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## Getting started with the STMicroelectronics X-CUBE-MEMS1 software package for STM32CubeMX

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### Introduction

This document provides the guidelines to configure and use the X-CUBE-MEMS1 software package for STM32CubeMX. The document contains a description of the provided sample applications, a description of the steps required to configure a generic project using the X-NUCLEO-IKS01A2 or the X-NUCLEO-IKS01A3 or the X-NUCLEO-IKS02A1 expansion board with a Nucleo board or several MEMS components with custom boards, as well as a description of the steps to configure and use the sample applications provided in the package.

Information and documentation related to the MEMS components, the X-NUCLEO-IKS01A2, the X-NUCLEO-IKS01A3 and the X-NUCLEO-IKS02A1 expansion boards and the ST expansion software for motion MEMS and environmental sensors are available on [www.st.com](http://www.st.com).

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# 1 Acronyms and abbreviations

Table 1: list of acronyms

Acronym	Description
MEMS	Micro-ElectroMechanical Systems
HAL	Hardware Abstraction Layer
I2C	Inter-Integrated Circuit
IOT	Internet Of Things
IP	Internet Protocol
LAN	Local Area Network
NVIC	Nested Vectored Interrupt Controller
ODR	Output Data Rate
PCB	Printed Circuit Board
RTC	Real Time Clock
RTOS	Real Time Operating System
SPI	Serial Peripheral Interface
U(S)ART	Universal (Synchronous) Asynchronous Receiver Transmitter
USB	Universal Serial BUS
TCP	Transmission Control Protocol

## 2

# What is STM32Cube?

STM32Cube™ represents an original initiative by STMicroelectronics to ease developers' life by reducing development effort, time and cost. STM32Cube covers the STM32 portfolio. Version 1.x of STM32Cube includes:

- STM32CubeMX, a graphical software configuration tool that allows the generation of C initialization code using graphical wizards.
- A comprehensive embedded software platform, delivered per series (such as the STM32CubeF4 for STM32F4 series).
  - STM32Cube HAL, an STM32 abstraction layer embedded software, ensuring maximized portability across the STM32 portfolio;
  - a consistent set of middleware components, such as RTOS, USB, TCP/IP, graphics;
  - all embedded software utilities, including a full set of examples.

## 3

# License

The software provided in this package is licensed under [Software License Agreement SLA0077](#).

## 4

# Sample Applications Description

In this section, a short overview of the sample applications included in the X-CUBE-MEMS1 pack is provided.

The sample applications:

- are ready-to-use projects that can be generated through the STM32CubeMX for any Nucleo board and using the X-NUCLEO-IKS01A2 or the X-NUCLEO-IKS01A3 or the X-NUCLEO-IKS02A1 expansion board.
- are ready-to-use projects that can be generated through the STM32CubeMX for any board equipped with an STM32 MCU and using the several supported MEMS components.
- show the users how to use the APIs of the several MEMS components to correctly initialize and use the ST MEMS devices.

### 4.1

## **IKS01A3\_DataLogTerminal**

This application shows how to use the X-NUCLEO-IKS01A3 to send sensor data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can view the data from all on-board environment sensors (temperature, humidity and pressure sensors) and all on-board inertial sensors (accelerometer, gyroscope and magnetometer sensors) using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

### 4.2

## **IKS01A3\_LIS2DW12\_6DOrientation**

This application shows how to use the LIS2DW12 component of the X-NUCLEO-IKS01A3 expansion board to find out the 6D orientation, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can rotate the board to change the 6D orientation and then view the data using a hyper terminal or just push the user button to display the current 6D orientation. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

### 4.3

## **IKS01A3\_LIS2DW12\_SelfTest**

This application shows how to use the LIS2DW12 component of the X-NUCLEO-IKS01A3 expansion board to test the accelerometer operation mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the self-test and then view the data using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

### 4.4

## **IKS01A3\_LIS2DW12\_WakeUp**

This application shows how to detect the wake up event using the LIS2DW12 component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can try to touch the STM32 Nucleo board; when the wake up event is detected, the Nucleo board LED is switched on for a while. The Nucleo board user button can be used to enable/disable the wake up detection feature.

## **4.5 IKS01A3\_LIS2MDL\_SelfTest**

This application shows how to use the LIS2MDL component of the X-NUCLEO-IKS01A3 expansion board to test the magnetometer operation mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the self-test and then view the data using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

## **4.6 IKS01A3\_LPS22HH\_FIFO Mode**

This application shows how to use the LPS22HH component of the X-NUCLEO-IKS01A3 to store pressure and temperature data in FIFO mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, press the user button to store pressure and temperature data in the FIFO mode and then view the data using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

## **4.7 IKS01A3\_LSM6DSO\_6DOrientation**

This application shows how to use the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board to find out the 6D orientation, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can rotate the board to change the 6D orientation and then view the data using a hyper terminal or just push the user button to display the current 6D orientation. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

## **4.8 IKS01A3\_LSM6DSO\_FIFOContinuousMode**

This application shows how to use the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board to store gyroscope data in FIFO continuous mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO demo in continuous mode and then view the data using a hyper terminal. By pressing again the STM32 Nucleo board user button, FIFO continuous mode changes into FIFO bypass mode. If you press the user button once again, the FIFO demo restarts in continuous mode and so on. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

## **4.9 IKS01A3\_LSM6DSO\_FIFO Mode**

This application shows how to use the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board to store gyroscope data in FIFO mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO mode demo and then view the data using a hyper terminal; press the user button to launch again the FIFO mode demo. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

## **4.10 IKS01A3\_LSM6DSO\_FreeFall**

This application shows how to detect the free fall event using the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can try to let the STM32 Nucleo board falling; when the free fall event is detected, the Nucleo board LED is switched on for a while. The Nucleo board user button can be used to

enable/disable the free fall detection feature.

#### 4.11

#### **IKS01A3\_LSM6DSO\_Pedometer**

This application shows how to use the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board to count steps, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can shake the board to simulate the steps and then view the data using a hyper terminal or can push the user button to reset the step counter. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

#### 4.12

#### **IKS01A3\_LSM6DSO\_SelfTest**

This application shows how to use the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board to test accelerometer and gyroscope operation mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the self-test and then view the data using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

#### 4.13

#### **IKS01A3\_LSM6DSO\_SingleDoubleTap**

This application shows how to detect the single and double tap events using the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can try to tap the STM32 Nucleo board; when the single tap event is detected, the Nucleo board LED is switched on for a while. The user can press the user button to pass from the single tap detection to the double tap detection feature; when the double tap event is detected, the LED is switched on twice for a while. The user can press again the Nucleo board user button to disable the single/double tap detection feature and so on.

#### 4.14

#### **IKS01A3\_LSM6DSO\_Tilt**

This application shows how to detect the tilt event using the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can try to tilt the STM32 Nucleo board; when the tilt event is detected, the Nucleo board LED is switched on for a while. The Nucleo board user button can be used to enable/disable the tilt detection feature.

#### 4.15

#### **IKS01A3\_LSM6DSO\_WakeUp**

This application shows how to detect the wake up event using the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can try to touch the STM32 Nucleo board; when the wake up event is detected, the Nucleo board LED is switched on for a while. The Nucleo board user button can be used to enable/disable the wake up detection feature.

#### 4.16

#### **IKS01A3\_STTS751\_TemperatureLimit**

This application shows how to measure temperature and detect exceeding of temperature limits using the STTS751 component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can heat up or cool down the board and view the data using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

#### 4.17

#### **IKS01A3\_IntensityDetection**

This application shows how to use the MotionID middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a

Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture and is intended for wrist-based devices. The application is able to distinguish motion intensity in a range from 0 to 10 (according to the library indexes) corresponding to the following activities: on desk, hand on bed/couch/cushion, light movements, biking, typing/writing, high intensity typing/slow walking, washing hands/walking, fast walking/jogging, running/brushing teeth, sprinting.

#### 4.18

#### **IKS01A3\_DataLogFusion**

This application shows how to use the MotionFX middleware library developed by STMicroelectronics with the LSM6DSO and LIS2MDL components of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time motion-sensor data fusion demonstrated on the teapot rotation. It also performs gyroscope bias and magnetometer hard iron calibration.

#### 4.19

#### **IKS01A3\_GyroscopeCalibration**

This application shows how to use the MotionGC middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time gyroscope calibration through angular zero-rate level coefficients (offset) used to correct gyroscope data.

#### 4.20

#### **IKS01A3\_AccelerometerCalibration**

This application shows how to use the MotionAC middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time accelerometer calibration through offset and scale factor coefficients used to correct accelerometer data.

#### 4.21

#### **IKS01A3\_MagnetometerCalibration**

This application shows how to use the MotionMC middleware library developed by STMicroelectronics with the LIS2MDL component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time magnetometer calibration using hard iron (HI) and scale factor coefficients to correct magnetometer data.

#### 4.22

#### **IKS01A3\_TiltSensing**

This application shows how to use the MotionTL middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM

Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the tilt angles of the user device, i.e. cell phone. It is also able to perform accelerometer 6-position calibration.

#### 4.23

#### **IKS01A3\_VerticalContext**

This application shows how to use the MotionVC middleware library developed by STMicroelectronics with the LSM6DSO and LPS22HH components of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about vertical movement. It is able to detect a change of altitude and distinguish the type of vertical movement: stairs, elevator, and escalator.

#### 4.24

#### **IKS01A3\_CarryPosition**

This application shows how to use the MotionCP middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about how the user is carrying a device (i.e. cell phone). It is able to distinguish the following positions: on desk, in hand, near head, shirt pocket, trouser pocket, swinging arm and jacket pocket.

#### 4.25

#### **IKS01A3\_ECompass**

This application shows how to use the MotionEC middleware library developed by STMicroelectronics with the LSM6DSO and LIS2MDL components of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the device orientation and movement status based on data from a device. It provides the following outputs: device orientation (quaternions, Euler angles), device rotation (virtual gyroscope functionality), gravity vector and linear acceleration.

#### 4.26

#### **IKS01A3\_GestureRecognition**

This application shows how to use the MotionGR middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the gesture just performed by the user with the device, such as a cell phone. It is able to distinguish the following gestures: pick up, glance, wake up.

#### 4.27

#### **IKS01A3\_AirplaneDetection**

This application shows how to use the MotionAD middleware library developed by STMicroelectronics with the LSM6DSO, LPS22HH and HTS221 components of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture and is intended for handheld devices. The application is able to distinguish the airplane mode corresponding to the

following activities: on land, take off, landing.

#### 4.28

#### **IKS01A3\_DynamicInclinometer**

This application shows how to use the MotionDI middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time inclination data demonstrated on the vehicle rotation. It also performs accelerometer and gyroscope bias calibration.

