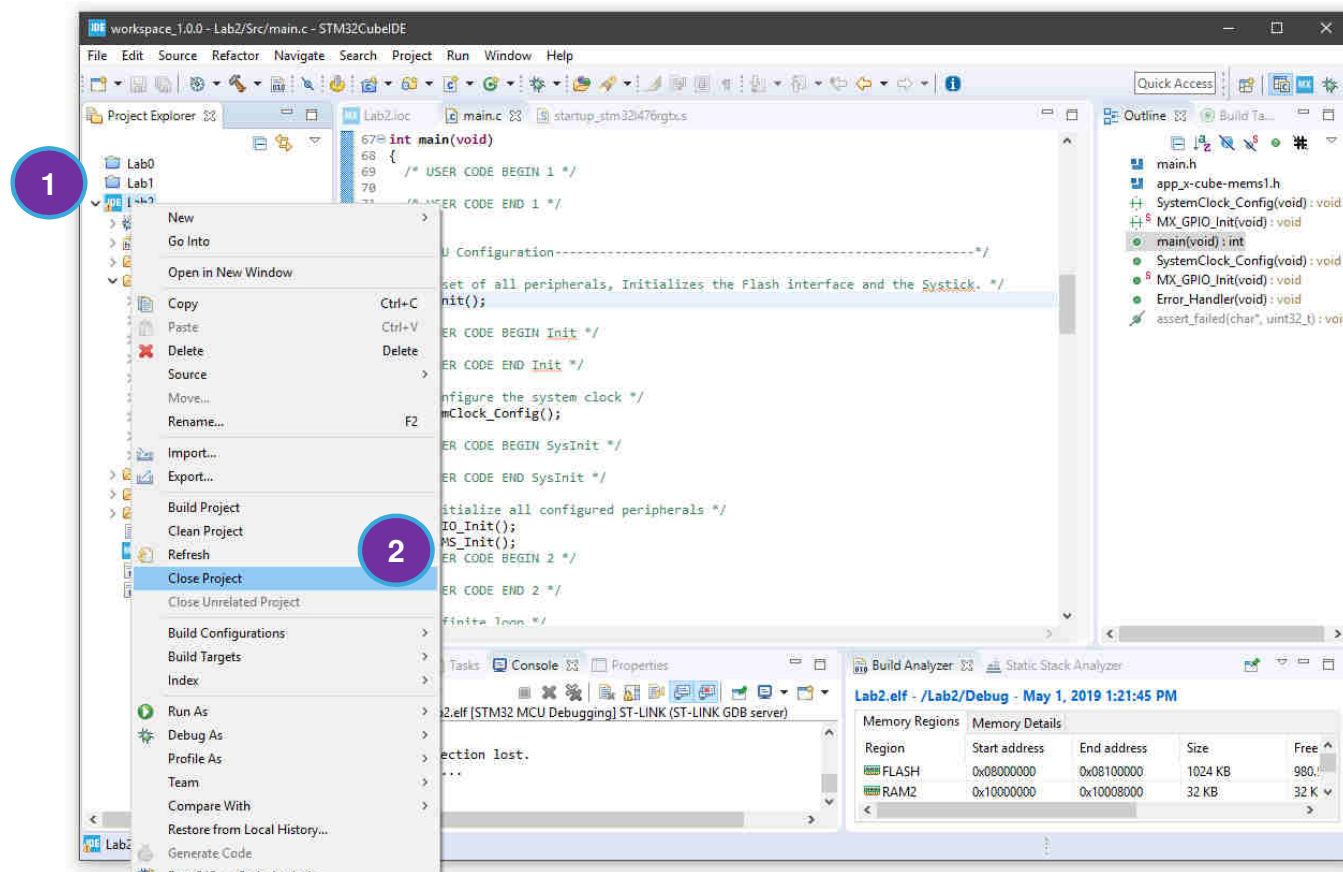




# Lab2 – Closing the project

144

1. Right-Click on **Lab2** project
2. Click on **Close Project**





# LAB3

## Goals:

- Configure a new project using X-CUBE-MEMS1
- Configure LSM6DSO accelerometer embedded step counter
- Enable interrupts in STM32CubeIDE



# LSM6DSO

146

## Accelerometer + Gyroscope Inertial Measurement Unit

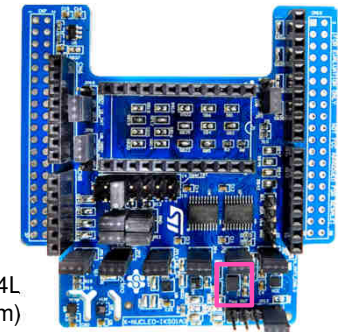
- 0.45mA power consumption (normal mode)
  - Accelerometer: 0.05mA, Gyroscope: 0.40mA
- Auxiliary SPI typically used for OIS / EIS or closed loop control; I3C Interface
- 9kB equivalent FIFO Memory for local data storage
- Finite State Machines (up to 16)
- Digital Features
  - Free fall
  - Pedometer 2.0
  - 6D / 4D
  - Tilt detection
  - Tap/ Double Tap

Lowest power consumption IMU → battery saving

Design Flexibility and cost optimization

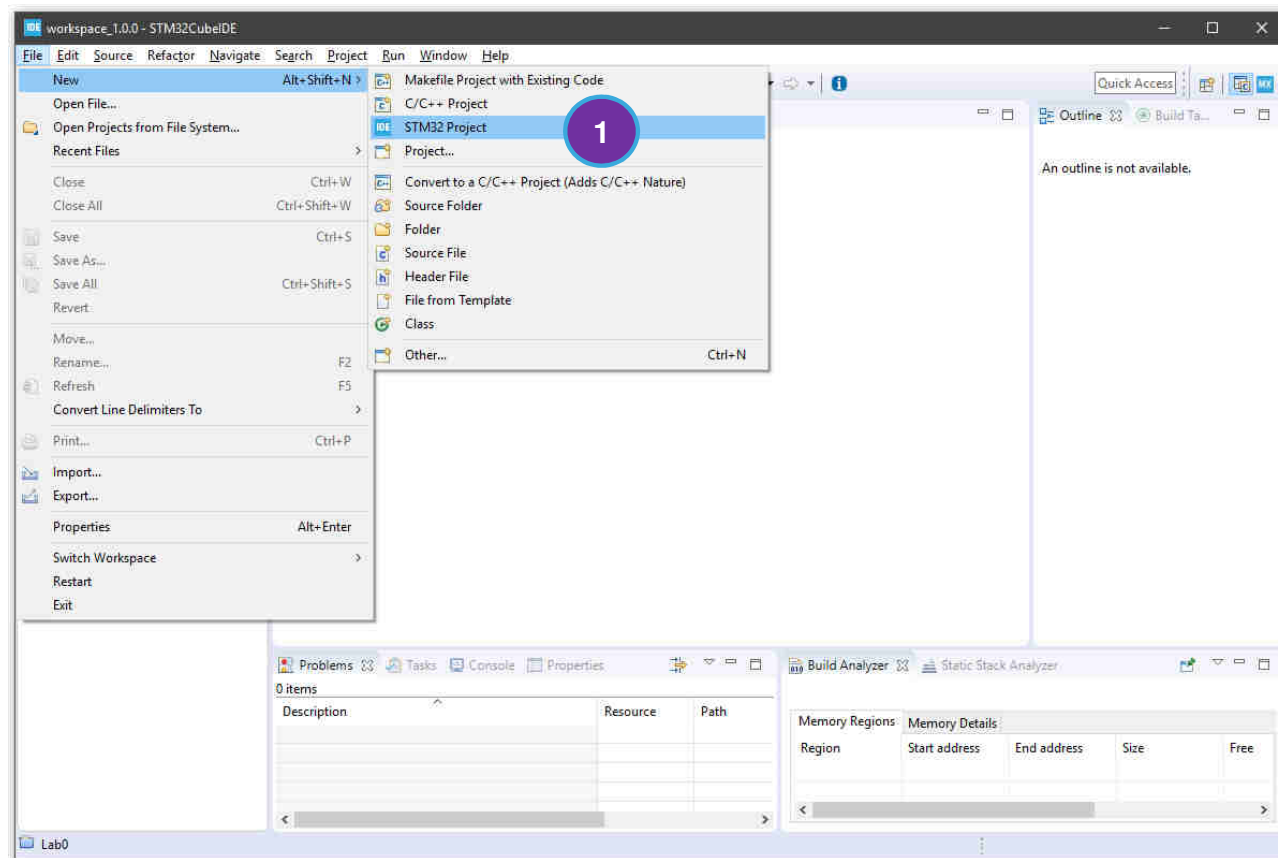
System power saving

Smart Functions with High Flexibility

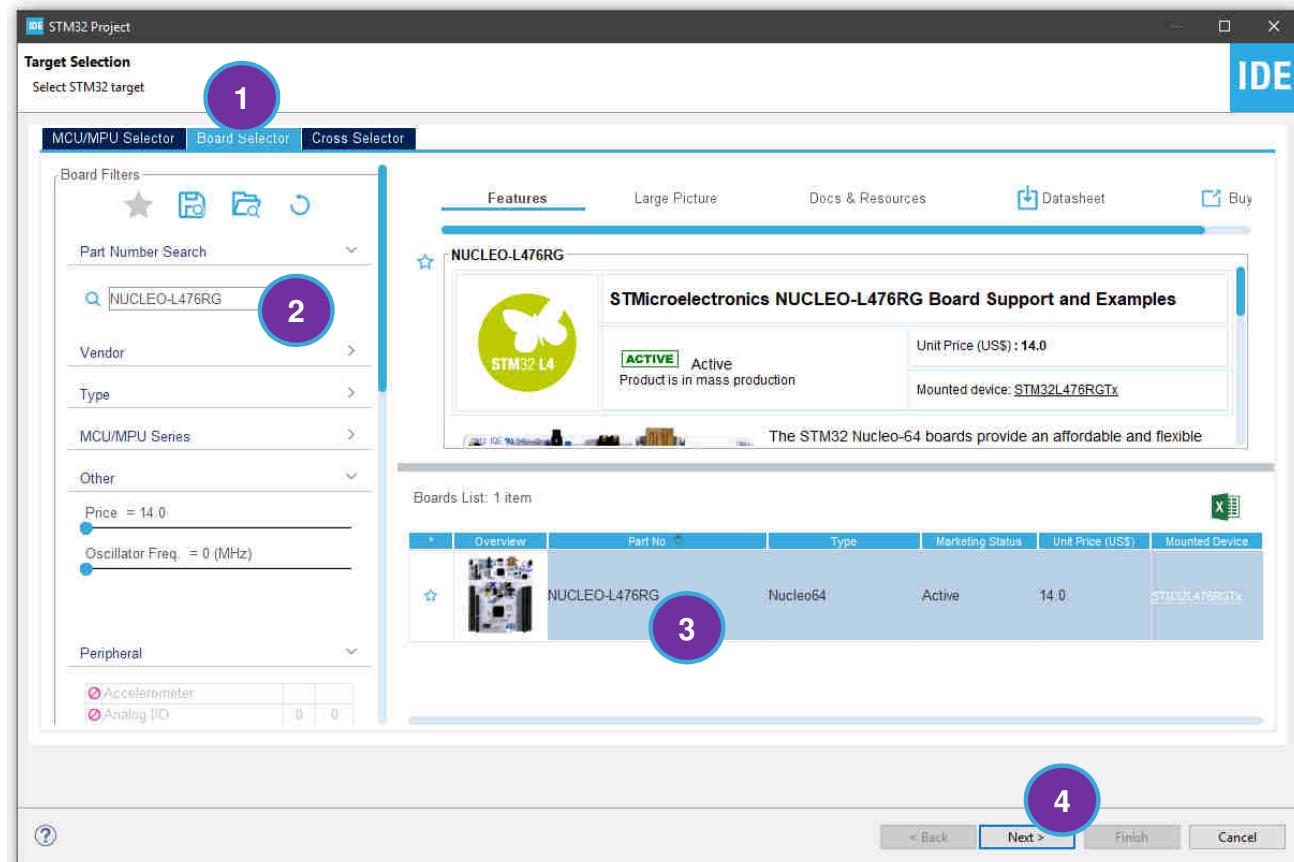


LGA-14L  
(2.5 x 3 x 0.83 mm)

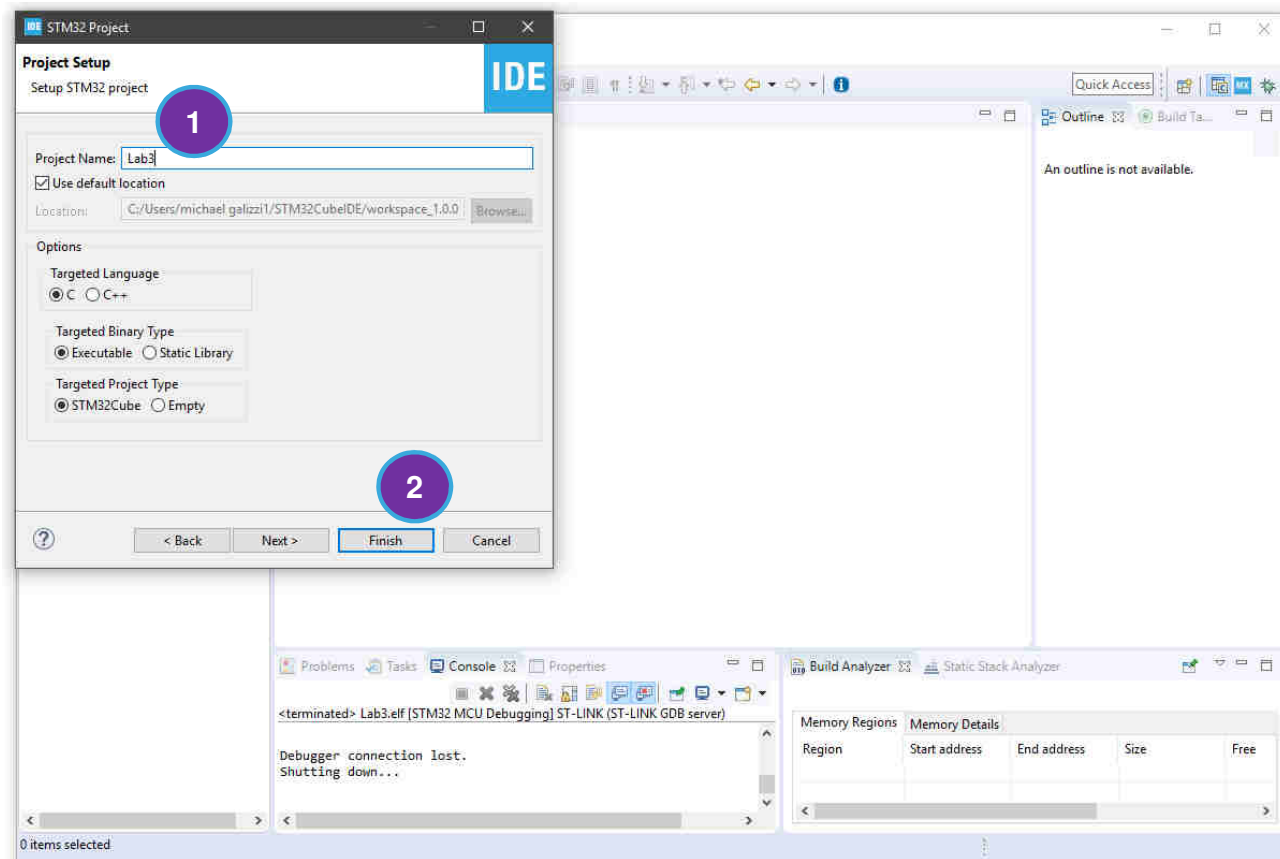
## 1. Click on **File > New > STM32 Project**



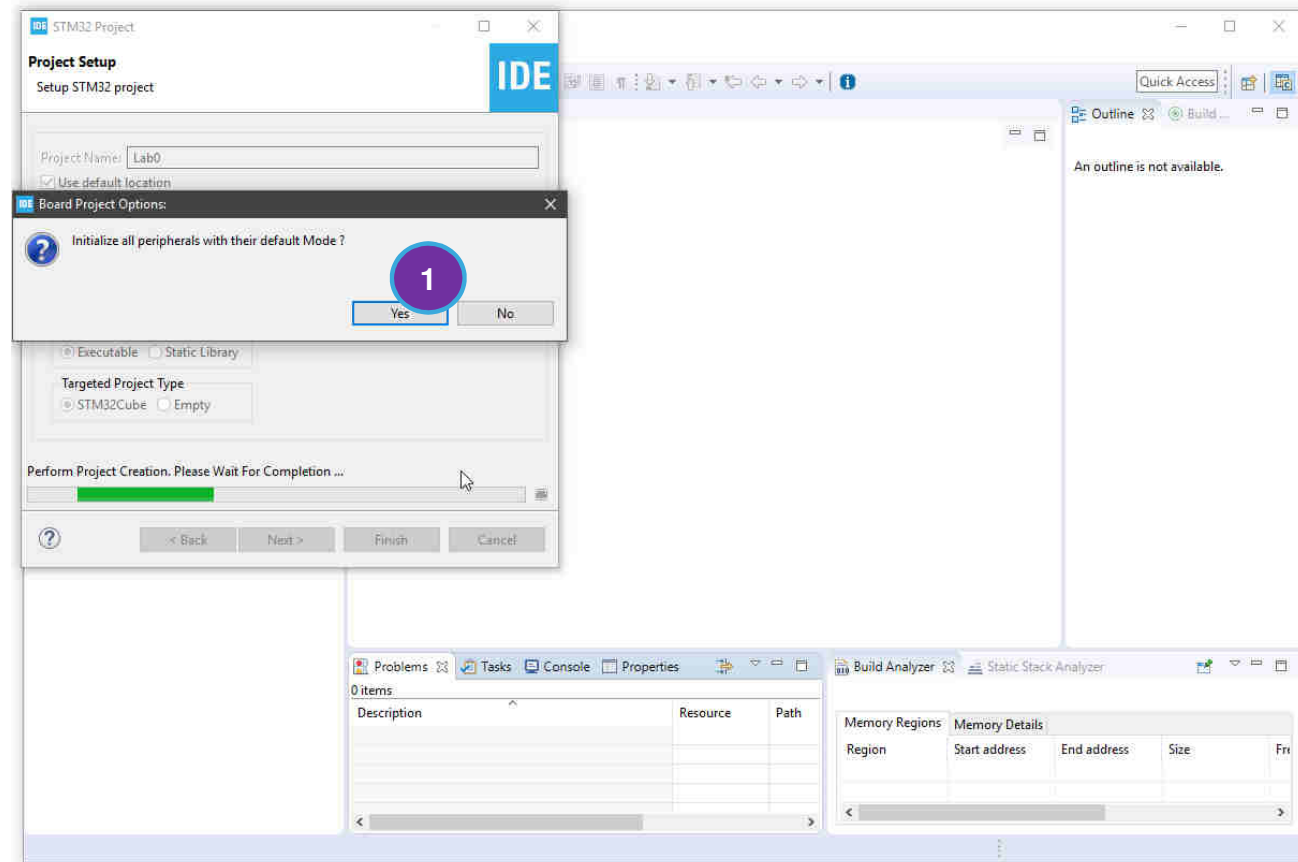
1. Click on **Board Selector**
2. Type **NUCLEO-L476RG**
3. Click on the board
4. Click **Next >**



1. Project Name **Lab3**
2. Click **Finish**



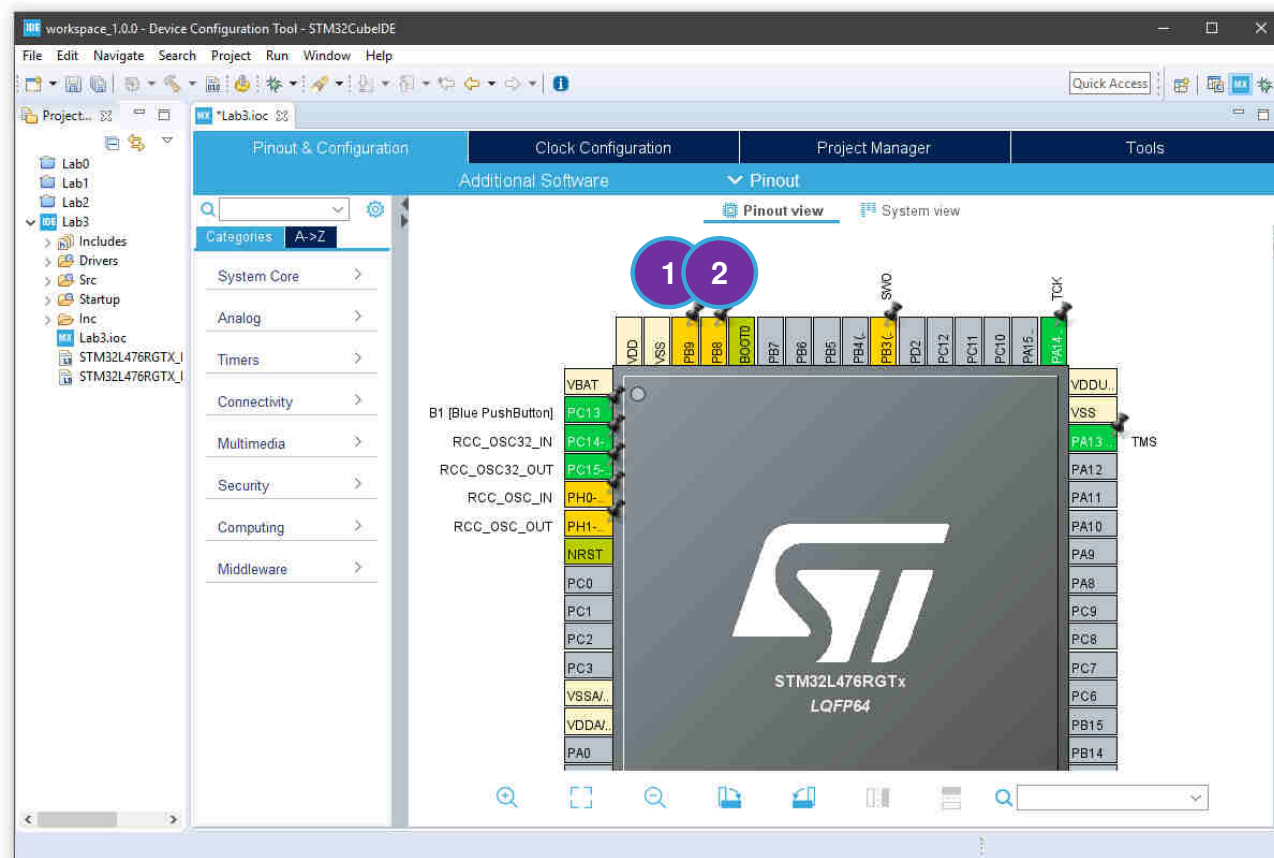
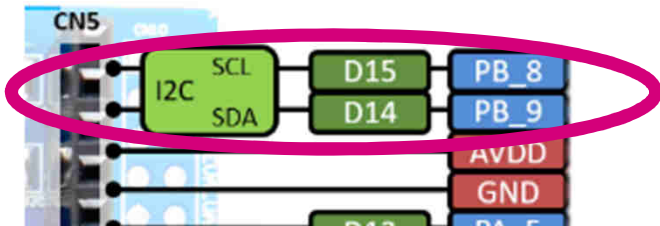
1. Click **Yes** to init peripherals in default mode



# Lab3 – Configure the I2C bus

151

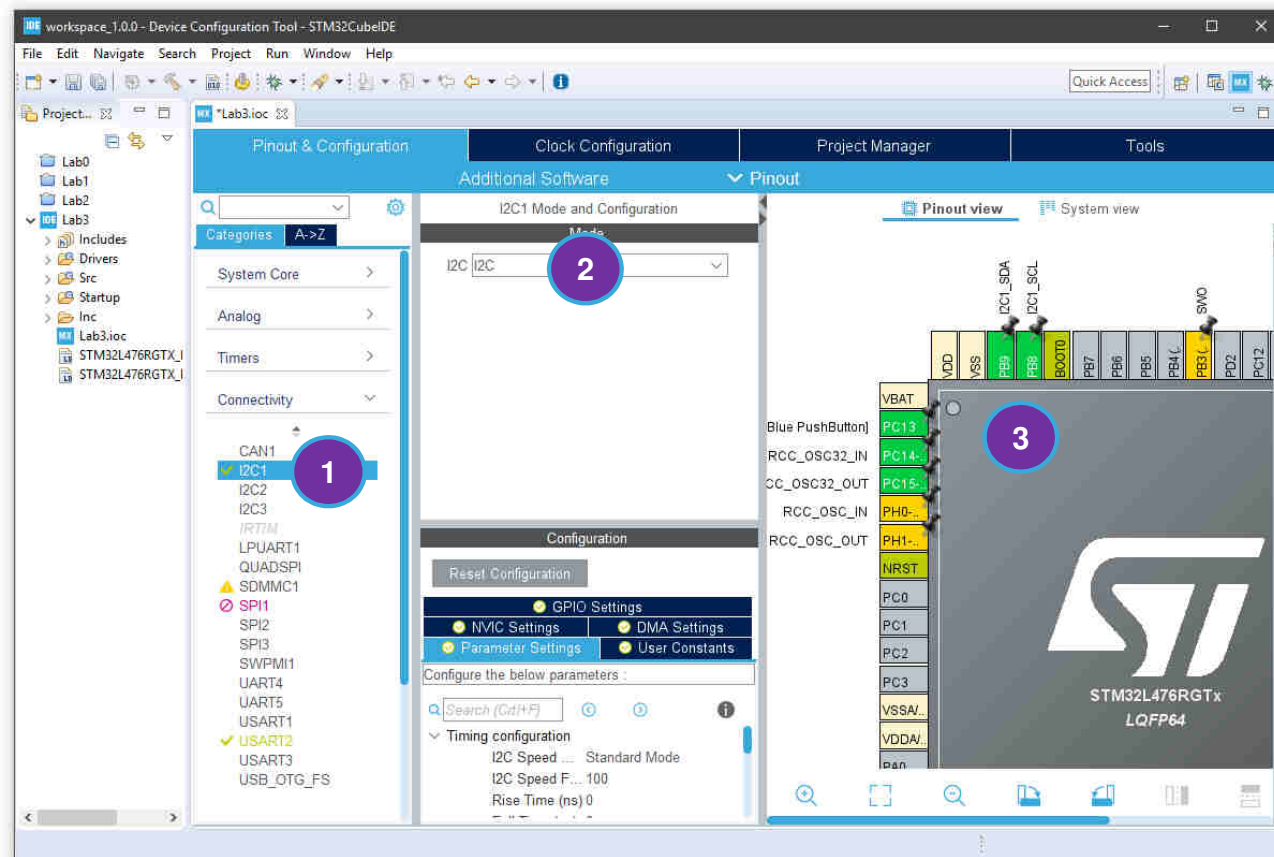
1. Left Click on **PB9** and select I2C1\_SDA
2. Left Click on **PB8** and select I2C1\_SCL



# Lab3 – Configure the I2C bus

152

1. Expand *Connectivity* tab and check **I2C1**
2. Select **I2C** in *I2C1 Mode and Configuration*
3. PB8 and PB9 should now become green

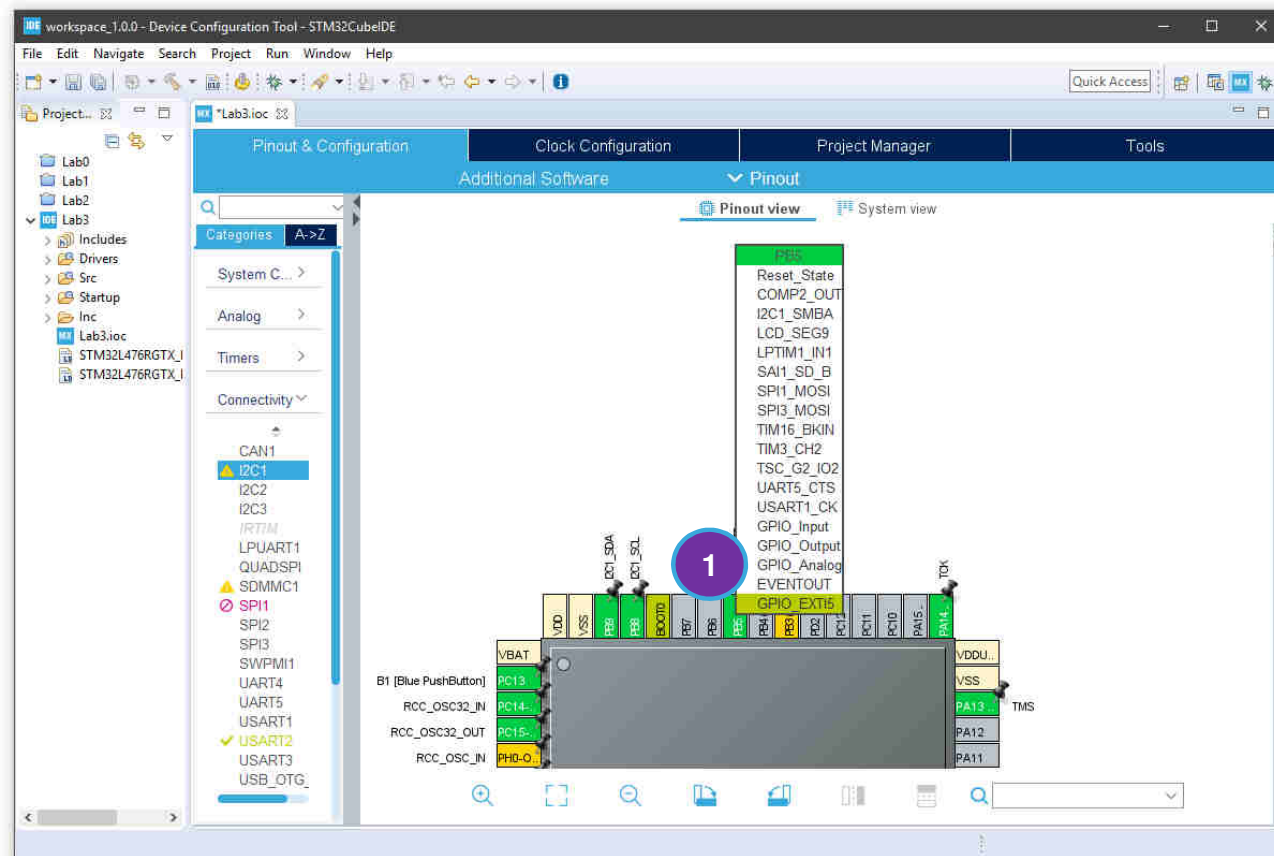
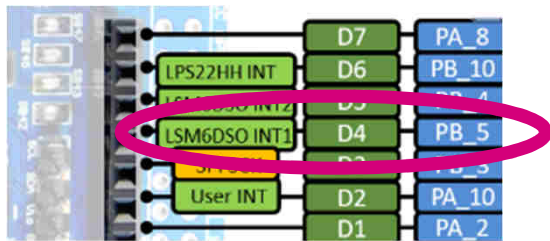




# Lab3 – Configure LSM6DSO interrupt

153

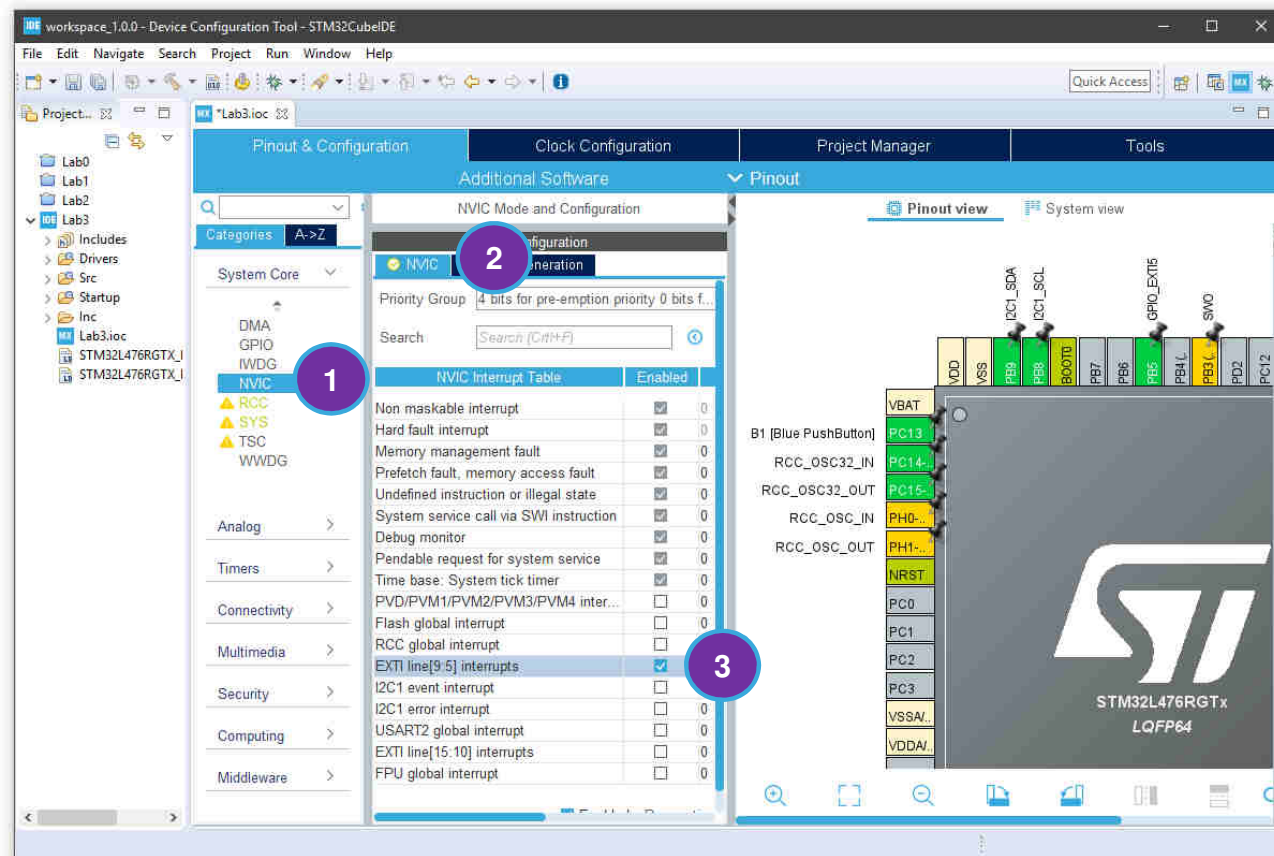
1. Left Click on **PB5** and select **GPIO\_EXTI5**



# Lab3 – Configure LSM6DSO interrupt

154

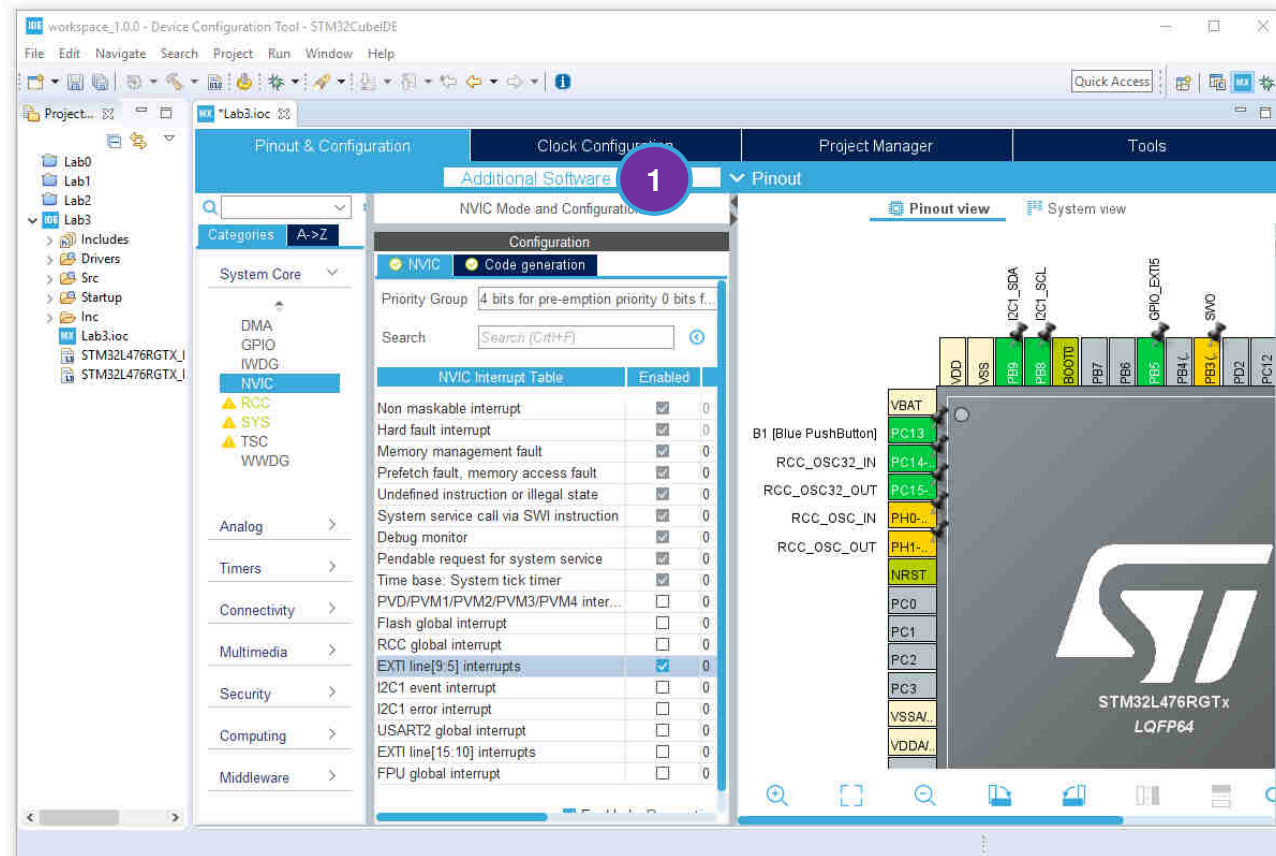
1. Check **NVIC** in tab System Core
2. Select **NVIC** in NVIC Mode and Configuration
3. Enable **EXTI line[9:5] interrupt**



# Lab3 – Select the MEMS library

155

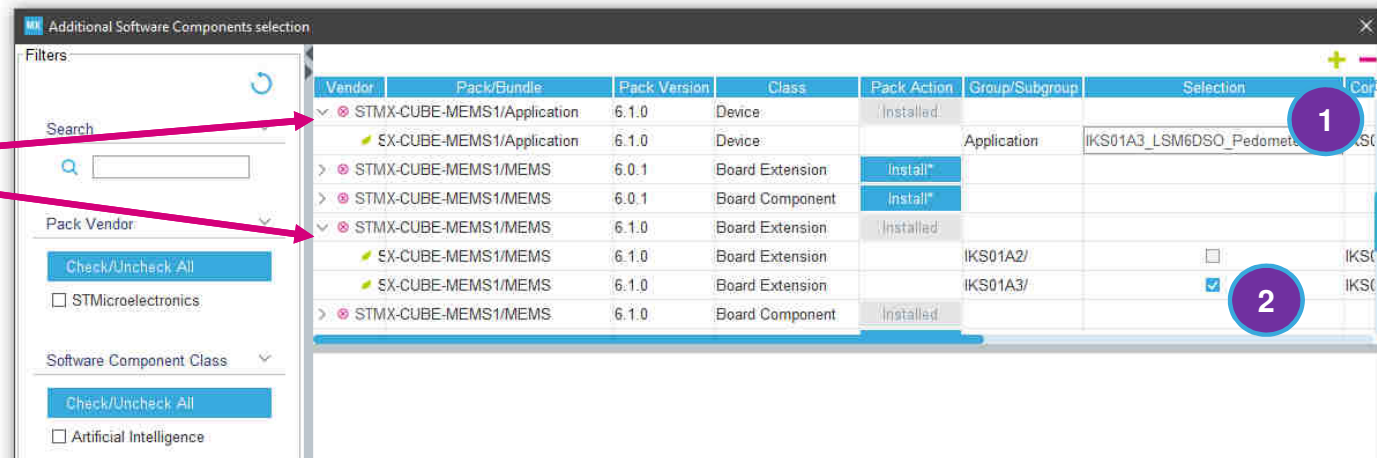
1. Click on **Additional Software**



# Lab3 – Select the MEMS library

156

Click to  
expand tree

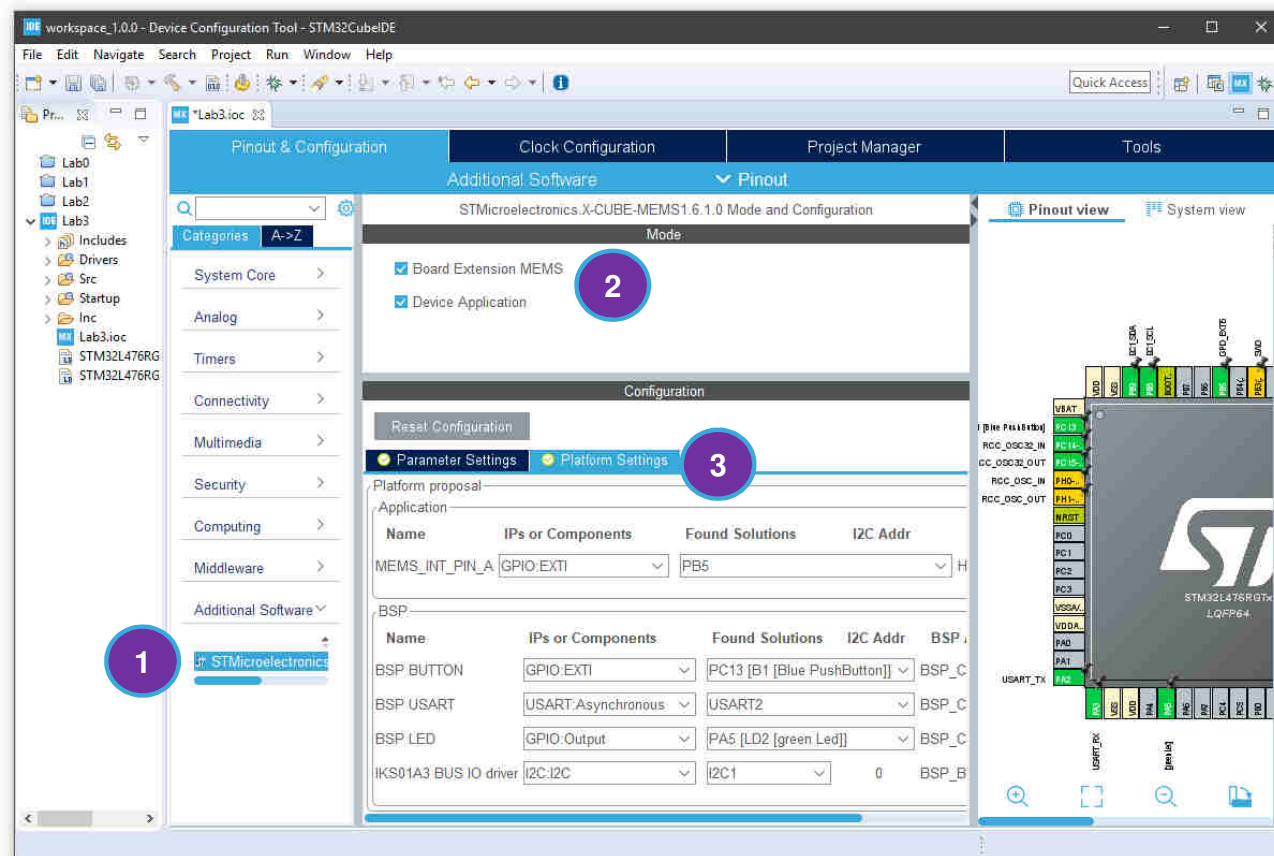


1. In X-CUBE-MEMS1/Application, Class “Device”:  
Select **IKS01A3\_LSM6DSO\_Pedometer**
2. In X-CUBE-MEMS1/MEMS, Class “Board Extension”:  
Check **IKS01A3/**
3. Click **OK**

# Lab3 – Configure the MEMS library

157

1. Expand Additional Software and select the X-CUBE-MEMS1
2. Check both:  
**Board Extension MEMS**  
**Device Application**
3. Configure Platform Settings as in picture



# Lab3 – Configure the MEMS library

158

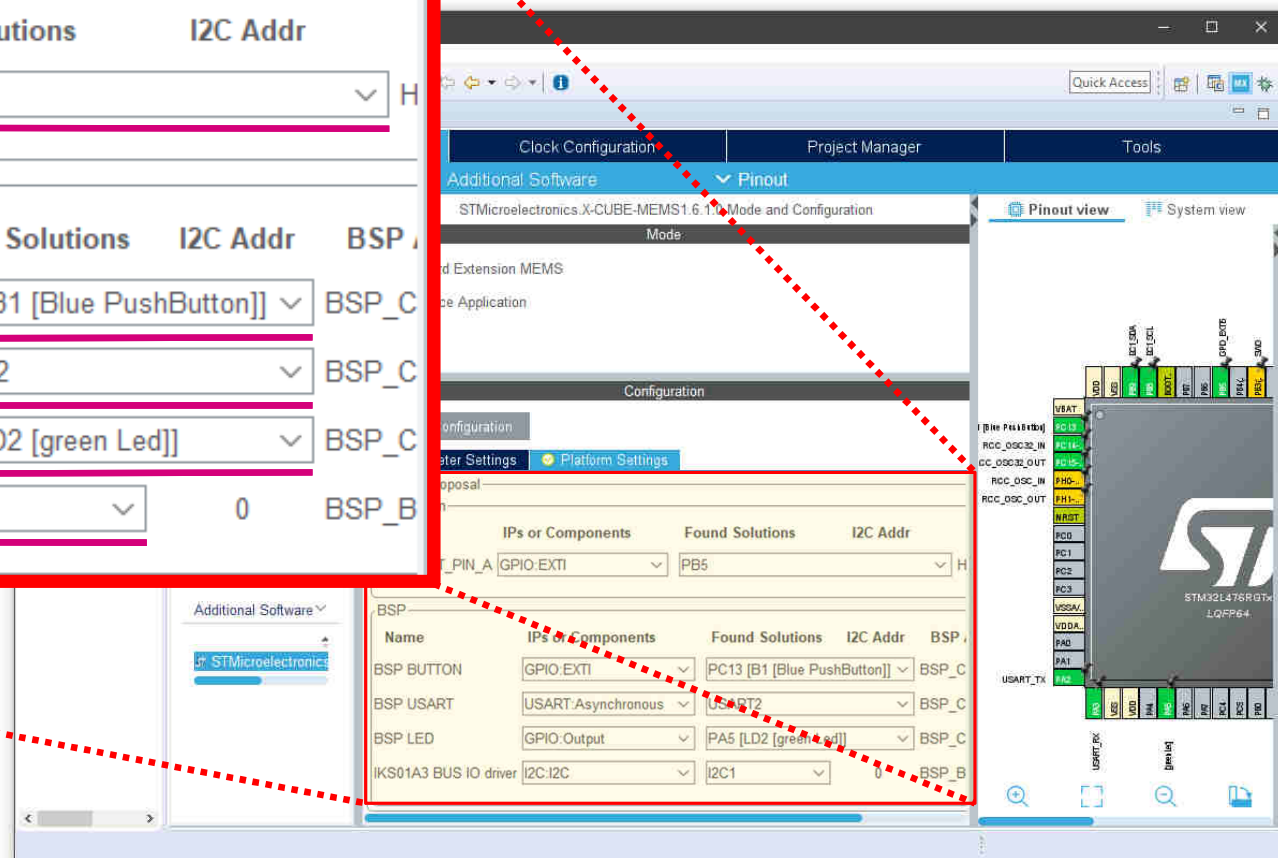
Platform proposal

Application

Name	IPs or Components	Found Solutions	I2C Addr
MEMS_INT_PIN_A	GPIO:EXTI	PB5	

BSP

Name	IPs or Components	Found Solutions	I2C Addr	BSP
BSP BUTTON	GPIO:EXTI	PC13 [B1 [Blue PushButton]]		BSP_C
BSP USART	USART:Asynchronous	USART2		BSP_C
BSP LED	GPIO:Output	PA5 [LD2 [green Led]]		BSP_C
IKS01A3 BUS IO driver	I2C:I2C	I2C1	0	BSP_B