#### 4.29

#### **IKS01A3\_ActiveTime**

This application shows how to use the MotionAT middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time number of user active seconds with the device, such as a cell phone.

#### 4.30

#### **IKS01A3\_ActivityRecognition**

This application shows how to use the MotionAR middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the detected activity performed by user with the device, such as a cell phone. It is able to distinguish the following activities: no activity, stationary, walking, fast walking, jogging, biking, driving.

#### 4.31

#### **IKS01A3\_ActivityRecognitionWrist**

This application shows how to use the MotionAW middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the detected activity performed by user with the wrist wearable device. It is able to distinguish the following activities: no activity, stationary, standing, sitting, lying, walking, fast walking, jogging, biking.

#### 4.32

#### **IKS01A3\_FallDetection**

This application shows how to use the MotionFD middleware library developed by STMicroelectronics with the LSM6DSO and LPS22HH components of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the detected fall event of user with the device.

#### 4.33

#### **IKS01A3\_FitnessActivities**

This application shows how to use the MotionFA middleware library developed by STMicroelectronics with the LSM6DSO and LPS22HH components of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the number of performed fitness activities with the device. It is able to count the following activities: biceps curl, squat, push-up.

#### 4.34

#### **IKS01A3\_Pedometer**

This application shows how to use the MotionPM middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the number of steps performed with the device.

#### 4.35

#### **IKS01A3\_PedometerWrist**

This application shows how to use the MotionPW middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the number of steps performed with the wrist wearable device.

#### 4.36

#### **IKS01A3\_PoseEstimation**

This application shows how to use the MotionPE middleware library developed by STMicroelectronics with the LSM6DSO component of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the user pose with the device. It is able to distinguish the following poses: sitting, standing, lying down.

#### 4.37

#### **IKS01A3\_StandingSittingDesk**

This application shows how to use the MotionSD middleware library developed by STMicroelectronics with the LSM6DSO and LPS22HH components of the X-NUCLEO-IKS01A3 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about whether the user is working behind the sitting desk or standing desk with the device.

#### 4.38

#### **IKS01A2\_DataLogTerminal**

This application shows how to use the X-NUCLEO-IKS01A2 to send sensor data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can view the data from all on-board environment sensors (temperature, humidity and pressure sensors) and all on-board inertial

sensors (accelerometer, gyroscope and magnetometer sensors) using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

#### **4.39 IKS01A2\_LPS22HB\_FIFOMode**

This application shows how to use the LPS22HB component of the X-NUCLEO-IKS01A2 to store pressure and temperature data in FIFO mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, press the user button to store pressure and temperature data in the FIFO mode and then view the data using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

#### **4.40 IKS01A2\_LSM6DSL\_6DOrientation**

This application shows how to use the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board to find out the 6D orientation, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can rotate the board to change the 6D orientation and then view the data using a hyper terminal or just push the user button to display the current 6D orientation. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

#### **4.41 IKS01A2\_LSM6DSL\_FIFOContinuousMode**

This application shows how to use the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board to store gyroscope data in FIFO continuous mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO demo in continuous mode and then view the data using a hyper terminal. By pressing again the STM32 Nucleo board user button, FIFO continuous mode changes into FIFO bypass mode. If you press the user button once again, the FIFO demo restarts in continuous mode and so on. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

#### **4.42 IKS01A2\_LSM6DSL\_FIFOLowPower**

This application shows how to use the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board to store accelerometer data in FIFO continuous mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO low power demo and then view the data using a hyper terminal; afterwards, the component enters sleep mode. The user can press the user button to launch again the FIFO low power demo. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

#### **4.43 IKS01A2\_LSM6DSL\_FIFOMode**

This application shows how to use the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board to store gyroscope data in FIFO mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO mode demo and then view the data using a hyper terminal; press the user button to launch again the FIFO mode demo. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

- 4.44 IKS01A2\_LSM6DSL\_FreeFall**  
This application shows how to detect the free fall event using the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can try to let the STM32 Nucleo board falling; when the free fall event is detected, the Nucleo board LED is switched on for a while. The Nucleo board user button can be used to enable/disable the free fall detection feature.
- 4.45 IKS01A2\_LSM6DSL\_MultiEvent**  
This application shows how to use the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board to detect free fall, tap, double tap, tilt, wake up, 6D Orientation and step events, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can simulate all the events and then view the data using a hyper terminal or can push the user button to enable/disable all hardware features. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.
- 4.46 IKS01A2\_LSM6DSL\_Pedometer**  
This application shows how to use the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board to count steps, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can shake the board to simulate the steps and then view the data using a hyper terminal or can push the user button to reset the step counter. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.
- 4.47 IKS01A2\_LSM6DSL\_SelfTest**  
This application shows how to use the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board to test accelerometer and gyroscope operation mode, send data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the self-test and then view the data using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.
- 4.48 IKS01A2\_LSM6DSL\_SingleDoubleTap**  
This application shows how to detect the single and double tap events using the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can try to tap the STM32 Nucleo board; when the single tap event is detected, the Nucleo board LED is switched on for a while. The user can press the user button to pass from the single tap detection to the double tap detection feature; when the double tap event is detected, the LED is switched on twice for a while. The user can press again the Nucleo board user button to disable the single/double tap detection feature and so on.
- 4.49 IKS01A2\_LSM6DSL\_Tilt**  
This application shows how to detect the tilt event using the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can try to tilt the STM32 Nucleo board; when the tilt event is detected, the Nucleo board LED is switched on for a while. The Nucleo board user button can be used to enable/disable the tilt detection feature.
- 4.50 IKS01A2\_LSM6DSL\_WakeUp**  
This application shows how to detect the wake up event using the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can try to touch the STM32 Nucleo board; when the wake up event is detected, the Nucleo

board LED is switched on for a while. The Nucleo board user button can be used to enable/disable the wake up detection feature.

#### **4.51 IKS01A2\_IntensityDetection**

This application shows how to use the MotionID middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture and is intended for wrist-based devices. The application is able to distinguish motion intensity in a range from 0 to 10 (according to the library indexes) corresponding to the following activities: on desk, hand on bed/couch/cushion, light movements, biking, typing/writing, high intensity typing/slow walking, washing hands/walking, fast walking/jogging, running/brushing teeth, sprinting.

#### **4.52 IKS01A2\_DataLogFusion**

This application shows how to use the MotionFX middleware library developed by STMicroelectronics with the LSM6DSL and LSM303AGR components of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time motion-sensor data fusion demonstrated on the teapot rotation. It also performs gyroscope bias and magnetometer hard iron calibration.

#### **4.53 IKS01A2\_GyroscopeCalibration**

This application shows how to use the MotionGC middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time gyroscope calibration through angular zero-rate level coefficients (offset) used to correct gyroscope data.

#### **4.54 IKS01A2\_AccelerometerCalibration**

This application shows how to use the MotionAC middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time accelerometer calibration through offset and scale factor coefficients used to correct accelerometer data.

#### **4.55 IKS01A2\_MagnetometerCalibration**

This application shows how to use the MotionMC middleware library developed by STMicroelectronics with the LSM303AGR component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time magnetometer calibration using hard iron (HI) and scale factor coefficients to correct magnetometer data.

- 4.56 IKS01A2\_TiltSensing**  
This application shows how to use the MotionTL middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the tilt angles of the user device, i.e. cell phone. It is also able to perform accelerometer 6-position calibration.
- 4.57 IKS01A2\_VerticalContext**  
This application shows how to use the MotionVC middleware library developed by STMicroelectronics with the LSM6DSL and LPS22HB components of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about vertical movement. It is able to detect a change of altitude and distinguish the type of vertical movement: stairs, elevator, and escalator.
- 4.58 IKS01A2\_CarryPosition**  
This application shows how to use the MotionCP middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about how the user is carrying a device (i.e. cell phone). It is able to distinguish the following positions: on desk, in hand, near head, shirt pocket, trouser pocket, swinging arm and jacket pocket.
- 4.59 IKS01A2\_ECompass**  
This application shows how to use the MotionEC middleware library developed by STMicroelectronics with the LSM6DSL and LSM303AGR components of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the device orientation and movement status based on data from a device. It provides the following outputs: device orientation (quaternions, Euler angles), device rotation (virtual gyroscope functionality), gravity vector and linear acceleration.
- 4.60 IKS01A2\_GestureRecognition**  
This application shows how to use the MotionGR middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the gesture just performed by the user with the device, such as a cell phone. It is able to distinguish the following gestures: pick up, glance, wake up.

- 4.61 IKS01A2\_AirplaneDetection**  
This application shows how to use the MotionAD middleware library developed by STMicroelectronics with the LSM6DSL, LPS22HB and HTS221 components of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture and is intended for handheld devices. The application is able to distinguish the airplane mode corresponding to the following activities: on land, take off, landing.
- 4.62 IKS01A2\_DynamicInclinometer**  
This application shows how to use the MotionDI middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time inclination data demonstrated on the vehicle rotation. It also performs accelerometer and gyroscope bias calibration.
- 4.63 IKS01A2\_ActiveTime**  
This application shows how to use the MotionAT middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time number of user active seconds with the device, such as a cell phone.
- 4.64 IKS01A2\_ActivityRecognition**  
This application shows how to use the MotionAR middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the detected activity performed by user with the device, such as a cell phone. It is able to distinguish the following activities: no activity, stationary, walking, fast walking, jogging, biking, driving.
- 4.65 IKS01A2\_ActivityRecognitionWrist**  
This application shows how to use the MotionAW middleware library developed by STMicroelectronics with the LSM6DS2 component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the detected activity performed by user with the wrist wearable device. It is able to distinguish the following activities: no activity, stationary, standing, sitting, lying, walking, fast walking, jogging, biking.
- 4.66 IKS01A2\_FallDetection**  
This application shows how to use the MotionFD middleware library developed by

STMicroelectronics with the LSM6DSL and LPS22HB components of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the detected fall event of user with the device.

#### **4.67 IKS01A2\_FitnessActivities**

This application shows how to use the MotionFA middleware library developed by STMicroelectronics with the LSM6DSL and LPS22HB components of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the number of performed fitness activities with the device. It is able to count the following activities: biceps curl, squat, push-up.

#### **4.68 IKS01A2\_Pedometer**

This application shows how to use the MotionPM middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the number of steps performed with the device.

#### **4.69 IKS01A2\_PedometerWrist**

This application shows how to use the MotionPW middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the number of steps performed with the wrist wearable device.

#### **4.70 IKS01A2\_PoseEstimation**

This application shows how to use the MotionPE middleware library developed by STMicroelectronics with the LSM6DSL component of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the user pose with the device. It is able to distinguish the following poses: sitting, standing, lying down.

#### **4.71 IKS01A2\_StandingSittingDesk**

This application shows how to use the MotionSD middleware library developed by STMicroelectronics with the LSM6DSL and LPS22HB components of the X-NUCLEO-IKS01A2 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about whether the user is working behind the sitting desk or standing desk with the

device.

#### **4.72 IKS02A1\_DataLogTerminal**

This application shows how to use the X-NUCLEO-IKS02A1 to send sensor data from a STM32 Nucleo board using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can view the data from all on-board inertial sensors (accelerometer, gyroscope and magnetometer sensors) using a hyper terminal. The application serial settings can be configured by user changing the settings of USART in the CubeMX GUI.

#### **4.73 IKS02A1\_DataLogFusion**

This application shows how to use the MotionFX middleware library developed by STMicroelectronics with the ISM330DHCX and IIS2MDC components of the X-NUCLEO-IKS02A1 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time motion-sensor data fusion demonstrated on the teapot rotation. It also performs gyroscope bias and magnetometer hard iron calibration.

#### **4.74 IKS02A1\_GyroscopeCalibration**

This application shows how to use the MotionGC middleware library developed by STMicroelectronics with the ISM330DHCX component of the X-NUCLEO-IKS02A1 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time gyroscope calibration through angular zero-rate level coefficients (offset) used to correct gyroscope data.

#### **4.75 IKS02A1\_AccelerometerCalibration**

This application shows how to use the MotionAC middleware library developed by STMicroelectronics with the ISM330DHCX component of the X-NUCLEO-IKS02A1 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time accelerometer calibration through offset and scale factor coefficients used to correct accelerometer data.

#### **4.76 IKS02A1\_MagnetometerCalibration**

This application shows how to use the MotionMC middleware library developed by STMicroelectronics with the IIS2MDC component of the X-NUCLEO-IKS02A1 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time magnetometer calibration using hard iron (HI) and scale factor coefficients to correct magnetometer data.

#### **4.77 IKS02A1\_TiltSensing**

This application shows how to use the MotionTL middleware library developed by STMicroelectronics with the ISM330DHCX component of the X-NUCLEO-IKS02A1 expansion

board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the tilt angles of the user device, i.e. cell phone. It is also able to perform accelerometer 6-position calibration.

#### **4.78 IKS02A1\_ECompass**

This application shows how to use the MotionEC middleware library developed by STMicroelectronics with the ISM330DHCX and IIS2MDC components of the X-NUCLEO-IKS02A1 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the device orientation and movement status based on data from a device. It provides the following outputs: device orientation (quaternions, Euler angles), device rotation (virtual gyroscope functionality), gravity vector and linear acceleration.

#### **4.79 IKS02A1\_DynamicInclinometer**

This application shows how to use the MotionDI middleware library developed by STMicroelectronics with the ISM330DHCX component of the X-NUCLEO-IKS02A1 expansion board and a STM32 Nucleo board. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time inclination data demonstrated on the vehicle rotation. It also performs accelerometer and gyroscope bias calibration.

#### **4.80 DataLogTerminal**

This application shows how to use the several MEMS components supported in the CubeMX MEMS Library to send sensor data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can view the data from all selected environment sensors (temperature, humidity and pressure sensors) and all selected inertial sensors (accelerometer, gyroscope and magnetometer sensors) using a hyper terminal. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.81 LIS2DW12\_6DOrientation**

This application shows how to use the LIS2DW12 component via I2C or via SPI 4-Wires interface to find out the 6D orientation, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can rotate the board to change the 6D orientation and then view the data using a hyper terminal or just push the user button to display the current 6D orientation. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

## **4.82 LIS2DW12\_SelfTest**

This application shows how to use the LIS2DW12 component via I2C or via SPI 4-Wires interface to test the accelerometer operation mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the self-test and then view the data using a hyper terminal. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

## **4.83 LIS2DW12\_WakeUp**

This application shows how to detect the wake up event using the LIS2DW12 component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can try to touch the STM32 Nucleo board; when the wake up event is detected, the board LED is switched on for a while. The board user button can be used to enable/disable the wake up detection feature. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

## **4.84 LIS2MDL\_SelfTest**

This application shows how to use the LIS2MDL component via I2C or via SPI 4-Wires interface to test the magnetometer operation mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the self-test and then view the data using a hyper terminal. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

## **4.85 LPS22HB\_FIFOMode**

This application shows how to use the LPS22HB component via I2C or via SPI 4-Wires interface to store pressure and temperature data in FIFO mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, press the user button to store pressure and temperature data in the FIFO mode and then view the data using a hyper terminal. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

## **4.86 LPS22HH\_FIFOMode**

This application shows how to use the LPS22HH component via I2C or via SPI 4-Wires interface to store pressure and temperature data in FIFO mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, press the user button to store pressure and temperature data in the FIFO mode and then view the data using a hyper terminal. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

- 4.87 LSM6DSL\_6DOrientation**
- This application shows how to use the LSM6DSL component via I2C or via SPI 4-Wires interface to find out the 6D orientation, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can rotate the board to change the 6D orientation and then view the data using a hyper terminal or just push the user button to display the current 6D orientation. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.
- 4.88 LSM6DSL\_FIFOContinuousMode**
- This application shows how to use the LSM6DSL component via I2C or via SPI 4-Wires interface to store gyroscope data in FIFO continuous mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO demo in continuous mode and then view the data using a hyper terminal. By pressing again the user button, FIFO continuous mode changes into FIFO bypass mode. If you press the user button once again, the FIFO demo restarts in continuous mode and so on. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.
- 4.89 LSM6DSL\_FIFOLowPower**
- This application shows how to use the LSM6DSL component via I2C or via SPI 4-Wires interface to store accelerometer data in FIFO continuous mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO low power demo and then view the data using a hyper terminal; afterwards, the component enters sleep mode. The user can press the user button to launch again the FIFO low power demo. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.
- 4.90 LSM6DSL\_FIFOMode**
- This application shows how to use the LSM6DSL component via I2C or via SPI 4-Wires interface to store gyroscope data in FIFO mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO mode demo and then view the data using a hyper terminal; press the user button to launch again the FIFO mode demo. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.
- 4.91 LSM6DSL\_FreeFall**
- This application shows how to detect the free fall event using the LSM6DSL component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can try to let the board falling; when the free fall event is detected, the board LED is switched on for a while. The user button can be used to enable/disable the

free fall detection feature. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.92 LSM6DSL\_MultiEvent**

This application shows how to use the LSM6DSL component via I2C or via SPI 4-Wires interface to detect free fall, tap, double tap, tilt, wake up, 6D Orientation and step events, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can simulate all the events and then view the data using a hyper terminal or can push the user button to enable/disable all hardware features. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.93 LSM6DSL\_Pedometer**

This application shows how to use the LSM6DSL component via I2C or via SPI 4-Wires interface to count steps, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can shake the board to simulate the steps and then view the data using a hyper terminal or can push the user button to reset the step counter. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.94 LSM6DSL\_SelfTest**

This application shows how to use the LSM6DSL component via I2C or via SPI 4-Wires interface to test accelerometer and gyroscope operation mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the self-test and then view the data using a hyper terminal. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.95 LSM6DSL\_SingleDoubleTap**

This application shows how to detect the single and double tap events using the LSM6DSL component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can try to tap the board; when the single tap event is detected, the board LED is switched on for a while. The user can press the user button to pass from the single tap detection to the double tap detection feature; when the double tap event is detected, the LED is switched on twice for a while. The user can press again the user button to disable the single/double tap detection feature and so on. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.96 LSM6DSL\_Tilt**

This application shows how to detect the tilt event using the LSM6DSL component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can try to tilt the board; when the tilt event is detected, the board LED is switched on for a while. The user button can be used to enable/disable the tilt detection feature. The

application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.97 LSM6DSL\_WakeUp**

This application shows how to detect the wake up event using the LSM6DSL component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can try to touch the board; when the wake up event is detected, the board LED is switched on for a while. The board user button can be used to enable/disable the wake up detection feature. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.98 LSM6DSO\_6DOrientation**

This application shows how to use the LSM6DSO component via I2C or via SPI 4-Wires interface to find out the 6D orientation, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can rotate the board to change the 6D orientation and then view the data using a hyper terminal or just push the user button to display the current 6D orientation. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.99 LSM6DSO\_FIFOContinuousMode**

This application shows how to use the LSM6DSO component via I2C or via SPI 4-Wires interface to store gyroscope data in FIFO continuous mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO demo in continuous mode and then view the data using a hyper terminal. By pressing again the user button, FIFO continuous mode changes into FIFO bypass mode. If you press the user button once again, the FIFO demo restarts in continuous mode and so on. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.100 LSM6DSO\_FIFOMode**

This application shows how to use the LSM6DSO component via I2C or via SPI 4-Wires interface to store gyroscope data in FIFO mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the FIFO mode demo and then view the data using a hyper terminal; press the user button to launch again the FIFO mode demo. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.101 LSM6DSO\_FreeFall**

This application shows how to detect the free fall event using the LSM6DSO component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can try to let the board falling; when the free fall event is detected,

the board LED is switched on for a while. The user button can be used to enable/disable the free fall detection feature. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.102 LSM6DSO\_Pedometer**

This application shows how to use the LSM6DSO component via I2C or via SPI 4-Wires interface to count steps, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can shake the board to simulate the steps and then view the data using a hyper terminal or can push the user button to reset the step counter. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.103 LSM6DSO\_SelfTest**

This application shows how to use the LSM6DSO component via I2C or via SPI 4-Wires interface to test accelerometer and gyroscope operation mode, send data from a generic custom board based on a STM32 MCU using UART to a connected PC and display it on generic applications like Tera Term. After connection has been established, the user can push the user button to launch the self-test and then view the data using a hyper terminal. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.104 LSM6DSO\_SingleDoubleTap**

This application shows how to detect the single and double tap events using the LSM6DSO component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can try to tap the board; when the single tap event is detected, the board LED is switched on for a while. The user can press the user button to pass from the single tap detection to the double tap detection feature; when the double tap event is detected, the LED is switched on twice for a while. The user can press again the user button to disable the single/double tap detection feature and so on. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.105 LSM6DSO\_Tilt**

This application shows how to detect the tilt event using the LSM6DSO component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can try to tilt the board; when the tilt event is detected, the board LED is switched on for a while. The user button can be used to enable/disable the tilt detection feature. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.106 LSM6DSO\_WakeUp**

This application shows how to detect the wake up event using the LSM6DSO component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can try to touch the board; when the wake up event is detected, the board LED is switched on for a while. The board user button can be used to enable/disable the wake up detection feature. The application requires configuring in the custom board a GPIO

pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.107 STTS751\_TemperatureLimit**

This application shows how to measure temperature and detect exceeding of temperature limits using the STTS751 component via I2C or via SPI 4-Wires interface on a generic custom board based on a STM32 MCU. After application starts, the user can heat up or cool down the board and view the data using a hyper terminal. The application requires configuring in the custom board a GPIO pin for a LED, a GPIO pin for a User Button and a GPIO pin for a UART/USART TX. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI.