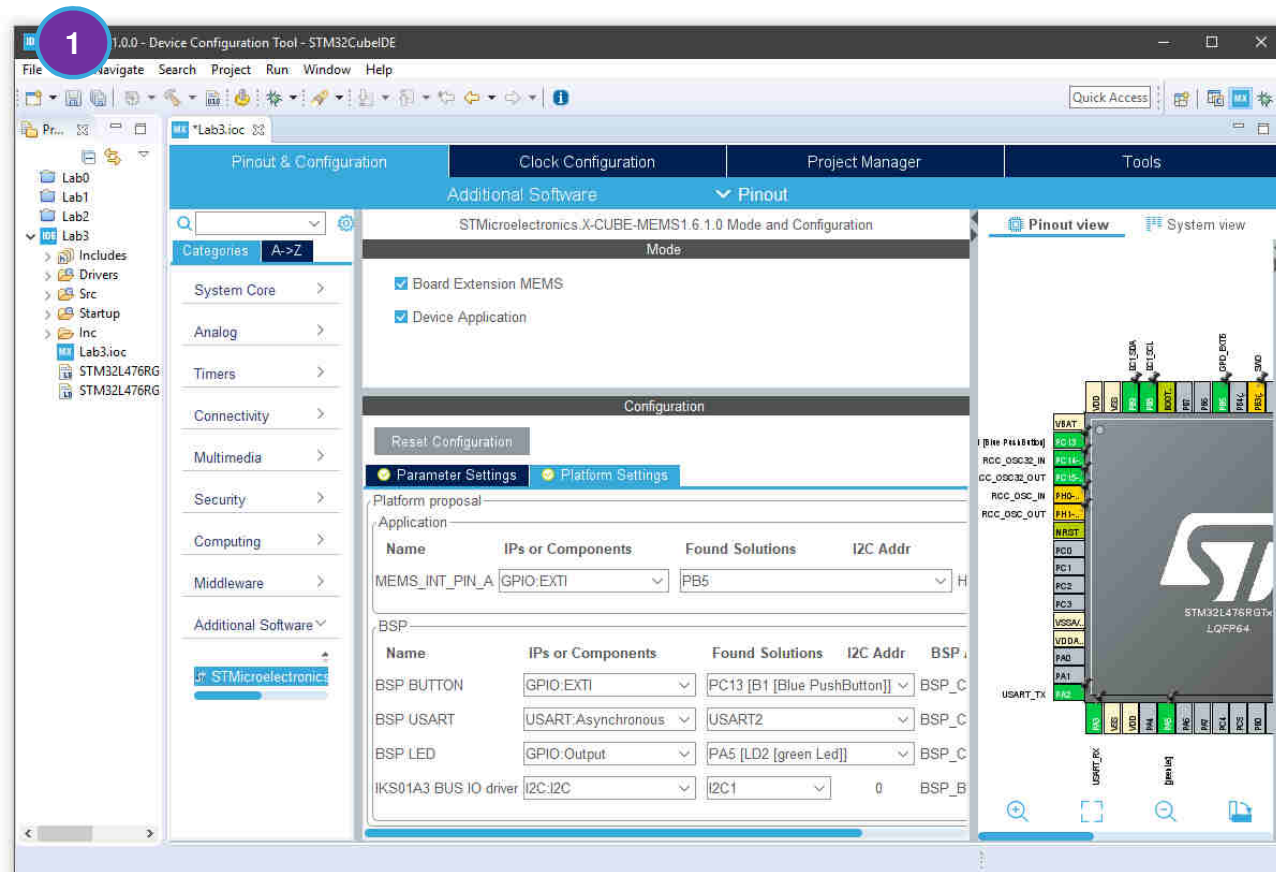
# Lab3 – Save the project

159

1. Click the save button



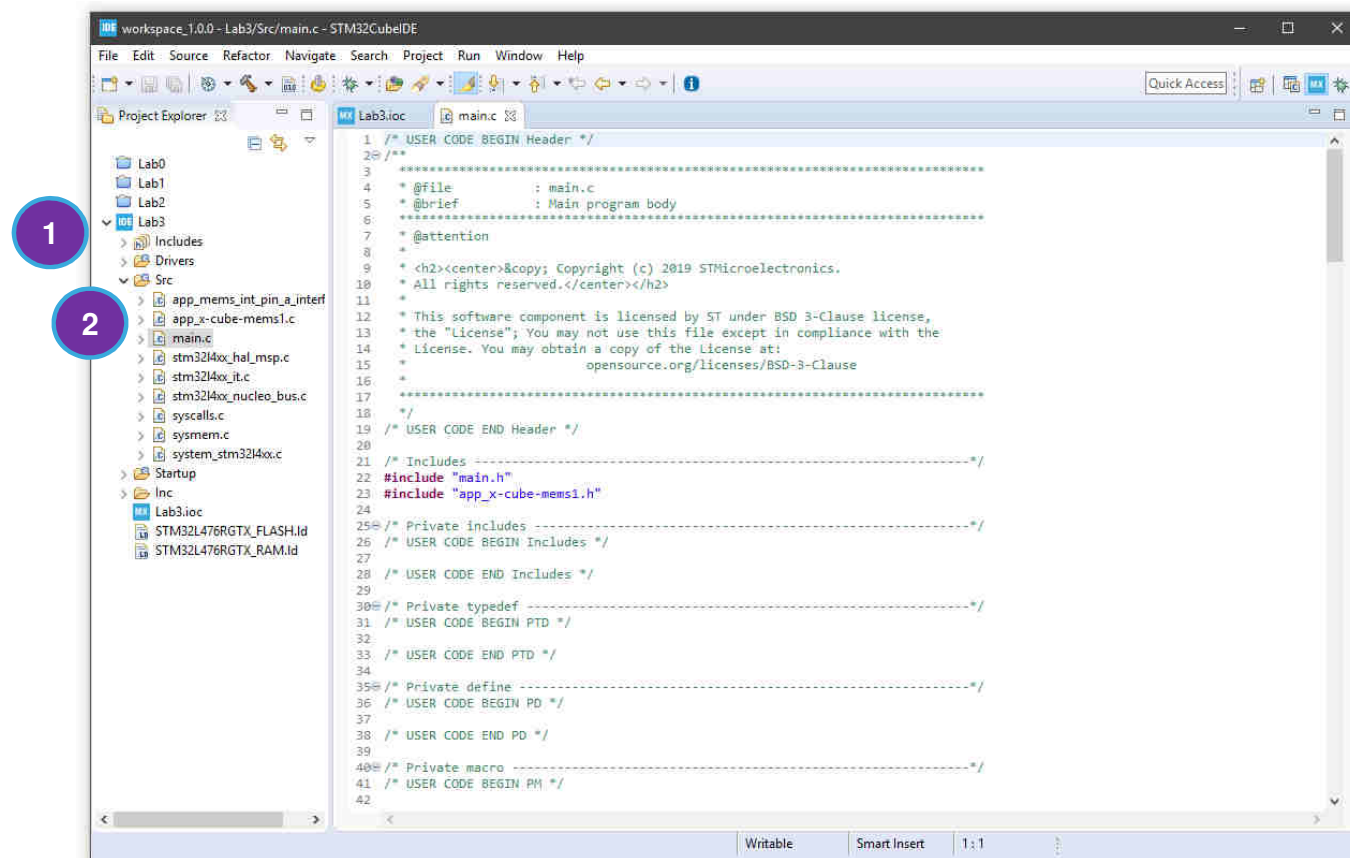
This action will generate the source code of this lab



# Lab3 – Code Editing

160


1. Expand **Src** in folder **Lab3**
2. Double click on **main.c**

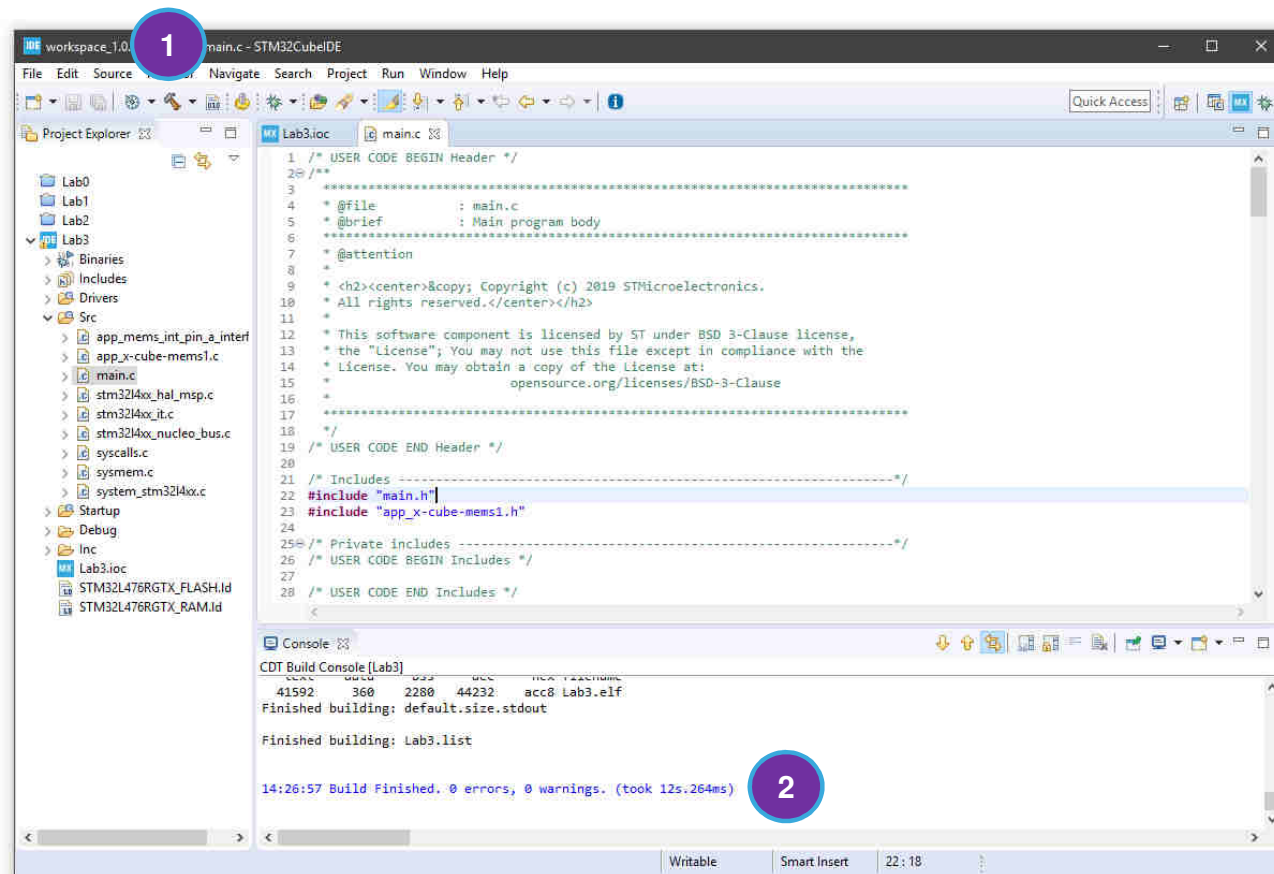




# Lab3 - Compiling

161

1. Click on the hammer  to begin compilation, or press **CTRL+B**
2. Compilation should terminate with 0 errors and 0 warning



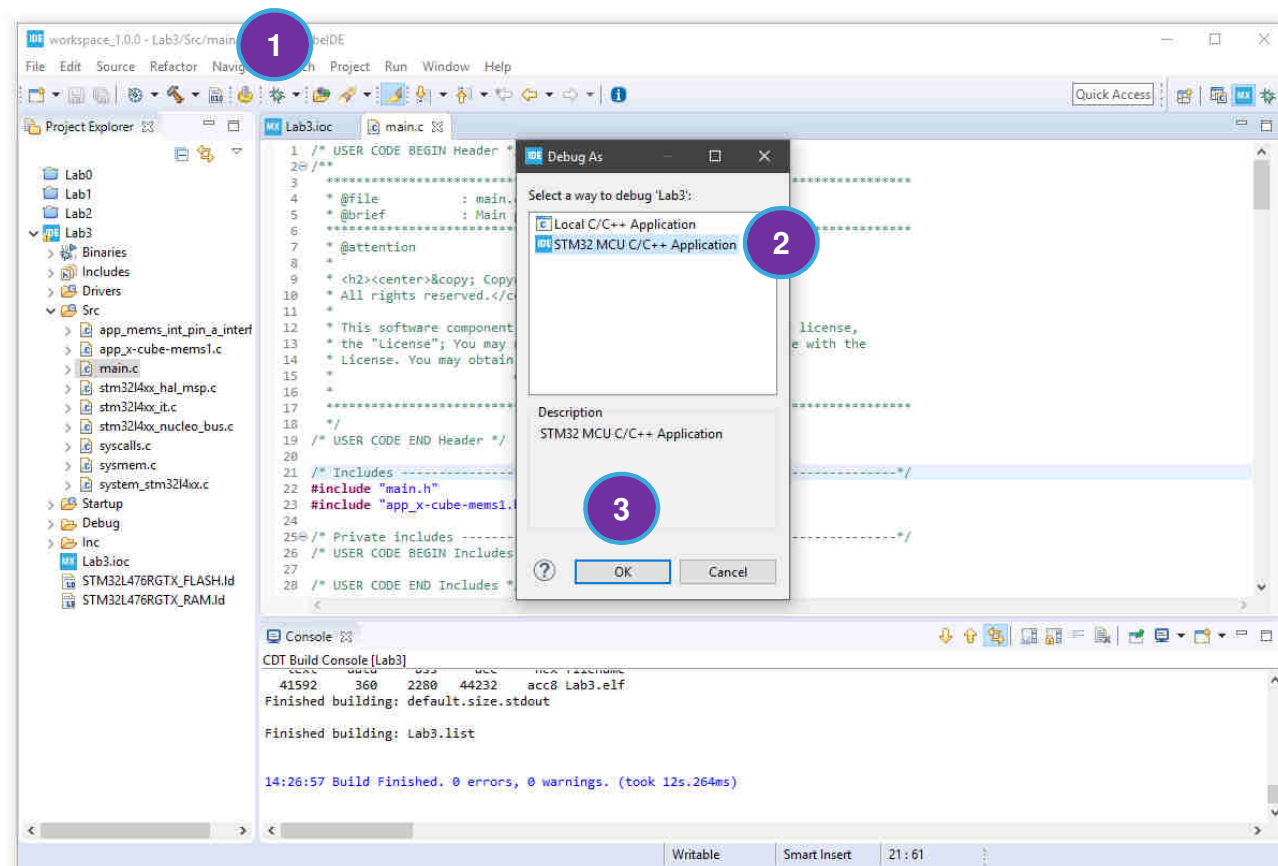
# Lab3 - Debugging

162

1. Click on the bug  to begin debugging

2. Select  
**STM32 MCU C/C++ App**

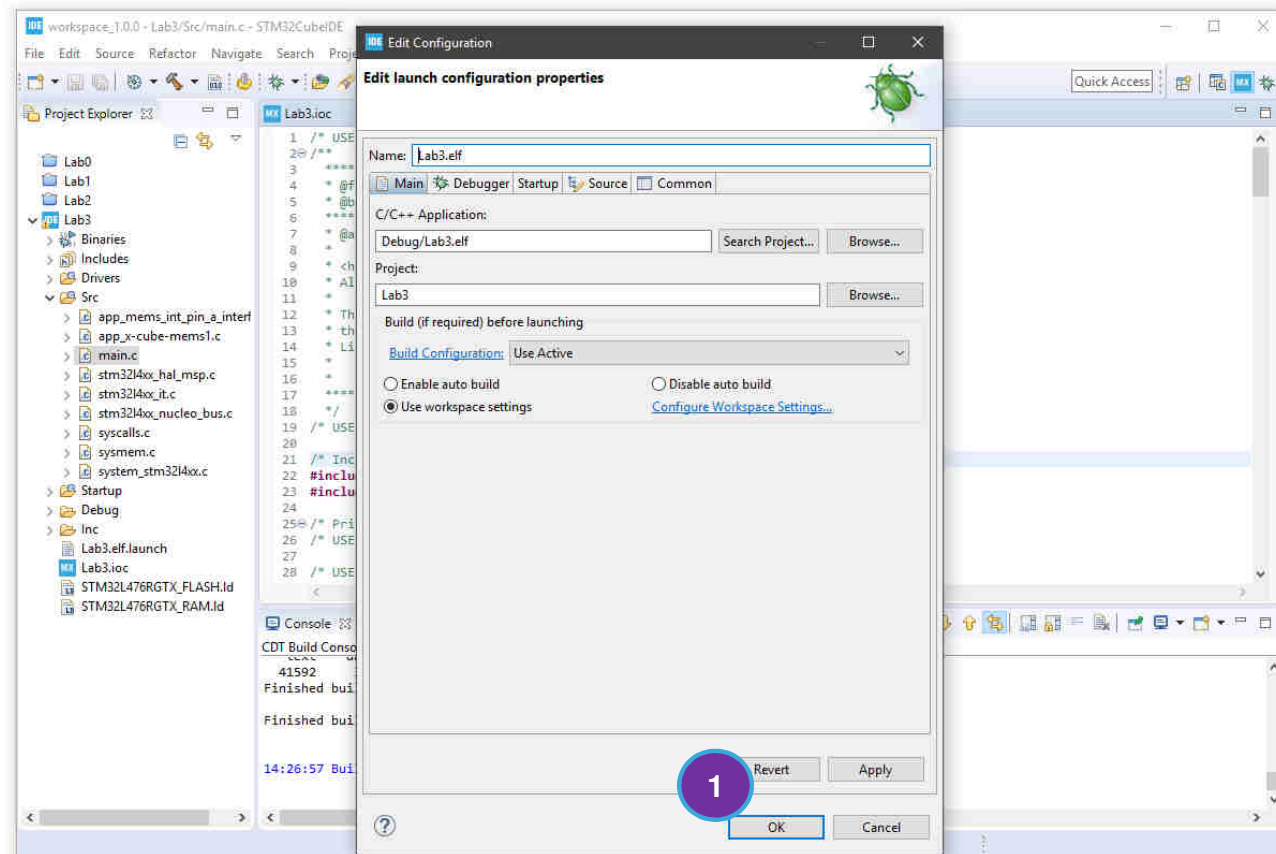
3. Click **OK**



# Lab3 - Debugging

163


1. Click **OK**

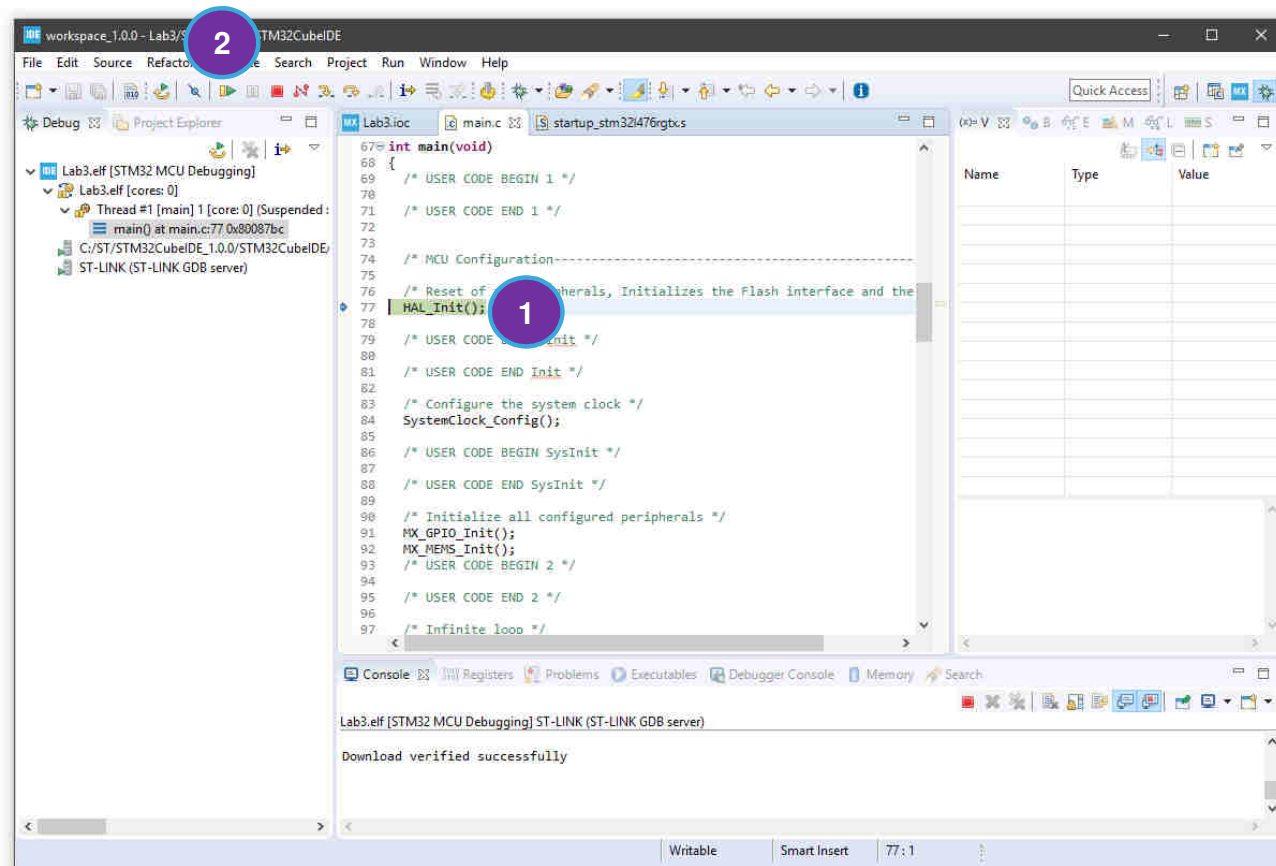


# Lab3 - Debugging

164

1. Code start at the first line of the main function

2. Click play  button to run the code



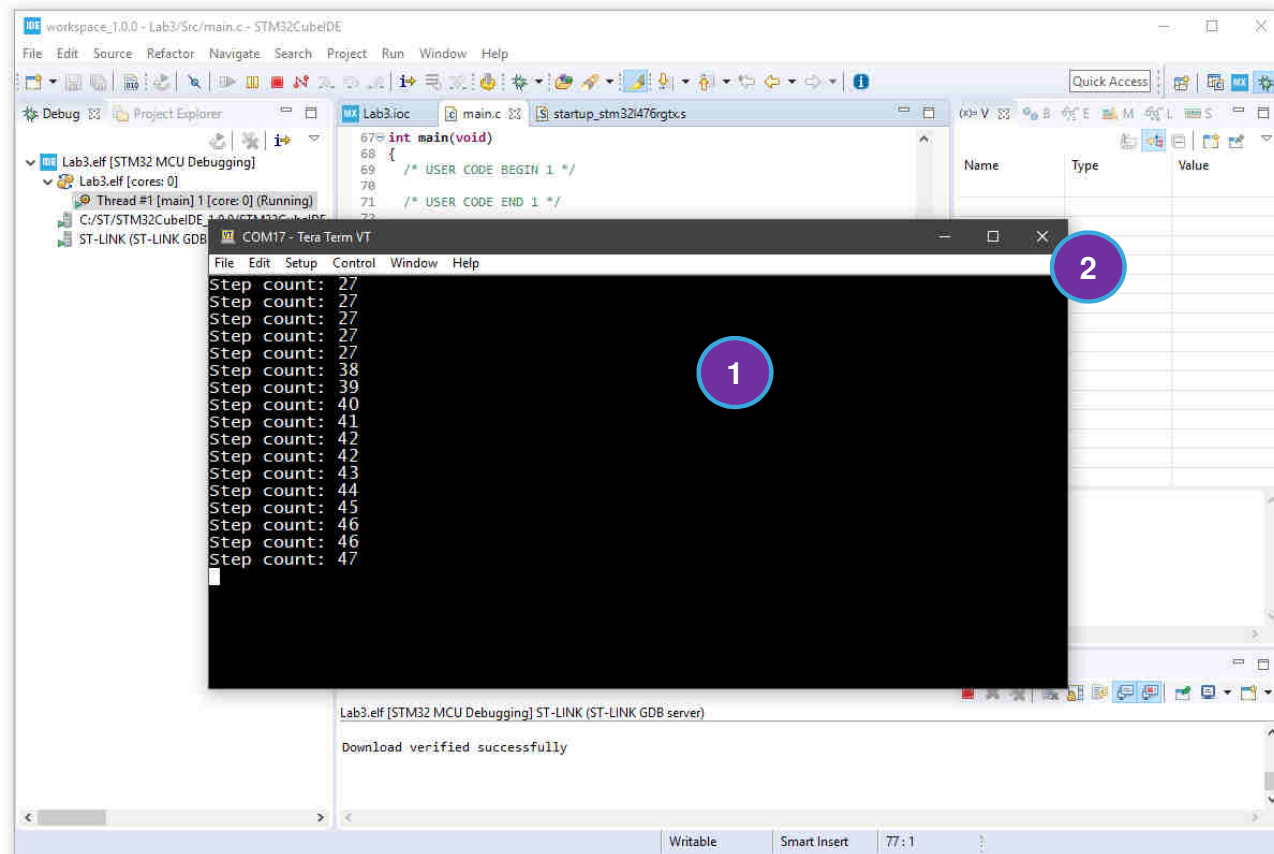
# Lab3 - Testing

165

1. Open Tera Term to view the output

**Simulate a walk by giving up/down movement to the board. Steps will be updated after about 10 steps**

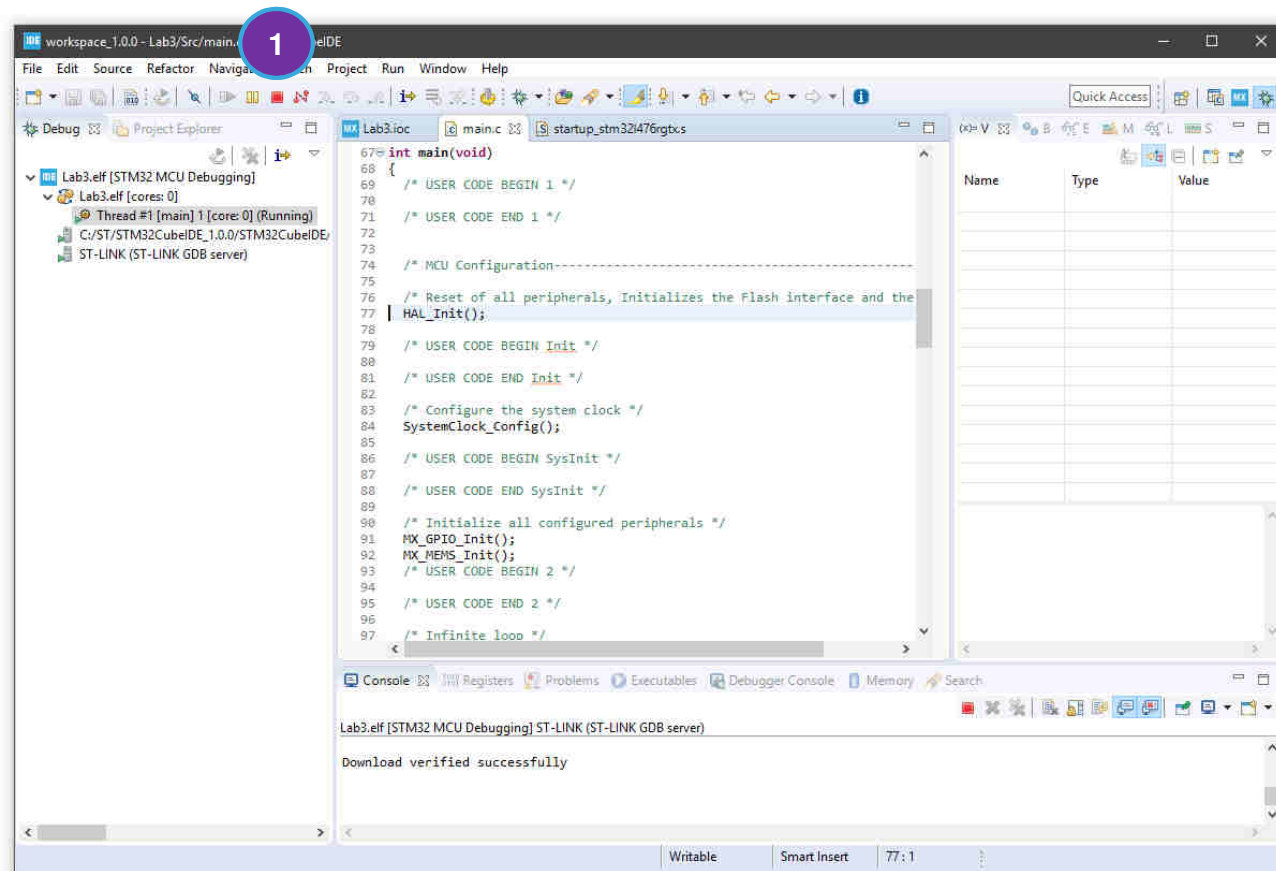
2. After testing close Tera Term by clicking **X**



# Lab3 - Debugging

166

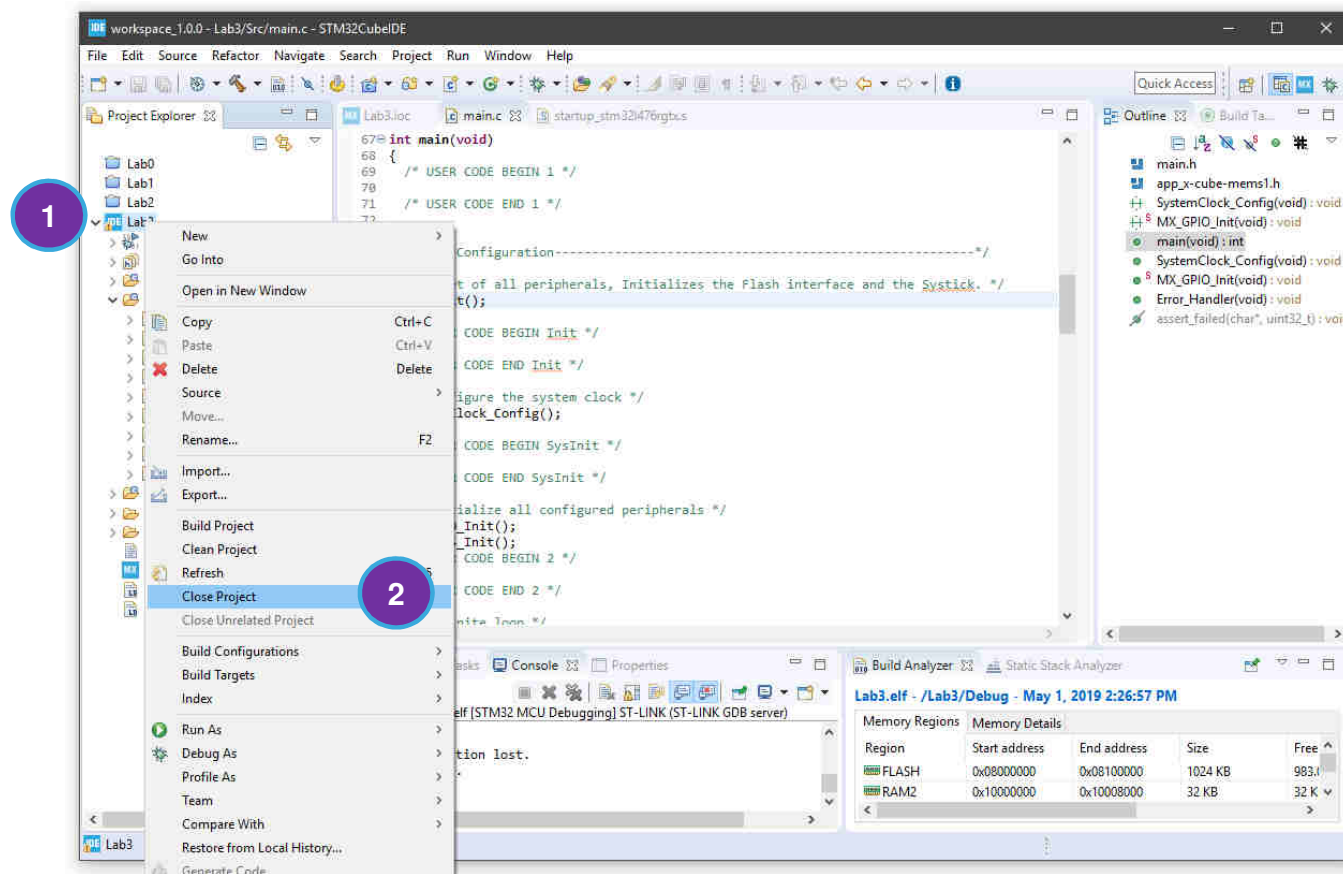
1. Click stop  button to interrupt the debugging



# Lab3 – Closing the project

167

1. Right-Click on **Lab3** project
2. Click on **Close Project**



# LAB4

## Goals:

- Configure a new project using X-CUBE-MEMS1
- Configure LIS2DW12 accelerometer in order to generate an interrupt when an acceleration is detected
- Enable interrupts in STM32CubeIDE
- Turn the led ON at wake-up



## Power saving and flexible Accelerometer

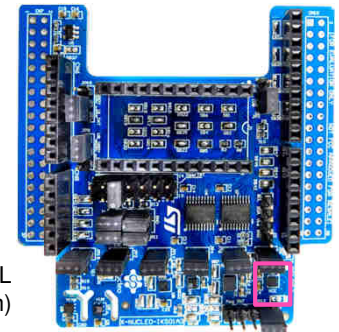
- Down to 0.38  $\mu\text{A}$  power consumption (1.6Hz ODR)
- High Perf. mode: up to 1600Hz with noise density 90  $\mu\text{g}/\sqrt{\text{Hz}}$
- 5 Power Modes + 2 Noise Modes
- 32-level FIFO buffer
- Digital Features
  - Free fall
  - Wake-up
  - 6D / 4D
  - Stationary/Motion detection
  - Double Tap

Enabling battery saving

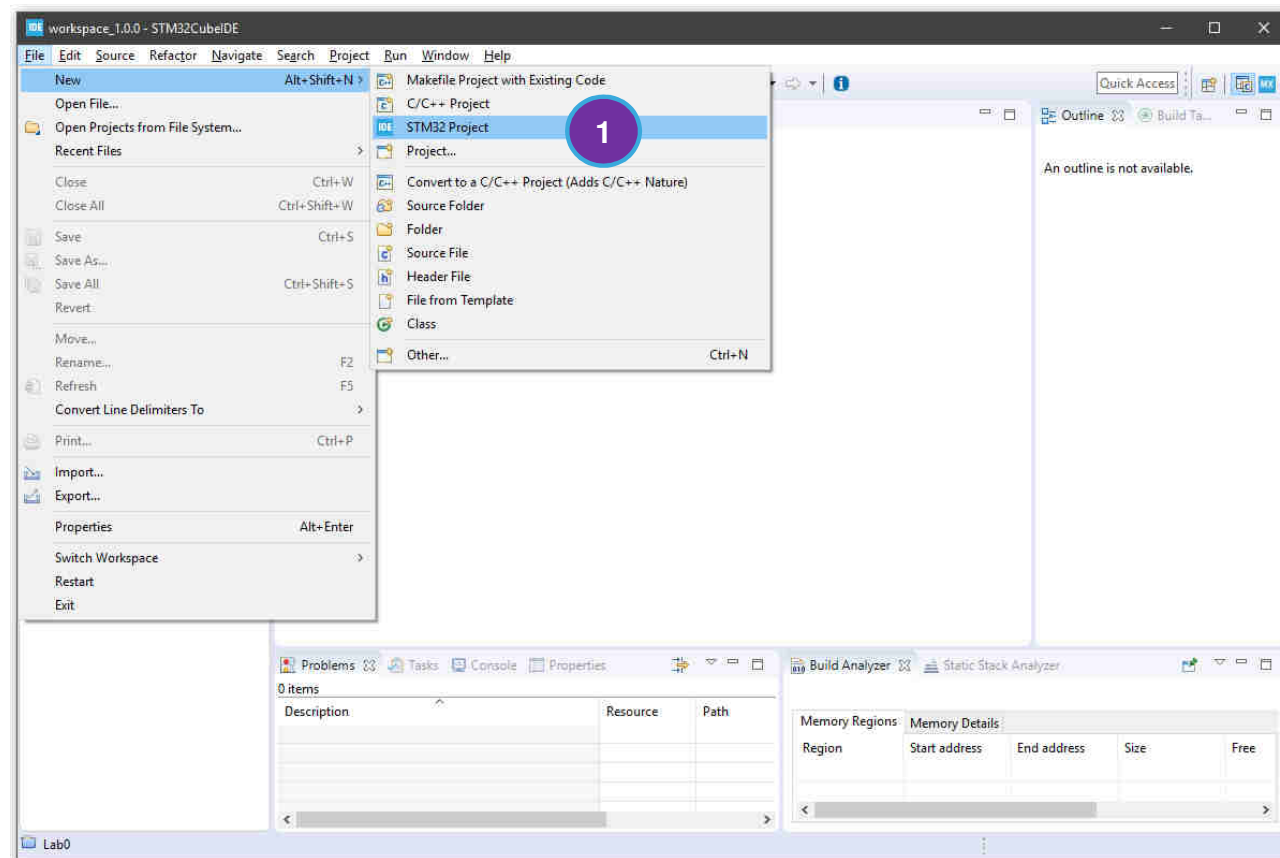
Accuracy

High Flexibility

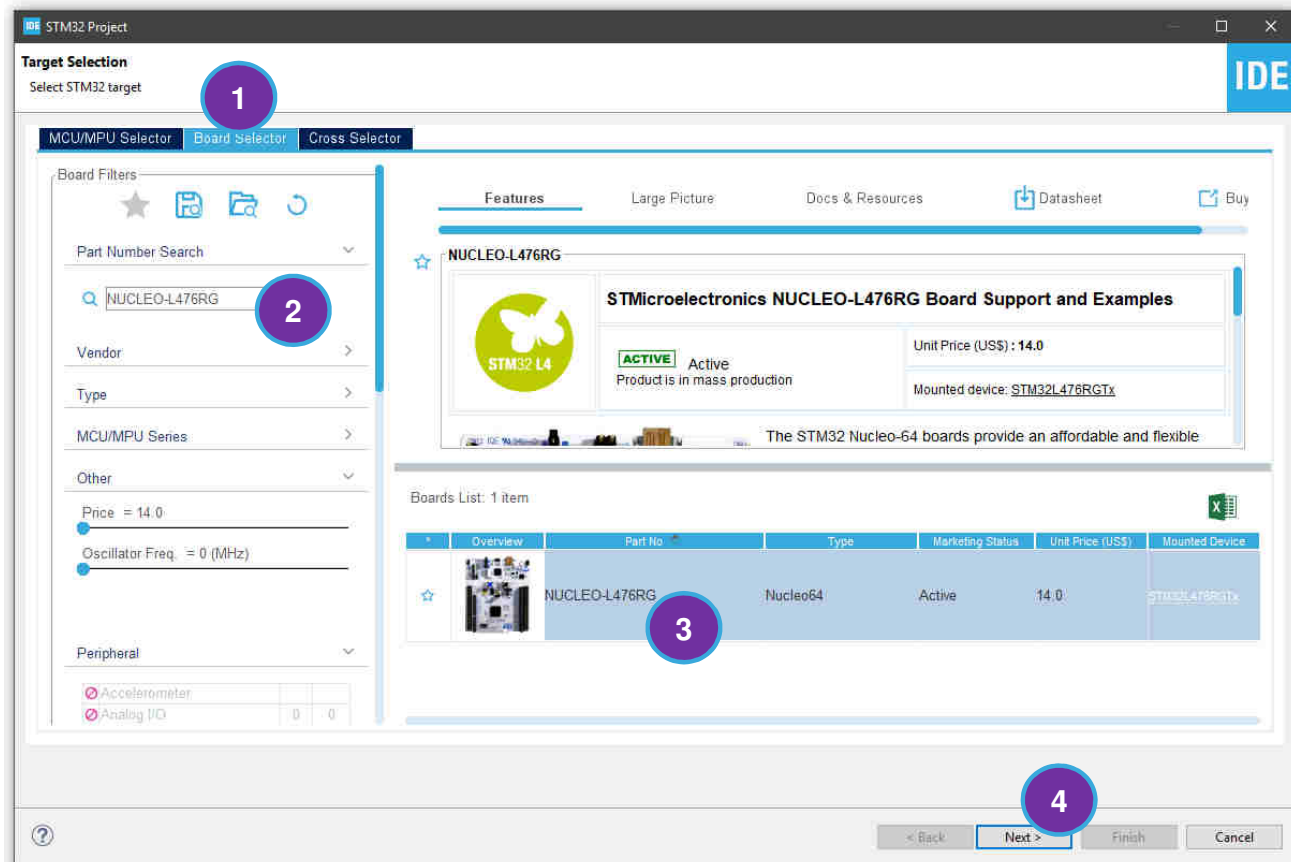
System Power Saving & Smart Functions



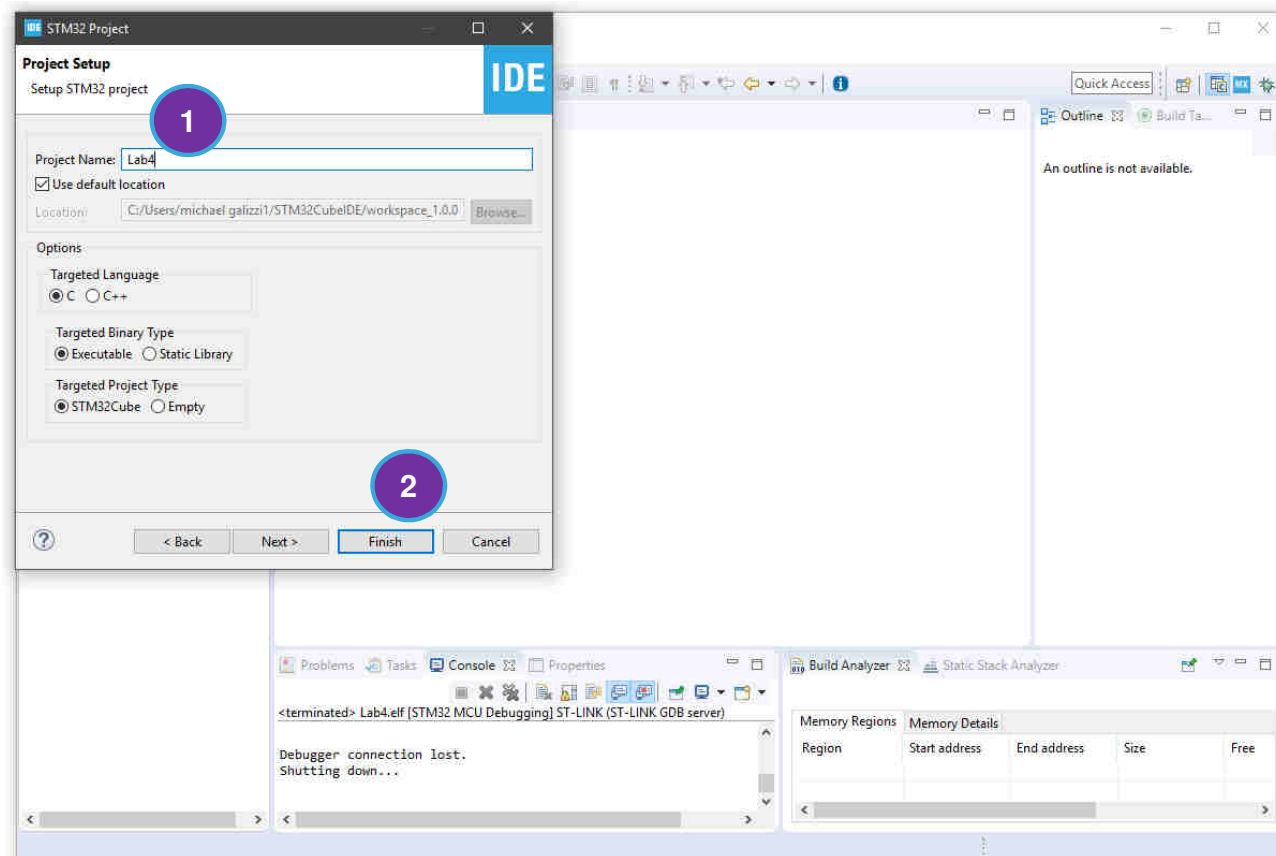
## 1. Click on **File > New > STM32 Project**



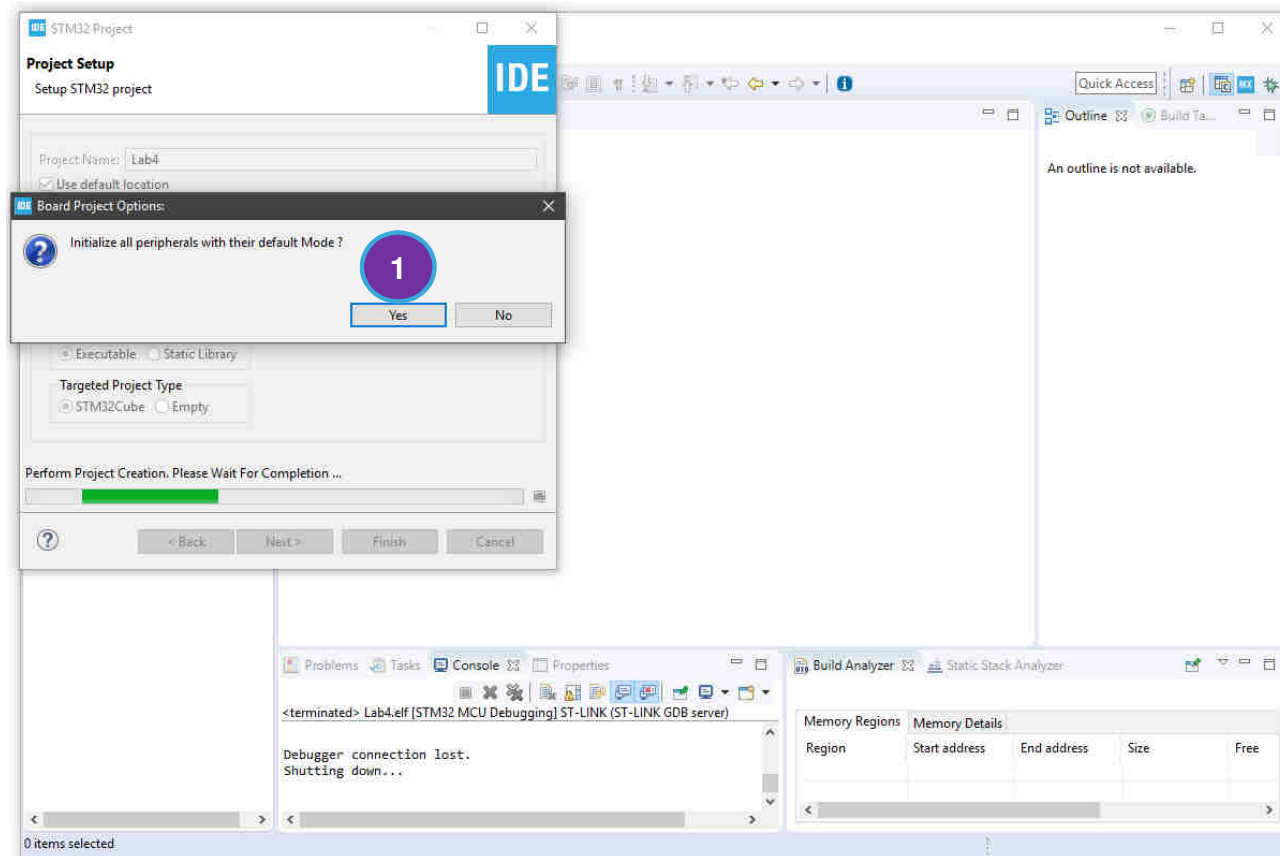
1. Click on **Board Selector**
2. Type **NUCLEO-L476RG**
3. Click on the board
4. Click **Next >**