#### **4.108 CUSTOM\_IntensityDetection**

This application shows how to use the MotionID middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubemX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture and is intended for wrist-based devices. The application is able to distinguish motion intensity in a range from 0 to 10 (according to the library indexes) corresponding to the following activities: on desk, hand on bed/couch/cushion, light movements, biking, typing/writing, high intensity typing/slow walking, washing hands/walking, fast walking/jogging, running/brushing teeth, sprinting.

#### **4.109 CUSTOM\_DataLogFusion**

This application shows how to use the MotionFX middleware library developed by STMicroelectronics with one of the several MEMS accelerometer, gyroscope and magnetometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time motion-sensor data fusion demonstrated on the teapot rotation. It also performs gyroscope bias and magnetometer hard iron calibration.

#### **4.110 CUSTOM\_GyroscopeCalibration**

This application shows how to use the MotionGC middleware library developed by STMicroelectronics with one of the several MEMS gyroscope components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART

chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time gyroscope calibration through angular zero-rate level coefficients (offset) used to correct gyroscope data.

#### **4.111 CUSTOM\_AccelerometerCalibration**

This application shows how to use the MotionAC middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubemX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time accelerometer calibration through offset and scale factor coefficients used to correct accelerometer data.

#### **4.112 CUSTOM\_MagnetometerCalibration**

This application shows how to use the MotionMC middleware library developed by STMicroelectronics with one of the several MEMS magnetometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubemX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time magnetometer calibration using hard iron (HI) and scale factor coefficients to correct magnetometer data.

#### **4.113 CUSTOM\_TiltSensing**

This application shows how to use the MotionTL middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubemX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the tilt angles of the user device, i.e. cell phone. It is also able to perform accelerometer 6-position calibration.

#### **4.114 CUSTOM\_VerticalContext**

This application shows how to use the MotionVC middleware library developed by

STMicroelectronics with one of the several MEMS accelerometer and pressure components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about vertical movement. It is able to detect a change of altitude and distinguish the type of vertical movement: stairs, elevator, and escalator.

#### **4.115    CUSTOM\_CarryPosition**

This application shows how to use the MotionCP middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about how the user is carrying a device (i.e. cell phone). It is able to distinguish the following positions: on desk, in hand, near head, shirt pocket, trouser pocket, swinging arm and jacket pocket.

#### **4.116    CUSTOM\_ECompass**

This application shows how to use the MotionEC middleware library developed by STMicroelectronics with one of the several MEMS accelerometer and magnetometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the device orientation and movement status based on data from a device. It provides the following outputs: device orientation (quaternions, Euler angles), device rotation (virtual gyroscope functionality), gravity vector and linear acceleration.

#### **4.117    CUSTOM\_GestureRecognition**

This application shows how to use the MotionGR middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-

GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the gesture just performed by the user with the device, such as a cell phone. It is able to distinguish the following gestures: pick up, glance, wake up.

#### **4.118    CUSTOM\_AirplaneDetection**

This application shows how to use the MotionAD middleware library developed by STMicroelectronics with one of the several MEMS accelerometer, pressure and temperature sensor components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture and is intended for handheld devices. The application is able to distinguish the airplane mode corresponding to the following activities: on land, take off, landing.

#### **4.119    CUSTOM\_DynamicInclinometer**

This application shows how to use the MotionDI middleware library developed by STMicroelectronics with one of the several MEMS accelerometer and gyroscope components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time inclination data demonstrated on the vehicle rotation. It also performs accelerometer and gyroscope bias calibration.

#### **4.120    CUSTOM\_ActiveTime**

This application shows how to use the MotionAT middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time number of user active seconds with the device, such as a cell phone.

#### **4.121    CUSTOM\_ActivityRecognition**

This application shows how to use the MotionAR middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the

CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the detected activity performed by user with the device, such as a cell phone. It is able to distinguish the following activities: no activity, stationary, walking, fast walking, jogging, biking, driving.

#### 4.122

#### **CUSTOM\_ActivityRecognitionWrist**

This application shows how to use the MotionAW middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the detected activity performed by user with the wrist wearable device. It is able to distinguish the following activities: no activity, stationary, standing, sitting, lying, walking, fast walking, jogging, biking.

#### 4.123

#### **CUSTOM\_FallDetection**

This application shows how to use the MotionFD middleware library developed by STMicroelectronics with one of the several MEMS accelerometer and pressure components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the detected fall event of user with the device.

#### 4.124

#### **CUSTOM\_FitnessActivities**

This application shows how to use the MotionFA middleware library developed by STMicroelectronics with one of the several MEMS accelerometer, gyroscope and pressure components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-

time information about the number of performed fitness activities with the device. It is able to count the following activities: biceps curl, squat, push-up.

#### **4.125 CUSTOM\_Pedometer**

This application shows how to use the MotionPM middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the number of steps performed with the device.

#### **4.126 CUSTOM\_PedometerWrist**

This application shows how to use the MotionPW middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the number of steps performed with the wrist wearable device.

#### **4.127 CUSTOM\_PoseEstimation**

This application shows how to use the MotionPE middleware library developed by STMicroelectronics with one of the several MEMS accelerometer components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the user pose with the device. It is able to distinguish the following poses: sitting, standing, lying down.

#### **4.128 CUSTOM\_StandingSittingDesk**

This application shows how to use the MotionSD middleware library developed by STMicroelectronics with one of the several MEMS accelerometer and pressure components supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of

UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about whether the user is working behind the sitting desk or standing desk with the device.

#### **4.129    AccelCalibration2\_IIS2ICLX**

This application shows how to use the MotionAC2 middleware library developed by STMicroelectronics with IIS2ICLX 2-axis accelerometer component supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time accelerometer calibration through offset and scale factor coefficients used to correct accelerometer data.

#### **4.130    TiltSensing2\_IIS2ICLX**

This application shows how to use the MotionTL2 middleware library developed by STMicroelectronics with IIS2ICLX 2-axis accelerometer component supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature. The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides real-time information about the tilt angles of the user device, i.e. cell phone. It is also able to perform 2-axis accelerometer 4-position calibration.

#### **4.131    PresenceDetection\_STHS34PF80**

This application shows how to use the InfraredPD middleware library developed by STMicroelectronics with STHS34PF80 TMOS infrared temperature component supported in the CubeMX MEMS Library on a generic custom board and a STM32 Nucleo board. Every MEMS component can be configured via I2C or via SPI 4-Wires (if it is supported). The application requires to configure in the custom board a GPIO pin for a LED, a GPIO pin for a User Button, a GPIO pin for a UART/USART TX and a GPIO input pin for a I3C SW disable feature (if supported). The application serial settings can be configured by user changing the settings of UART/USART chosen in the CubeMX GUI. After application starts, the user can view the data using a Unicoleo-GUI application also developed by STMicroelectronics. The library is designed to be used on STM32 microcontrollers based on the ARM Cortex-M0+, ARM Cortex-M3, ARM Cortex-M4, ARM Cortex-M7 and ARM Cortex-M33 architecture. The application provides and displays data in LSB format - ambient temperature, object temperature, compensated object temperature and change rate of compensated object temperature. On top of that it displays the flags – object motion detection and object presence detection.

## 5

# Installing the X-CUBE-MEMS1 pack in STM32CubeMX

After downloading (from [www.st.com](http://www.st.com)), installing and launching the STM32CubeMX, the X-CUBE-MEMS1 pack can be installed in few steps.

1. From the menu, select Help > Manage embedded software packages

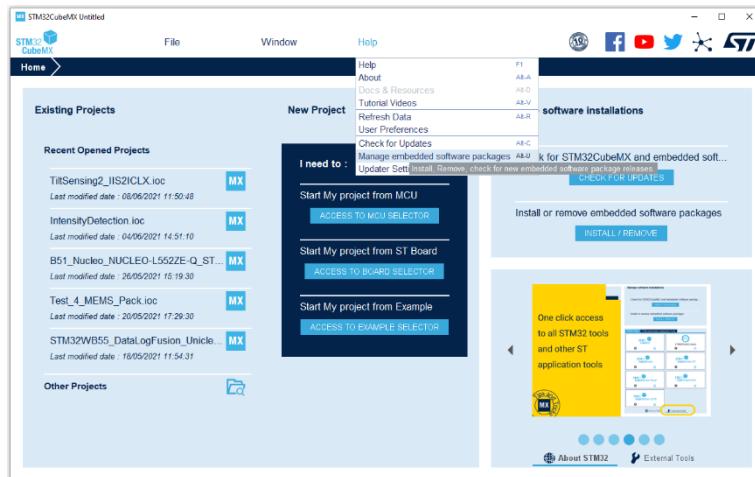


Figure 1 Managing embedded software packs in STM32CubeMX

2. From the Embedded Software Packages Manager window, press the 'Refresh' button to get an updated list of the add-on packs. Go to the 'STMicroelectronics' tab to find the X-CUBE-MEMS1 pack.

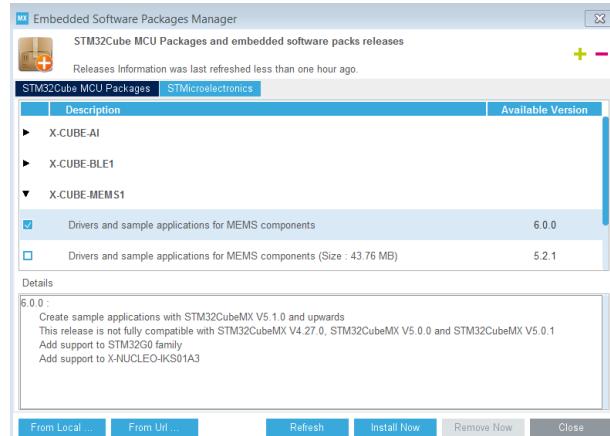
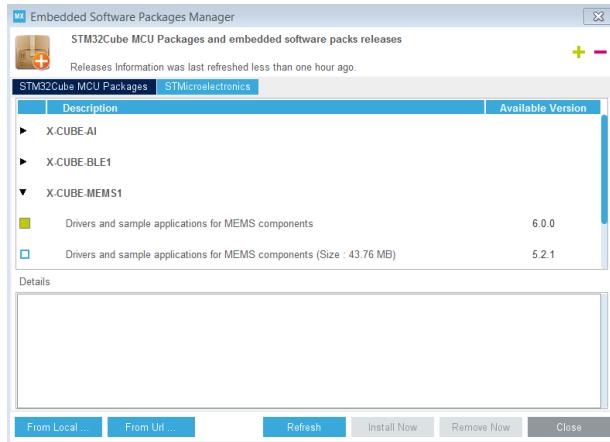


Figure 2 Installing the X-CUBE-MEMS1 pack in STM32CubeMX

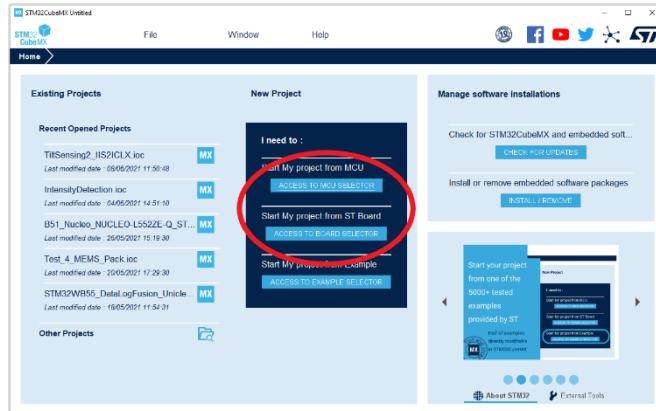
3. Select it checking the corresponding box and install it pressing the 'Install Now' button. Once the installation is completed, the corresponding box will become green, the 'Close' button can be pressed and the configuration of a new project can start.



**Figure 3** The X-CUBE-MEMS1 pack in STM32CubeMX

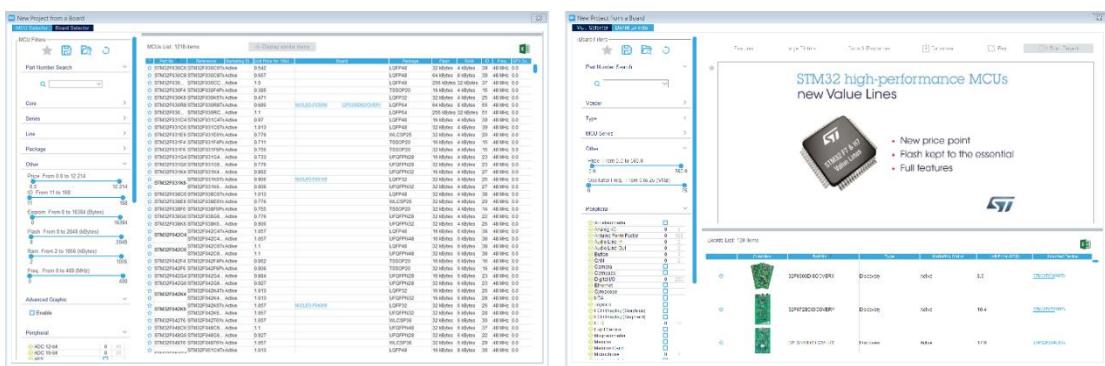
## 6 Starting a new project

After launching the STM32CubeMX, you can choose if starting a **New Project** from the MCU Selector or from the Board Selector.



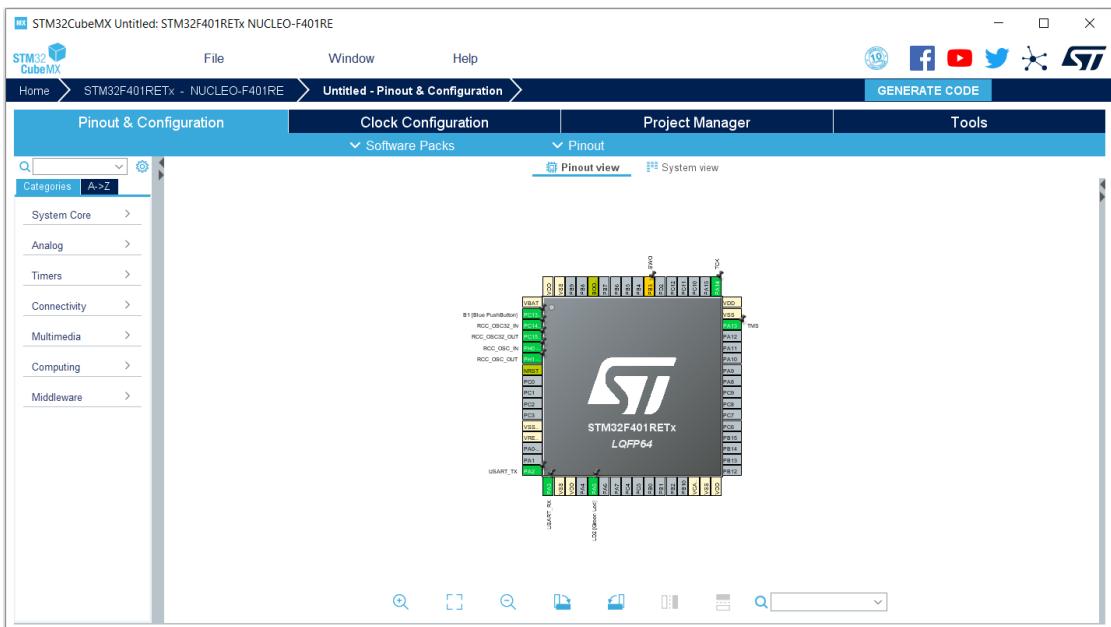
**Figure 4** STM32CubeMX main page

The **MCU/Board selector** window will pop up. From this window, the STM32 MCU or platform can be selected.



**Figure 5 STM32CubeMX MCU/Board Selector windows**

After selecting the MCU or the Board, the selected STM32 pinout will appear. From this window the user can set up the project, by adding one or more Software Packs and peripherals and configuring the clock.



**Figure 6 STM32CubeMX Pinout & Configuration window**

To add the X-CUBE-MEMS1 software pack to the project, the “Software Packs” button and then the “Select Components” item must be clicked.

From the Software Packs Component Selector window, the user can either choose to generate, for the selected MCU/Board, one of the enclosed sample applications or a new project. In this latter case, the user must just implement the main application logic without bothering with the pinout and peripherals configuration code that will be automatically generated by STM32CubeMX.

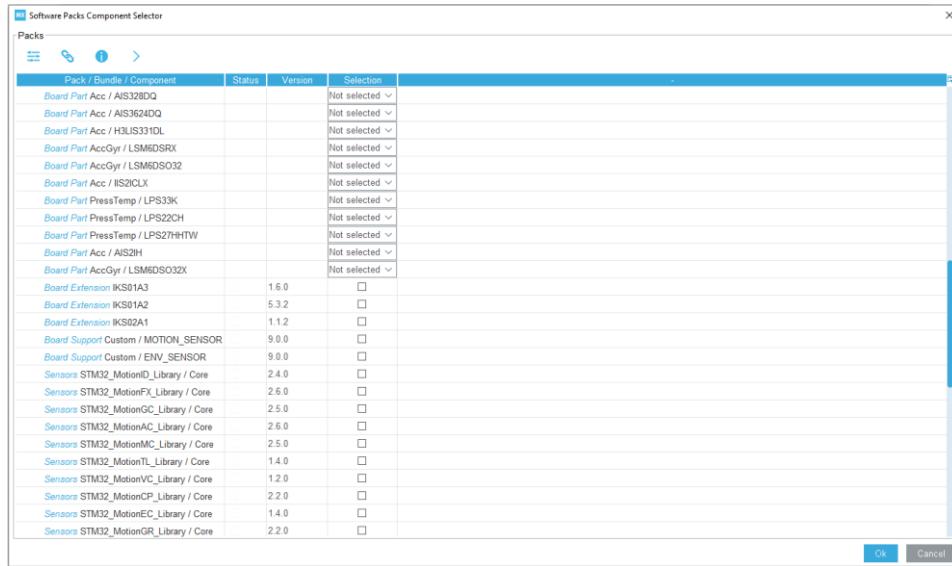


Figure 7 STM32CubeMX Software Packs Component Selector window

## 7

## STM32 Configuration Steps

The X-NUCLEO-IKS01A2 or the X-NUCLEO-IKS01A3 or the X-NUCLEO-IKS02A1 interfaces with the STM32 microcontroller via the I2C bus. Hence, assuming a user wants to interface the X-NUCLEO-IKS01A2 or X-NUCLEO-IKS01A3 or X-NUCLEO-IKS02A1 expansion board with a STM32 Nucleo 64 pins board (e.g. a Nucleo-F401RETx) or a STM32 Nucleo 144 pins board (e.g. a Nucleo F429ZITx), no particular hardware modification must be done.

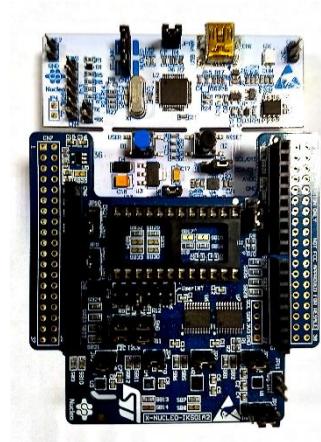
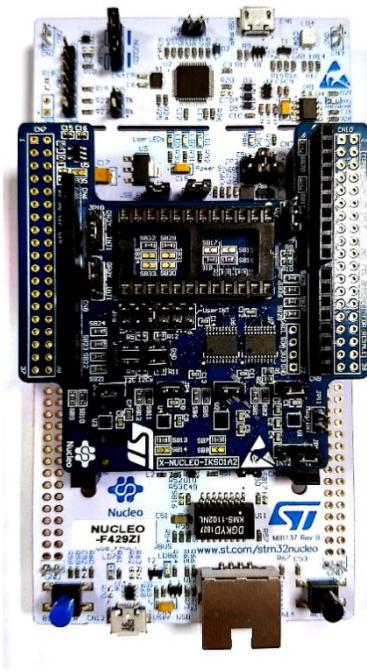
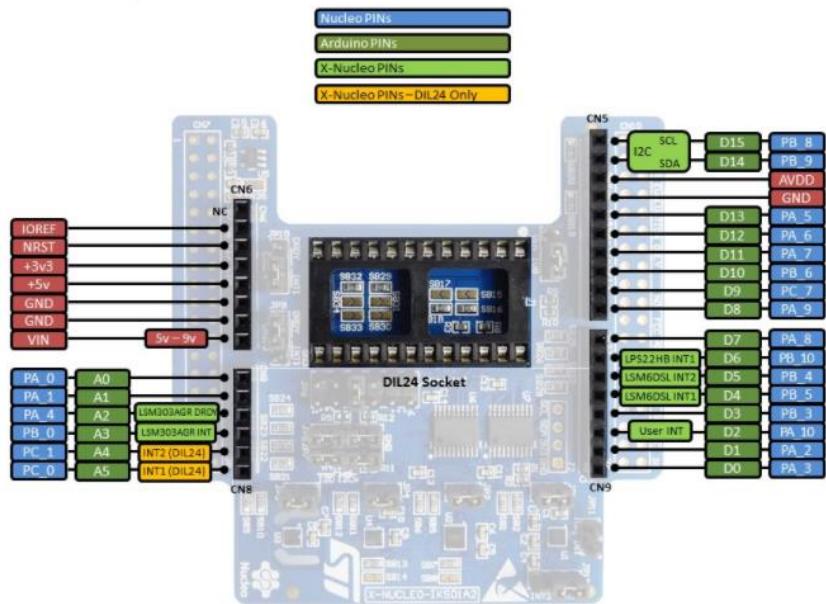