1. Project Name **Lab4**
2. Click **Finish**

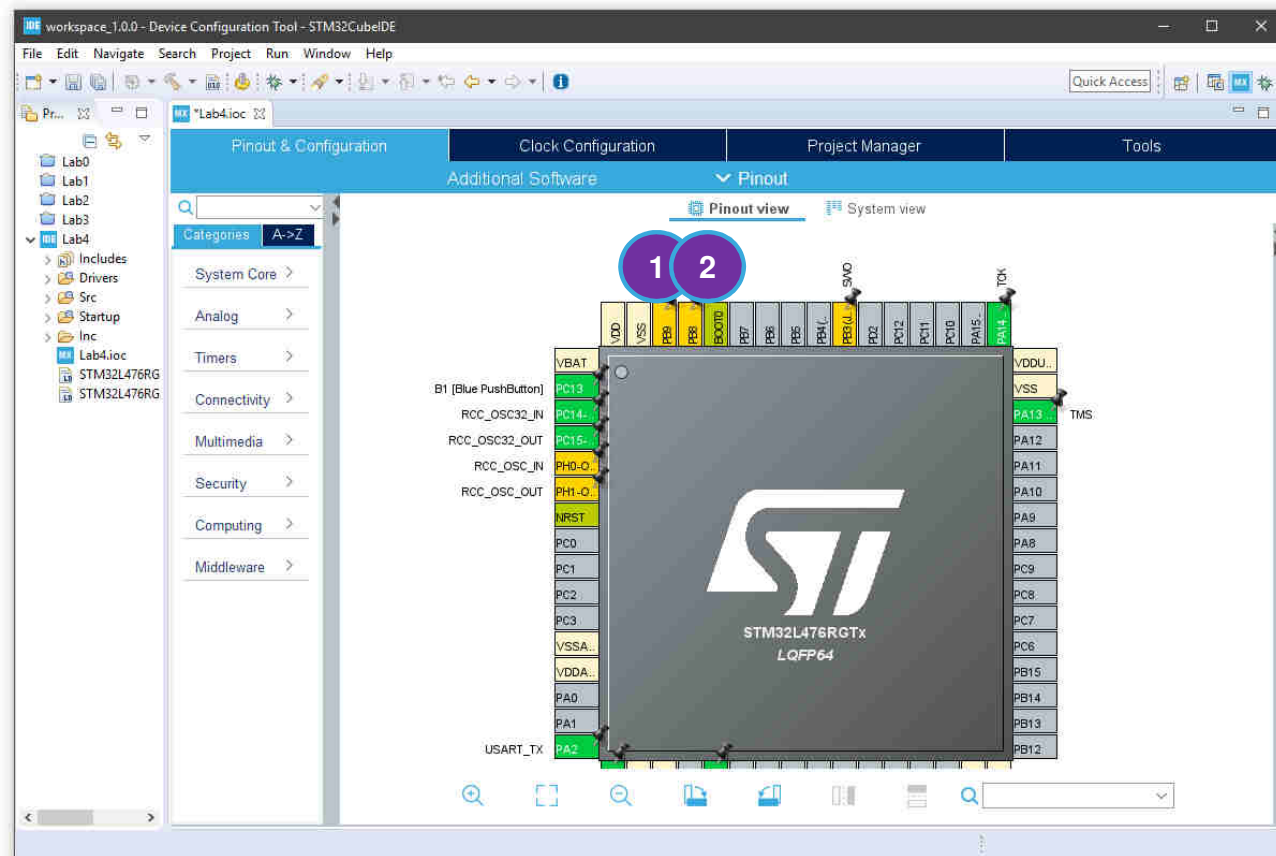
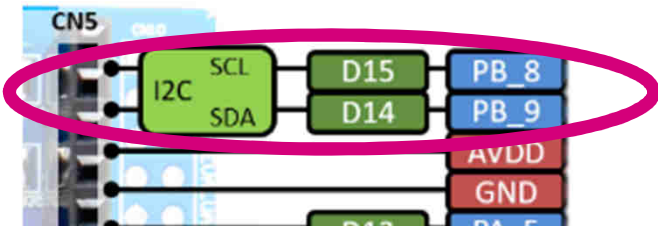


1. Click **Yes** to init peripherals in default mode



# Lab4 – Configure the I2C bus

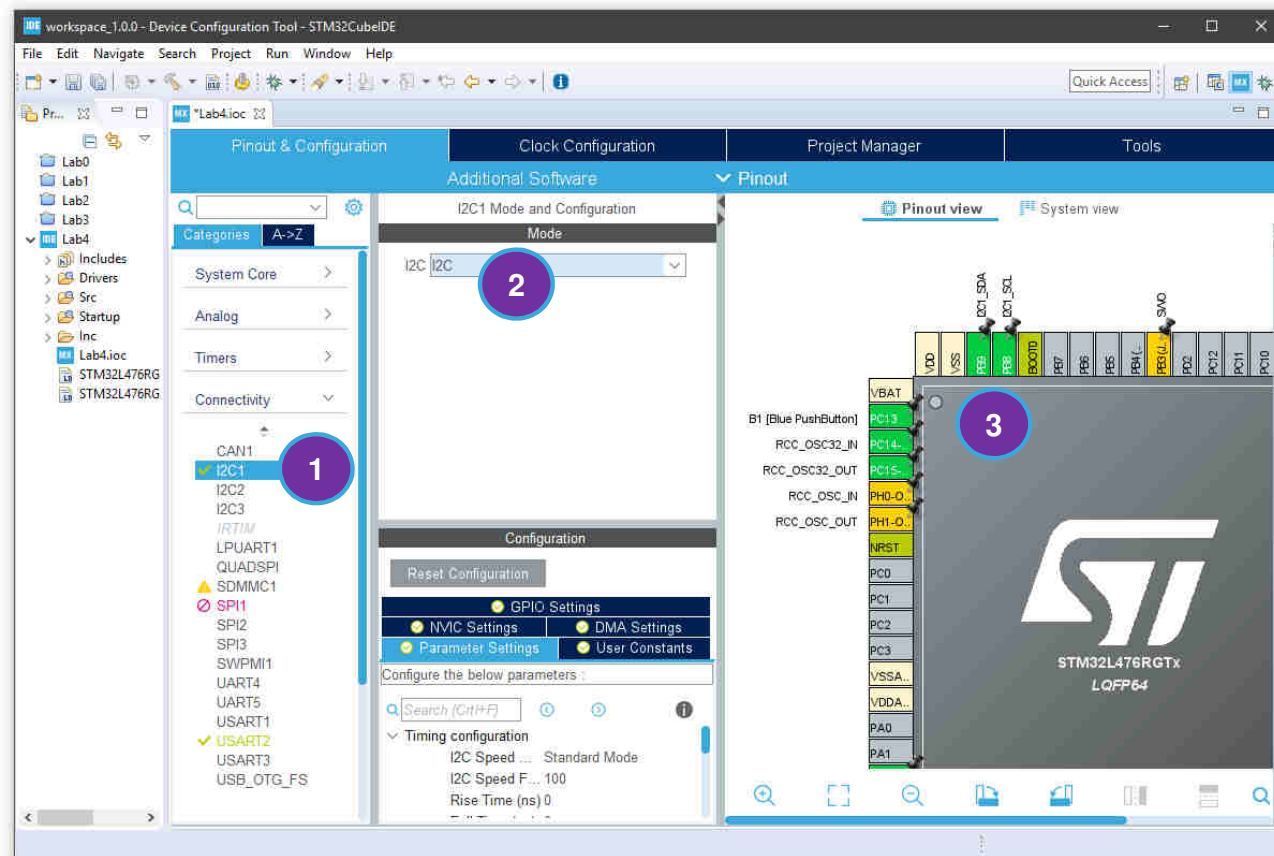
1. Left Click on **PB9** and select I2C1\_SDA
2. Left Click on **PB8** and select I2C1\_SCL



# Lab4 – Configure the I2C bus

175

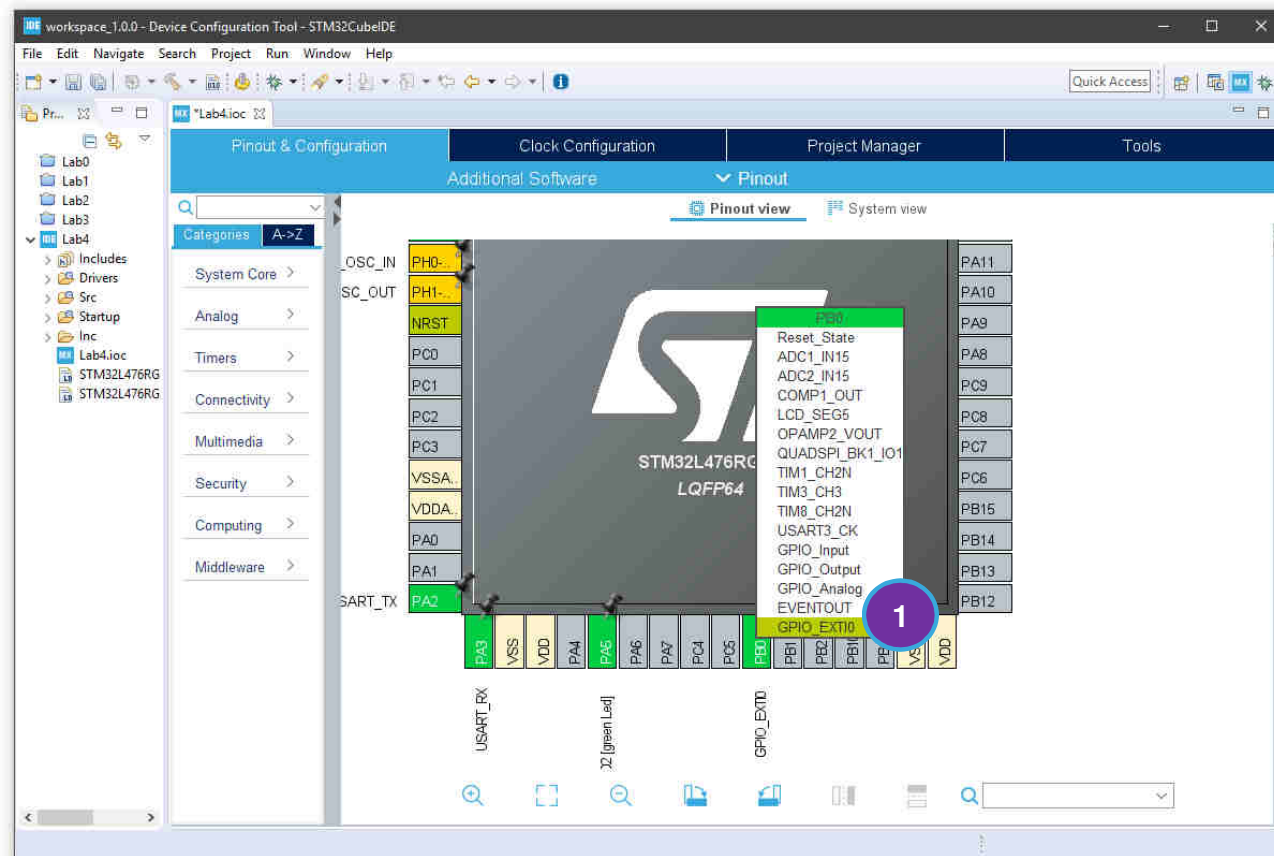
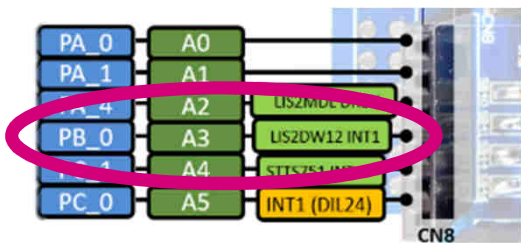
1. Expand *Connectivity* tab and check **I2C1**
2. Select **I2C** in *I2C1 Mode and Configuration*
3. PB8 and PB9 should now become green



# Lab4 – Configure LIS2DW12 interrupt

176

1. Left Click on **PB0** and select **GPIO\_EXTI0**

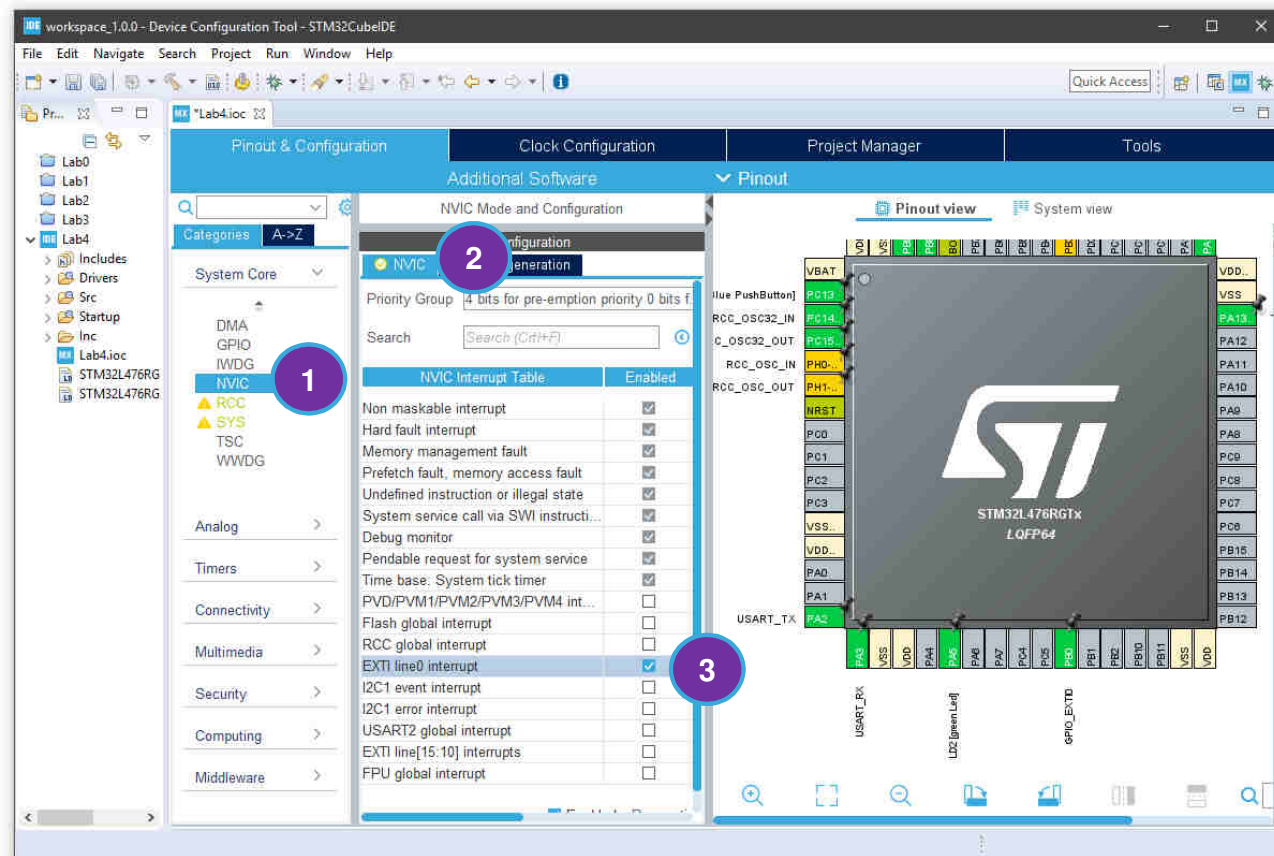




# Lab4 – Configure LIS2DW12 interrupt

177

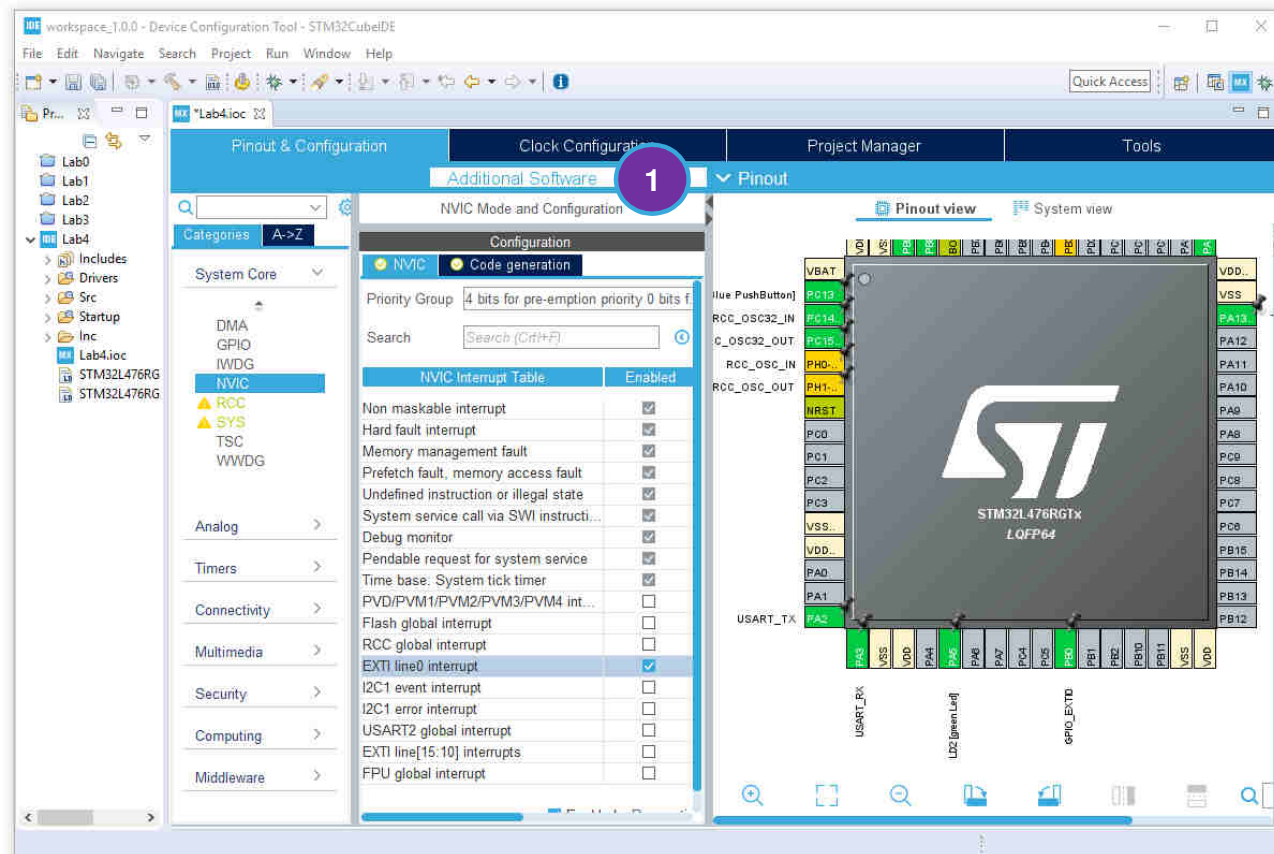
1. Check **NVIC** in tab System Core
2. Select **NVIC** in NVIC Mode and Configuration
3. Enable **EXTI line0 interrupt**



# Lab4 – Select the MEMS library

178

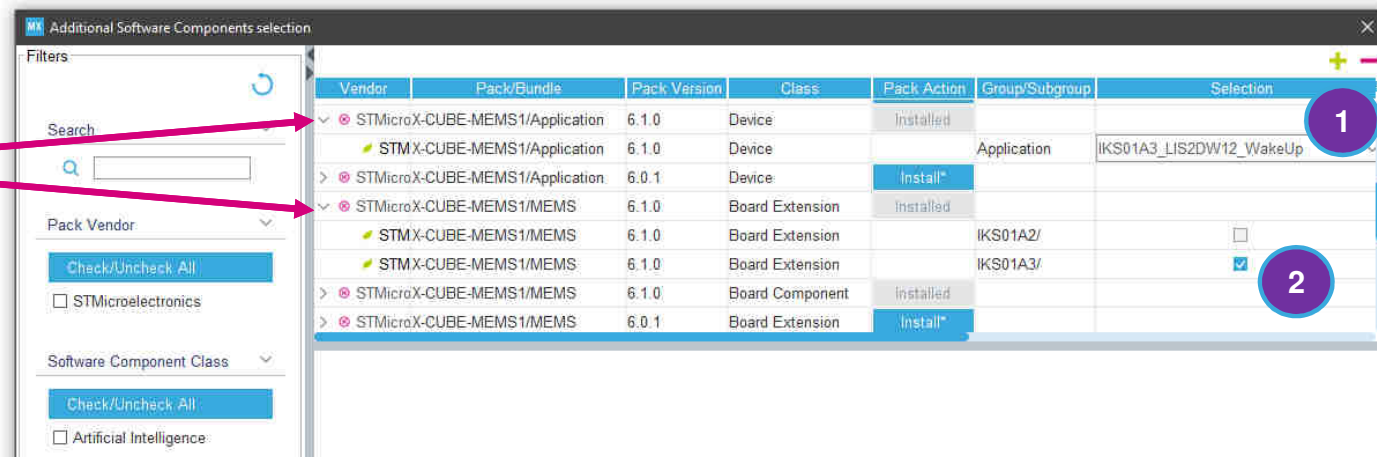
1. Click on **Additional Software**



# Lab4 – Select the MEMS library

179

Click to  
expand tree

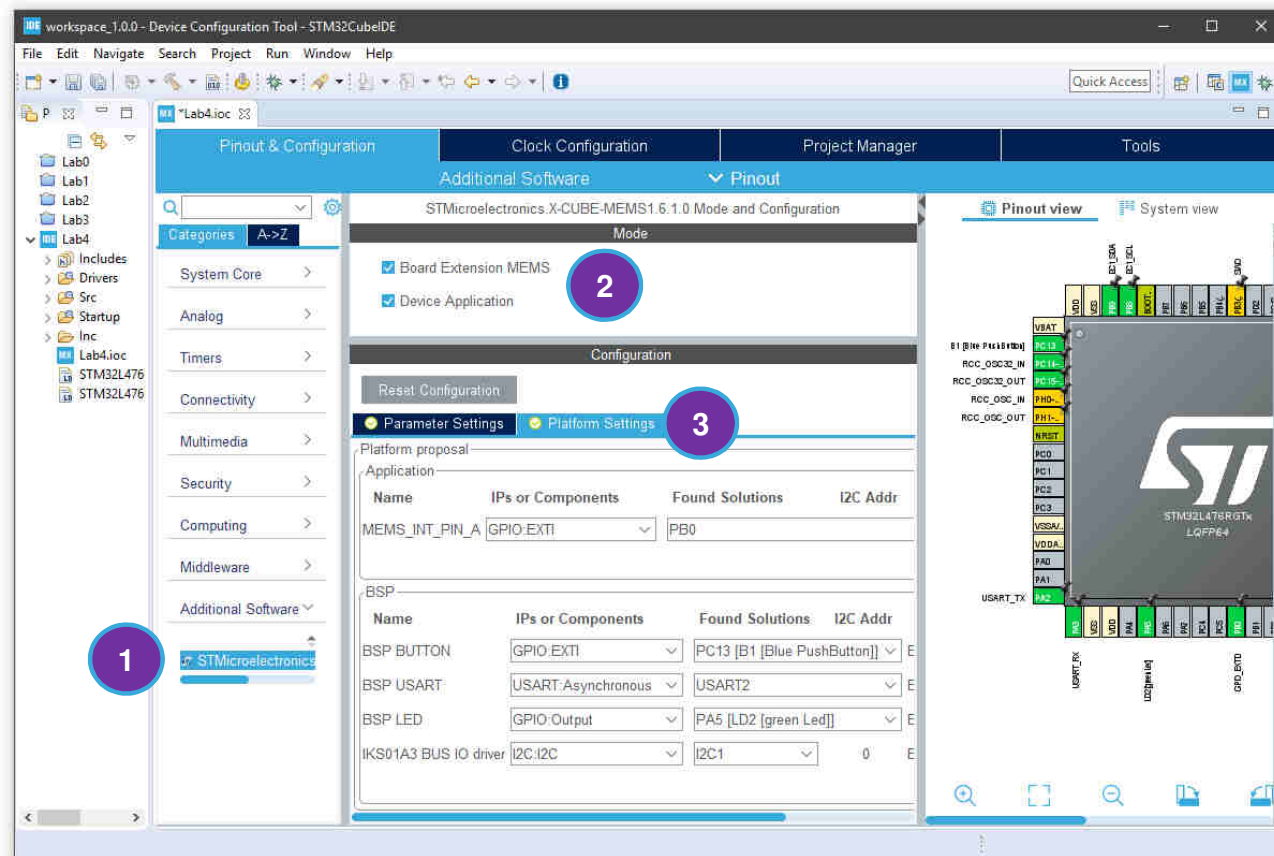


1. In X-CUBE-MEMS1/Application, Class “Device”:  
Select **IKS01A3\_LIS2DW12\_WakeUp**
2. In X-CUBE-MEMS1/MEMS, Class “Board Extension”:  
Check **IKS01A3/**
3. Click **OK**

# Lab4 – Configure the MEMS library

180

1. Expand Additional Software and select the X-CUBE-MEMS1
2. Check both:  
**Board Extension MEMS**  
**Device Application**
3. Configure Platform Settings as in picture



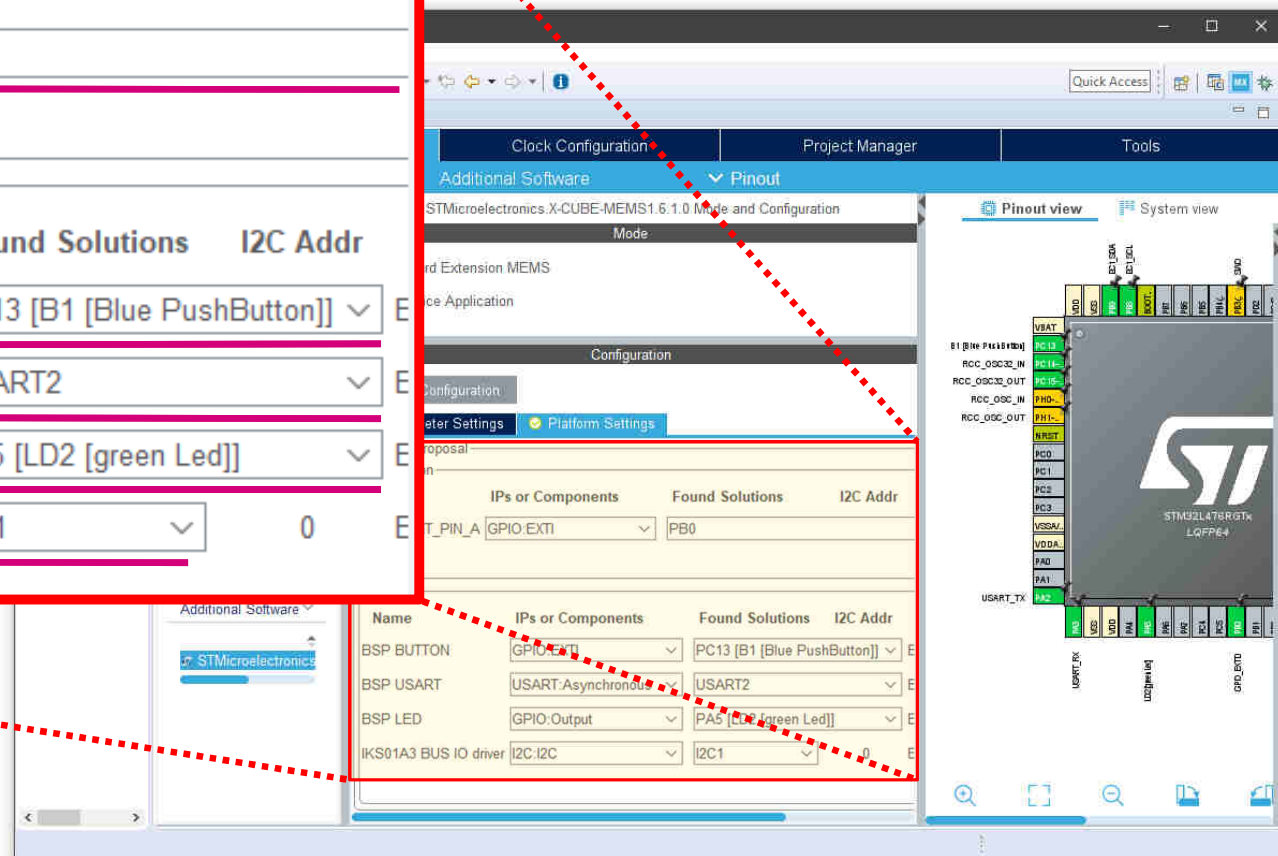
# Lab4 – Configure the MEMS library

181

Application			
Name	IPs or Components	Found Solutions	I2C Addr
MEMS_INT_PIN_A	GPIO:EXTI	PB0	

BSP			
Name	IPs or Components	Found Solutions	I2C Addr
BSP BUTTON	GPIO:EXTI	PC13 [B1 [Blue PushButton]]	
BSP USART	USART:Asynchronous	USART2	
BSP LED	GPIO:Output	PA5 [LD2 [green Led]]	
IKS01A3 BUS IO driver	I2C:I2C	I2C1	0



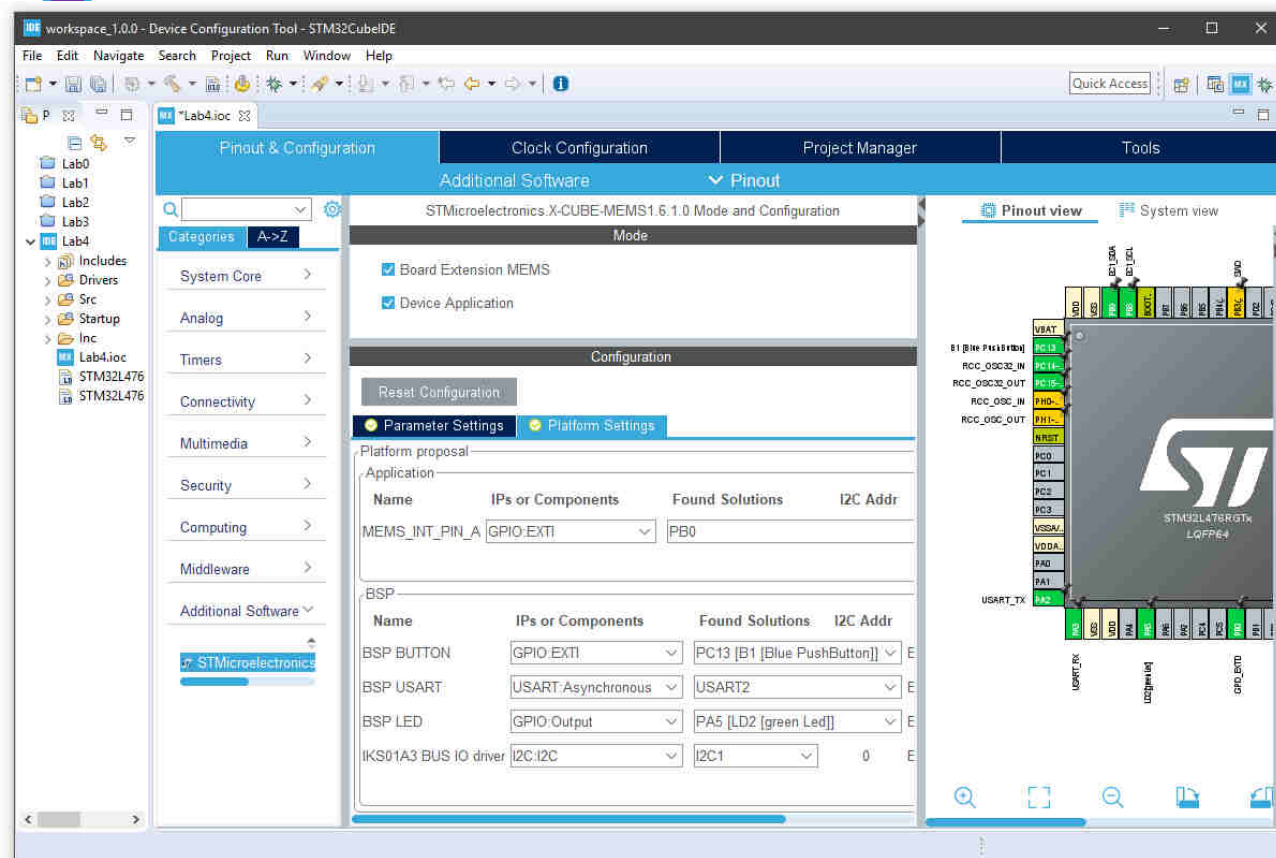
# Lab4 – Save the project

182

1. Click the save button



This action will generate the source code of this lab

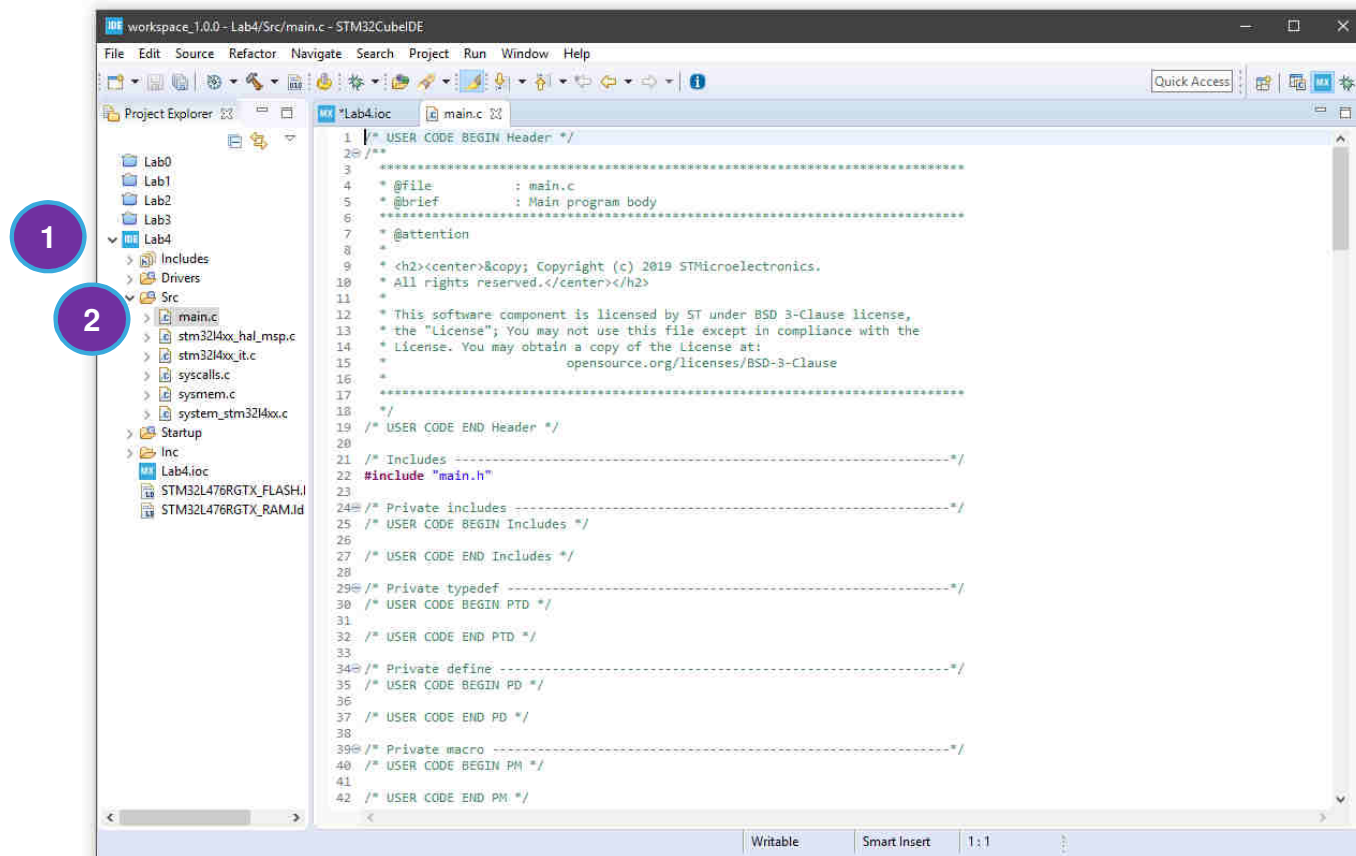




# Lab4 – Code Editing


183

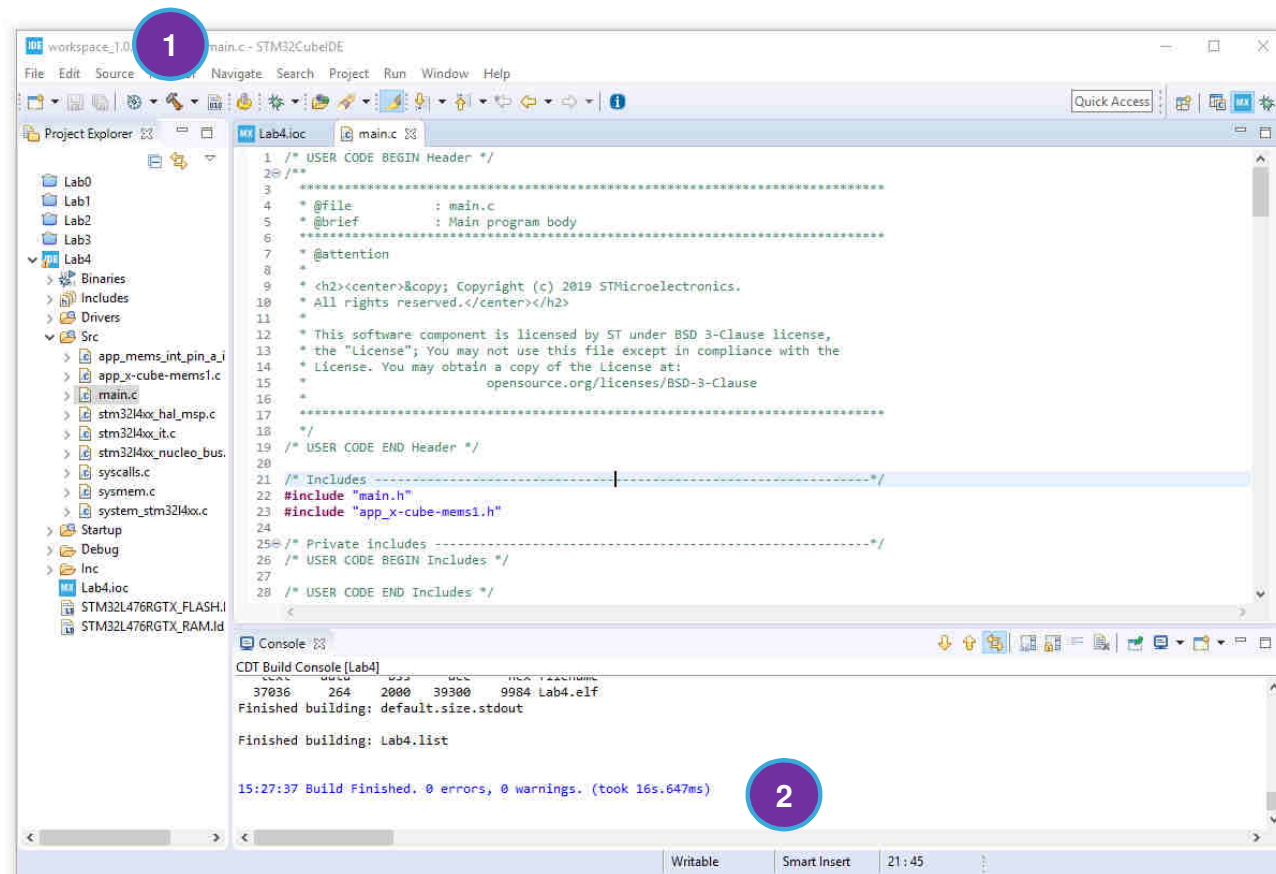
1. Expand **Src** in folder **Lab4**
2. Double click on **main.c**



# Lab4 - Compiling

184

1. Click on the hammer  to begin compilation, or press **CTRL+B**
2. Compilation should terminate with 0 errors and 0 warning





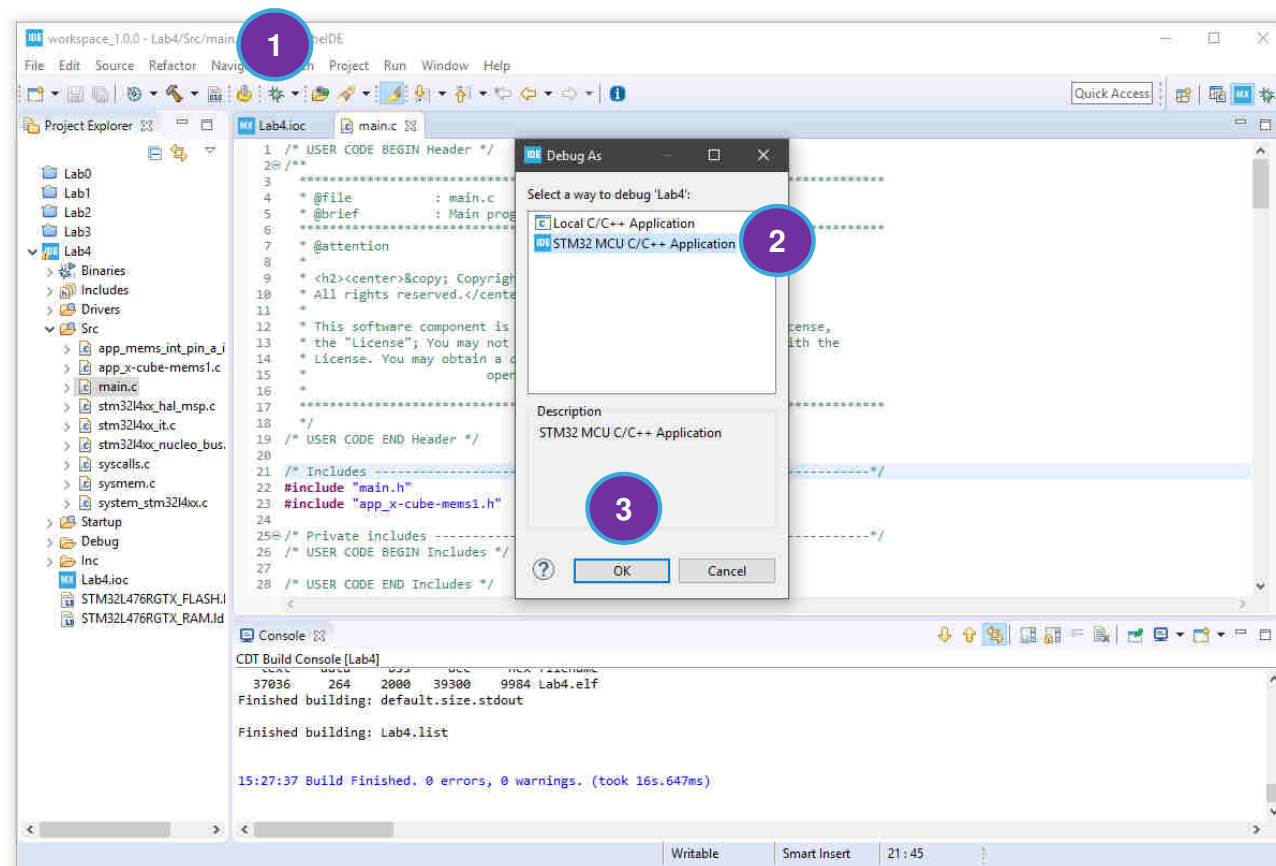
# Lab4 - Debugging

185

1. Click on the bug  to begin debugging

2. Select **STM32 MCU C/C++ App**

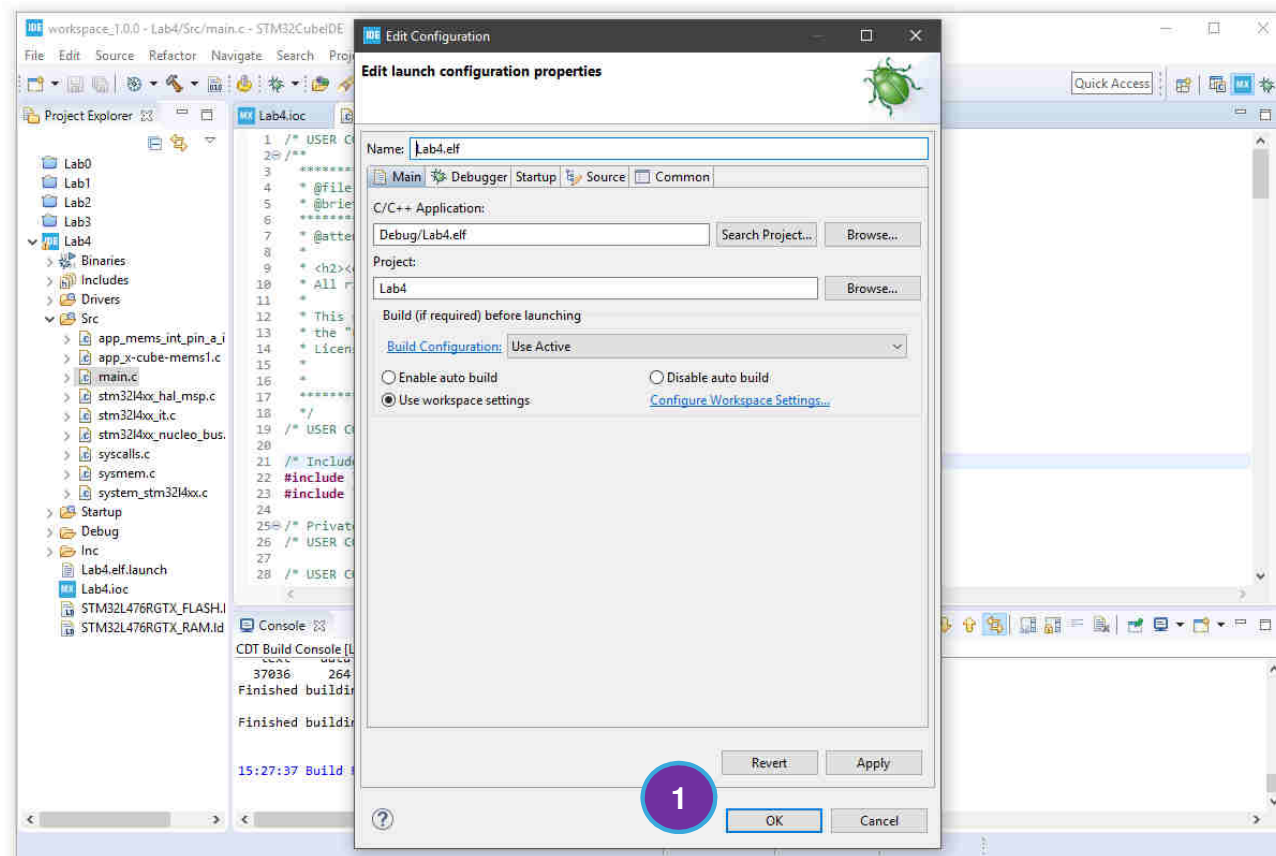
3. Click **OK**



# Lab4 - Debugging

186


1. Click **OK**

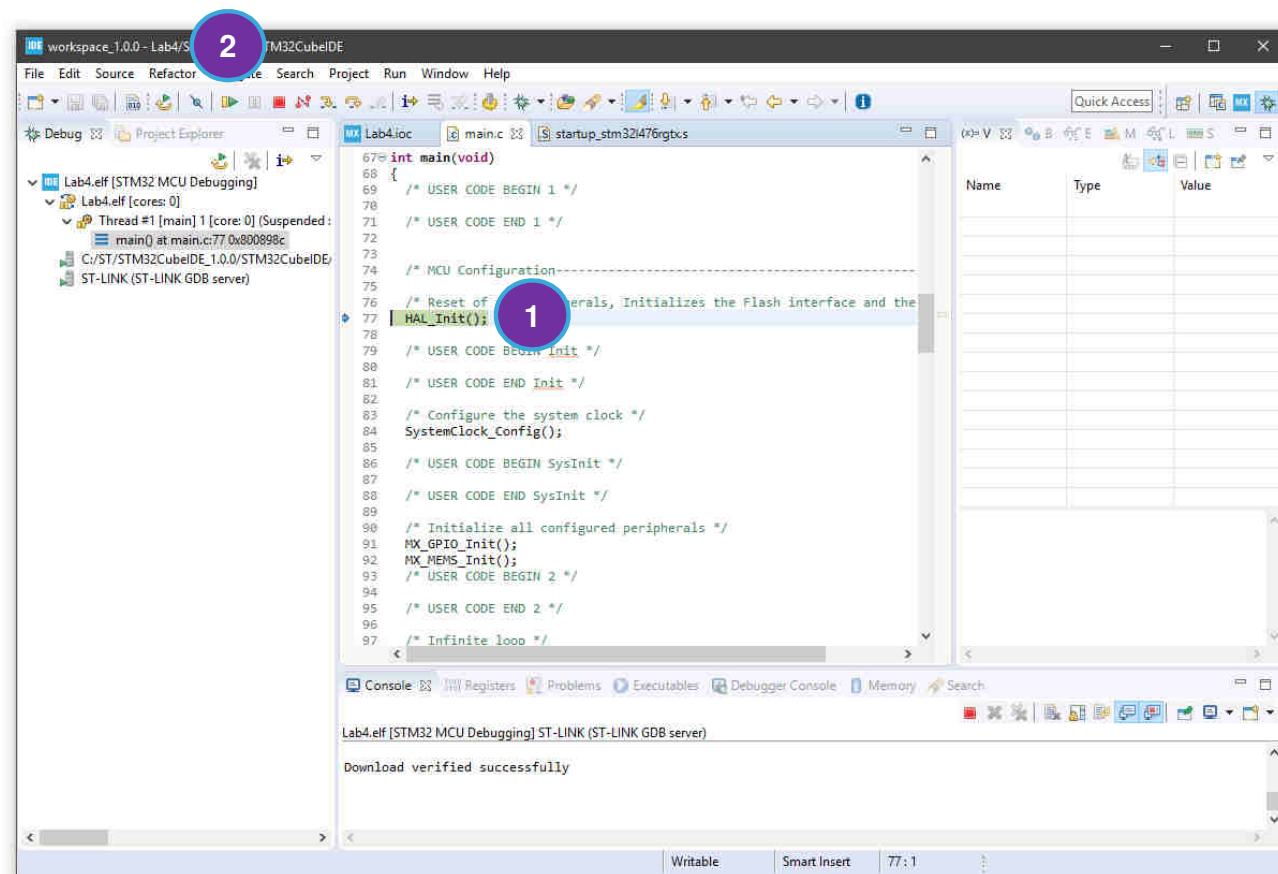


# Lab4 - Debugging

187

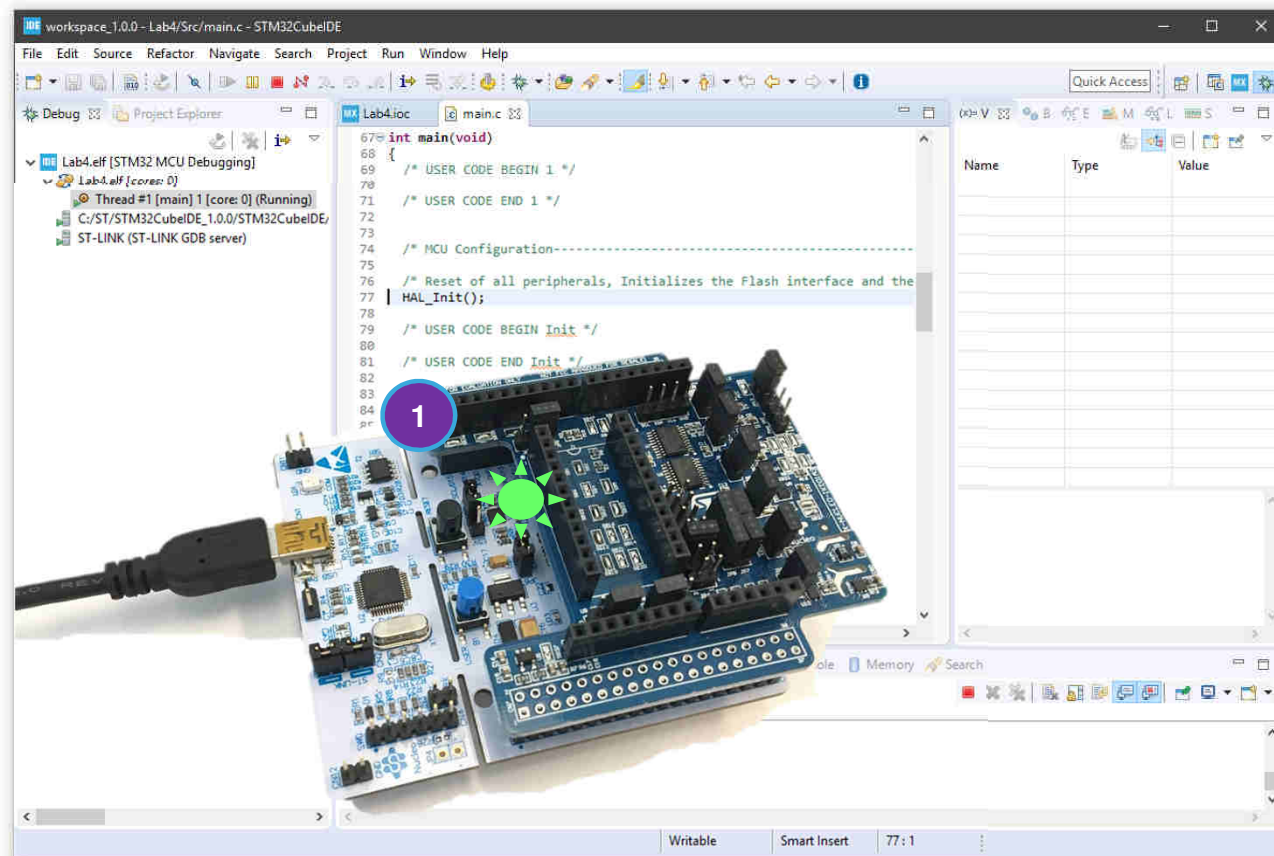
1. Code start at the first line of the main function

2. Click play  button to run the code



# Lab4 - Testing

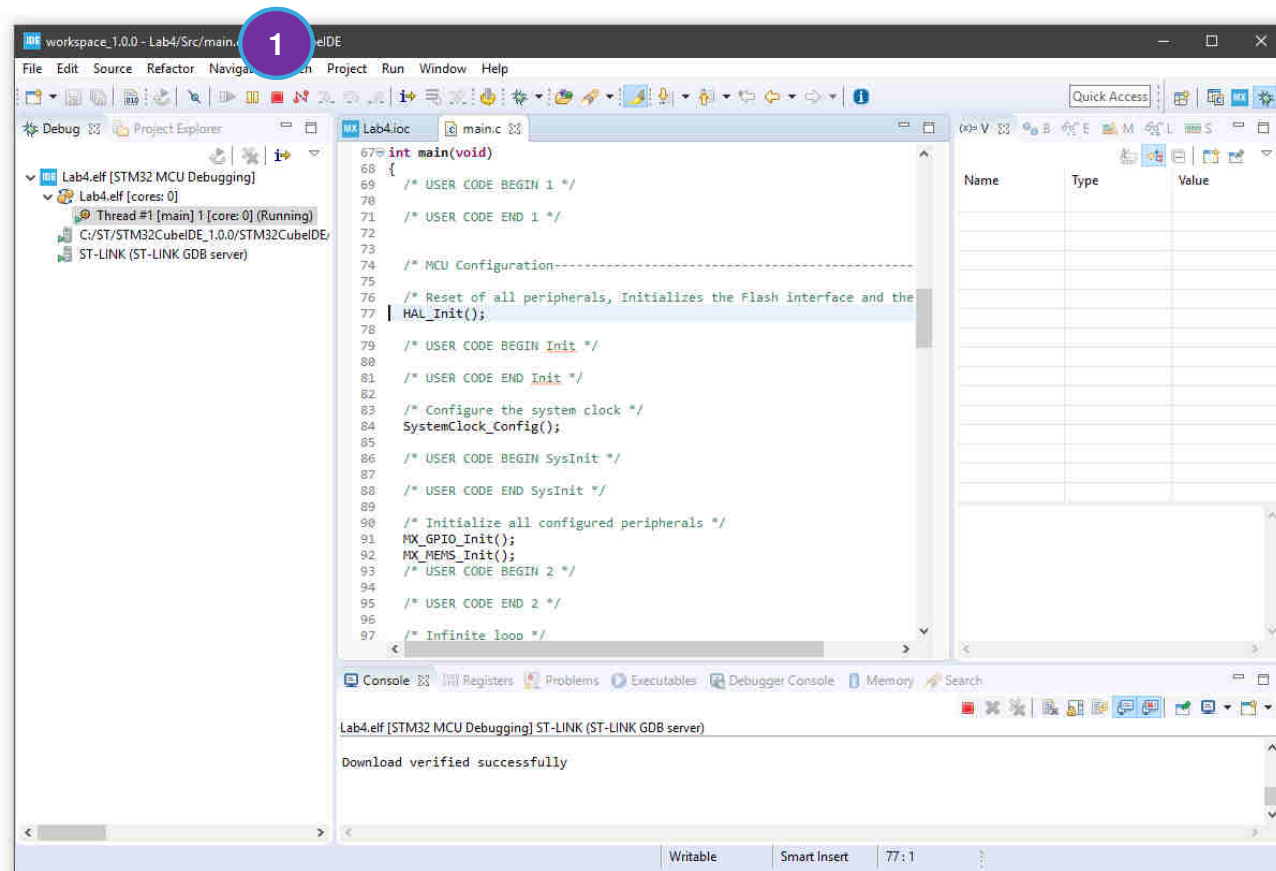
1. Shake the board and the GREEN led will turn ON



# Lab4 - Debugging

189

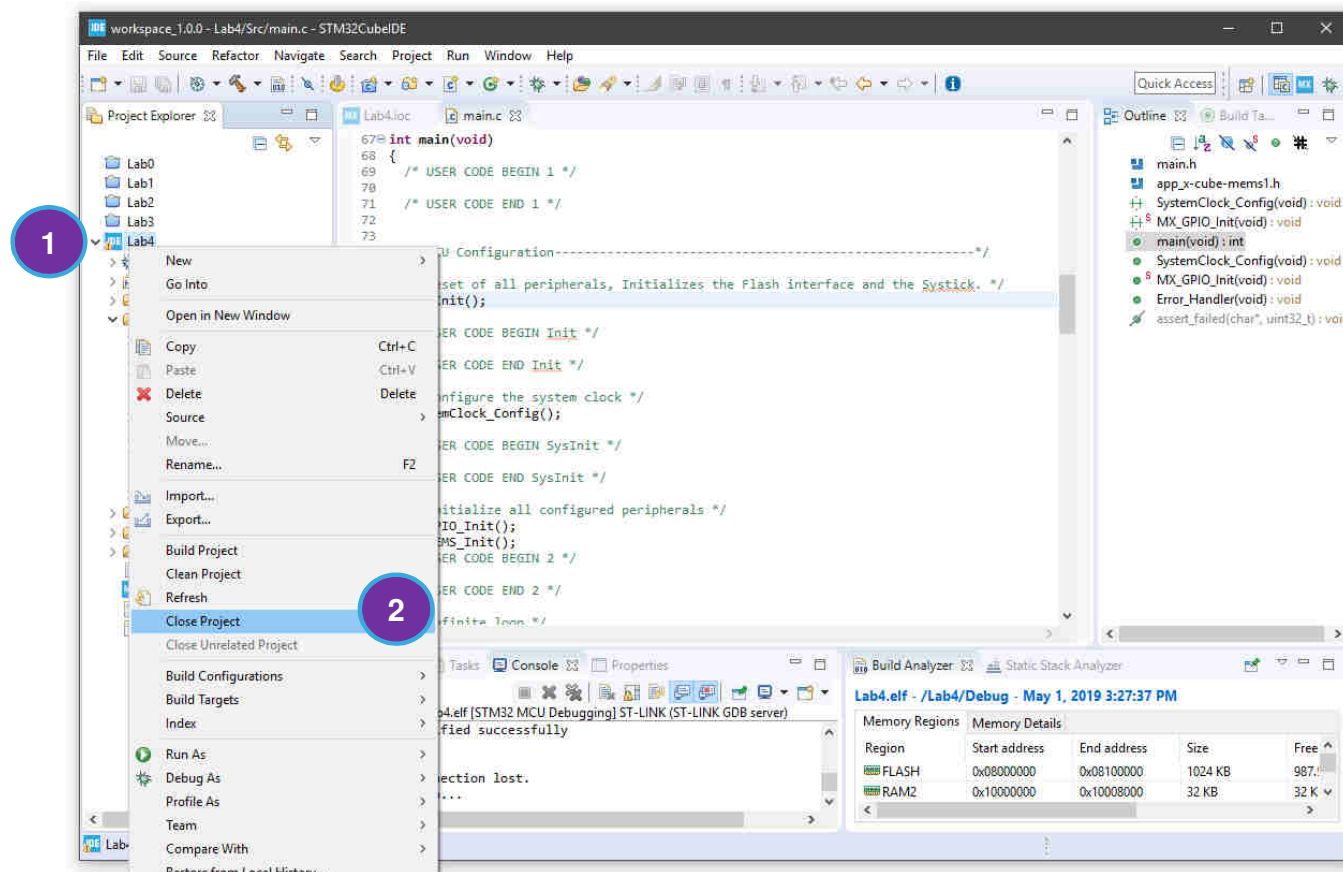
1. Click stop  button to interrupt the debugging



# Lab4 – Closing the project

190

1. Right-Click on **Lab4** project
2. Click on **Close Project**



# LAB5

## Goals:

- Configure a new project using X-CUBE-MEMS1
- **Configure LSM6DSO single and double tap detection**
- Enable interrupts in STM32CubeIDE
- Change tap threshold to increase sensitivity





# LSM6DSO

192

## Accelerometer + Gyroscope Inertial Measurement Unit

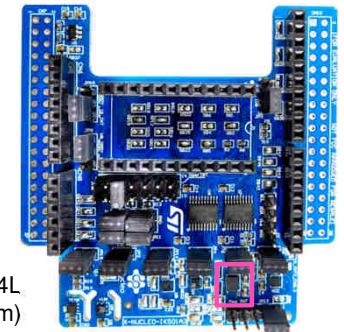
- 0.45mA power consumption (normal mode)
  - Accelerometer: 0.05mA, Gyroscope: 0.40mA
- Auxiliary SPI typically used for OIS / EIS or closed loop control; I3C Interface
- 9kB equivalent FIFO Memory for local data storage
- Finite State Machines (up to 16)
- Digital Features
  - Free fall
  - Pedometer 2.0
  - 6D / 4D
  - Tilt detection
  - Tap/ Double Tap

Lowest power consumption IMU → battery saving

Design Flexibility and cost optimization

System power saving

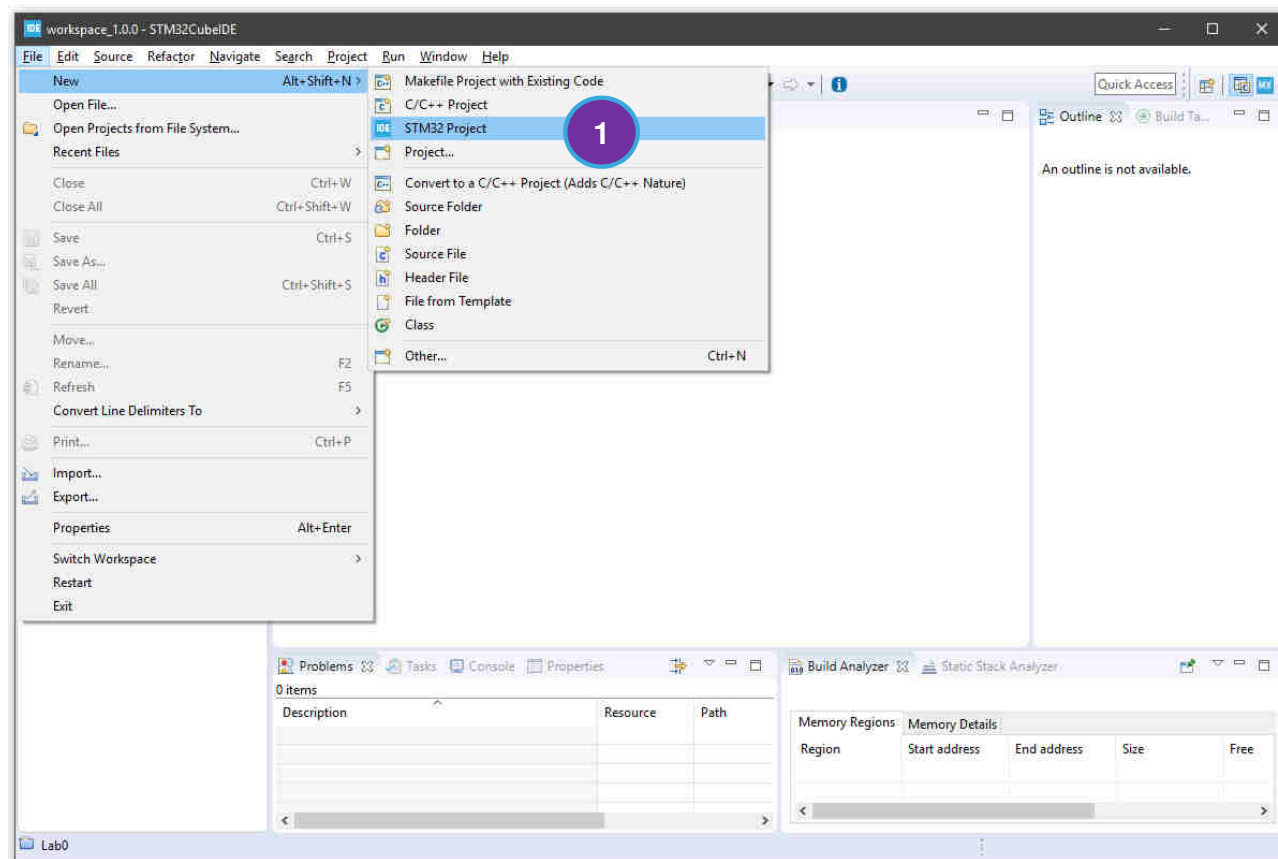
Smart Functions with High Flexibility



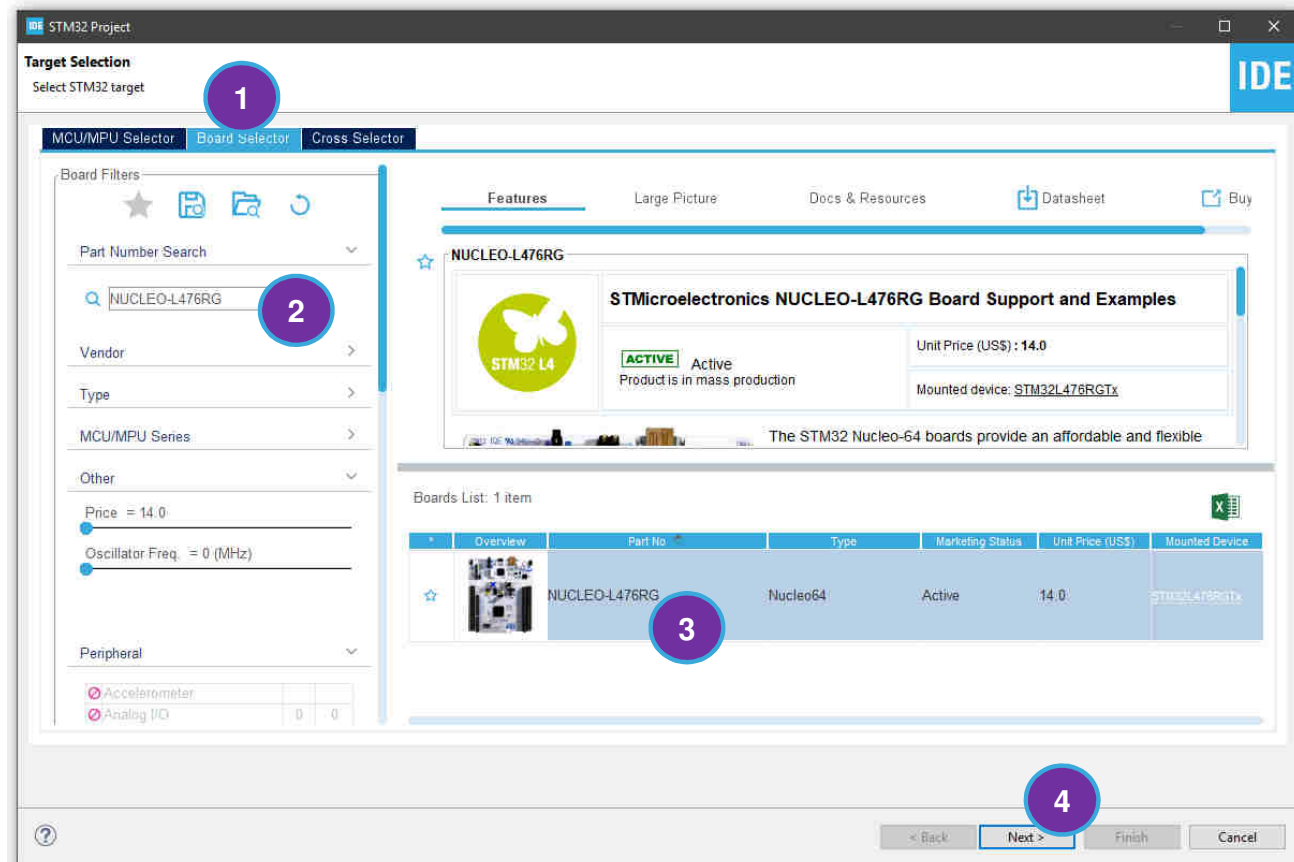
LGA-14L  
(2.5 x 3 x 0.83 mm)



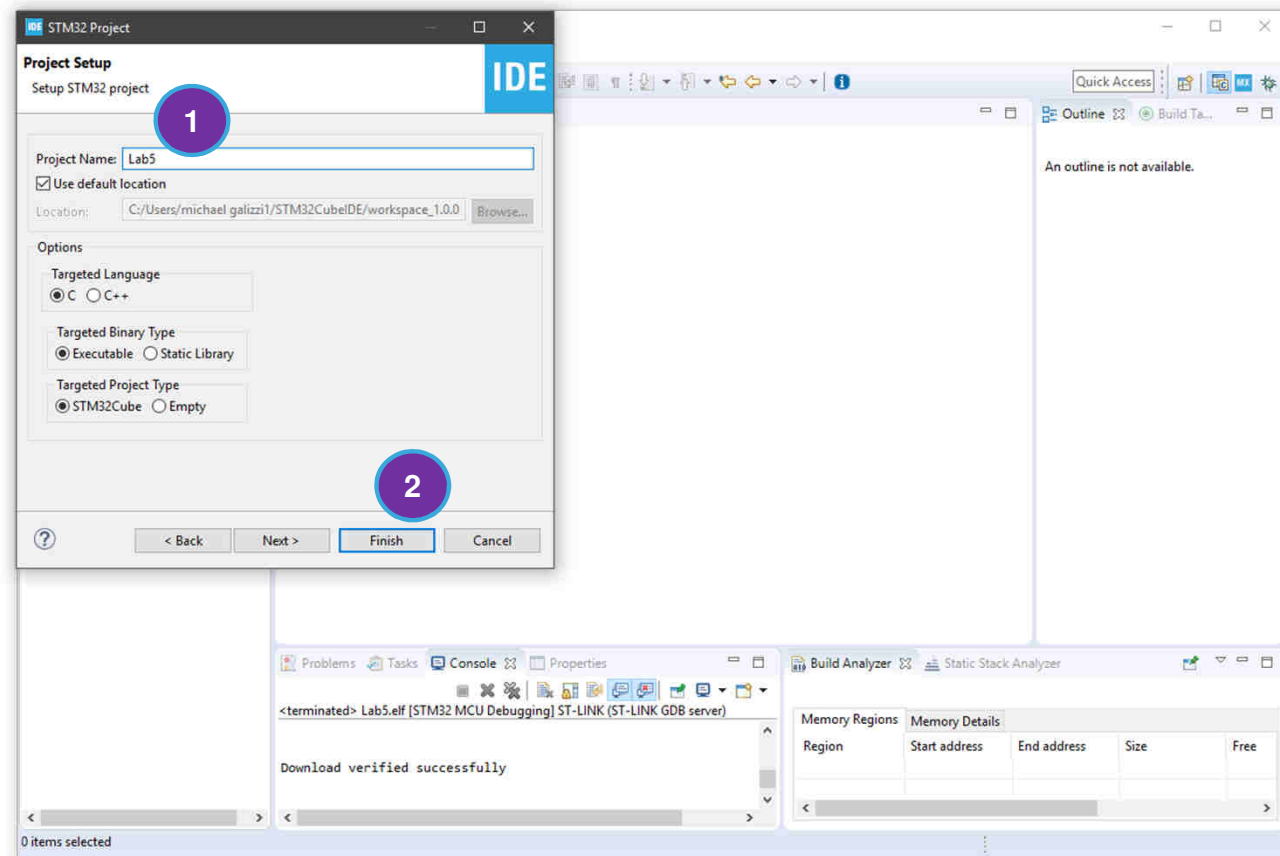
## 1. Click on **File > New > STM32 Project**



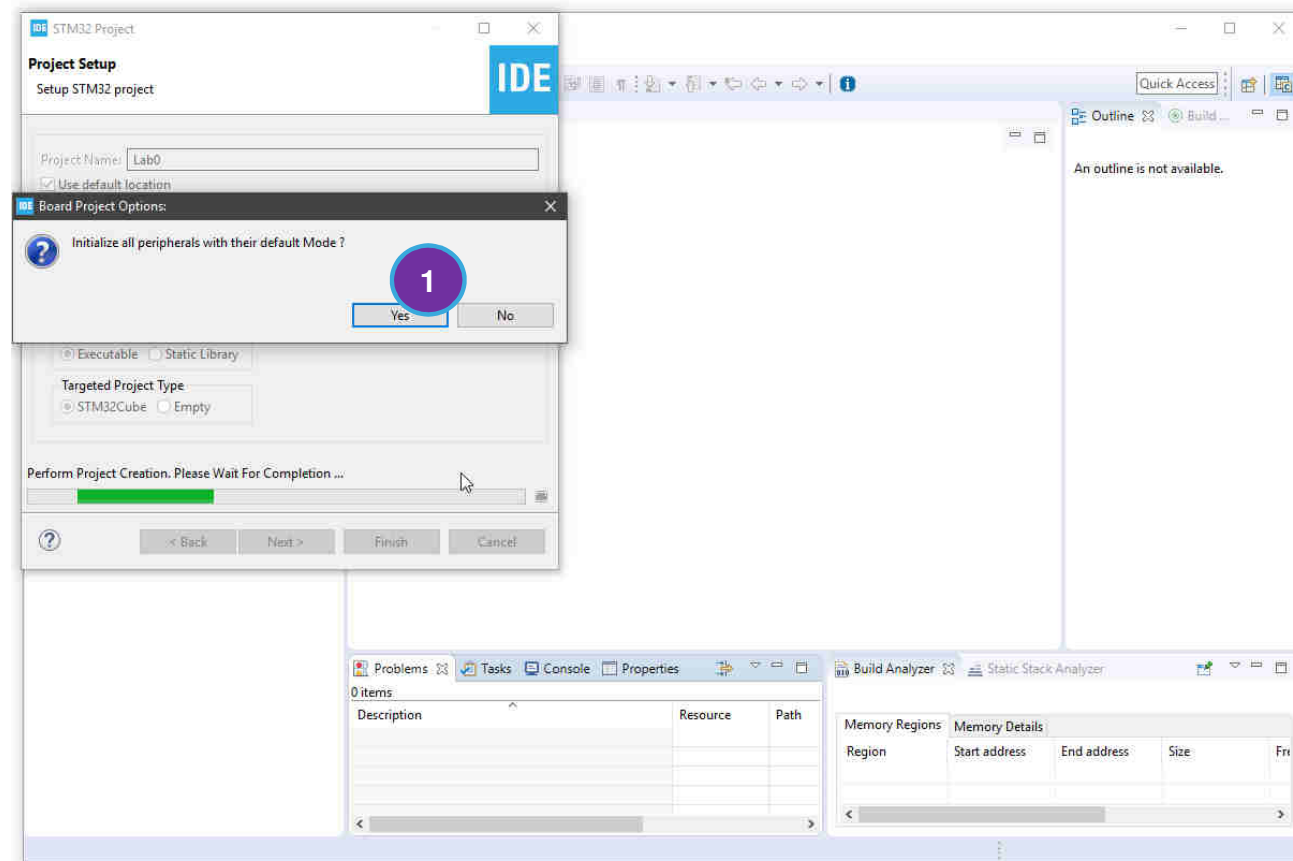
1. Click on **Board Selector**
2. Type **NUCLEO-L476RG**
3. Click on the board
4. Click **Next >**



1. Project Name **Lab5**
2. Click **Finish**



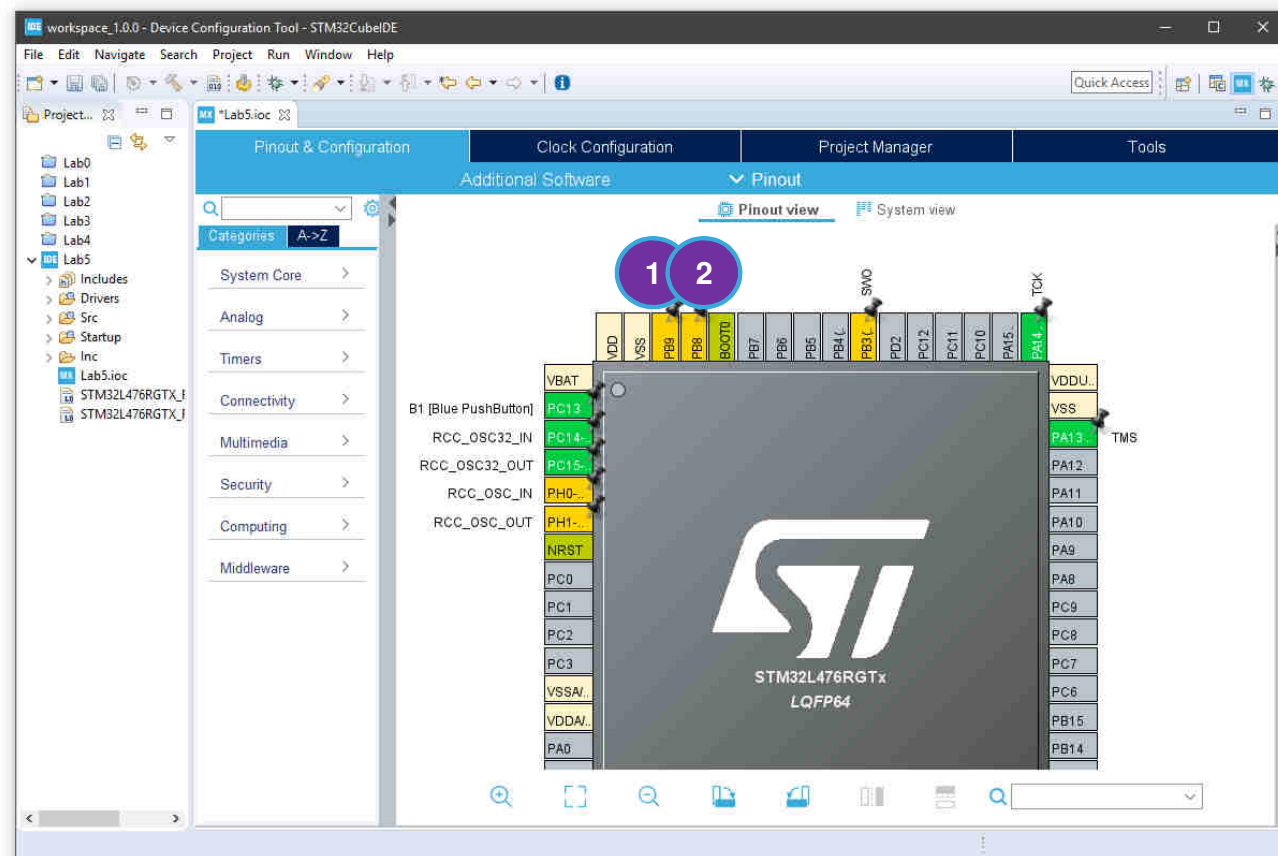
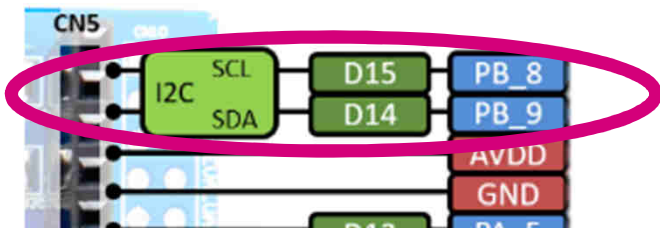
1. Click **Yes** to init peripherals in default mode



# Lab5 – Configure the I2C bus

197

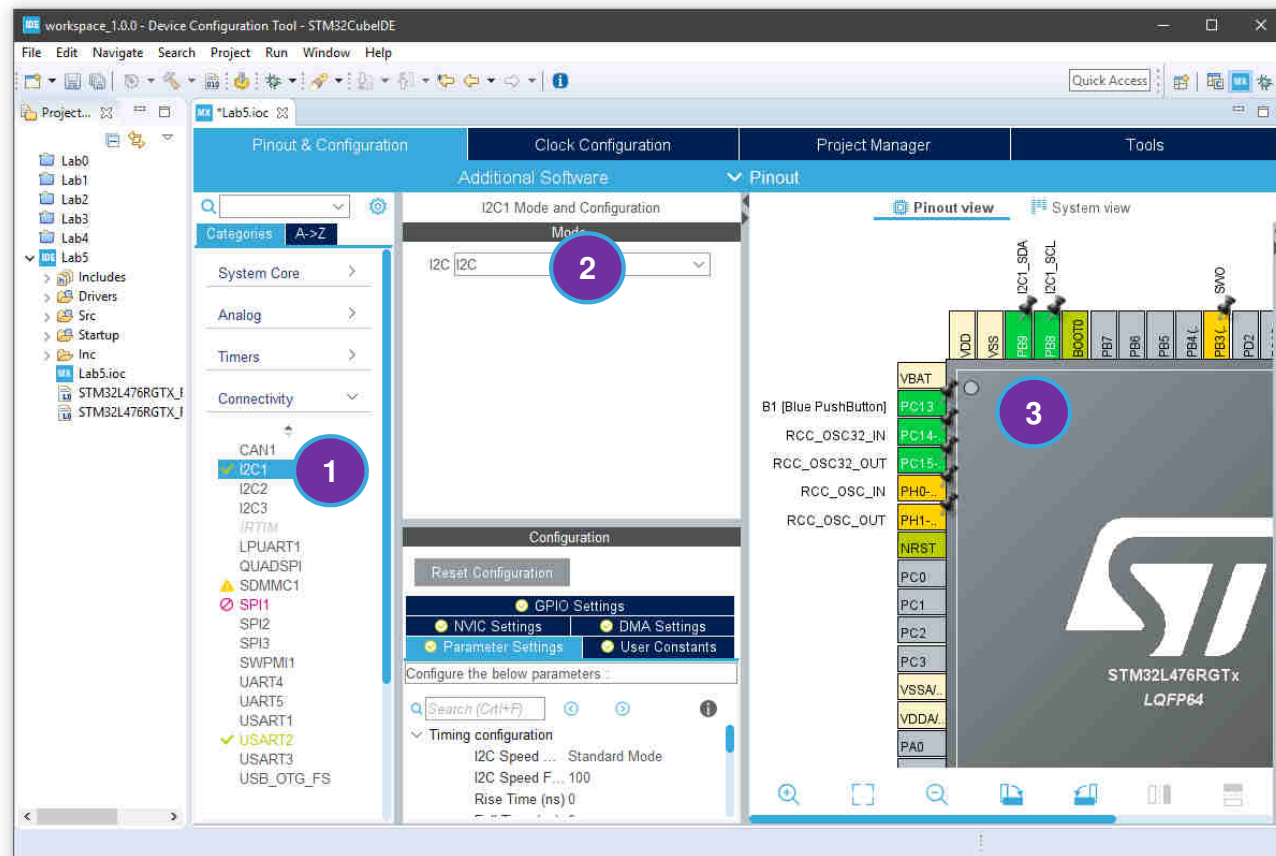
1. Left Click on **PB9** and select I2C1\_SDA
2. Left Click on **PB8** and select I2C1\_SCL



# Lab5 – Configure the I2C bus

198

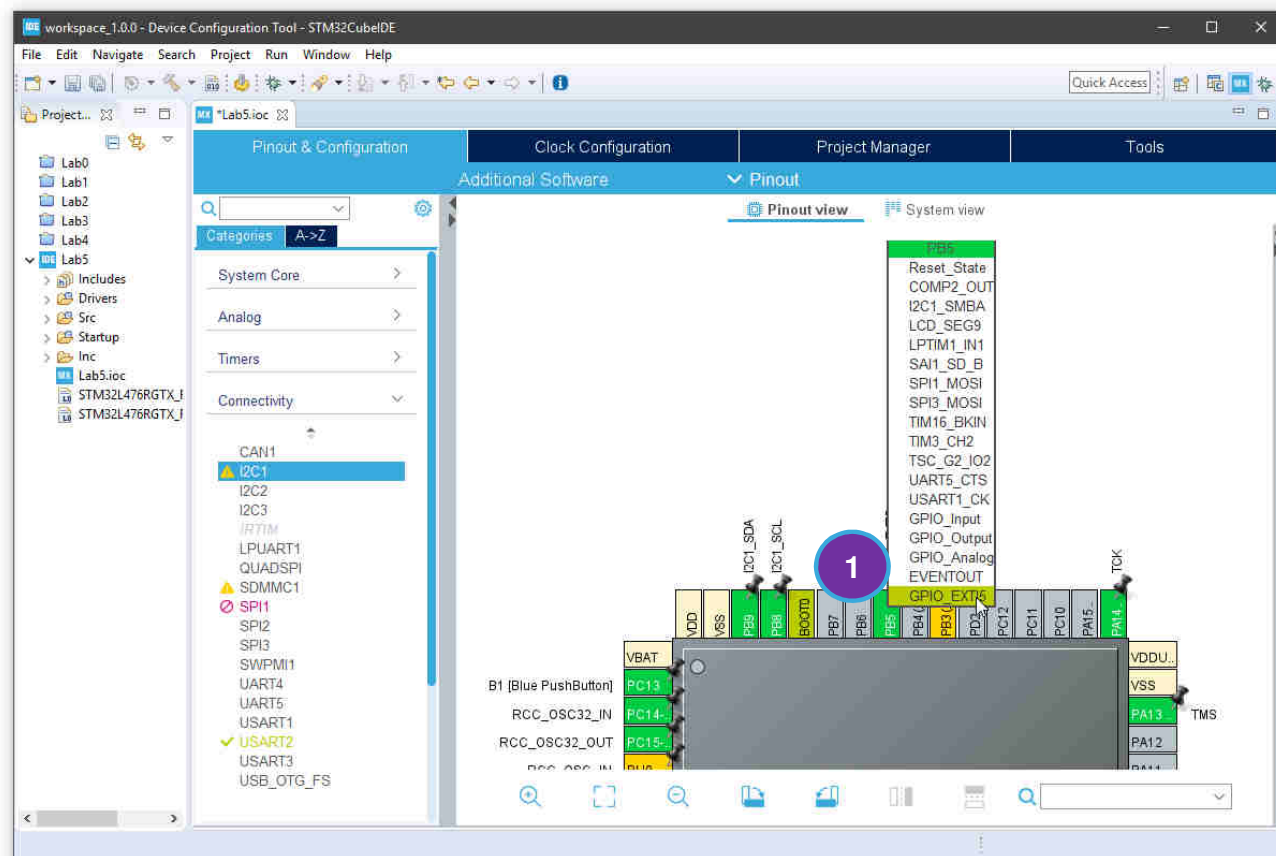
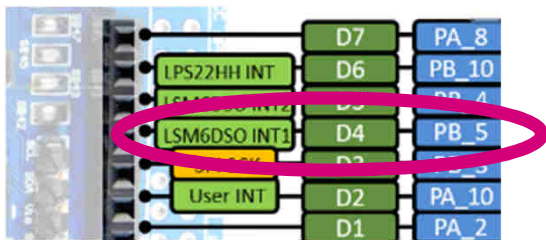
1. Expand *Connectivity* tab and check **I2C1**
2. Select **I2C** in *I2C1 Mode and Configuration*
3. PB8 and PB9 should now become green



# Lab5 – Configure LSM6DSO interrupt

199

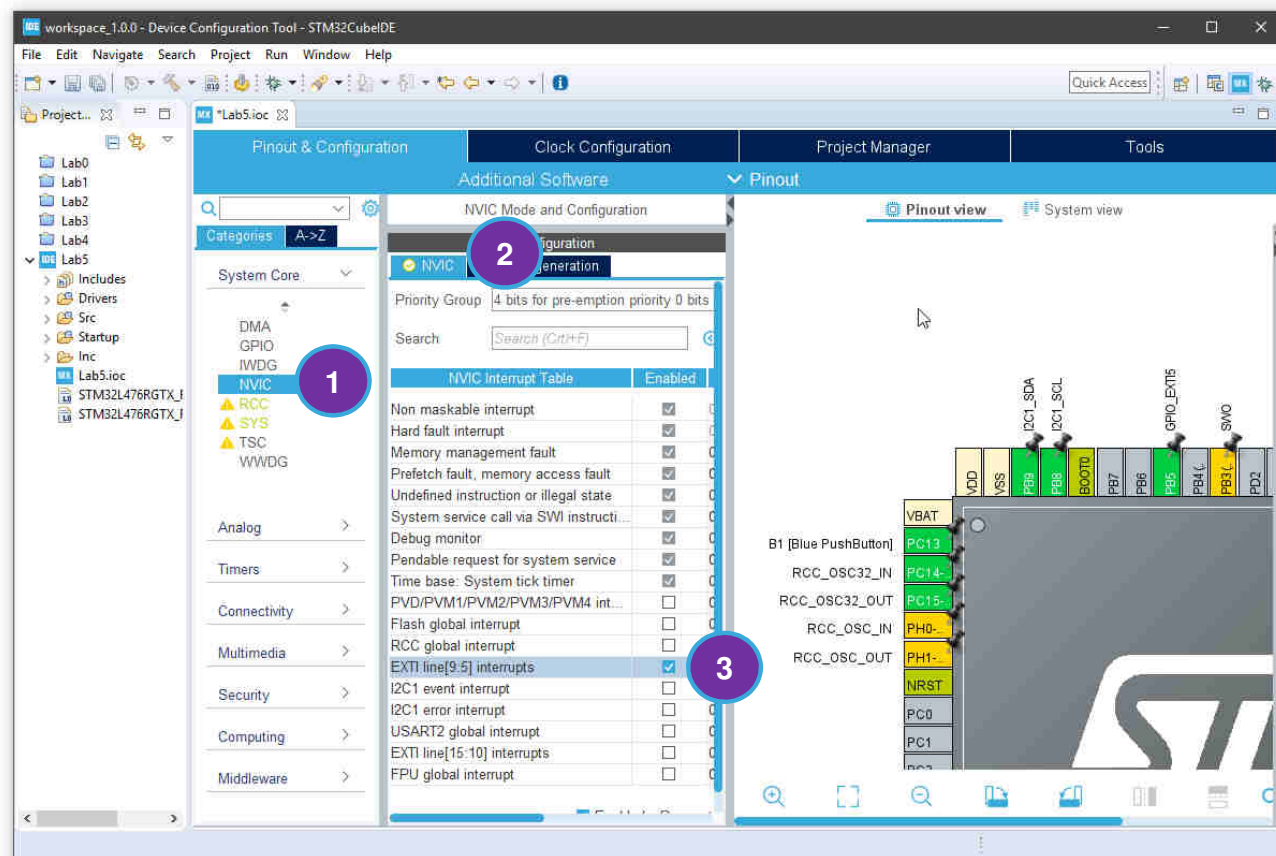
1. Left Click on **PB5** and select **GPIO\_EXTI5**



# Lab5 – Configure LSM6DSO interrupt

200

1. Check **NVIC** in tab System Core
2. Select **NVIC** in NVIC Mode and Configuration
3. Enable **EXTI line[9:5] interrupt**