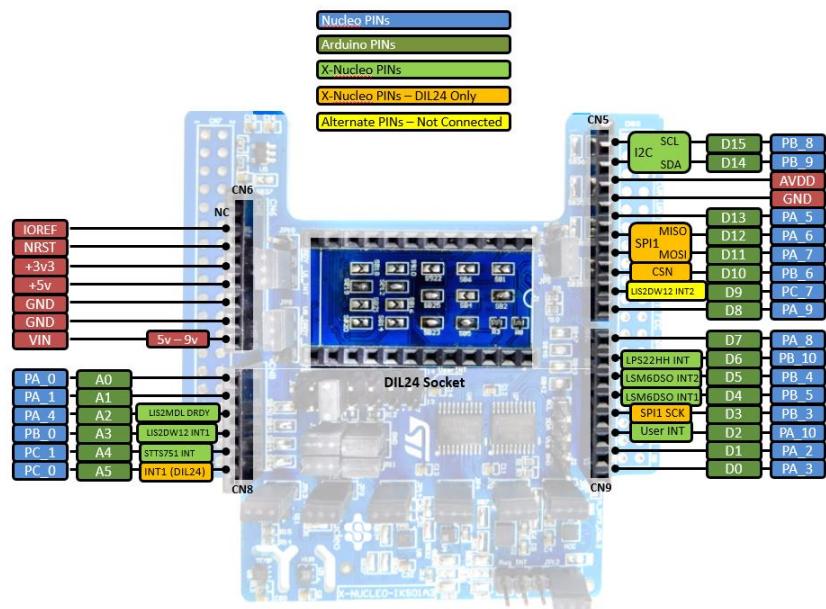
Figure 8 STM32 Nucleo 64 pins and X-NUCLEO-IKS01A2



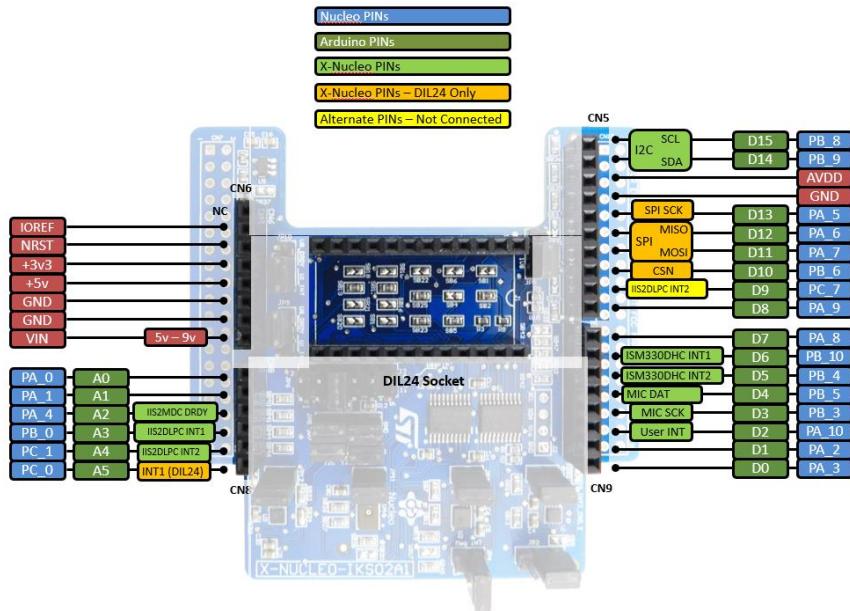
**Figure 9** STM32 Nucleo 144 pins and X-NUCLEO-IKS01A2



**Figure 10** X-NUCLEO-IKS01A2 pinout



**Figure 11** X-NUCLEO-IKS01A3 pinout



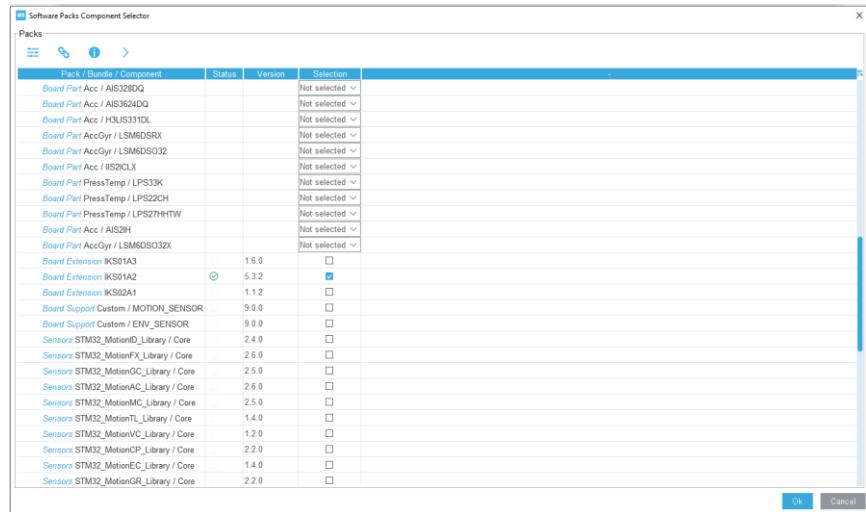
**Figure 12** X-NUCLEO-IKS02A1 pinout

## 7.1

### Use of MEMS Library without sample applications for X-NUCLEO-IKS01A2 or X-NUCLEO-IKS01A3 or X-NUCLEO-IKS02A1

This section outlines how to configure STM32CubeMX with X-NUCLEO-IKS01A2 or X-NUCLEO-IKS01A3 or X-NUCLEO-IKS02A1 when the use of the sample applications is not required. With such setup, only driver layers will be configured. This setup is useful when the user does not intend to leverage the sample application provided in the package.

To add the X-CUBE-MEMS1 software pack to the project, the “Software Packs” button and then the “Select Components” item must be clicked. From the “Software Packs Component Selector” window, the user has to select just the “Board Extension” class as shown in the figure below.



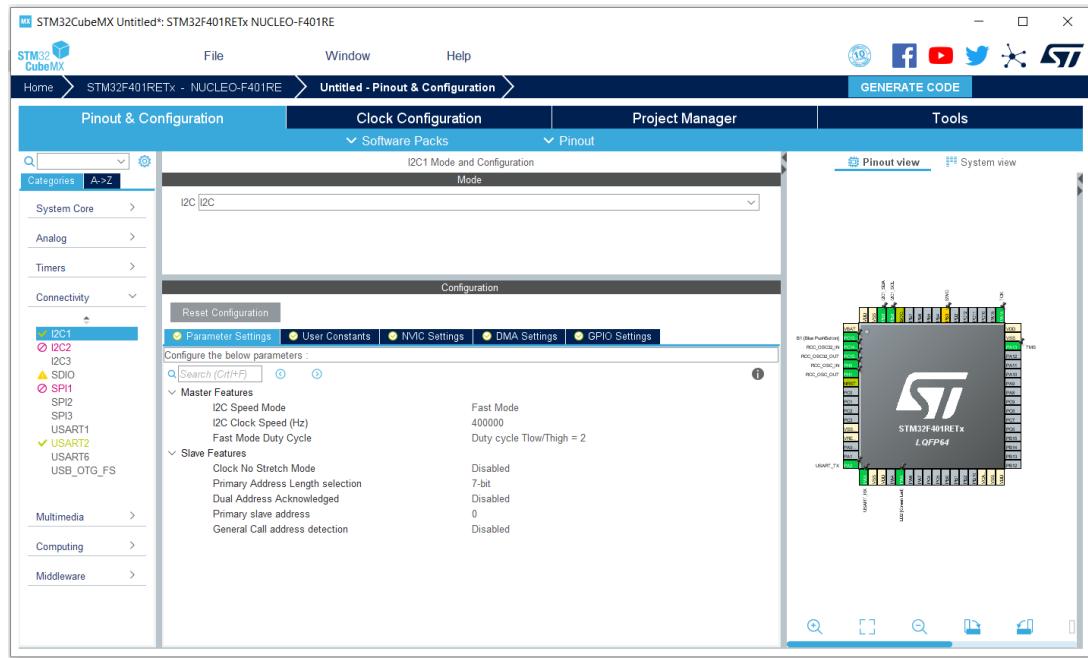
**Figure 13 STM32CubeMX Software Packs Component Selector window**

From the **Pinout & Configuration** tab:

- from the **Pinout** scheme, click on PB8 and set it as I2C1\_SCL;
- from the **Pinout** scheme, click on PB9 and set it as I2C1\_SDA;
- enable the I2C1 as I2C from the “Connectivity” category;
- Configure the I2C1 settings with I2C speed at 400KHz (Fast Mode) from the “Configuration” view;

From the **Pinout** scheme set:

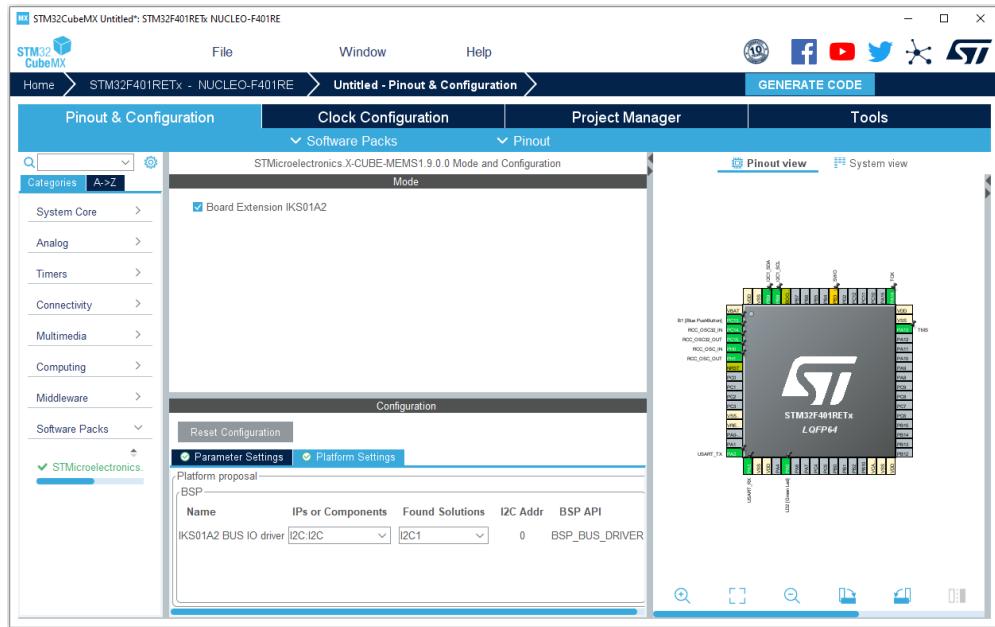
Nucleo 64		Nucleo 144	
PB8	I2C1_SCL	PB8	I2C1_SCL
PB9	I2C1_SDA	PB9	I2C1_SDA



**Figure 14** STM32CubeMX Pinout & Configuration tab and I2C settings

From the **Software Packs** category, press the ‘STMicroelectronics.X-CUBE-MEMS1.x.x.x’ item, enable the “Board Extension IKS01A2” checkbox from the “Mode” view and set the following Platform Settings from the “Configuration” view:

Name	BSP_Api	Supported IPs	Nucleo 64	Nucleo 144
IKS01A2 BUS IO driver	BSP_BUS_DRIVER	I2C:I2C	I2C1	I2C1



**Figure 15 STM32CubeMX Pinout & Configuration tab and Software Packs settings**

Once all the above described steps have been performed, the source code of the project using the **STMicroelectronics X-CUBE-MEMS1** software can be generated clicking the “GENERATE CODE” button.

## 7.2 Use of MEMS Library with sample applications for X-NUCLEO-IKS01A2 or X-NUCLEO-IKS01A3 or X-NUCLEO-IKS02A1

This section outlines how to configure STM32CubeMX with X-NUCLEO-IKS01A2 or X-NUCLEO-IKS01A3 or X-NUCLEO-IKS02A1 when the use of the sample applications is required. With such setup, all the components of the expansion software package, including applications, will be properly configured.

To add the X-CUBE-MEMS1 software pack to the project, the “Software Packs” button and then the “Select Components” item must be clicked. From the “Software Packs Component Selector” window, the user has to select just the “Board Extension” class and an application from the “Device” class as shown in the figure below.

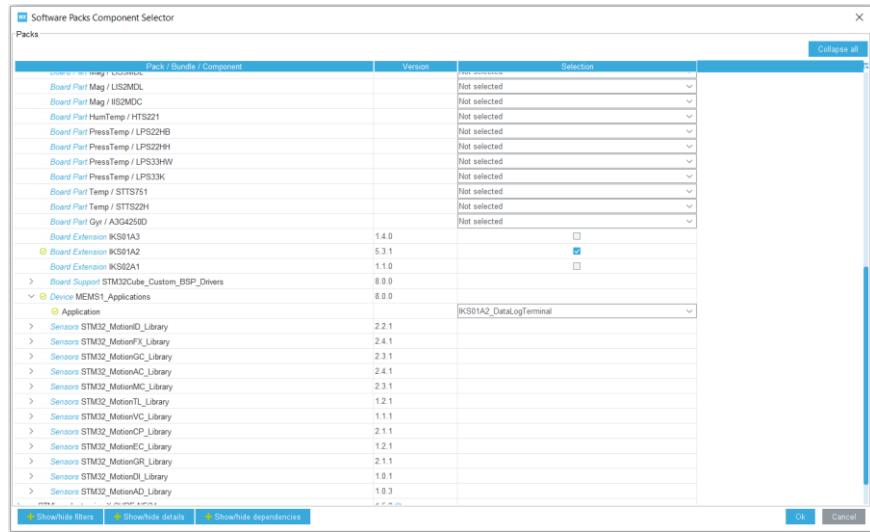


Figure 16 STM32CubeMX Software Packs Component Selector window example for the IKS01A2

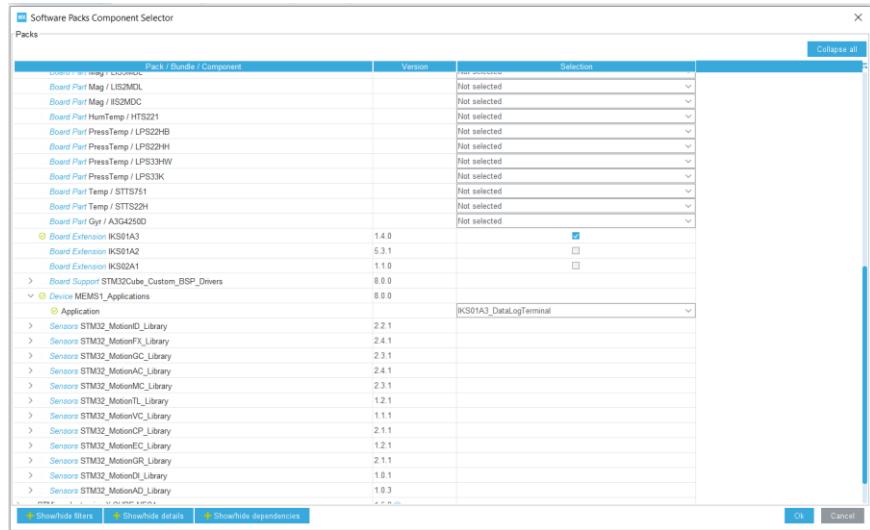
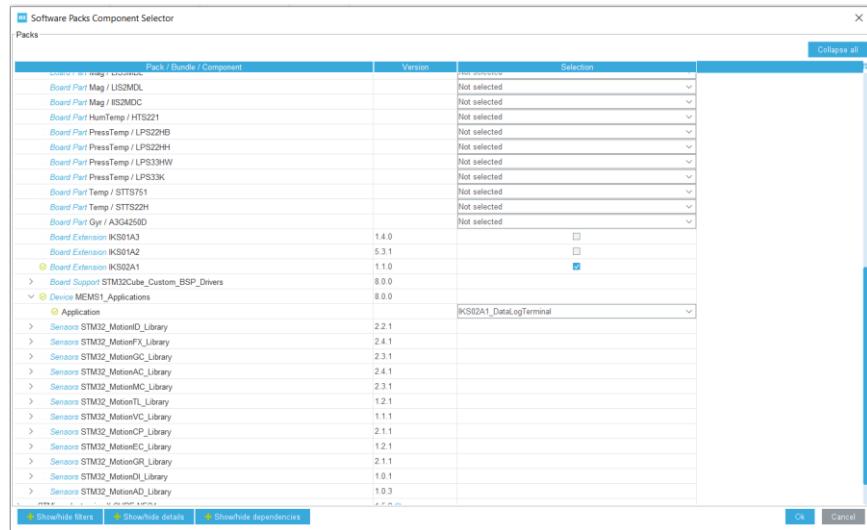


Figure 17 STM32CubeMX Software Packs Component Selector window example for the IKS01A3



**Figure 18 STM32CubeMX Software Packs Component Selector** window example for the IKS02A1

From the **Pinout & Configuration** tab:

- from the **Pinout** scheme, click on PB8 and set it as I2C1\_SCL;
- from the **Pinout** scheme, click on PB9 and set it as I2C1\_SDA;
- enable the I2C1 as I2C from the “Connectivity” category;
- if not enabled yet:
  - a. enable the USART2 in Asynchronous mode (for Nucleo 64) from the “Connectivity” category
  - b. enable the USART3 in Asynchronous mode (for Nucleo 144) from the “Connectivity” category

Note: The peripherals might be different, please check schematic of your board.

From the **Pinout** scheme, if not already set, if you are using the X-NUCLEO-IKS01A2 set:

Nucleo 64			Nucleo 144		
PIN	Mode	Label	PIN	Mode	Label
PB5	GPIO_EXTI5		PF14	GPIO_EXTI14	
PB4	GPIO_EXTI4		PE11	GPIO_EXTI11	
PB10	GPIO_EXTI10		PE9	GPIO_EXTI9	
PA2	USART2_TX	USART_TX	PD8	USART3_TX	USART_TX
PA3	USART2_RX	USART_RX	PD9	USART3_RX	USART_RX
PA5	GPIO_Output	LD2 [Green Led]	PB7	GPIO_Output	LD2[Blue]
PC13	GPIO_EXTI13	B1 [Blue PushButton]	PC13	GPIO_EXTI13	USER_Btn[B1]

From the **Pinout** scheme, if not already set, if you are using the X-NUCLEO-IKS01A3 set:

Nucleo 64			Nucleo 144		
PIN	Mode	Label	PIN	Mode	Label
PB5	GPIO_EXTI5		PF14	GPIO_EXTI14	
PB4	GPIO_EXTI4		PE11	GPIO_EXTI11	
PB10	GPIO_EXTI10		PE9	GPIO_EXTI9	
PB0	GPIO_EXTI0		PF3	GPIO_EXTI3	
PC1	GPIO_EXTI1		PF5	GPIO_EXTI5	
PA2	USART2_TX	USART_TX	PD8	USART3_TX	USART_TX
PA3	USART2_RX	USART_RX	PD9	USART3_RX	USART_RX
PA5	GPIO_Output	LD2 [Green Led]	PB7	GPIO_Output	LD2[Blue]
PC13	GPIO_EXTI13	B1 [Blue PushButton]	PC13	GPIO_EXTI13	USER_Btn[B1]

From the **Pinout** scheme, if not already set, if you are using the X-NUCLEO-IKS02A1 set:

Nucleo 64			Nucleo 144		
PIN	Mode	Label	PIN	Mode	Label
PA2	USART2_TX	USART_TX	PD8	USART3_TX	USART_TX
PA3	USART2_RX	USART_RX	PD9	USART3_RX	USART_RX
PA5	GPIO_Output	LD2 [Green Led]	PB7	GPIO_Output	LD2[Blue]
PC13	GPIO_EXTI13	B1 [Blue PushButton]	PC13	GPIO_EXTI13	USER_Btn[B1]