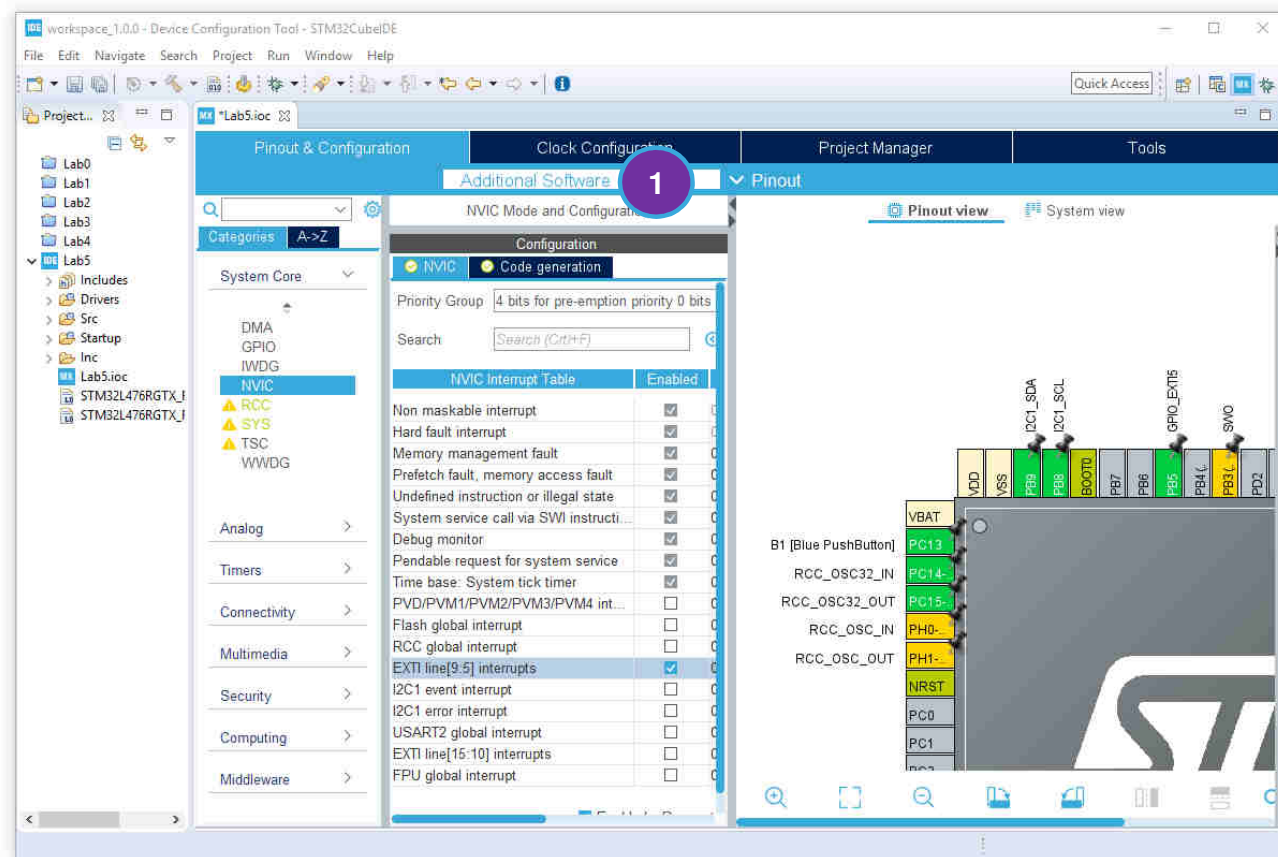




# Lab5 – Select the MEMS library

201

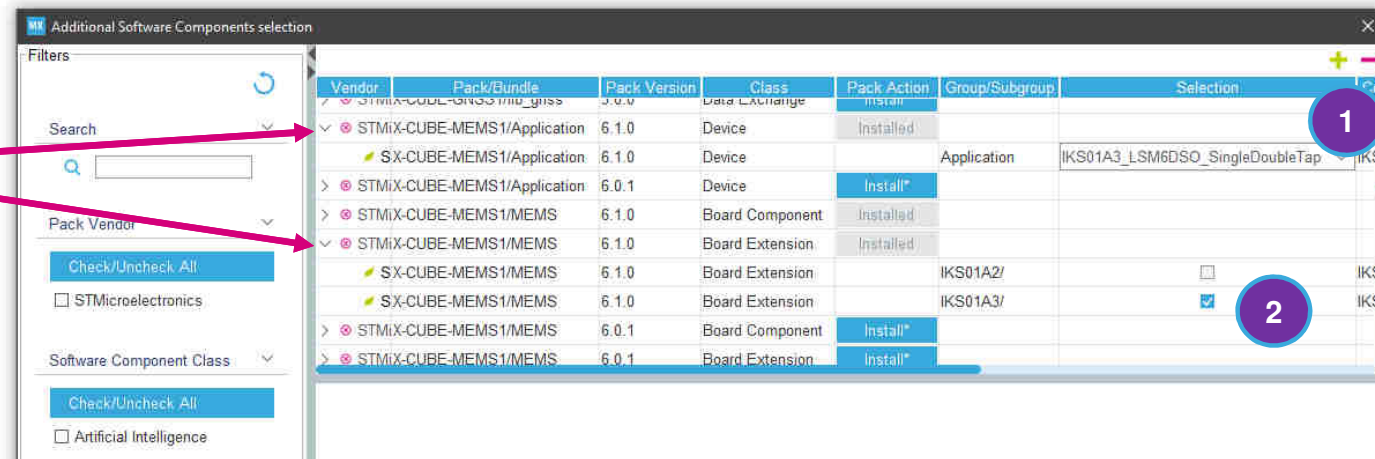
1. Click on **Additional Software**



# Lab5 – Select the MEMS library

202

Click to  
expand tree

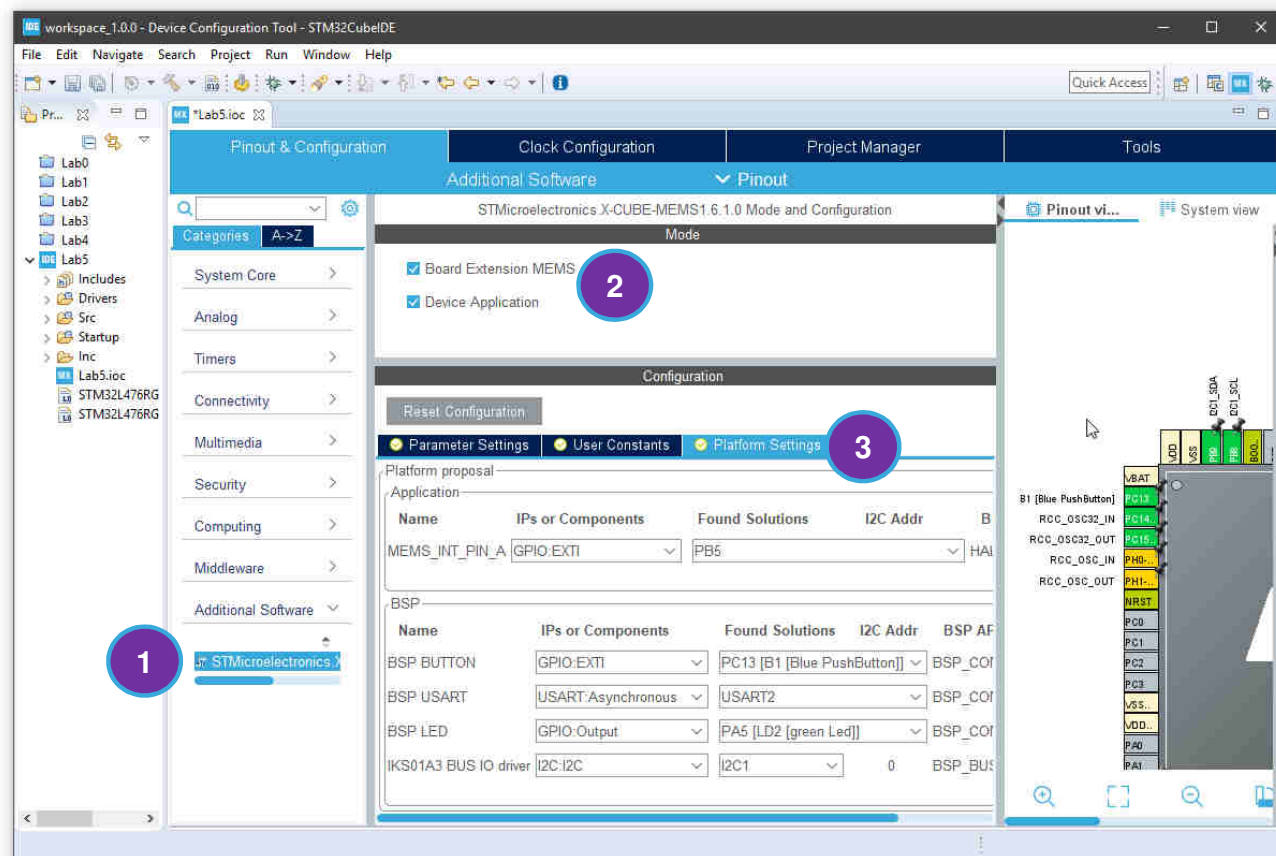


1. In X-CUBE-MEMS1/Application, Class “Device”:  
Select **IKS01A3\_LSM6DSO\_SingleDoubleTap**
2. In X-CUBE-MEMS1/MEMS, Class “Board Extension”:  
Check **IKS01A3/**
3. Click **OK**

# Lab5 – Configure the MEMS library

203

1. Expand Additional Software and select the X-CUBE-MEMS1
2. Check both:  
**Board Extension MEMS**  
**Device Application**
3. Configure Platform Settings as in picture



# Lab5 – Configure the MEMS library

204

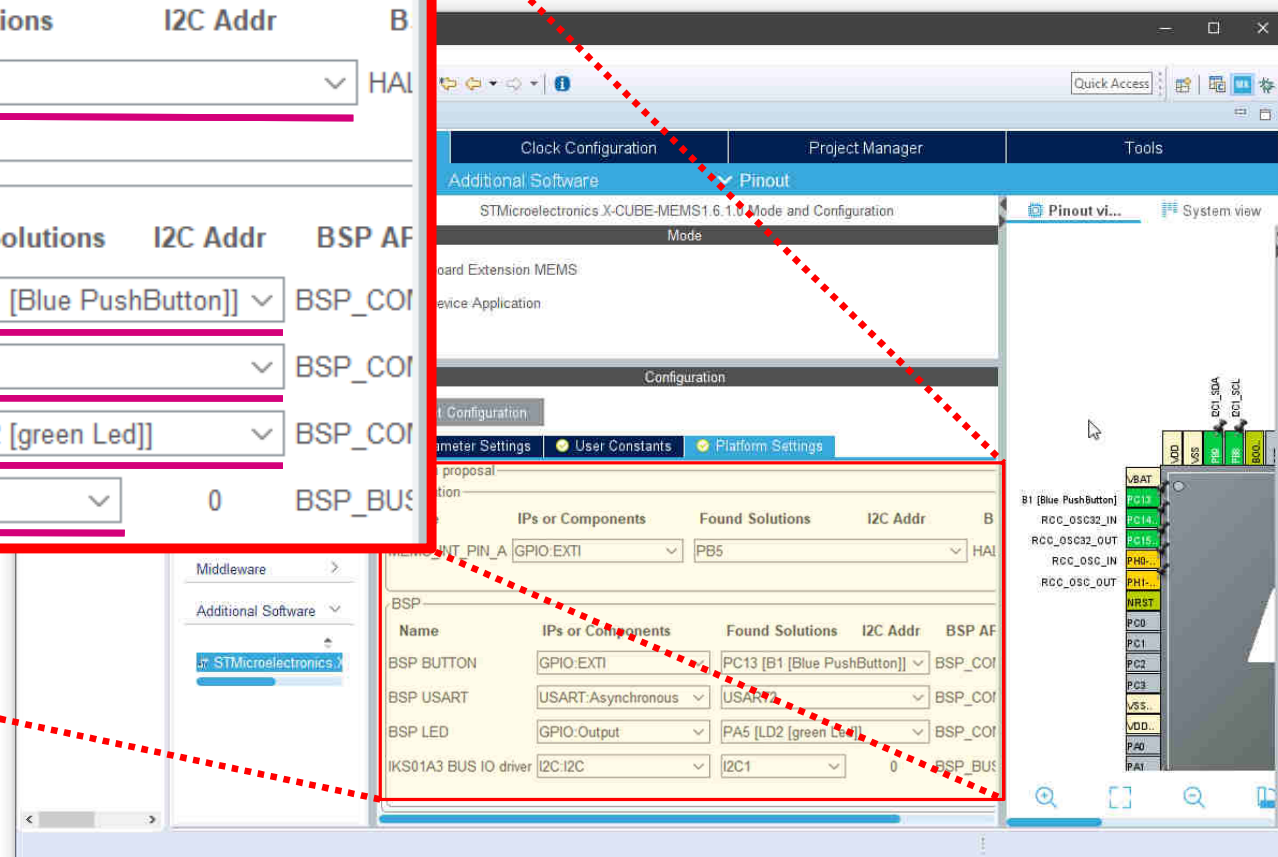
Platform proposal

Application

Name	IPs or Components	Found Solutions	I2C Addr	B
MEMS_INT_PIN_A	GPIO:EXTI	PB5		HAL

BSP

Name	IPs or Components	Found Solutions	I2C Addr	BSP AF
BSP BUTTON	GPIO:EXTI	PC13 [B1 [Blue PushButton]]		BSP_COI
BSP USART	USART:Asynchronous	USART2		BSP_COI
BSP LED	GPIO:Output	PA5 [LD2 [green Led]]		BSP_COI
IKS01A3 BUS IO driver	I2C:I2C	I2C1	0	BSP_BUS



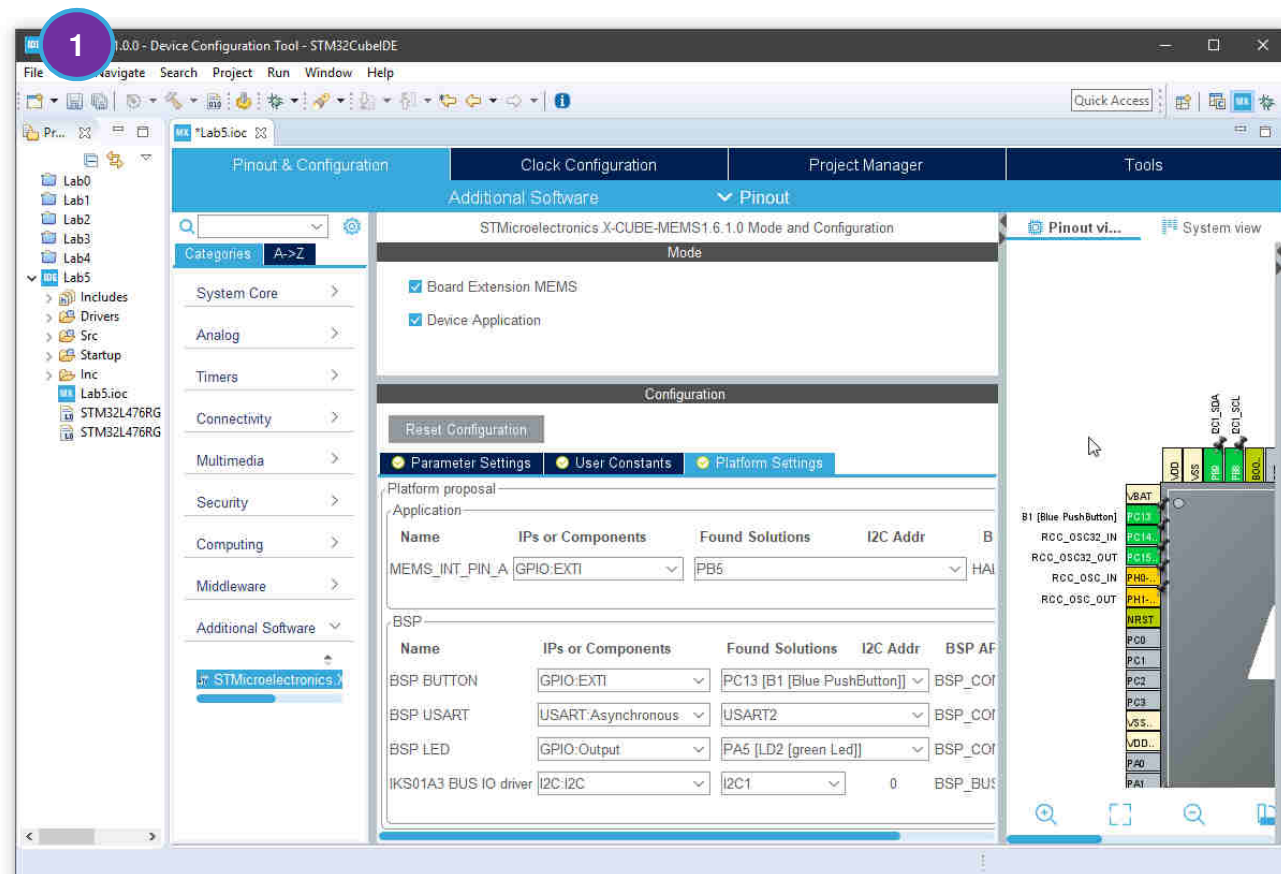
# Lab5 – Save the project

205

1. Click the save button



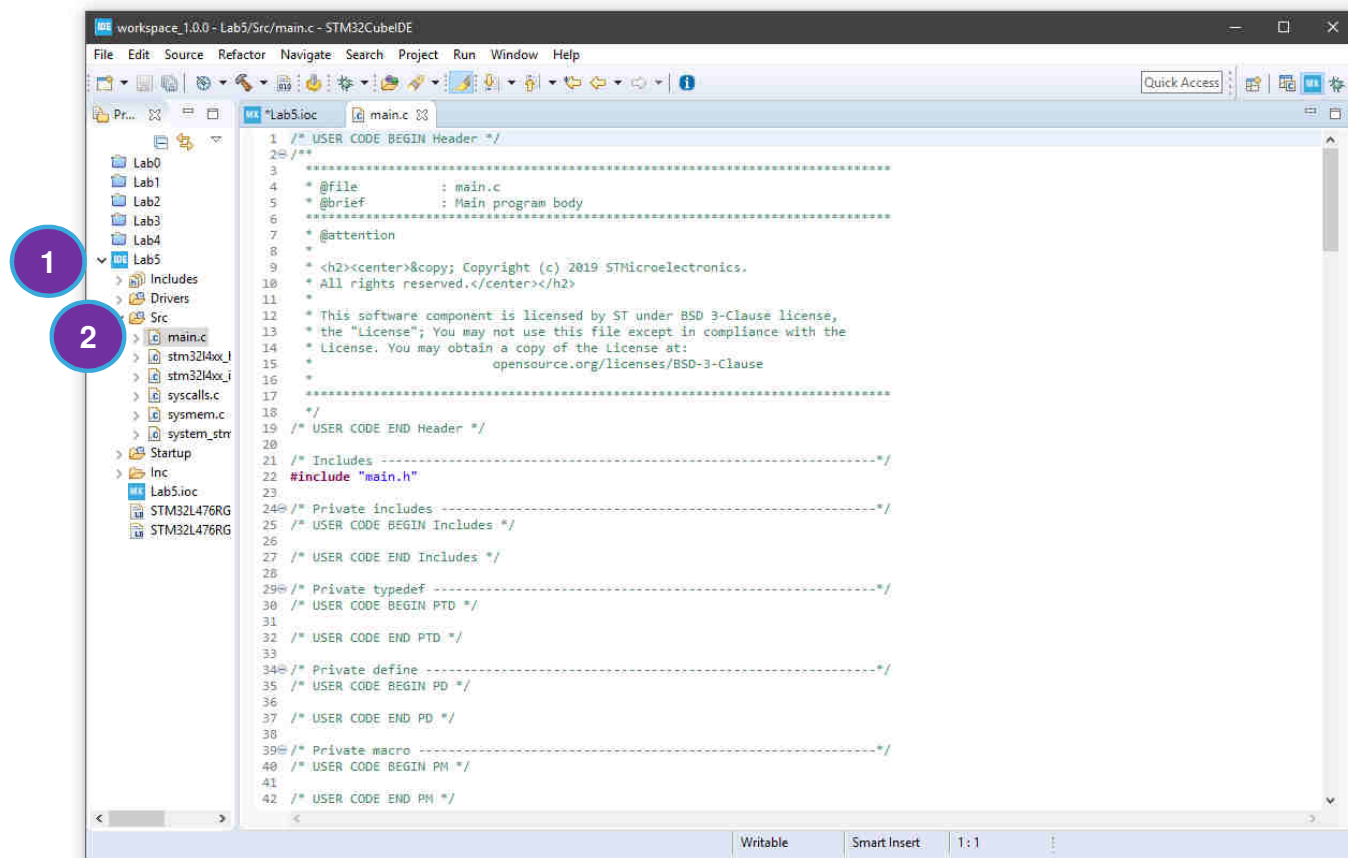
This action will generate the source code of this lab



# Lab5 – Code Editing


206

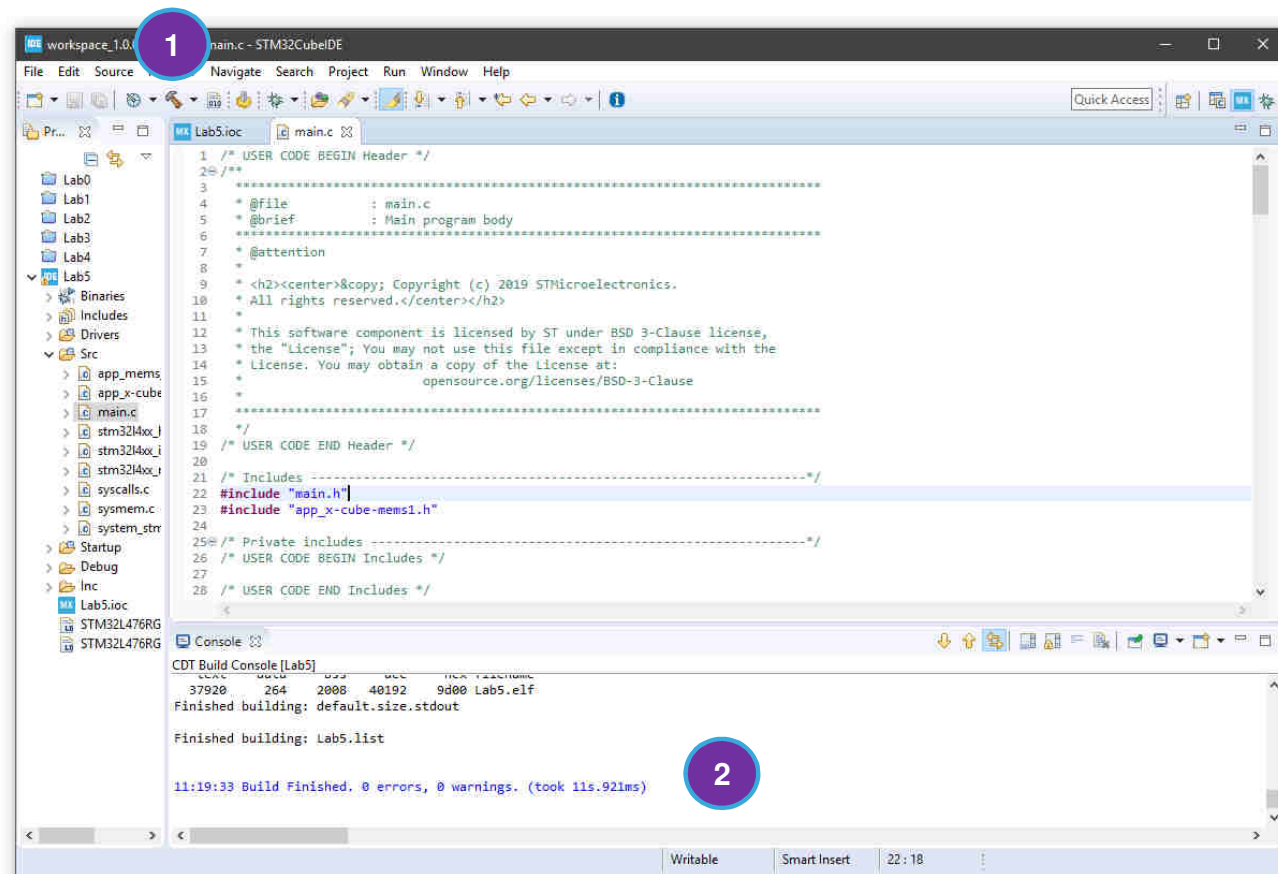
1. Expand **Src** in folder **Lab5**
2. Double click on **main.c**



# Lab5 - Compiling

207

1. Click on the hammer  to begin compilation, or press **CTRL+B**
2. Compilation should terminate with 0 errors and 0 warning





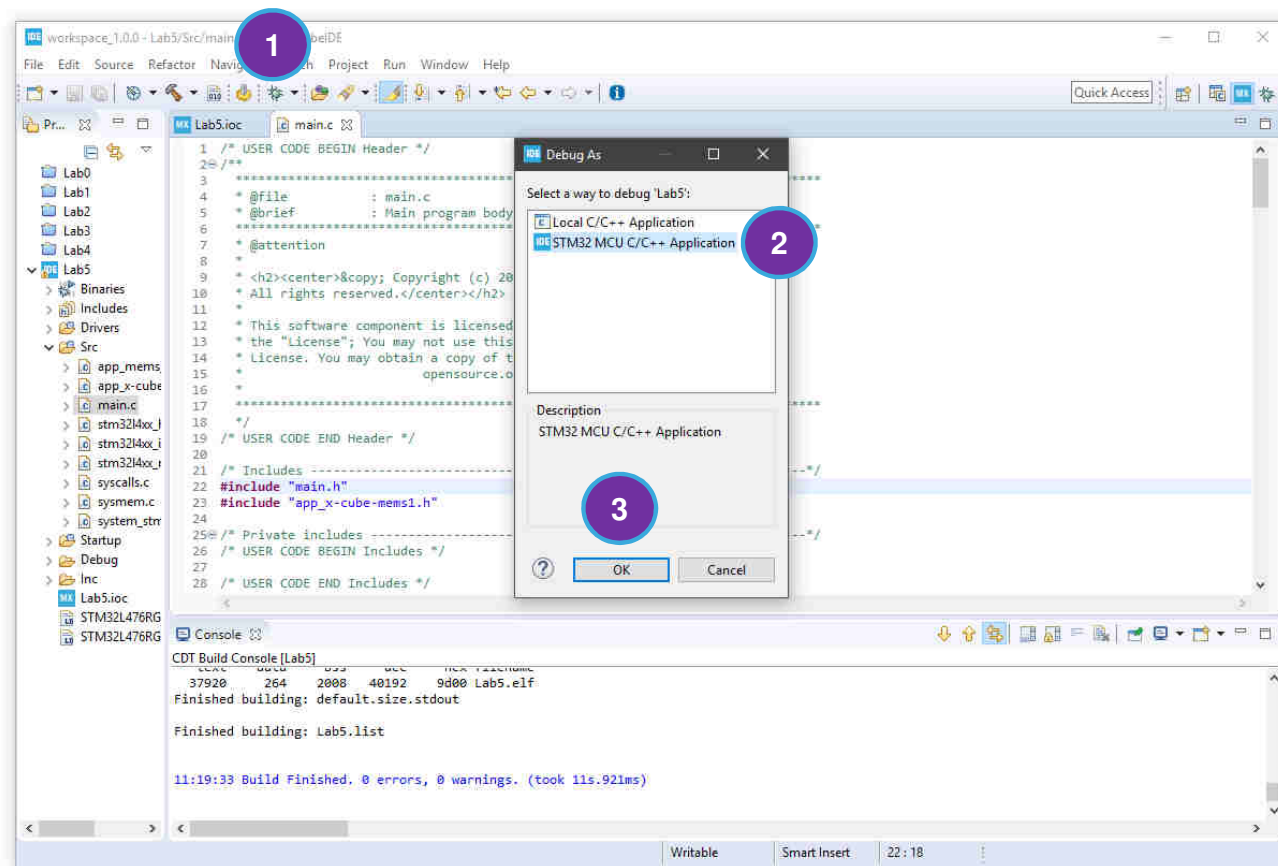
# Lab5 - Debugging

208

1. Click on the bug  to begin debugging

2. Select **STM32 MCU C/C++ App**

3. Click **OK**

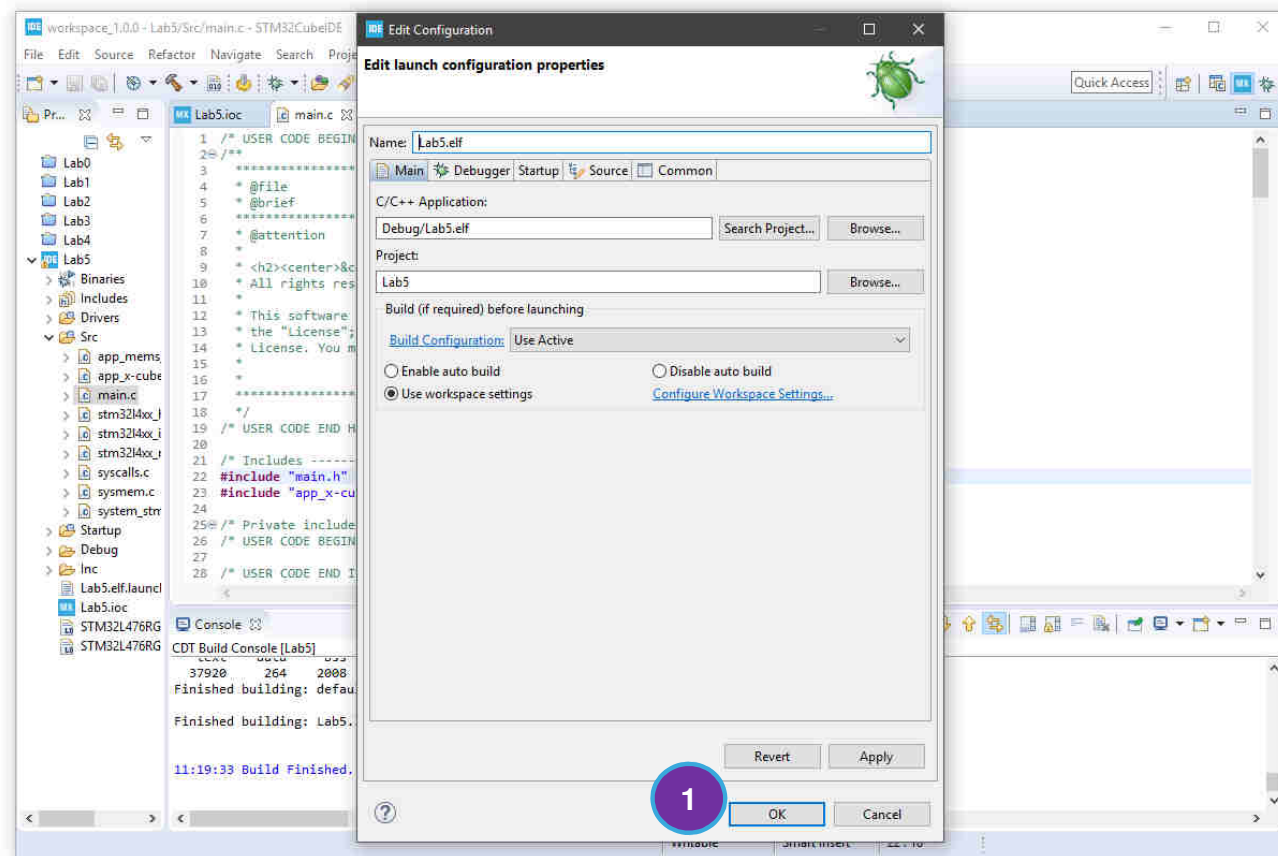




# Lab5 - Debugging

209

1. Click **OK**

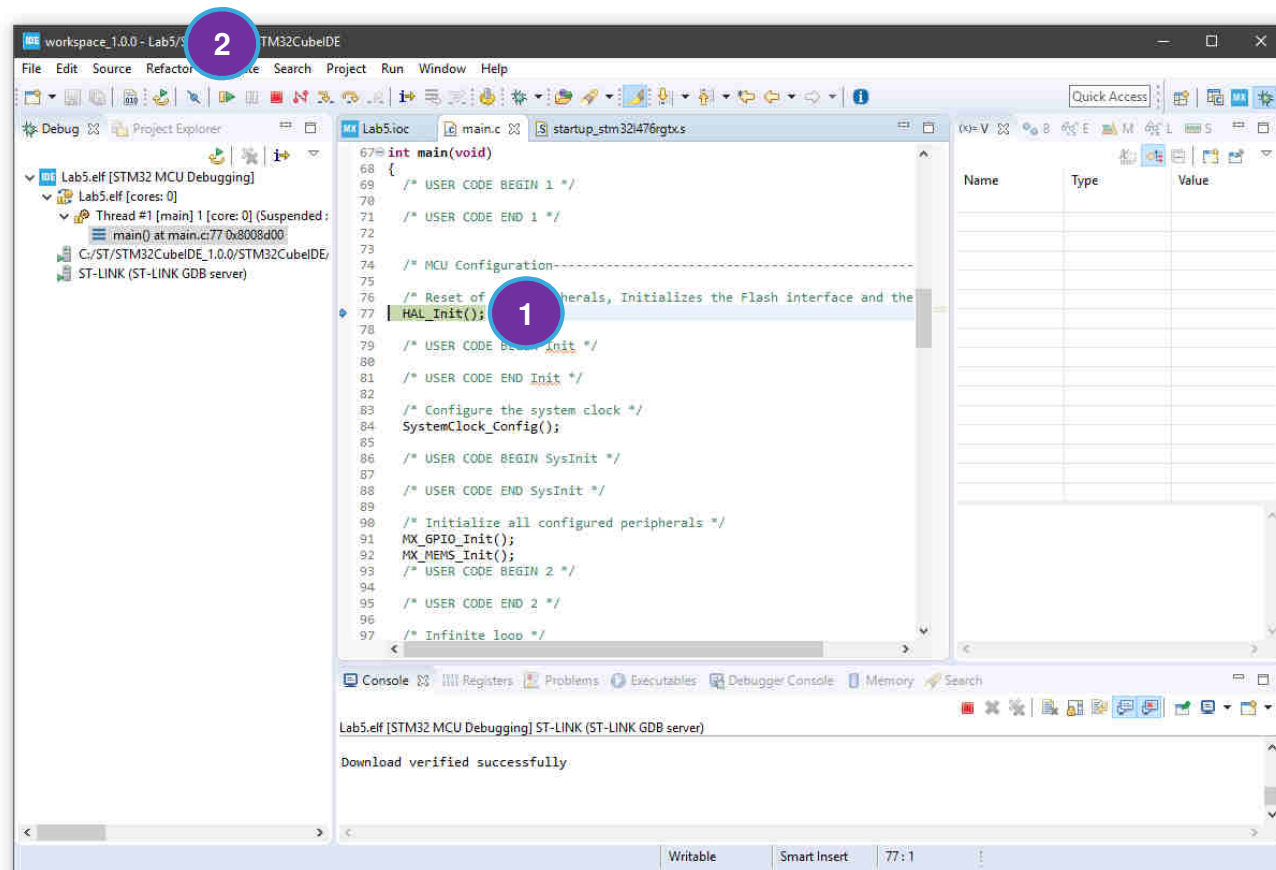


# Lab5 - Debugging

210

1. Code start at the first line of the main function

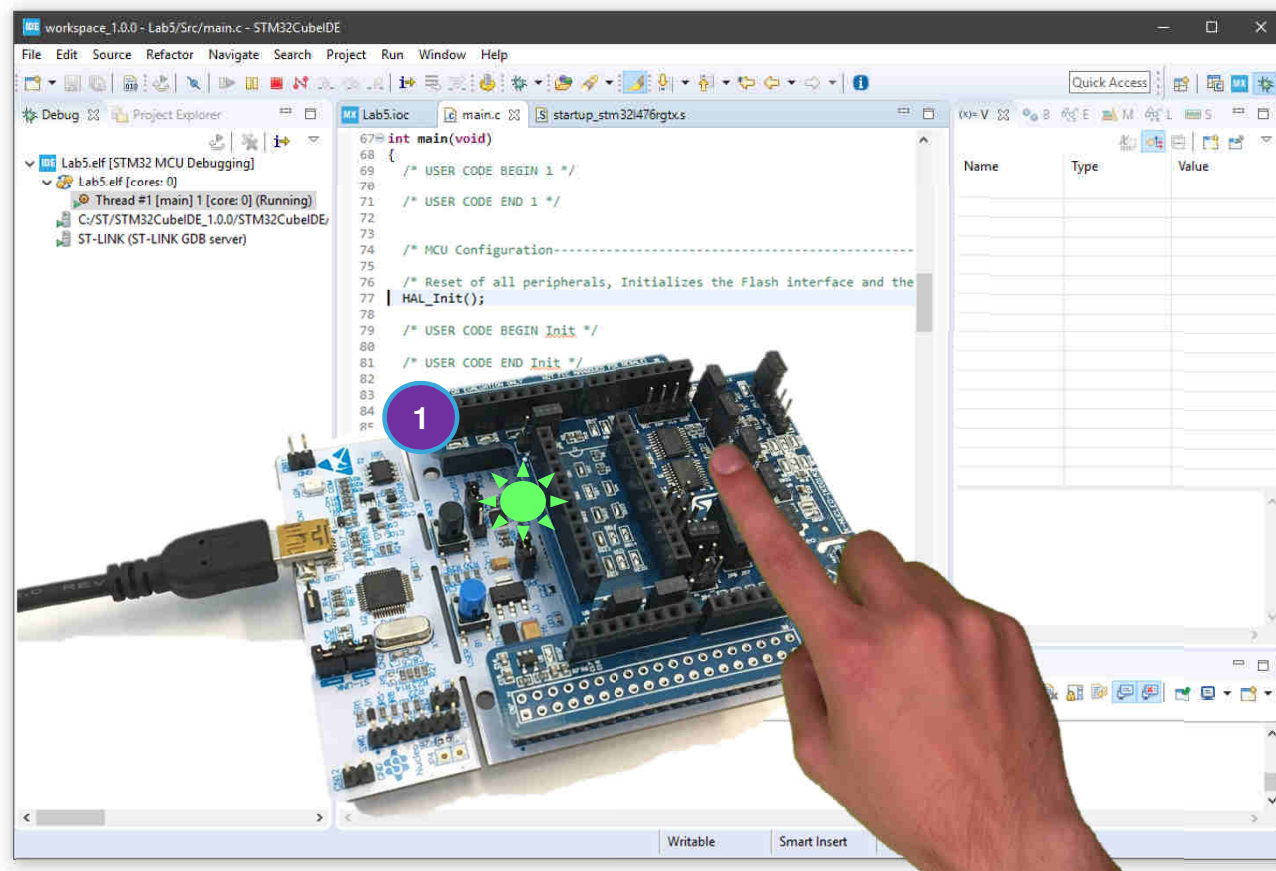
2. Click play  button to run the code



# Lab5 - Testing

211

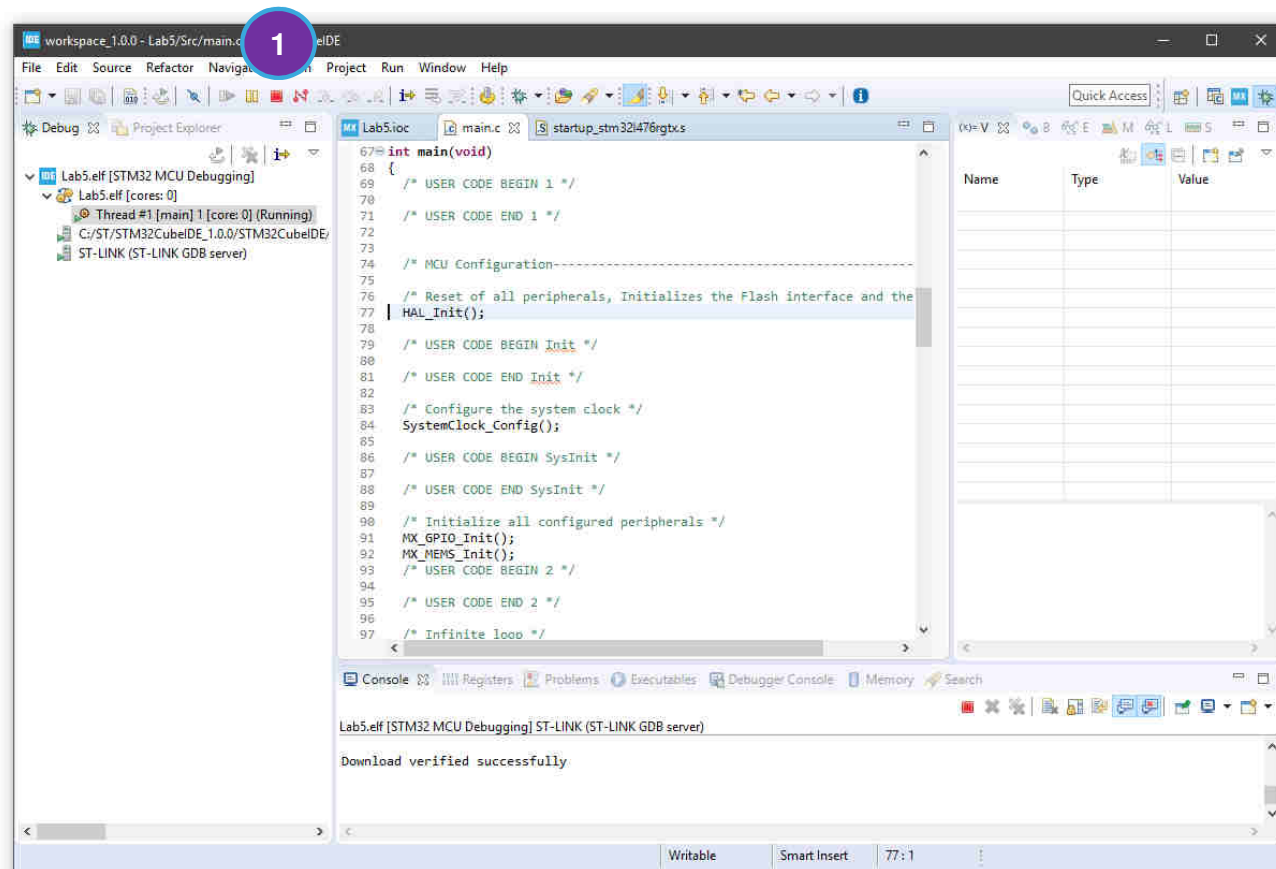
1. **TAP** or **DOUBLE TAP** the board and the GREEN led will turn ON



# Lab5 - Debugging

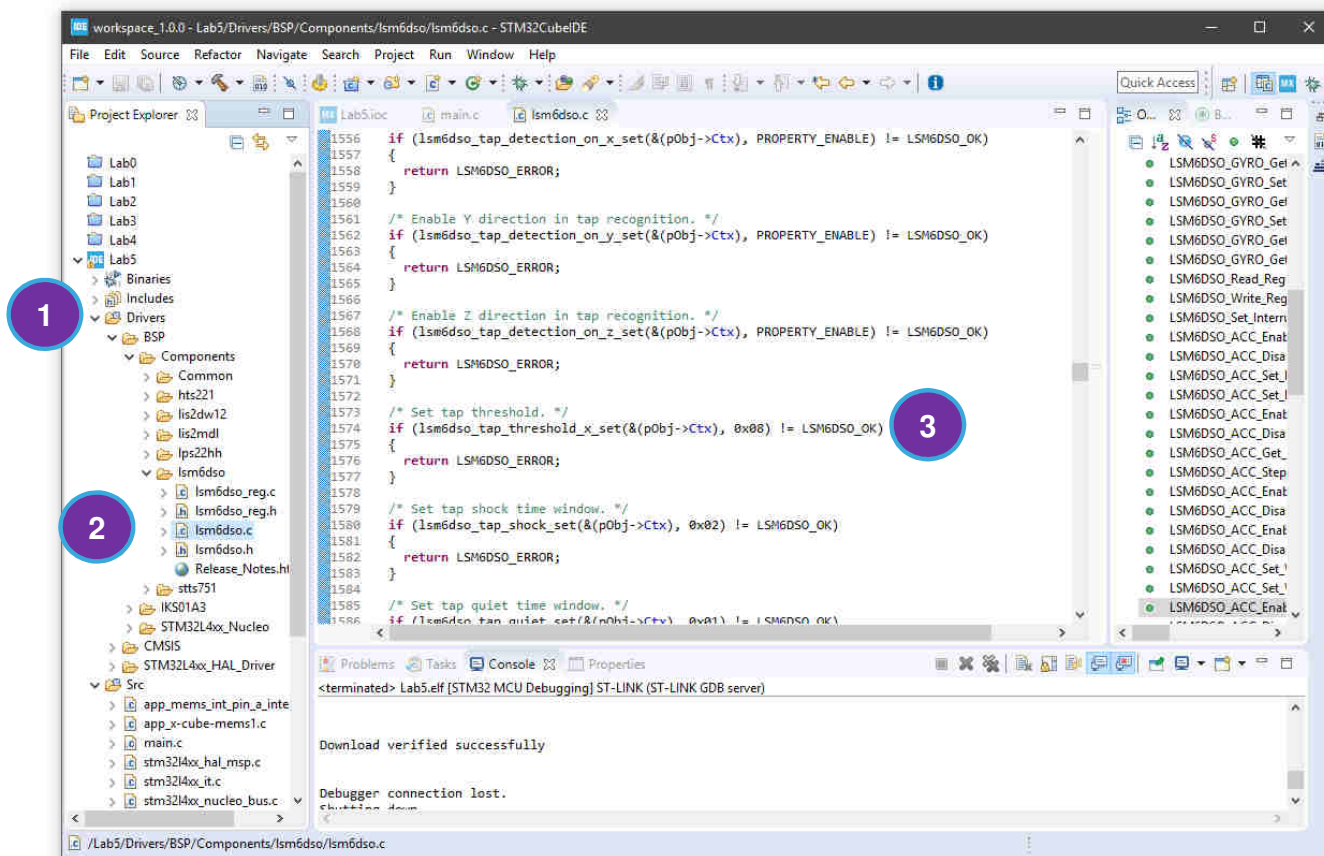
212

1. Click stop  button to interrupt the debugging



# Lab5 – Code editing 213

1. Expand folder **Drivers > BSP > Components > lsm6dso**
2. Open file **lsm6dso.c**
3. Go to **line #1574**



# Lab5 – Code editing 214

1. In **line #1574**, edit the threshold **from value 0x08 to value 0x02\***

2. Save modification



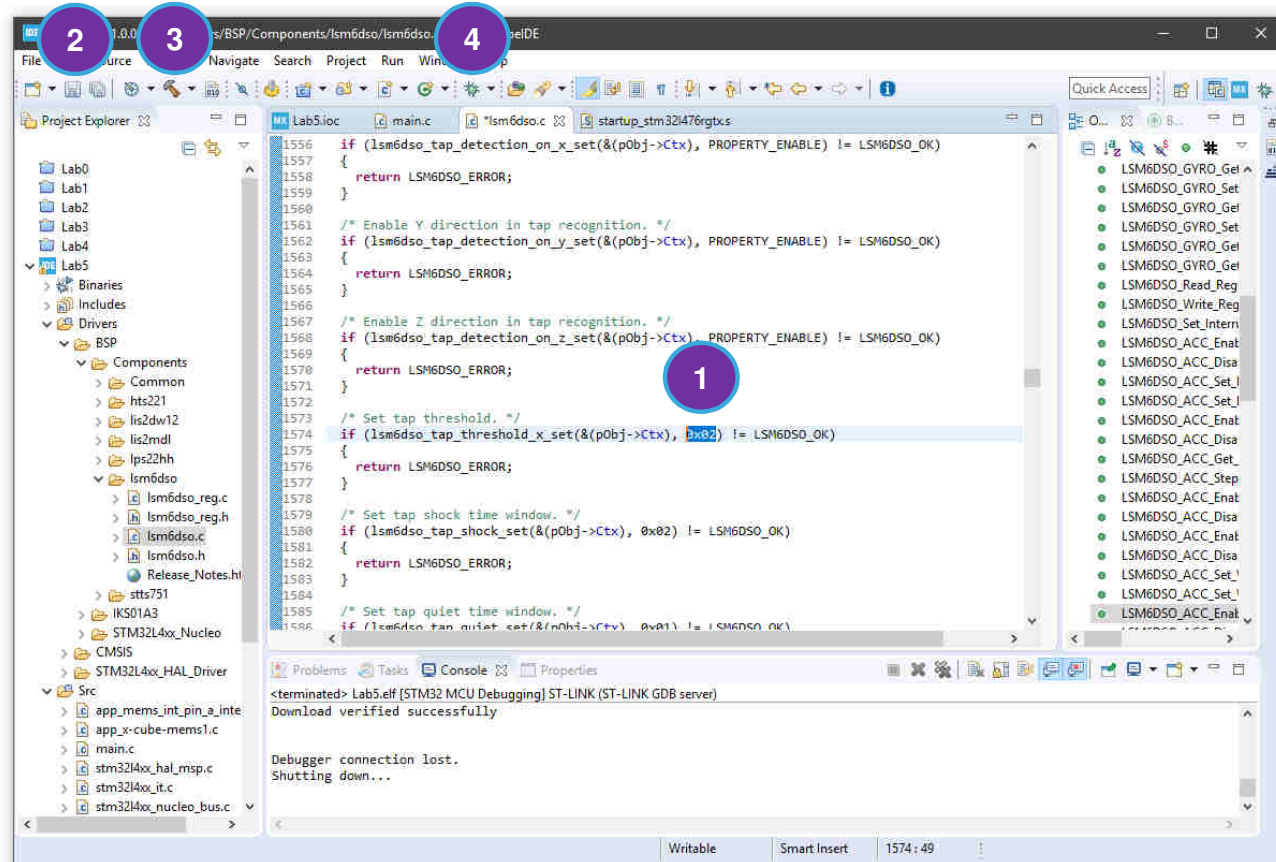
3. Recompile



4. Launch debug



\* This modification will reduce the threshold of the tap detection, increasing sensitivity of the recognized tap. For further details please refer to **Application Note AN5192 Section 5.5.1**



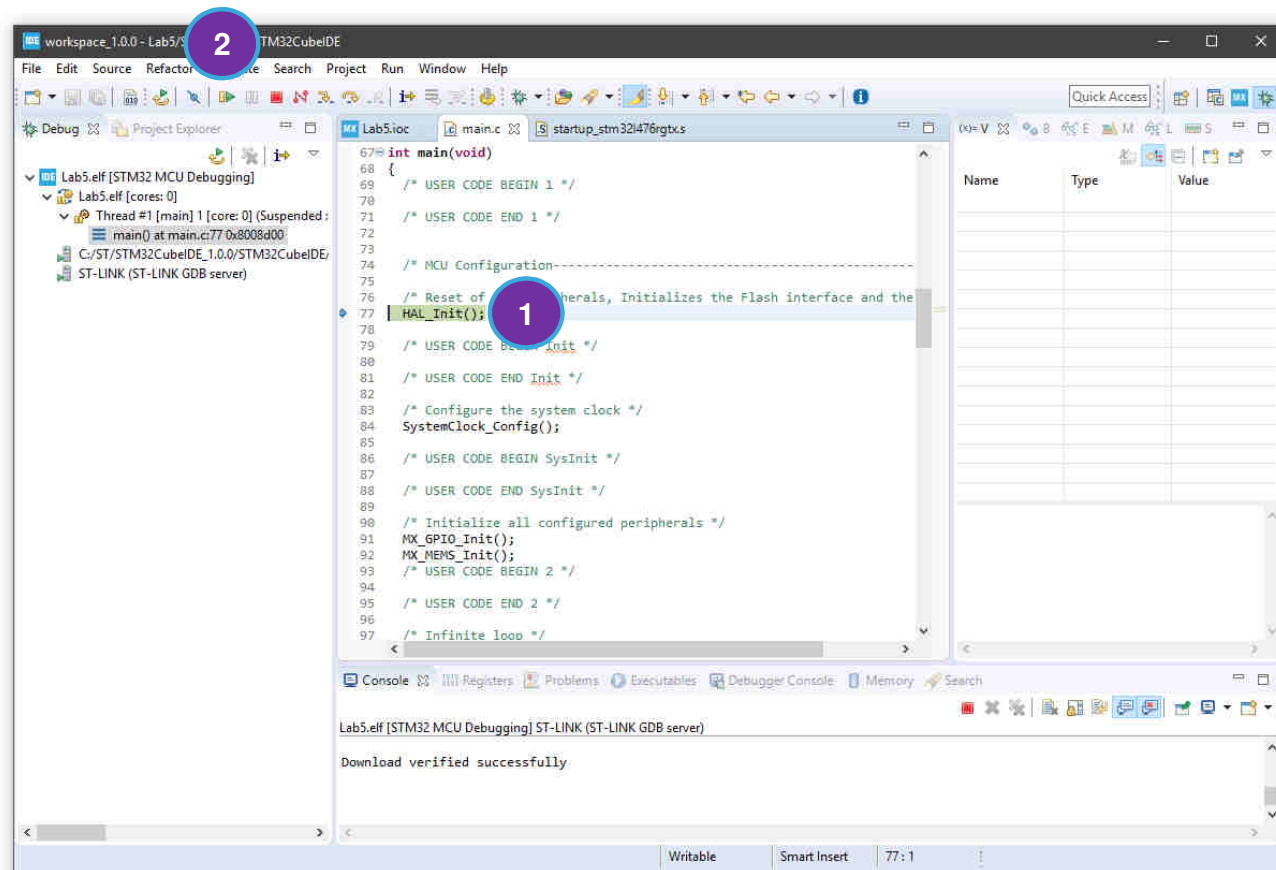


# Lab5 - Debugging

215

1. Code start at the first line of the main function

2. Click play  button to run the code



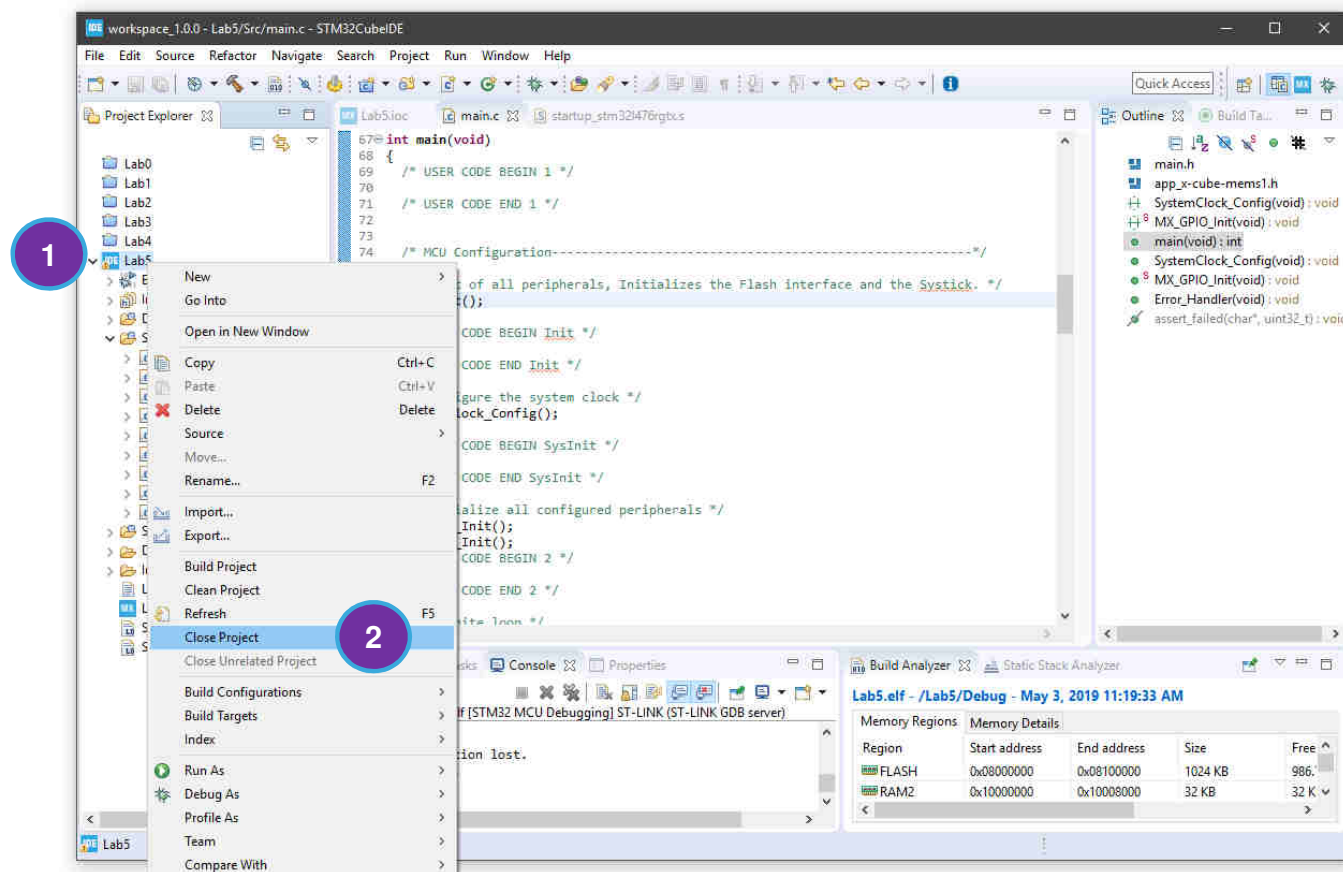


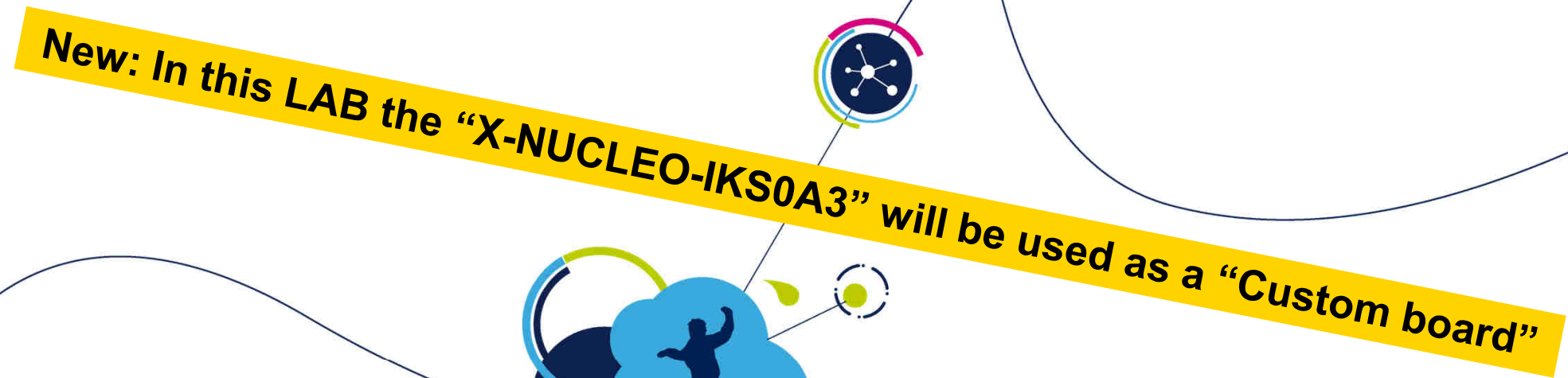


# Lab5 – Closing the project

217

1. Right-Click on **Lab5** project
2. Click on **Close Project**





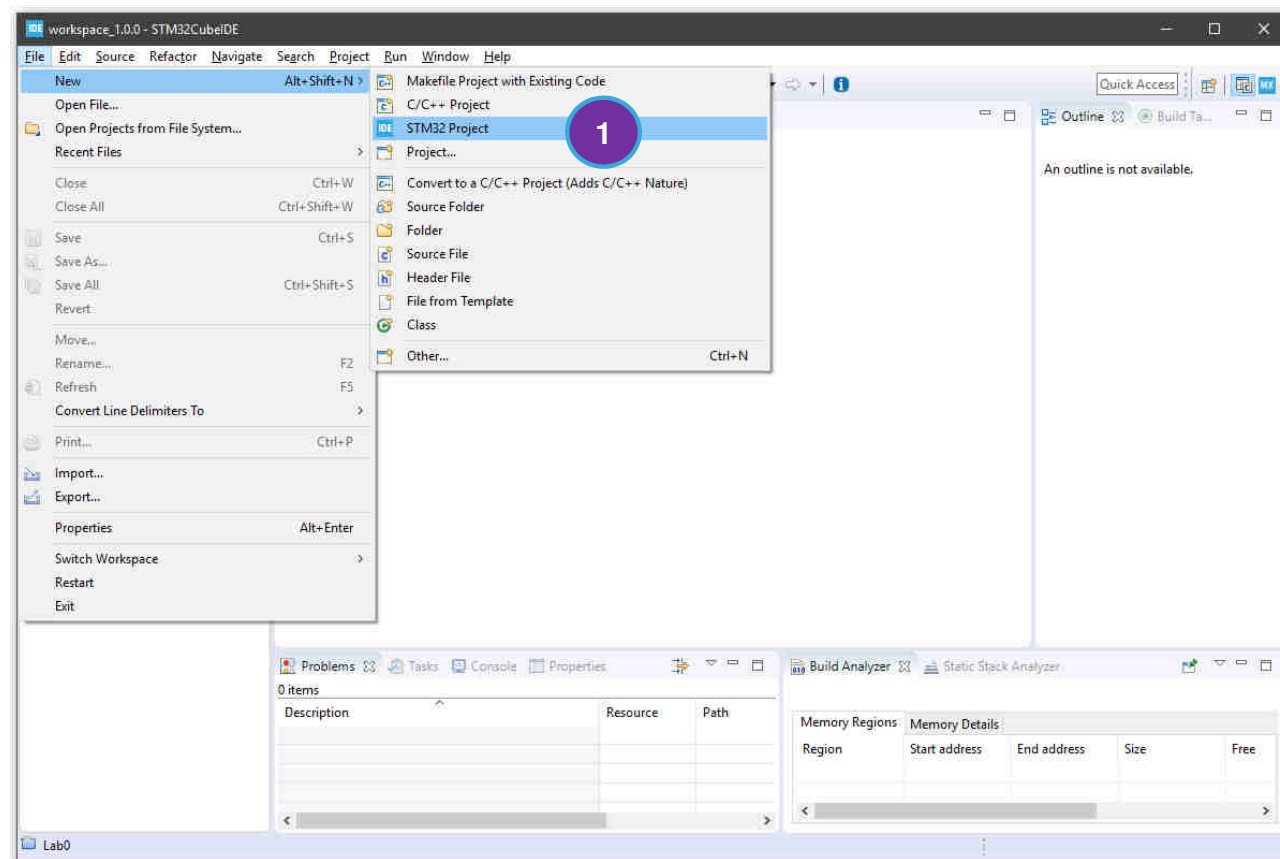
New: In this LAB the “X-NUCLEO-IKS0A3” will be used as a “Custom board”

# LAB6

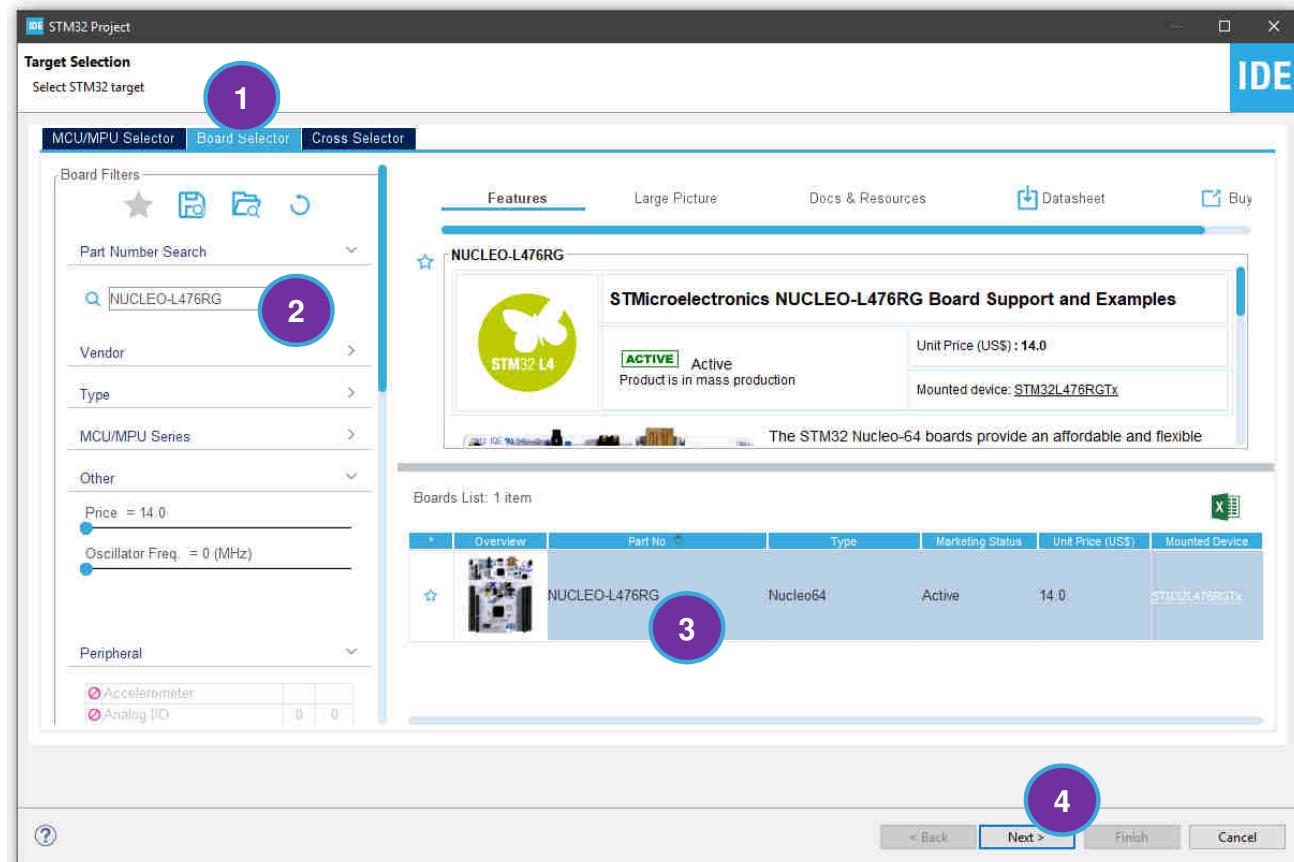
## Goals:

- Configure a new project using X-CUBE-MEMS1
- Configure LSM6DSO only for USB data logging
- Change Output Data Rate to log accelerometer and gyroscope at higher acquisition speed

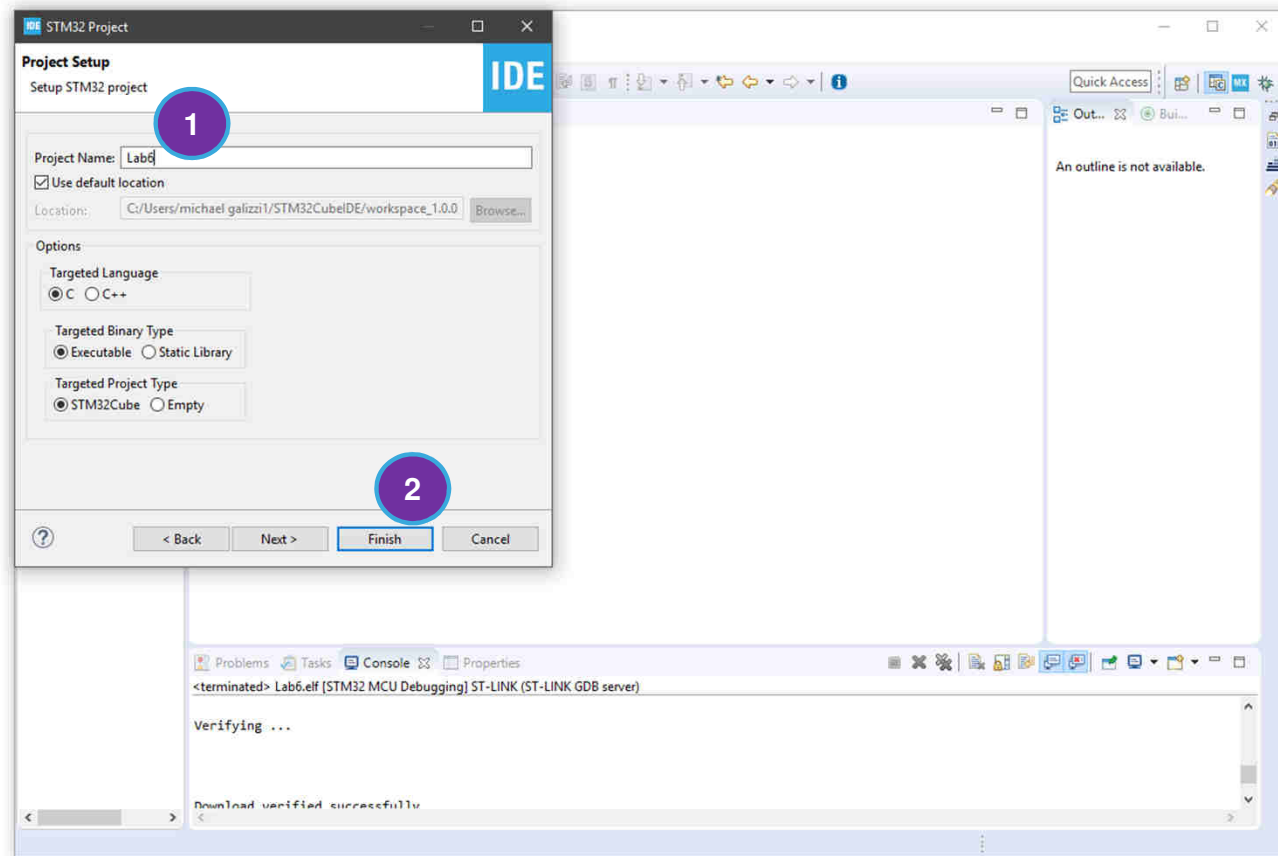
## 1. Click on **File > New > STM32 Project**



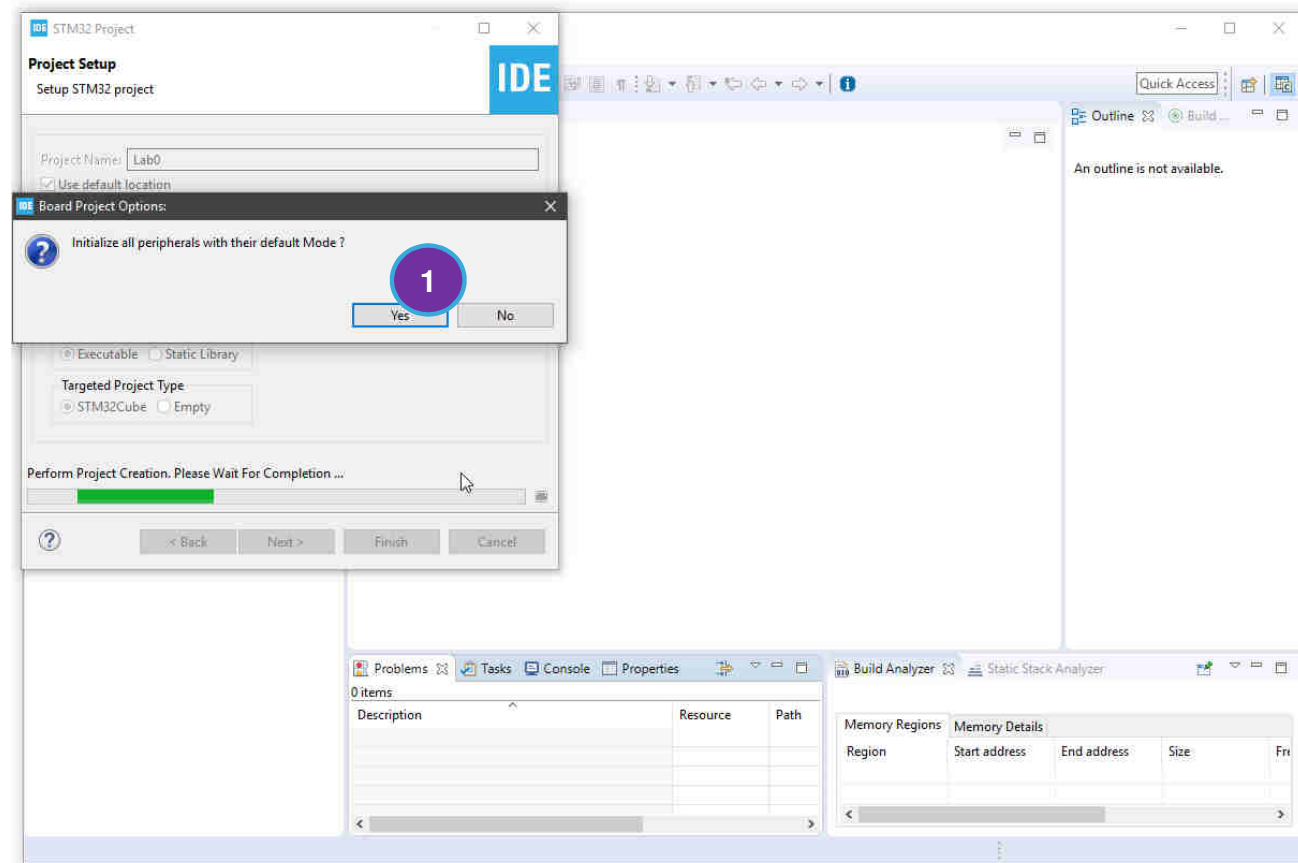
1. Click on **Board Selector**
2. Type **NUCLEO-L476RG**
3. Click on the board
4. Click **Next >**



1. Project Name **Lab6**
2. Click **Finish**



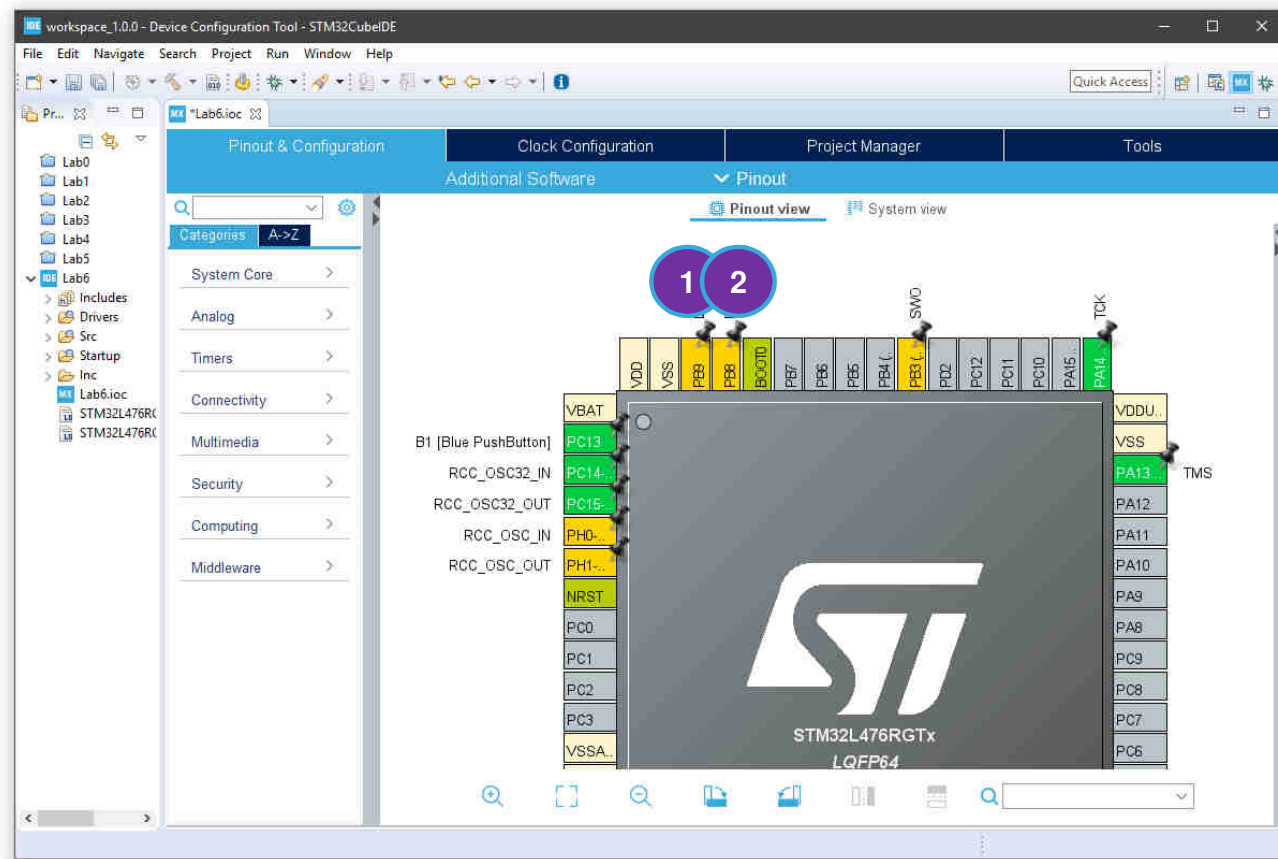
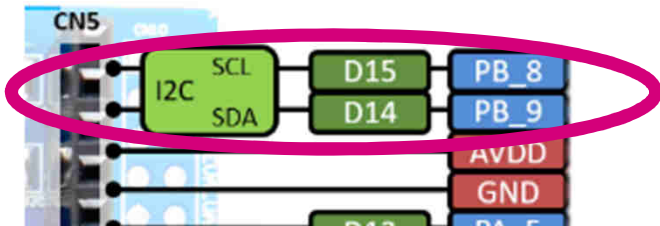
1. Click **Yes** to init peripherals in default mode



# Lab6 – Configure the I2C bus

223

1. Left Click on **PB9** and select I2C1\_SDA
2. Left Click on **PB8** and select I2C1\_SCL



# Lab6 – Configure the I2C bus

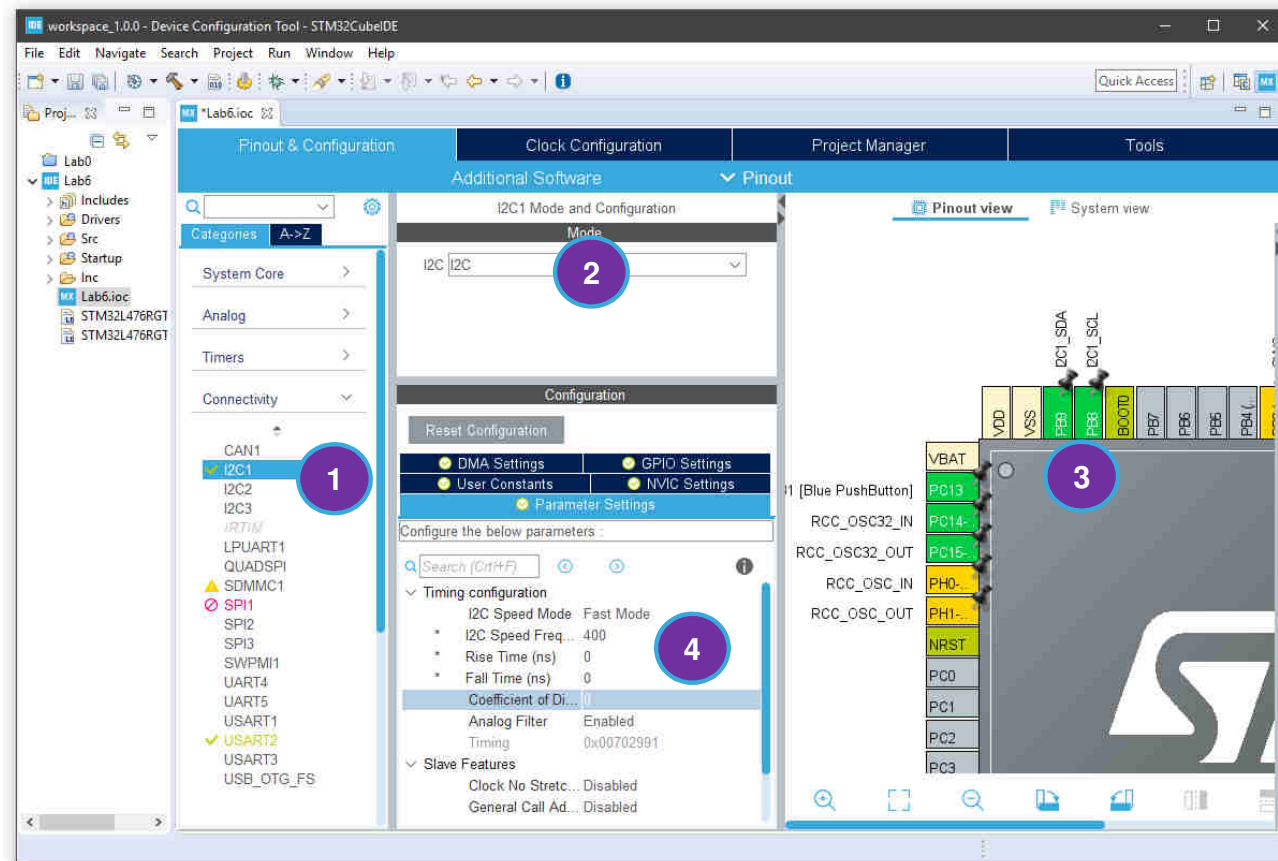
224

1. Expand *Connectivity* tab and check **I2C1**

2. Select **I2C** in *I2C1 Mode and Configuration*

3. PB8 and PB9 should now become green

4. Setup **Fast Mode** in **Parameter Settings**

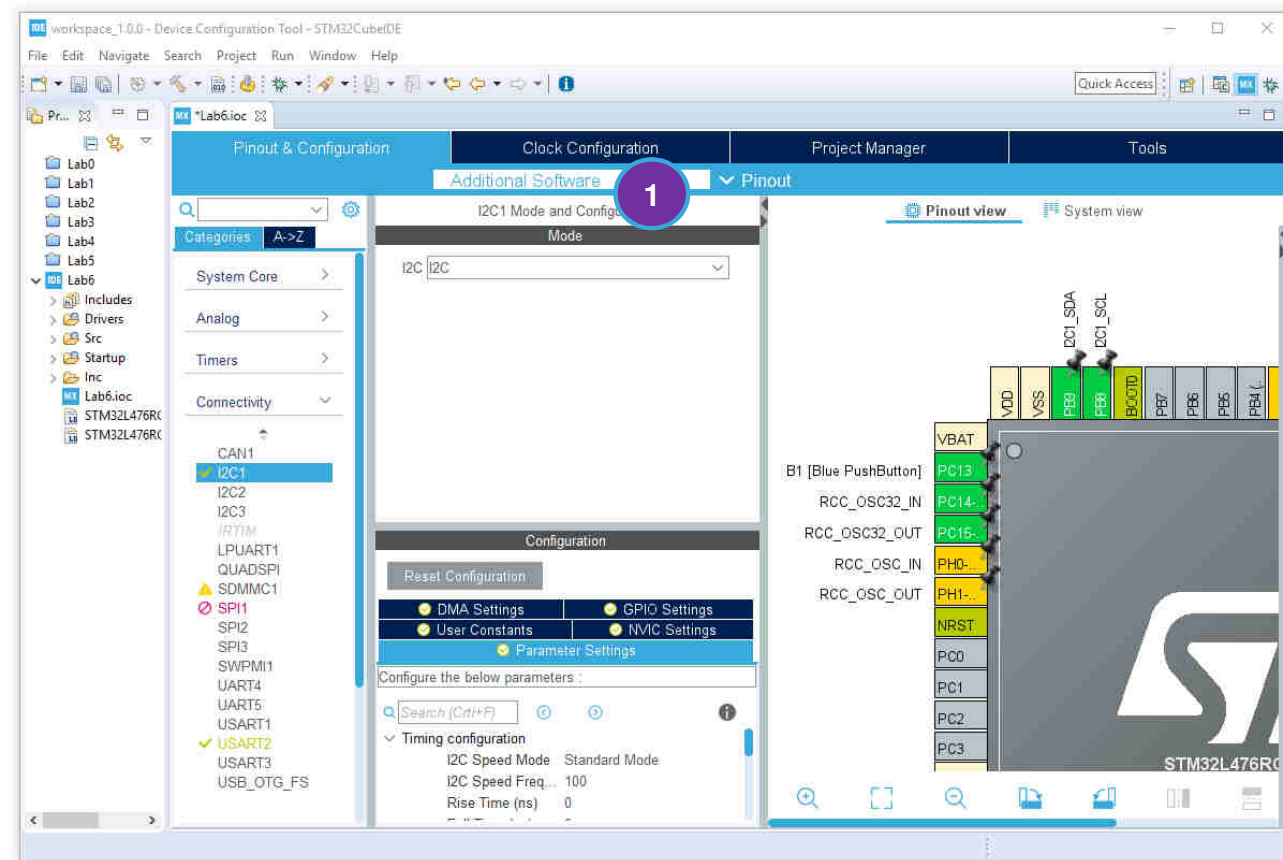




# Lab6 – Select the MEMS library

225

1. Click on **Additional Software**

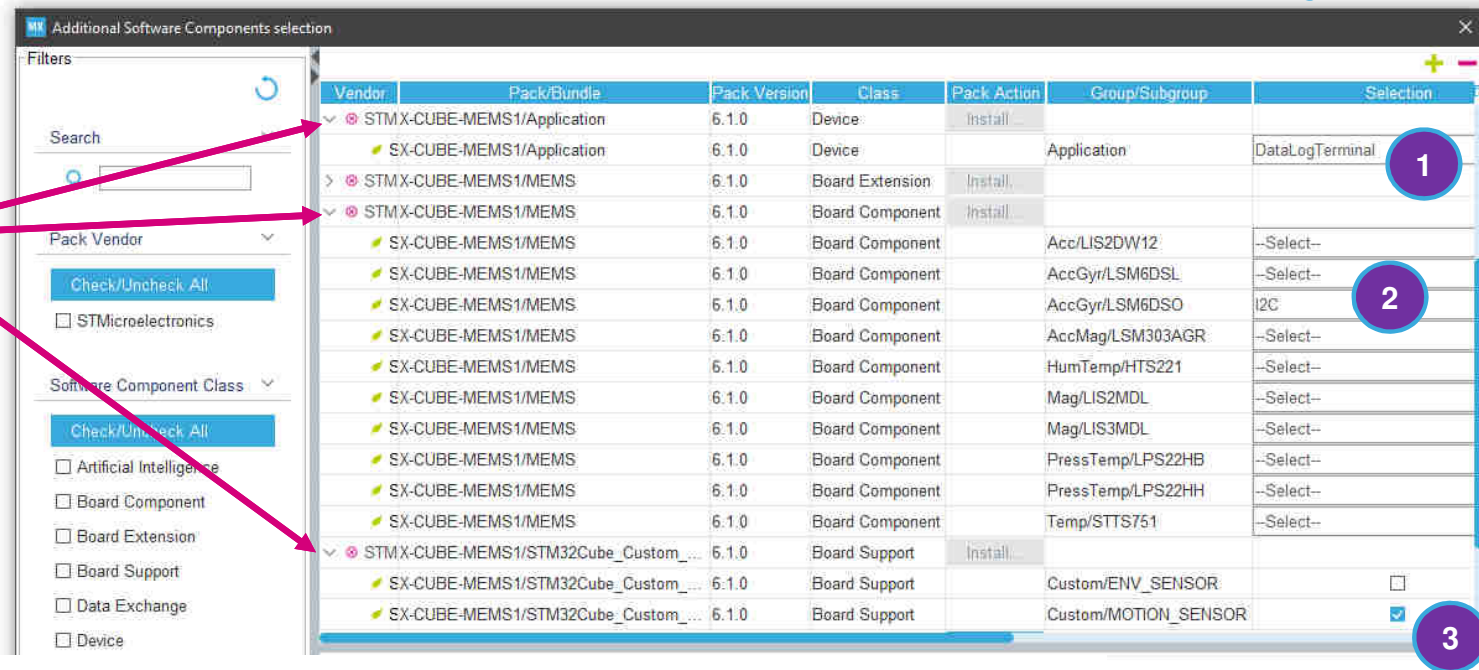


# Lab6 – Select the MEMS library

226

Attention:  
3 selection

Click to  
expand tree

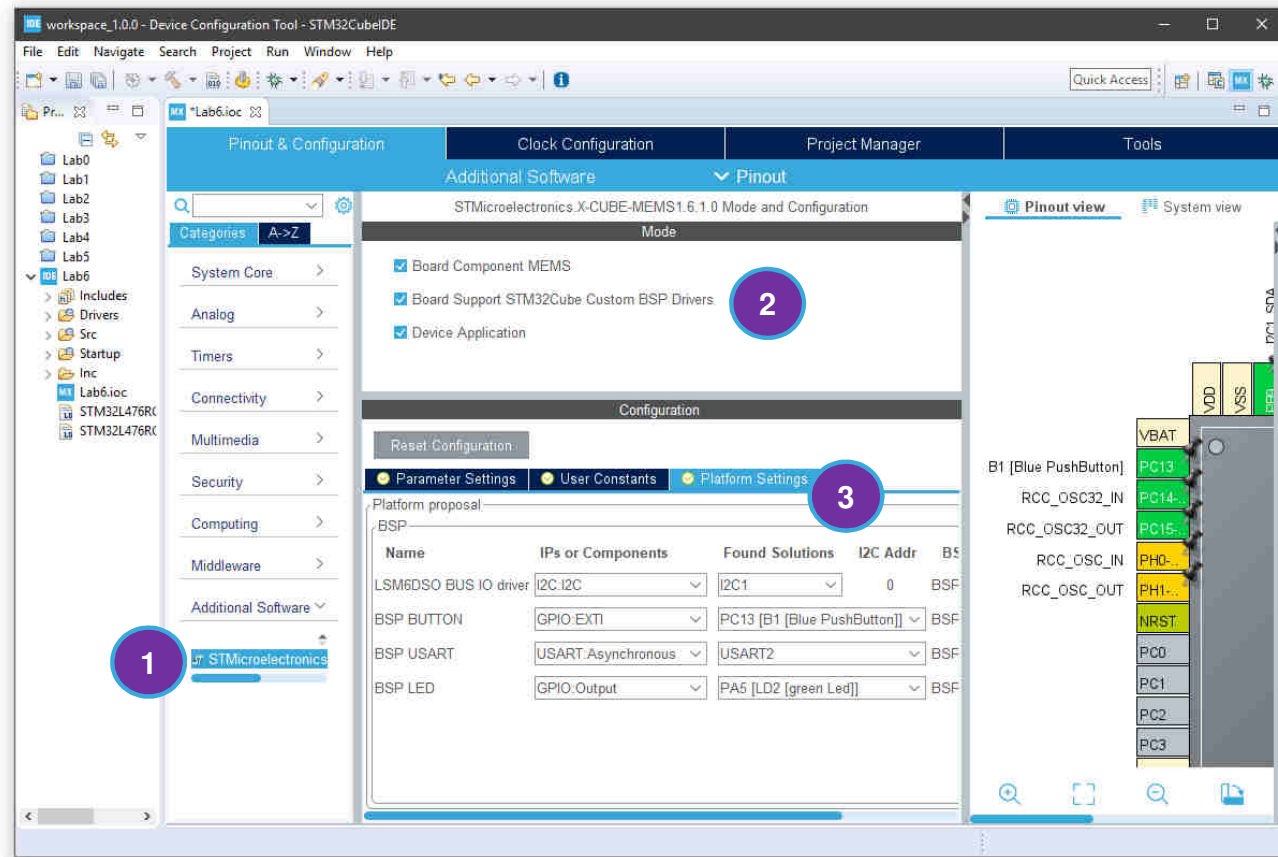


1. In X-CUBE-MEMS1/Application, Class "Device":  
Select **DataLogTerminal**
2. In X-CUBE-MEMS1/MEMS, Class "Board Component":  
In **AccGyr/LSM6DSO** Selection **I2C**
3. In X-CUBE-MEMS1/MEMS, Class "Board Support":  
Check **Custom/MOTION\_SENSOR**
4. Click **OK**

# Lab6 – Configure the MEMS library

227

1. Expand Additional Software and select the X-CUBE-MEMS1
2. Check both:  
**Board Component MEMS**  
**Board Support STM32...**  
**Device Application**
3. Configure **Platform Settings** as in picture



# Lab6 – Configure the MEMS library

228

The screenshot shows the STM32CubeIDE Platform Manager interface. A red box highlights the 'Platform proposal' table, which lists the components and their configurations. A red dotted line connects this box to a zoomed-in view of the same table, showing the details of the configuration.

Name	IPs or Components	Found Solutions	I2C Addr	BSP
LSM6DSO BUS IO driver	I2C:I2C	I2C1	0	BSP
BSP BUTTON	GPIO:EXTI	PC13 [B1 [Blue PushButton]]		BSP
BSP USART	USART:Asynchronous	USART2		BSP
BSP LED	GPIO:Output	PA5 [LD2 [green Led]]		BSP

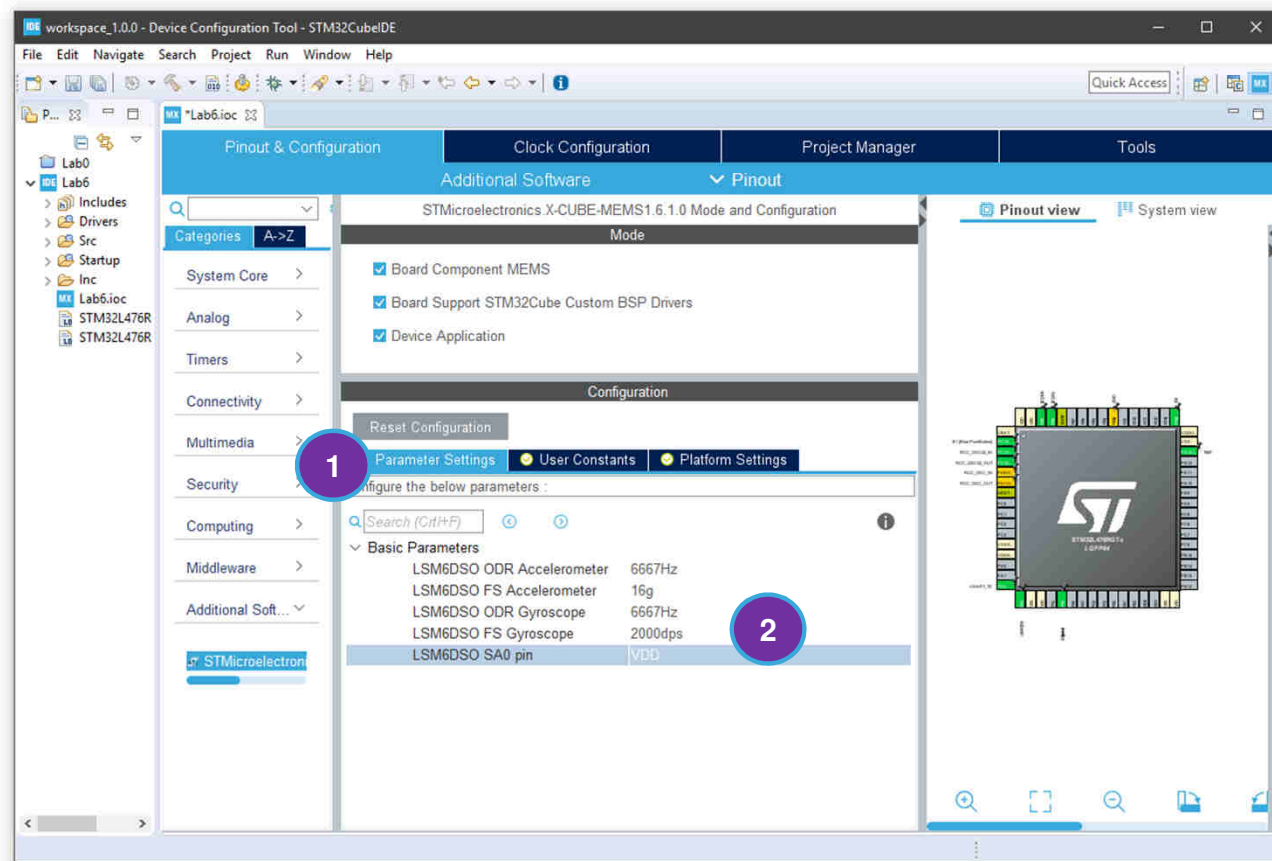
The zoomed-in view shows the same table, but with the 'Found Solutions' column expanded to show the specific pin and component names. The table is part of a larger configuration window, which also includes a 'Pinout view' and a 'System view'.

# Lab6 – Configure the MEMS library

229

1. Configure **Parameter Settings** as in picture

2. ODR\_Accelerometer: 6667Hz  
FS\_Accelerometer: 16g  
ODR\_Gyroscope: 6667Hz  
FS\_Gyroscope: 2000dps



# Lab6 – Configure the MEMS library

230

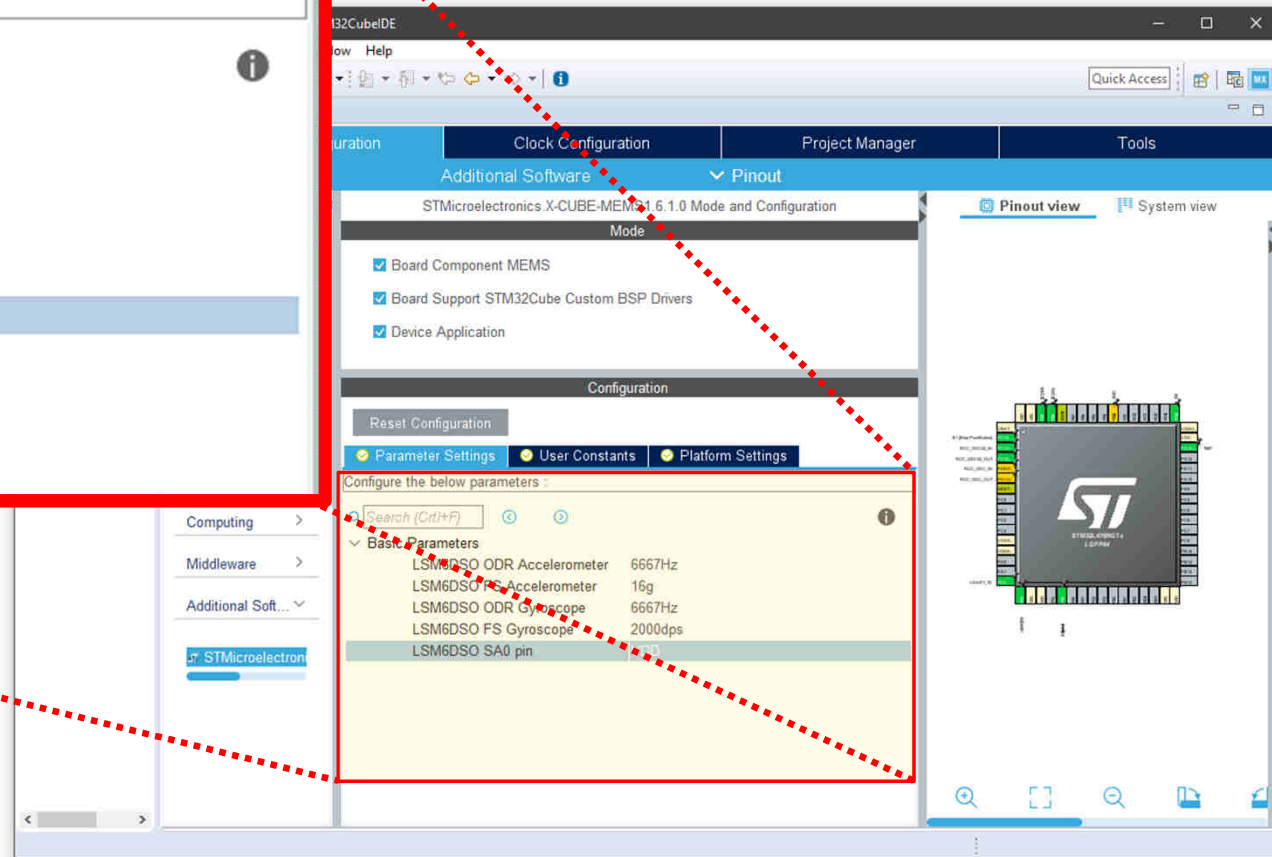
✓ Parameter Settings   ✓ User Constants   ✓ Platform Settings

Configure the below parameters :

Search (Ctrl+F)

Basic Parameters

LSM6DSO ODR Accelerometer	6667Hz
LSM6DSO FS Accelerometer	16g
LSM6DSO ODR Gyroscope	6667Hz
LSM6DSO FS Gyroscope	2000dps
LSM6DSO SA0 pin	VDD





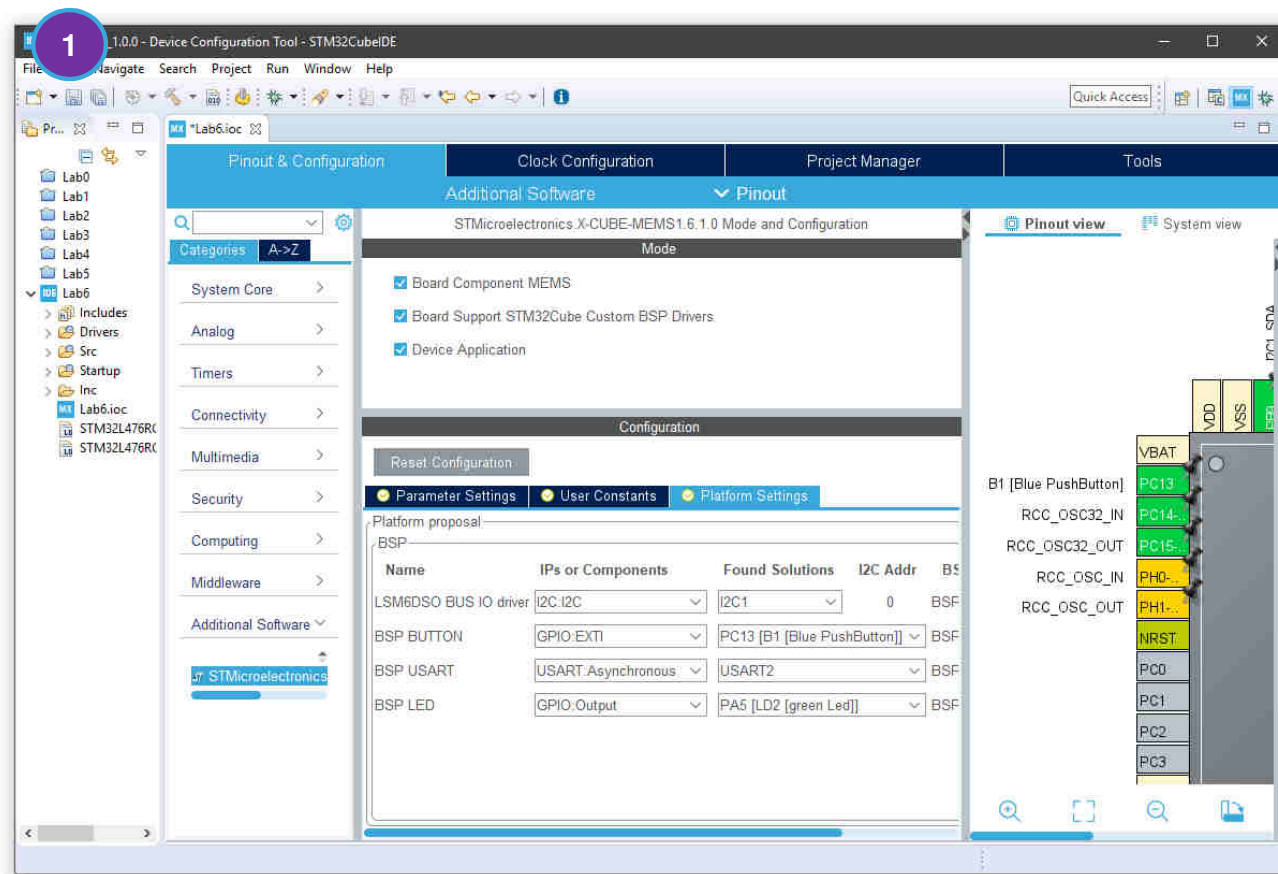
# Lab6 – Save the project

231

1. Click the save button



This action will generate the source code of this lab

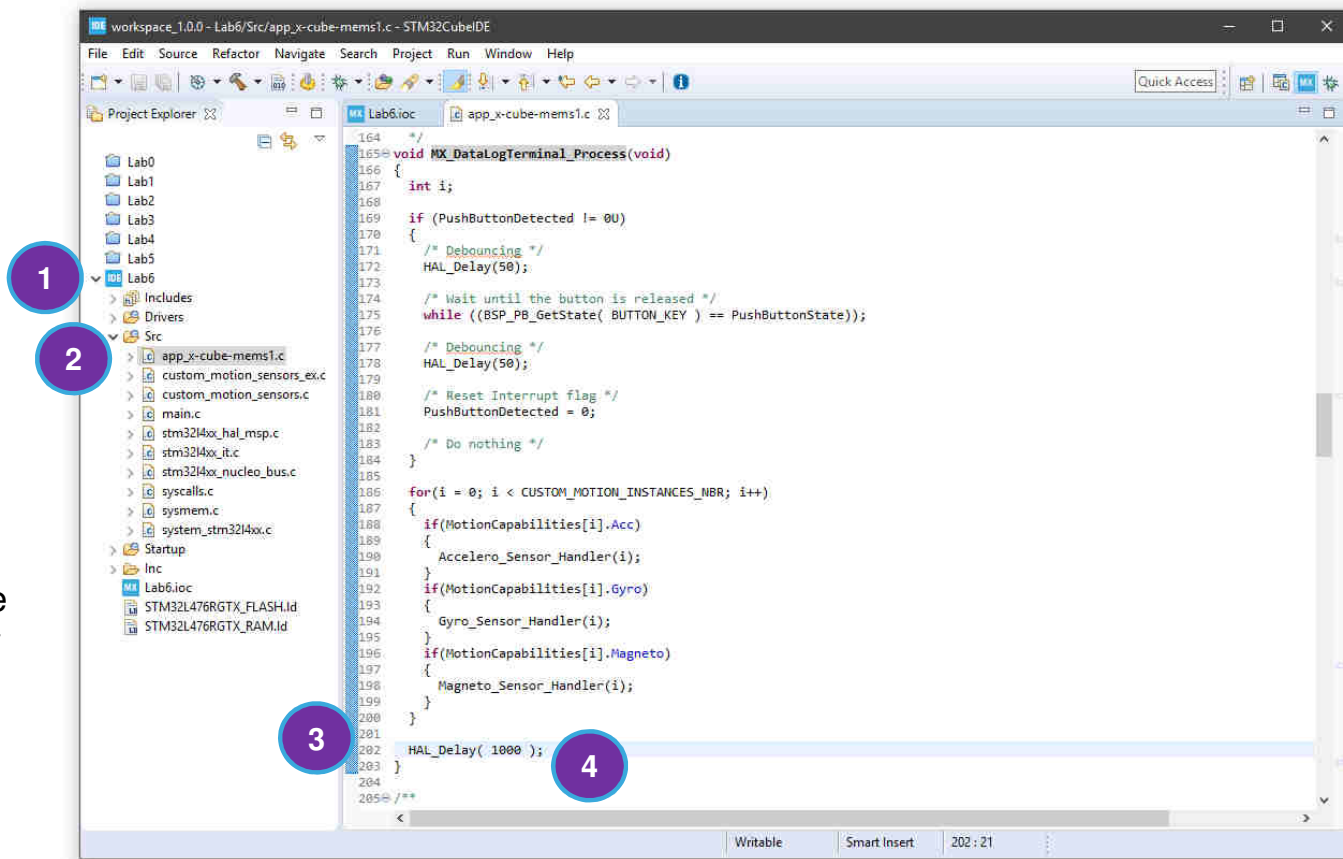


# Lab6 – Code Editing 1/2

232

1. Expand **Src** in folder **Lab6**
2. Double click on **app\_x-cube-mems1.c**
3. Go to line **#202**
4. Change it from **HAL\_Delay( 1000 );** to **HAL\_Delay( 50 );**

Note: Sensor ODR is 6667 Hz, meanwhile output on serial terminal is updated every 50 ms (20 Hz)



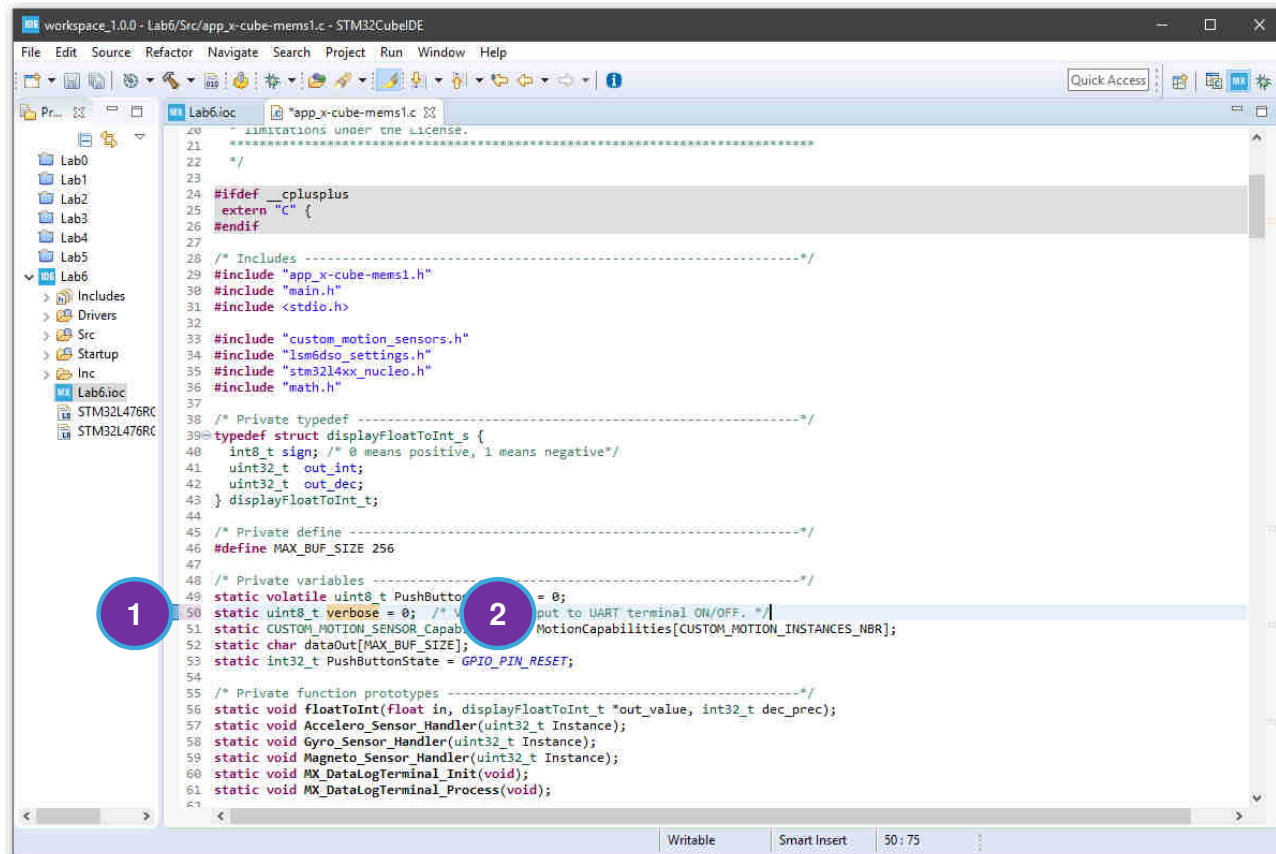


# Lab6 – Code Editing 2/2

233

1. Go to line **#50** of file **app\_x-cube-mems1.c**
2. Change it from  
**static uint8\_t verbose = 1;**  
to  
**static uint8\_t verbose = 0;**

This modification will reduce the serial terminal output info to only RAW accelerometer and gyroscope data



```
workspace_1.0.0 - Lab6/Src/app_x-cube-mems1.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
Lab6.ioc app_x-cube-mems1.c
/*
 * Limitations under the license.
 */
#ifdef __cplusplus
extern "C" {
#endif

/* Includes -----*/
#include "app_x-cube-mems1.h"
#include "main.h"
#include <stdio.h>

#include "custom_motion_sensors.h"
#include "lsm6dso_settings.h"
#include "stm32l4xx_nucleo.h"
#include "math.h"

/* Private typedef -----*/
typedef struct displayFloatToInt_s {
    int8_t sign; /* 0 means positive, 1 means negative*/
    uint32_t out_int;
    uint32_t out_dec;
} displayFloatToInt_t;


/* Private define -----*/
#define MAX_BUF_SIZE 256

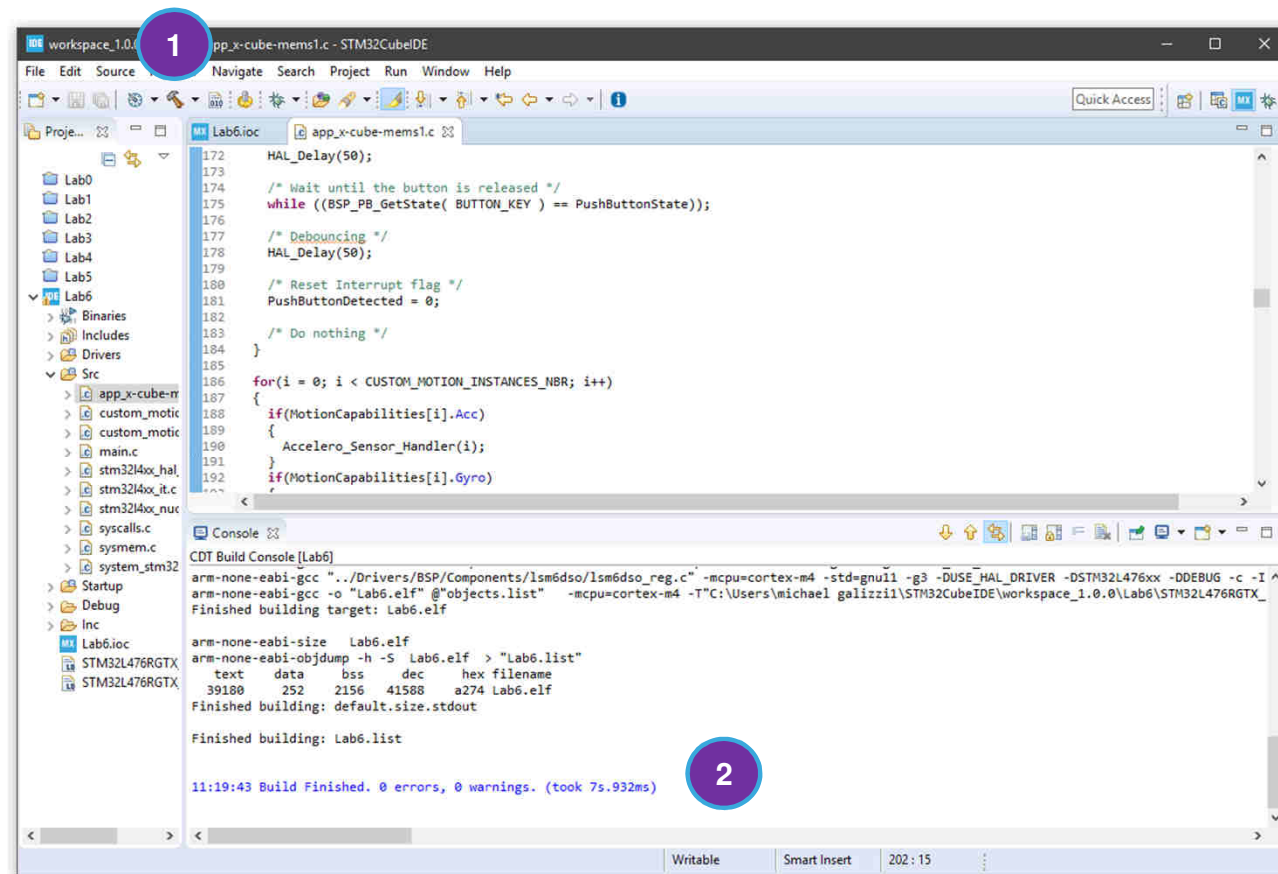
/* Private variables -----*/
static volatile uint8_t PushButtonState = 0;
static uint8_t verbose = 0; /* 0: no output to UART terminal ON/OFF. */
static CUSTOM_MOTION_SENSOR_Capabilities_t MotionCapabilities[CUSTOM_MOTION_INSTANCES_NBR];
static char dataOut[MAX_BUF_SIZE];
static int32_t PushButtonState = GPIO_PIN_RESET;

/* Private function prototypes -----*/
static void floatToInt(Float in, displayFloatToInt_t *out_value, int32_t dec_prec);
static void Accelero_Sensor_Handler(uint32_t Instance);
static void Gyro_Sensor_Handler(uint32_t Instance);
static void Magneto_Sensor_Handler(uint32_t Instance);
static void MX_DataLogTerminal_Init(void);
static void MX_DataLogTerminal_Process(void);
```

# Lab6 - Compiling

234

1. Click on the hammer  to begin compilation, or press **CTRL+B**
2. Compilation should terminate with 0 errors and 0 warning



```
workspace_1.0.0 - STM32CubeIDE
File Edit Source Navigate Search Project Run Window Help
Lab6.ioc app_x-cube-mems1.c
172 HAL_Delay(50);
173
174 /* Wait until the button is released */
175 while ((BSP_PB_GetState( BUTTON_KEY ) == PushButtonState));
176
177 /* Debouncing */
178 HAL_Delay(50);
179
180 /* Reset Interrupt flag */
181 PushButtonDetected = 0;
182
183 /* Do nothing */
184 }
185
186 for(i = 0; i < CUSTOM_MOTION_INSTANCES_NBR; i++)
187 {
188     if(MotionCapabilities[i].Acc)
189     {
190         Accelerometer_Handler(i);
191     }
192     if(MotionCapabilities[i].Gyro)
193     {
194         Gyro_Handler(i);
195     }
196 }
197
198 }
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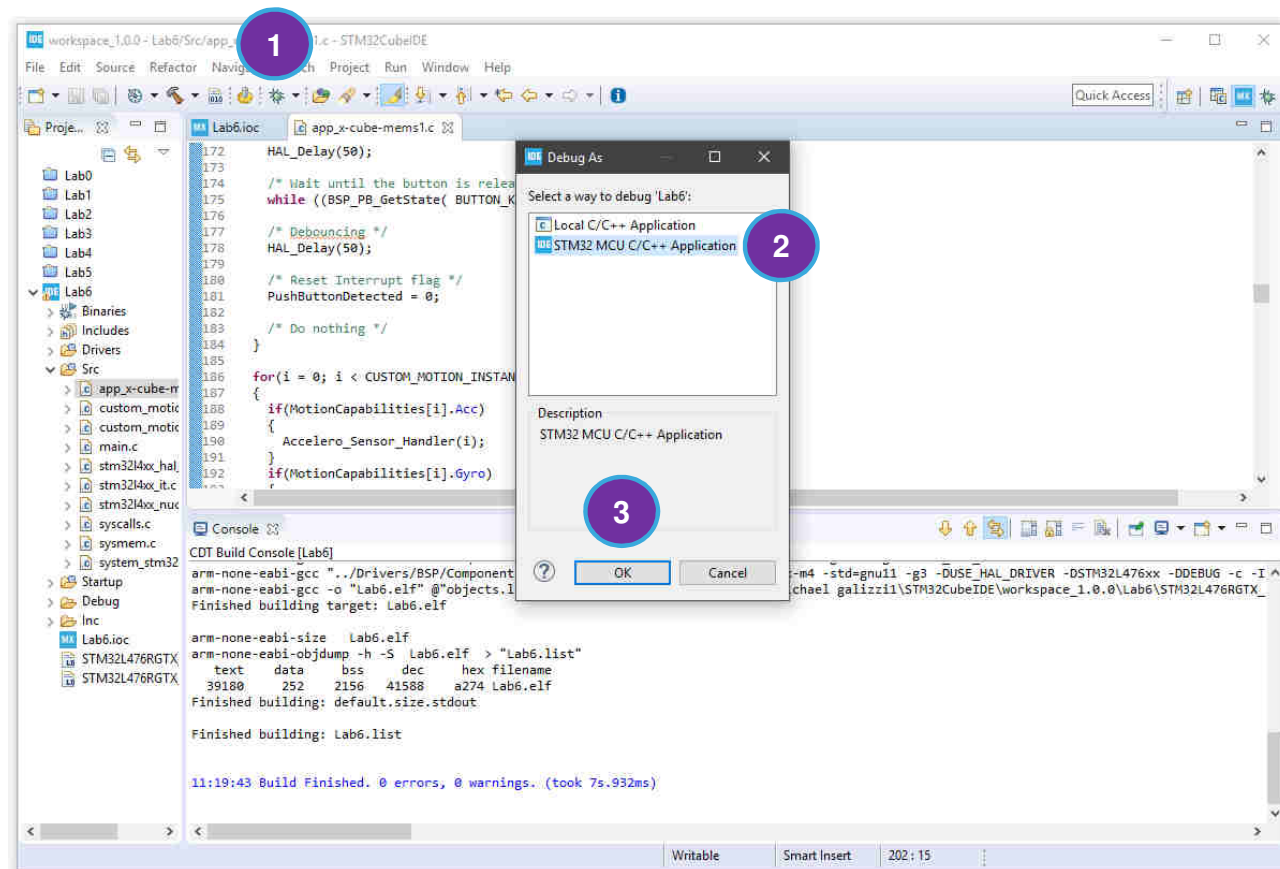
# Lab6 - Debugging

235

1. Click on the bug  to begin debugging

2. Select **STM32 MCU C/C++ App**

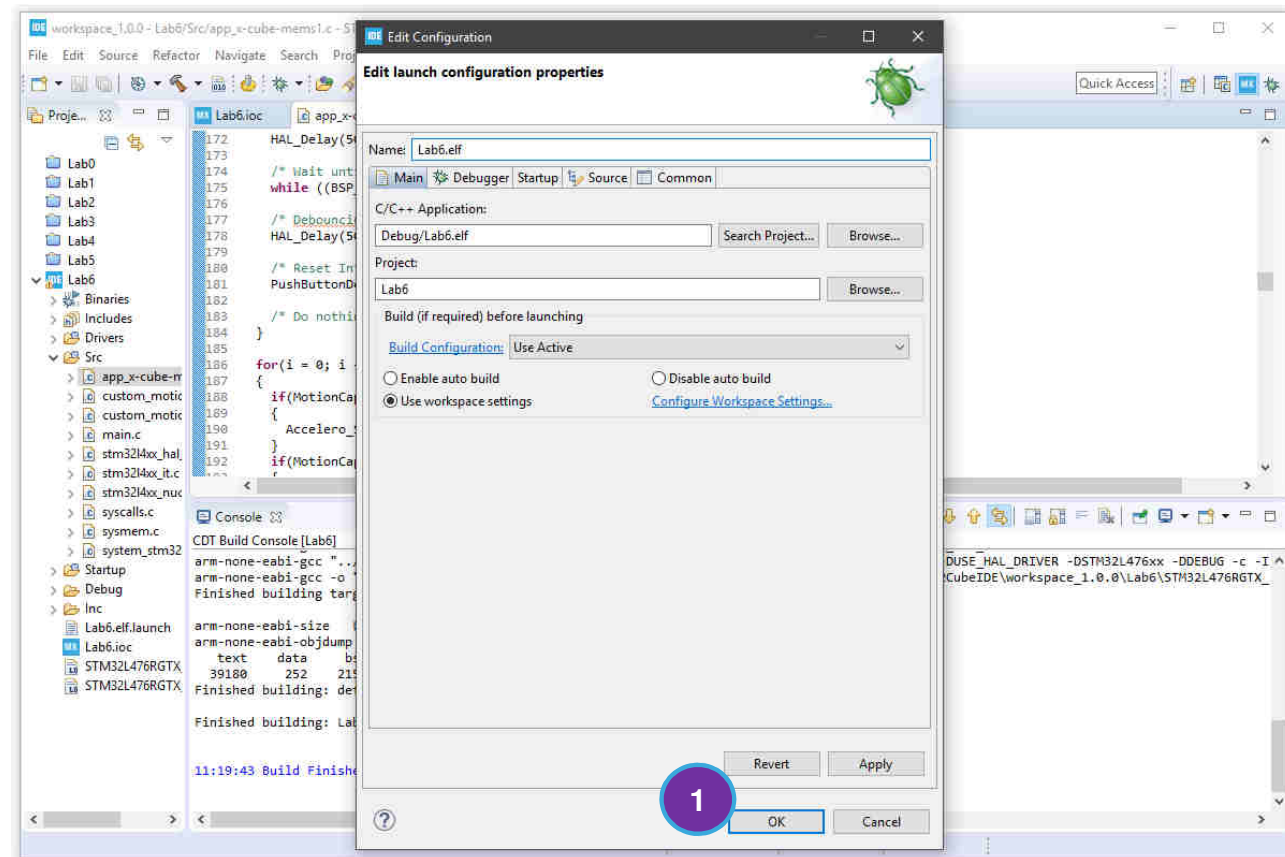
3. Click **OK**



# Lab6 - Debugging

236

1. Click **OK**

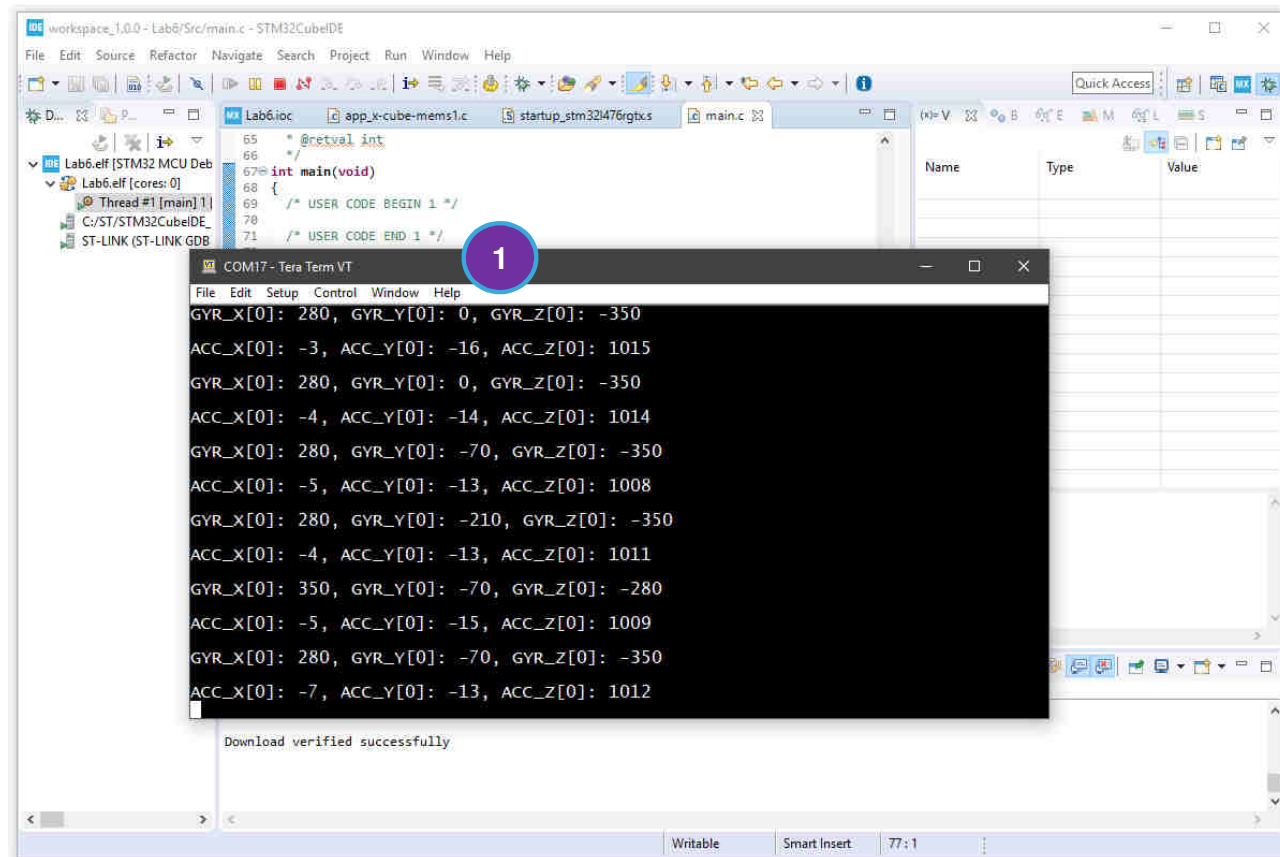




# Lab6 - Debugging

238

1. Open Tera Term to view the output



The screenshot shows an IDE window with a C program named `main.c` and a terminal window titled "COM17 - Tera Term VT". A red circle with the number "1" is placed over the terminal window, indicating the step to open Tera Term to view the output.

```
65 * @retval int
66 */
67 int main(void)
68 {
69     /* USER CODE BEGIN 1 */
70
71     /* USER CODE END 1 */
```

Output in Tera Term:

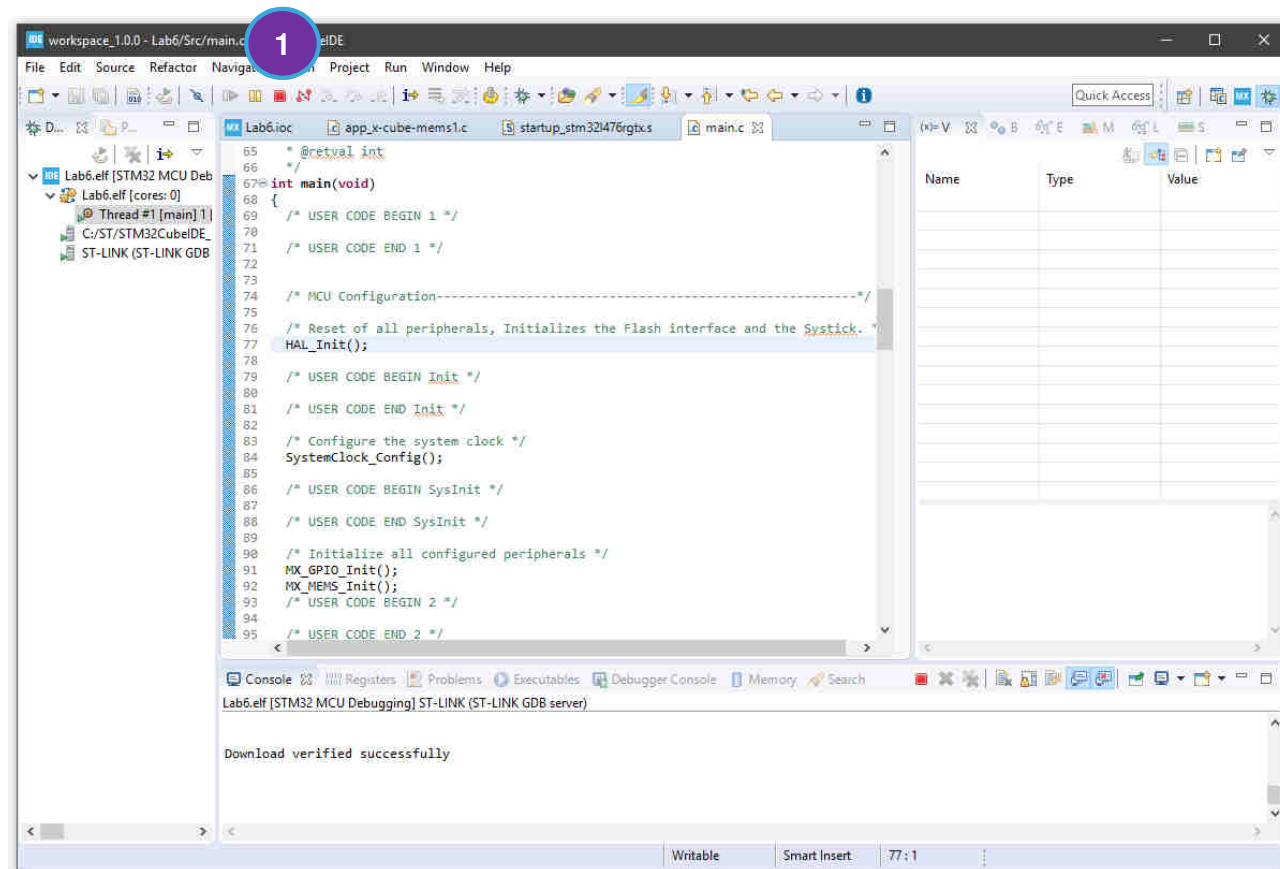
```
GYR_X[0]: 280, GYR_Y[0]: 0, GYR_Z[0]: -350
ACC_X[0]: -3, ACC_Y[0]: -16, ACC_Z[0]: 1015
GYR_X[0]: 280, GYR_Y[0]: 0, GYR_Z[0]: -350
ACC_X[0]: -4, ACC_Y[0]: -14, ACC_Z[0]: 1014
GYR_X[0]: 280, GYR_Y[0]: -70, GYR_Z[0]: -350
ACC_X[0]: -5, ACC_Y[0]: -13, ACC_Z[0]: 1008
GYR_X[0]: 280, GYR_Y[0]: -210, GYR_Z[0]: -350
ACC_X[0]: -4, ACC_Y[0]: -13, ACC_Z[0]: 1011
GYR_X[0]: 350, GYR_Y[0]: -70, GYR_Z[0]: -280
ACC_X[0]: -5, ACC_Y[0]: -15, ACC_Z[0]: 1009
GYR_X[0]: 280, GYR_Y[0]: -70, GYR_Z[0]: -350
ACC_X[0]: -7, ACC_Y[0]: -13, ACC_Z[0]: 1012
```

Download verified successfully

# Lab6 - Debugging

239

1. Click stop  button to interrupt the debugging

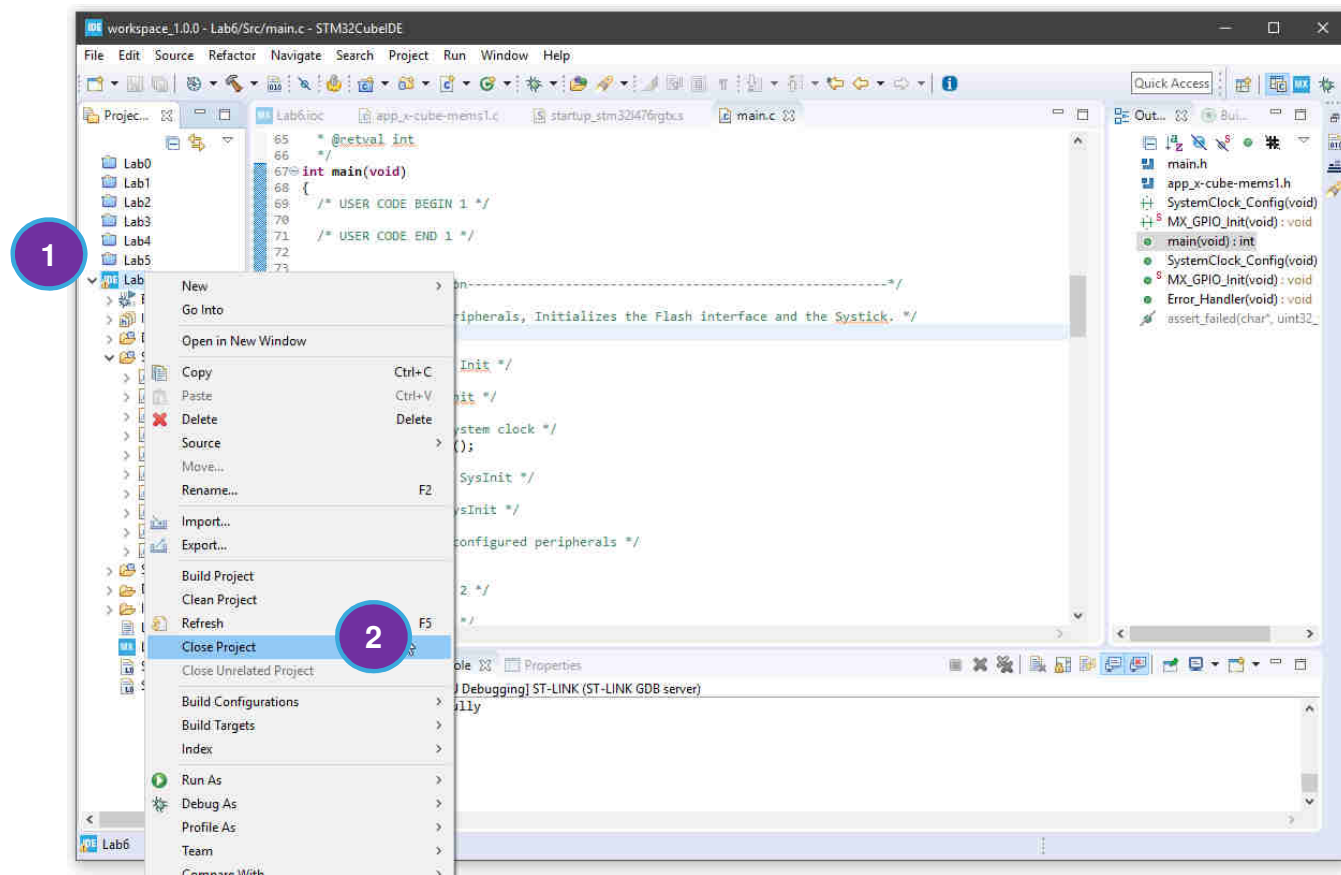




# Lab6 – Closing the project

240

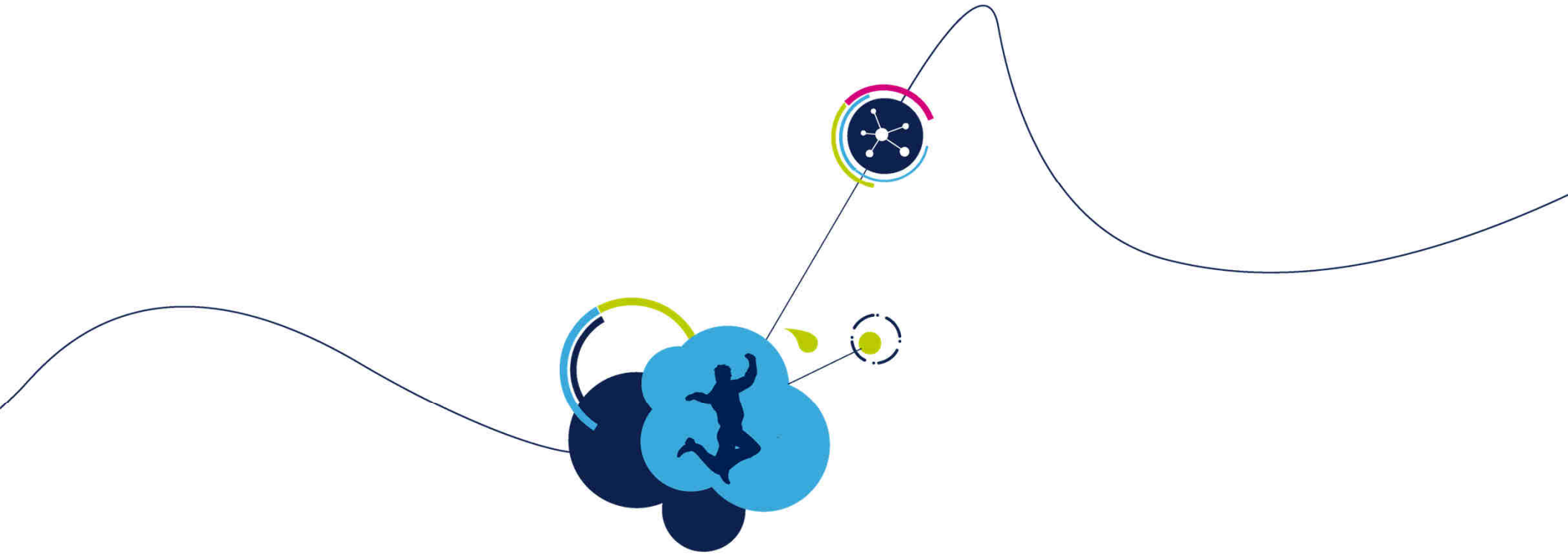
1. Right-Click on **Lab6** project
2. Click on **Close Project**





Thank You!

life.augmented

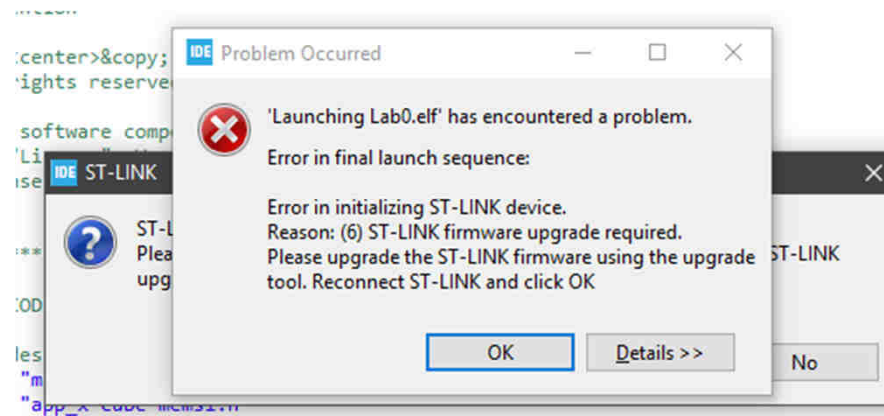


# Troubleshooting

# Common Issue #1

243

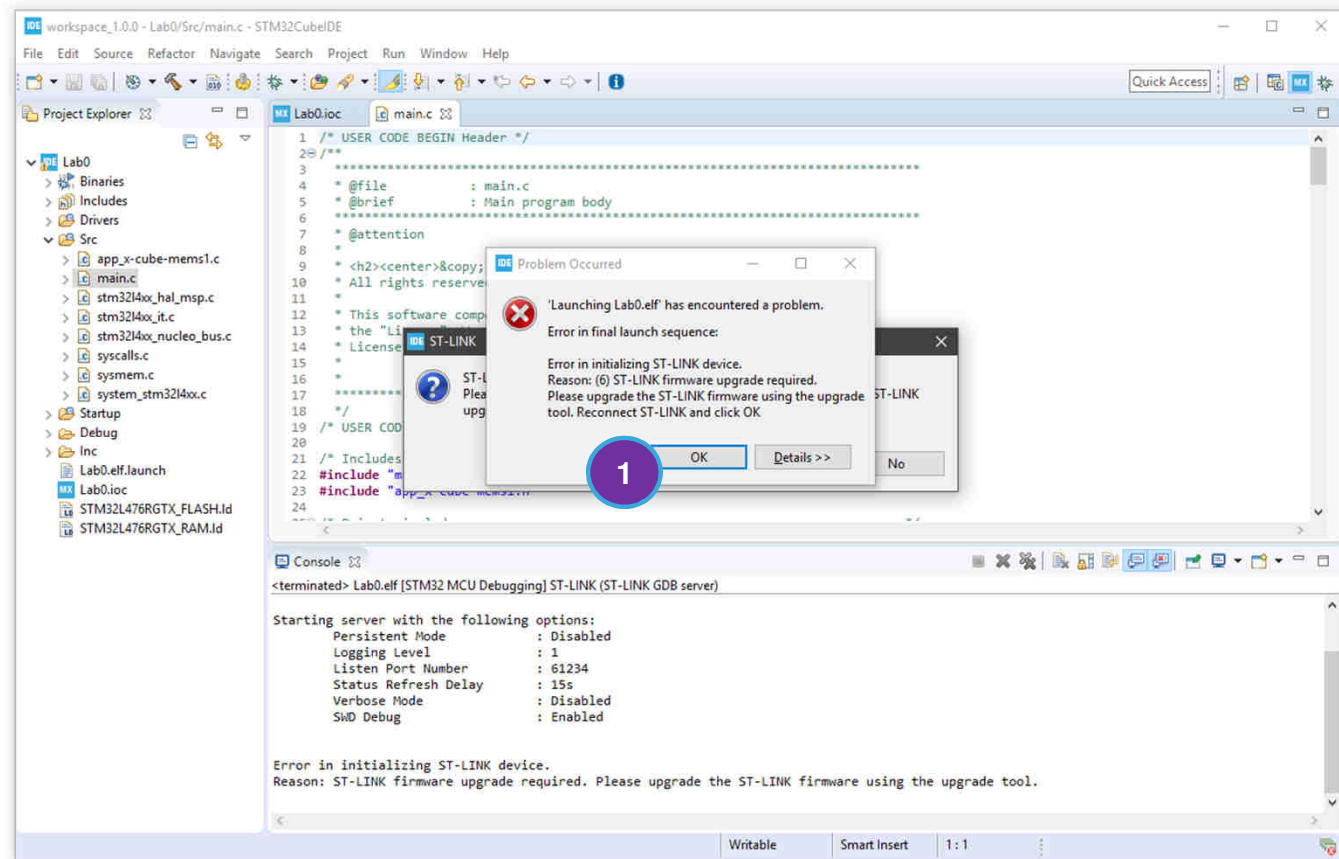
- *Description:* when debugging is launched by pressing , a **Problem Occurred** because ST-LINK need to be updated



# Common Issue #1: solution

244

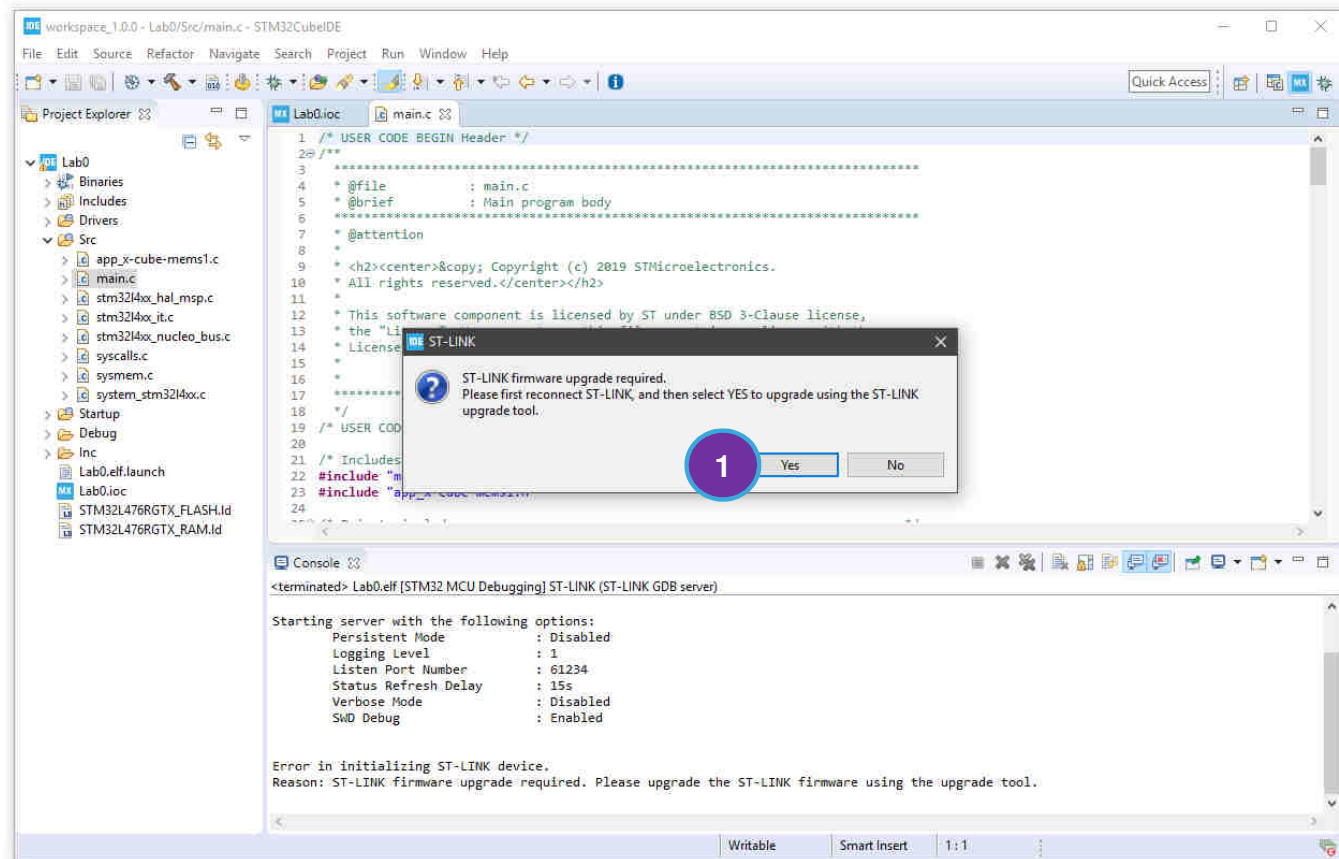
1. Click **OK** to run upgrade to latest firmware



# Common Issue #1: solution

245

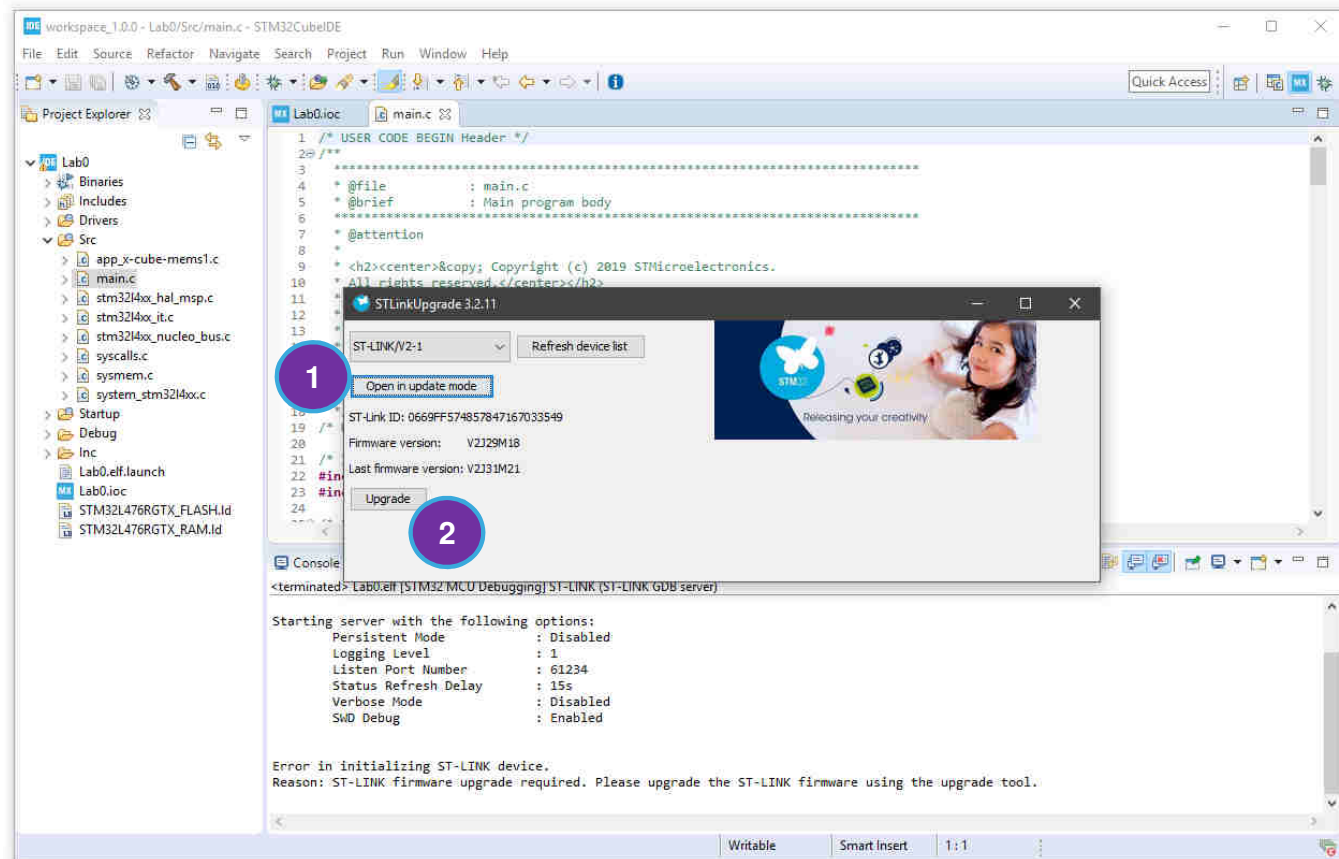
1. Click **Yes** when is asked to upgrade the ST-LINK



# Common Issue #1: solution

246

1. Click **Open in update mode** to force ST-LINK
2. Click on **Upgrade**

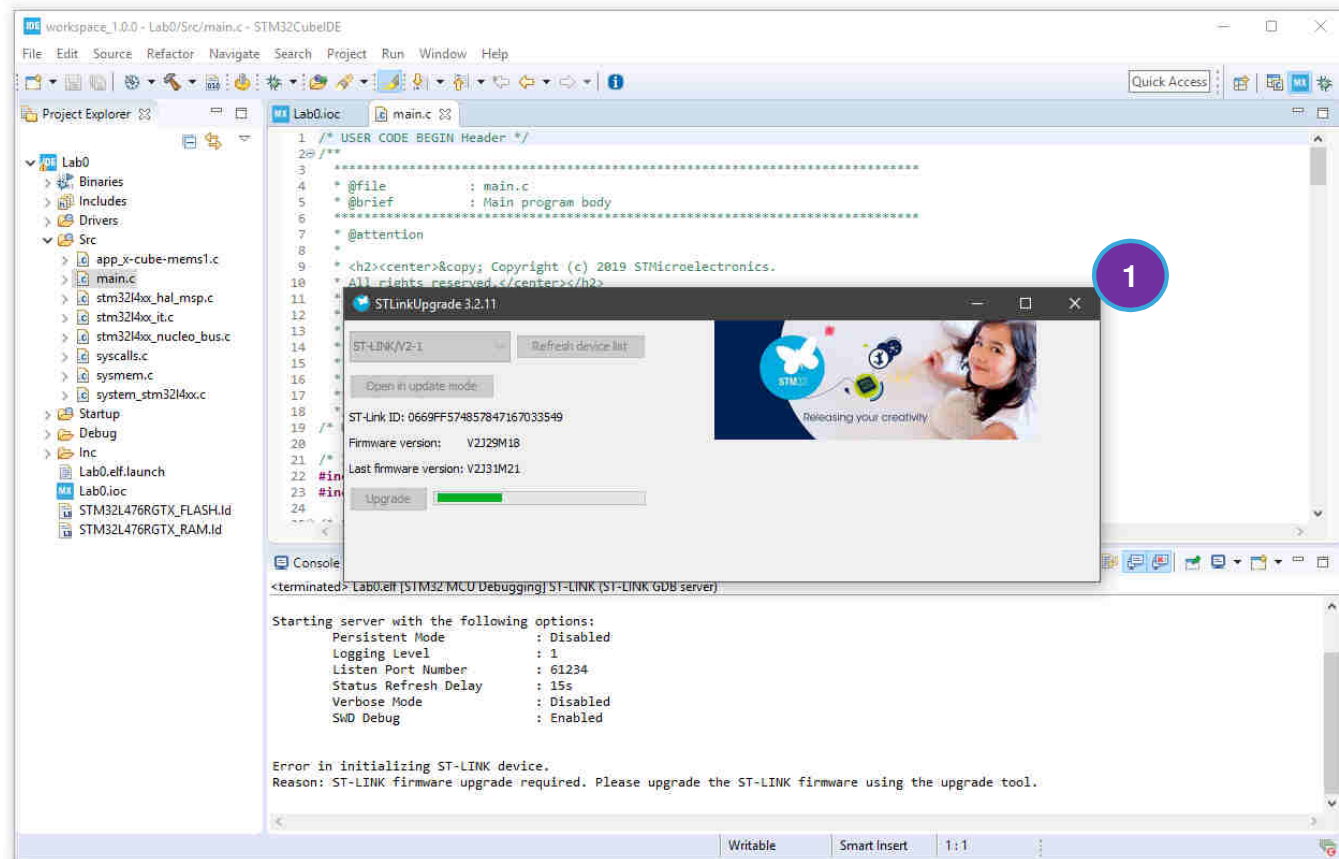


# Common Issue #1: solution

247


Wait until update is finished and then close the window.

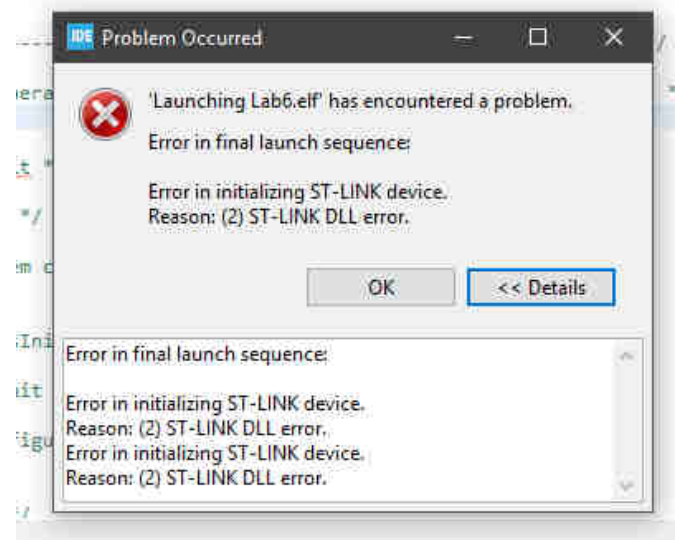
1. Click on **X** when finished



## Common Issue #2

248

- *Description:* when debugging is launched by pressing , a **Problem Occurred** because ST-LINK is not detected even if it is plugged correctly to the PC

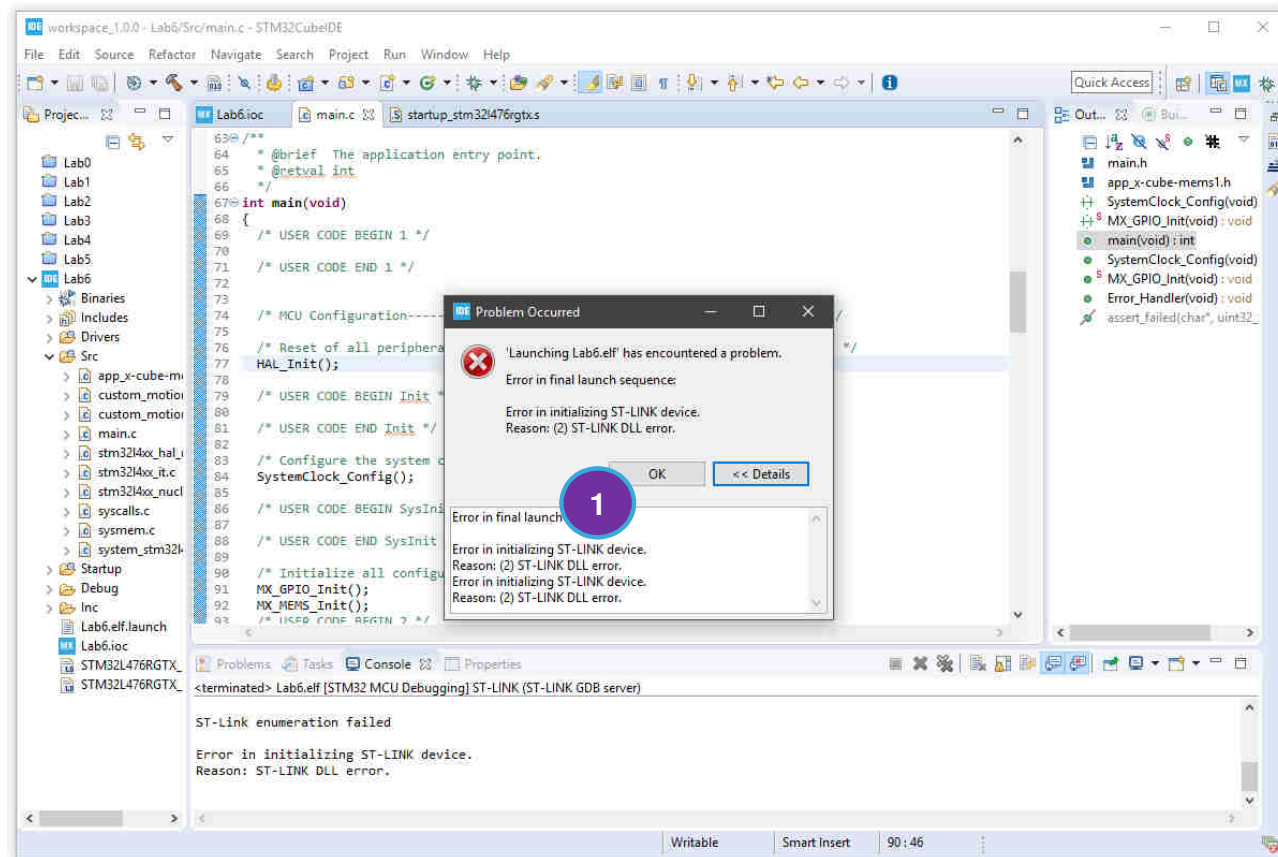




# Common Issue #2: solution

249

1. Click **OK** and proceed to install ST-LINK driver



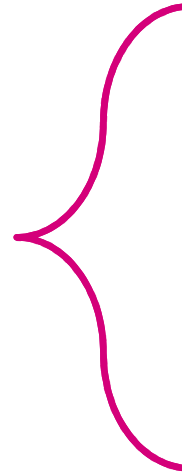
# Common Issue #2: solution

250

1. Extract the archive **en.stsw-link009.zip** located in **C:\X-CUBE-MEMS1\_HandsOn\Drivers**
2. Run installer for your PC architecture (32bit or 64bit)



en.stsw-link009.zip



amd64  
x86  
dpinst\_amd64.exe  
dpinst\_x86.exe  
readme.txt  
stlink\_bridge\_winusb.inf  
stlink\_dbg\_winusb.inf  
stlink\_VCP.inf  
stlink\_winusb\_install.bat  
stlinkbridgewinusb\_x64.cat  
stlinkbridgewinusb\_x86.cat  
stlinkdbgwinusb\_x64.cat  
stlinkdbgwinusb\_x86.cat  
stlinkvcp\_x64.cat  
stlinkvcp\_x86.cat

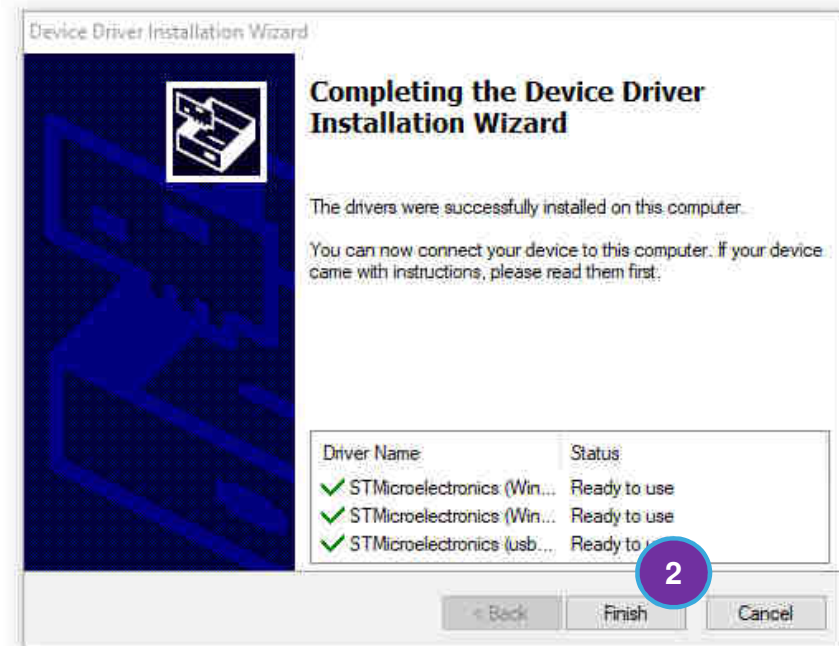
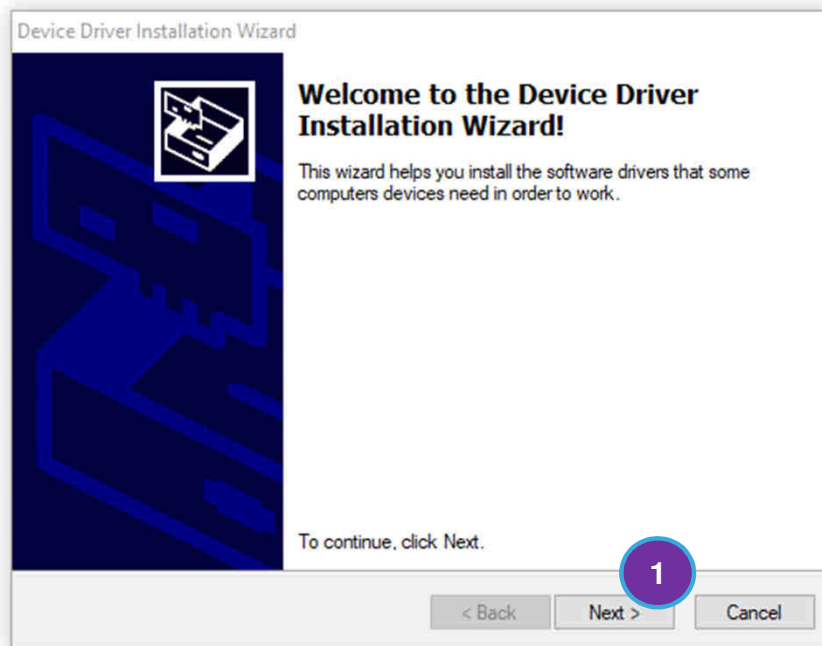
2



# Common Issue #2: solution


251

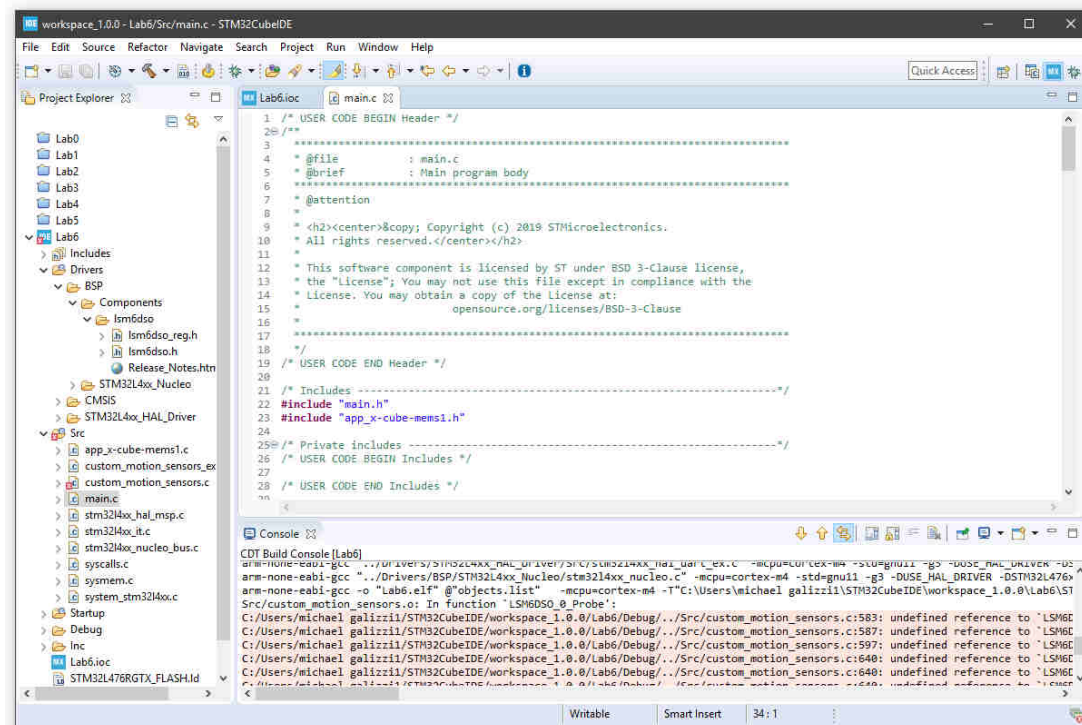
1. Click **Next >**
2. Click **Finish**



# Common Issue #3

252

- *Description:* regenerating the code by saving the project  after modify the .ioc file may lead to some missed source file inclusion and compilation will fails.



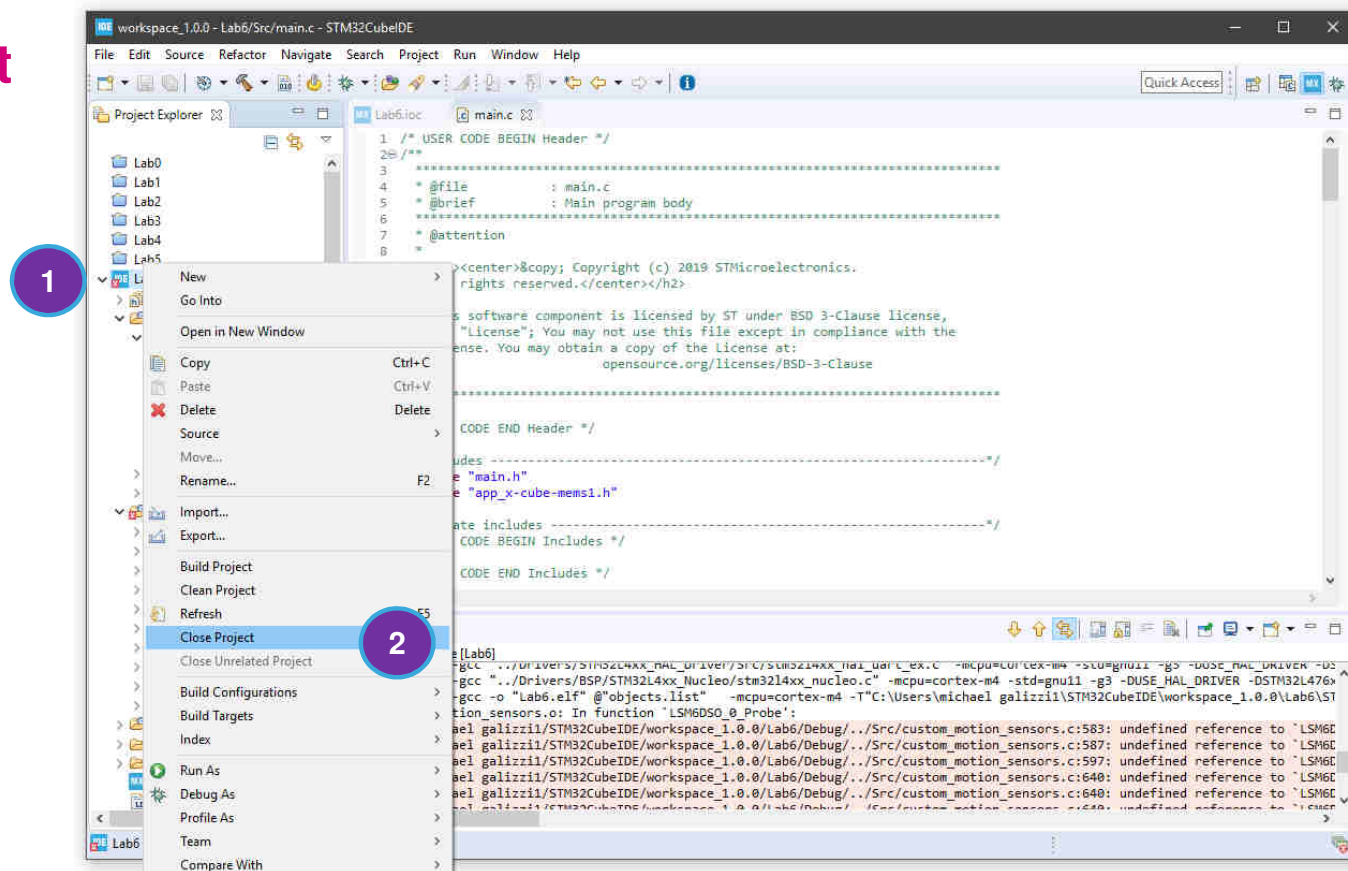
```
workspace_1.0.0 - Lab6/Src/main.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
Lab0
Lab1
Lab2
Lab3
Lab4
Lab5
Lab6
  Includes
  Drivers
  BSP
    Components
      Ism6ds0
        Ism6ds0_reg.h
        Ism6ds0.h
        Release_Notes.htm
      STM32L4xx_Nucleo
      CMSIS
      STM32L4xx_HAL_Driver
    Src
      app_x-cube-mems1.c
      custom_motion_sensors_ex
      custom_motion_sensors.c
      main.c
      stm32l4xx_hal_msp.c
      stm32l4xx_it.c
      stm32l4xx_nucleo_bus.c
      syscalls.c
      system.c
      system_stm32l4xx.c
  Startup
  Debug
  Inc
  Lab6.ioc
  STM32L476GTX_FLASH.ld

Lab6.ioc
1 /* USER CODE BEGIN Header */
2 /**
3  * @file
4  * @brief : Main program body
5  * @attention
6  *
7  * <h2><center>&copy; Copyright (c) 2019 STMicroelectronics.
8  * All rights reserved.</center></h2>
9  *
10  * This software component is licensed by ST under BSD 3-Clause license,
11  * the "License"; You may not use this file except in compliance with the
12  * License. You may obtain a copy of the license at:
13  * opensource.org/licenses/BSD-3-Clause
14  */
15 /* USER CODE END Header */
16
17
18 /* Includes */
19 #include "main.h"
20 #include "app_x-cube-mems1.h"
21
22 /* Private includes */
23 /* USER CODE BEGIN Includes */
24
25 /* USER CODE END Includes */
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# Common Issue #3: solution

253

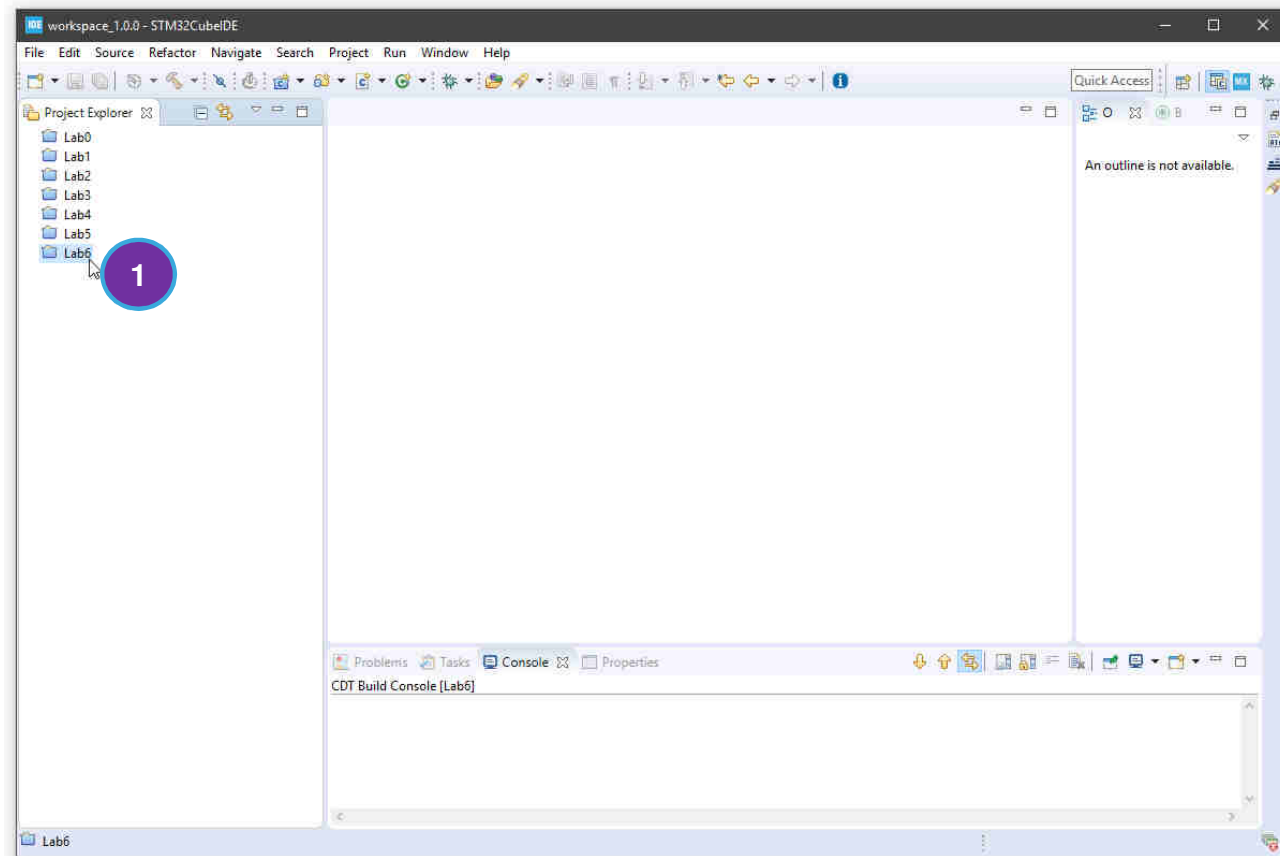
1. Right click on the project
2. Click on **Close Project**



# Common Issue #3: solution

254

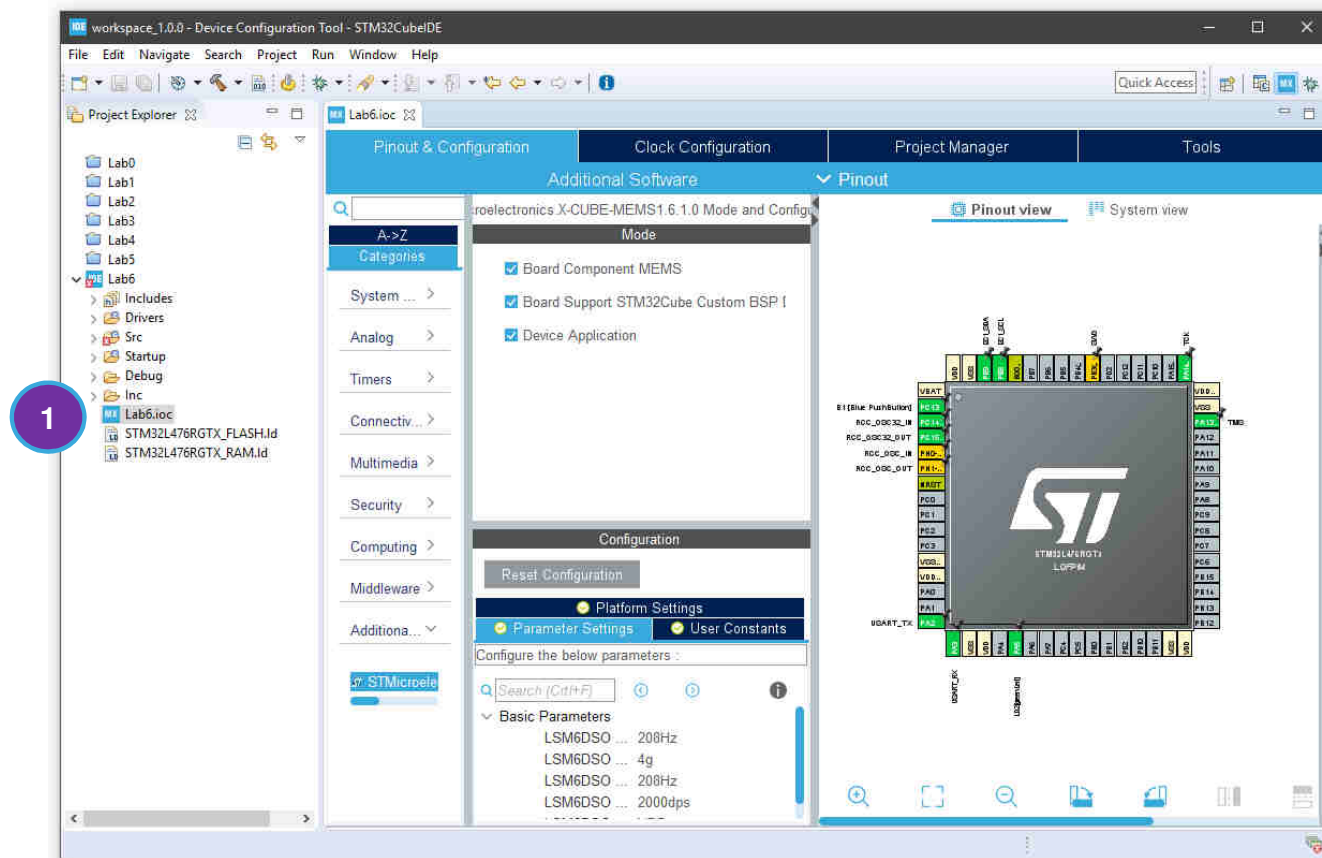
1. Double click the project to open it back



# Common Issue #3: solution

255


1. **Open the .ioc** file and modify something in the project in order that is possible to save it again

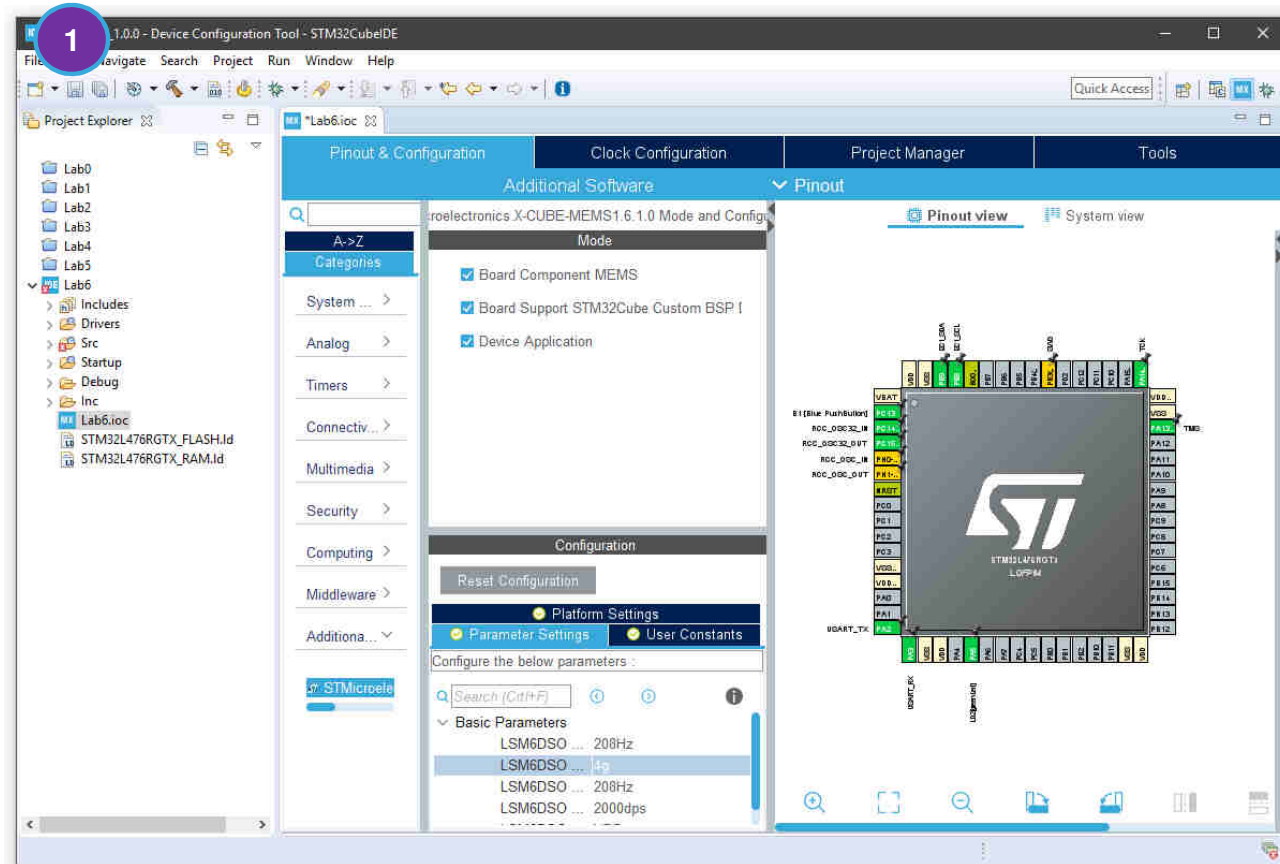




# Common Issue #3: solution

256

1. Save the project by clicking on  At this point included files will be restored correctly



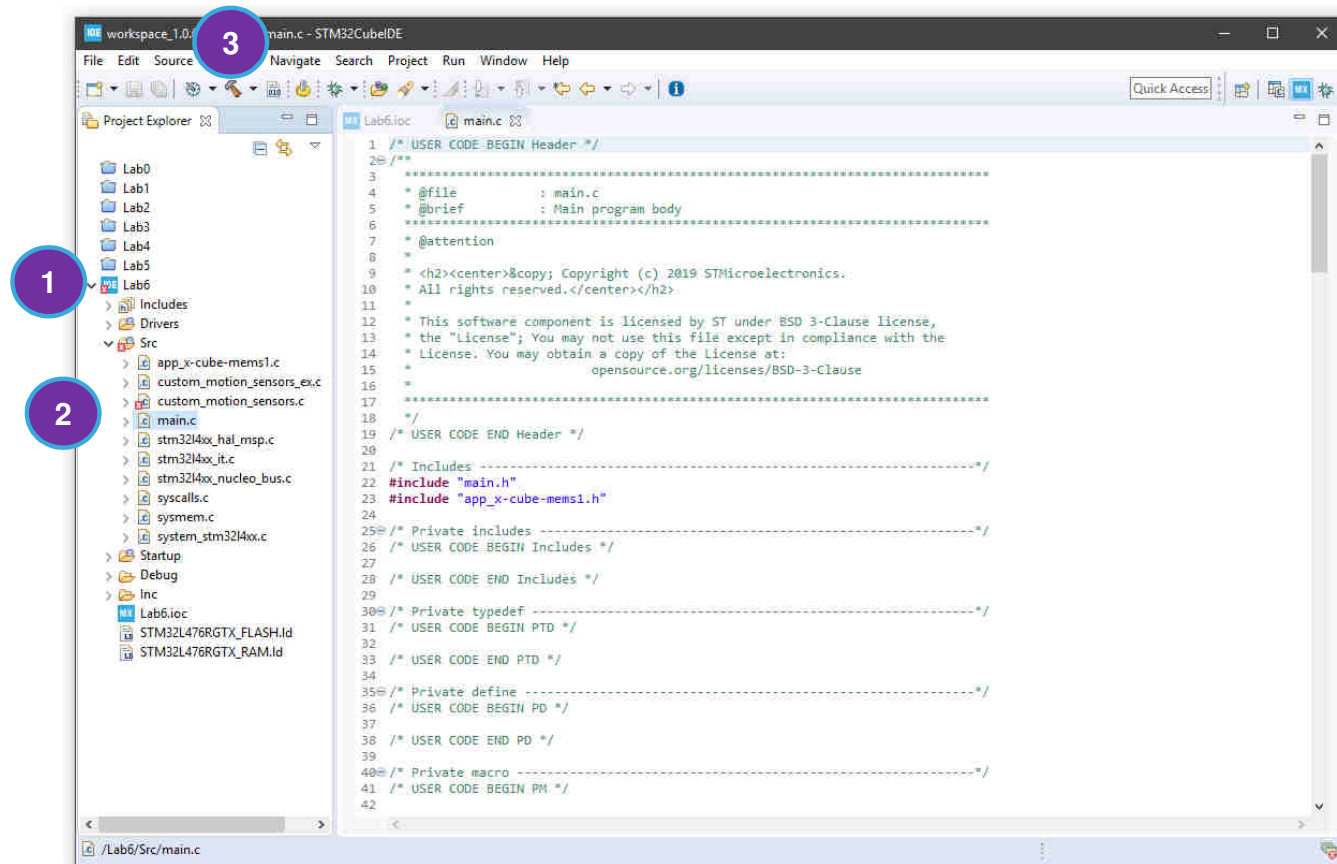


# Common Issue #3: solution

257

1. Expand **Src** folder and open **main.c**

2. Compile by clicking on



# Common Issue #3: solution

258

1. Compilation should now terminate without warnings/errors

The screenshot displays the STM32CubeIDE interface. On the left, the Project Explorer shows the project structure with 'Lab6' selected. The main editor window shows the 'main.c' file with the following code:

```
1 /* USER CODE BEGIN Header */
2 /**
3  * @file      : main.c
4  * @brief     : Main program body
5  *
6  * @attention
7  *
8  * <h2><center>&copy; Copyright (c) 2019 STMicroelectronics.
9  * All rights reserved.</center></h2>
10  *
11  * This software component is licensed by ST under BSD 3-Clause license,
12  * the "License"; You may not use this file except in compliance with the
13  * License. You may obtain a copy of the license at:
14  * opensource.org/licenses/BSD-3-Clause
15  *
16  */
17 /* USER CODE END Header */
18
19 /* Includes */
20 #include "main.h"
21 #include "app_x-cube-mems1.h"
22
23 /* Private includes */
24 /* USER CODE BEGIN Includes */
25
26 /* USER CODE END Includes */
27
28 /* USER CODE BEGIN Main */
29
```

The Console window at the bottom shows the following output:

```
CDT Build Console [Lab6]
39188 256 2160 41604 a284 Lab6.elf
Finished building: default.size.stdout
Finished building: Lab6.list
17:10:00 Build Finished. 0 errors, 0 warnings. (took 8s.580ms)
```

A red circle with the number '1' is overlaid on the console output, indicating the successful completion of the build.