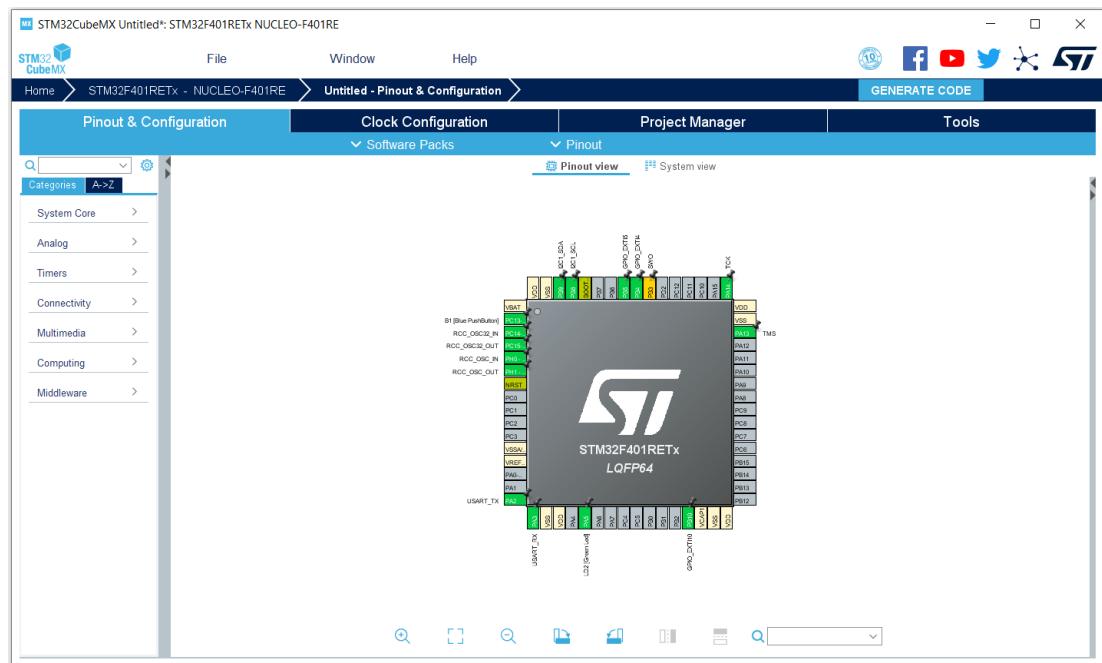
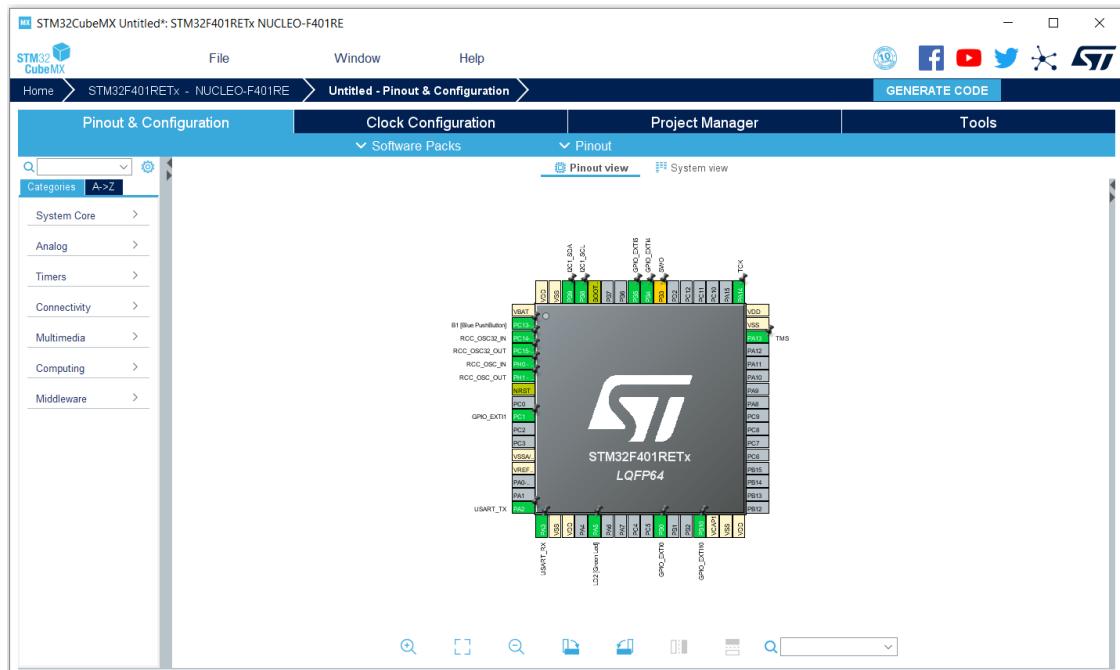
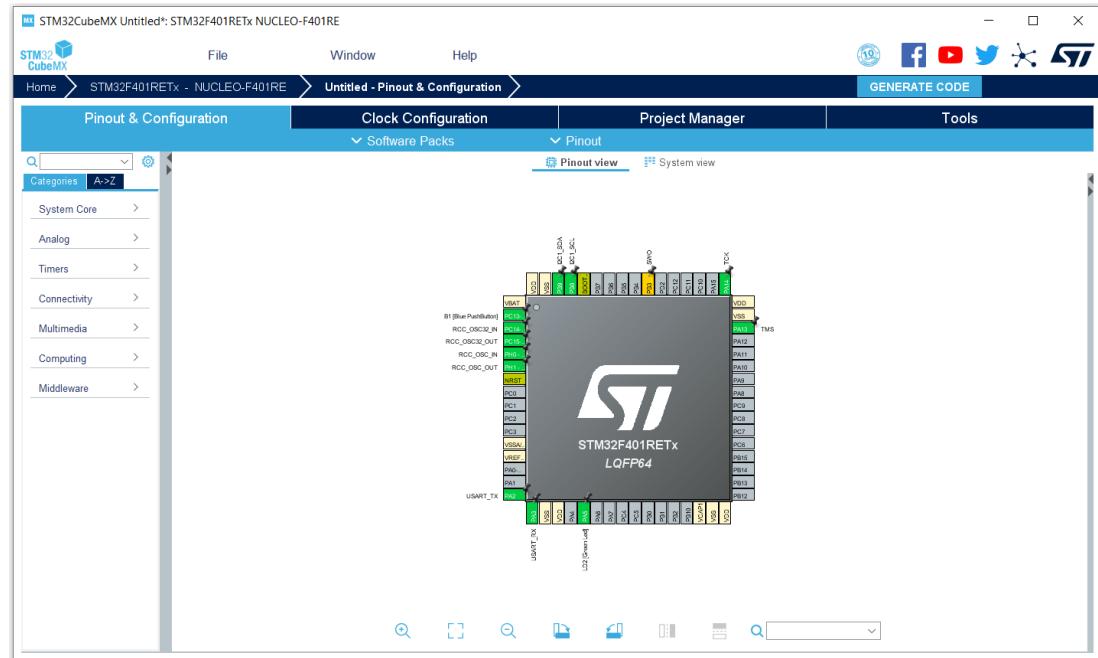


Figure 19 STM32CubeMX **Pinout & Configuration** tab for X-NUCLEO-IKS01A2



**Figure 20 STM32CubeMX Pinout & Configuration tab for X-NUCLEO-IKS01A3**



**Figure 21** STM32CubeMX Pinout & Configuration tab for X-NUCLEO-IKS02A1

From the **Software Packs** category, press the ‘STMicroelectronics.X-CUBE-MEMS1.x.x.x’ item, enable the “Board Extension IKS0XAX” and the “Device MEMS1 Applications”

checkboxes from the “Mode” view.

If you are using the X-NUCLEO-IKS01A2, you need to set the following Platform Settings from the “Configuration” view (take into account that according the example chosen some settings can appear or not):

Name	BSP_Api	Supported IPs	Nucleo 64	Nucleo 144
IKS01A2 BUS IO driver	BSP_BUS_DRIVER	I2C:I2C	I2C1	I2C1
MEMS_INT_PIN_A (All IKS01A2 applications except to IKS01A2_LPS22HB_FIFOMode)	HAL_EXTI_DRIVER	GPIO:EXTI	PB5	PF14
MEMS_INT_PIN_A (IKS01A2_LPS22HB_FIFOMode application)	HAL_EXTI_DRIVER	GPIO:EXTI	PB10	PE9
MEMS_INT_PIN_B	HAL_EXTI_DRIVER	GPIO:EXTI	PB4	PE11
BSP LED	BSP_COMMON_DRIVER	GPIO:Output	PA5	PB7
BSP BUTTON	BSP_COMMON_DRIVER	GPIO:EXTI	PC13	PC13
BSP USART	BSP_COMMON_DRIVER	USART:Asynchronous	USART2	USART3

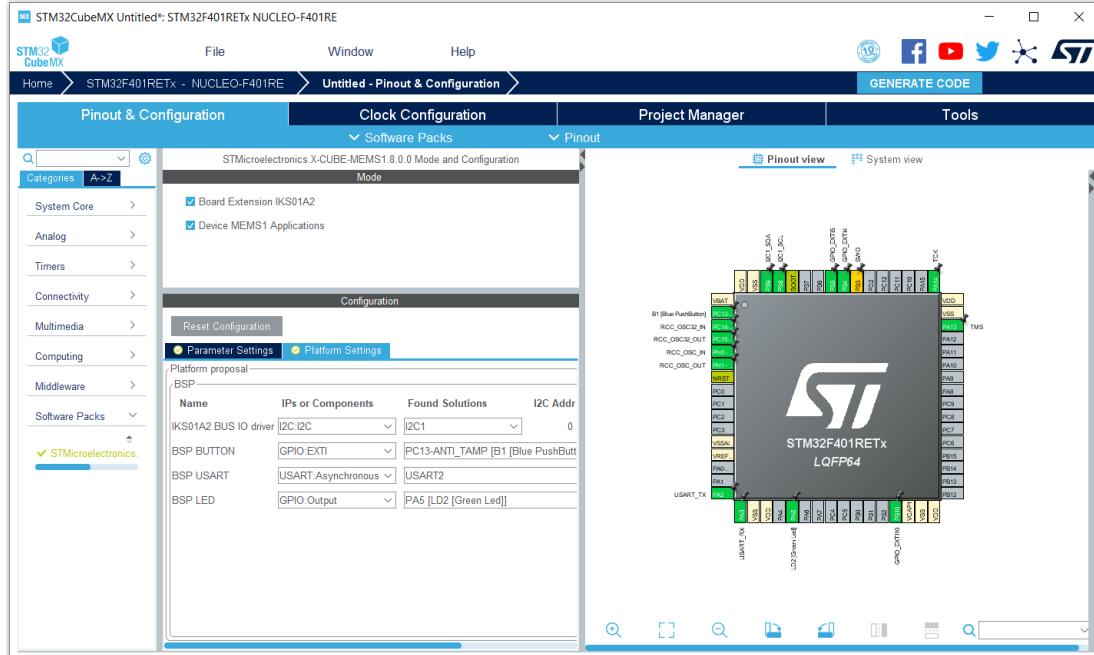
If you are using the X-NUCLEO-IKS01A3, you need to set the following Platform Settings from the “Configuration” view (take into account that according the example chosen some settings can appear or not):

Name	BSP_Api	Supported IPs	Nucleo 64	Nucleo 144
IKS01A3 BUS IO driver	BSP_BUS_DRIVER	I2C:I2C	I2C1	I2C1
MEMS_INT_PIN_A (All IKS01A3 applications based on LSM6DSO component)	HAL_EXTI_DRIVER	GPIO:EXTI	PB5	PF14
MEMS_INT_PIN_A (IKS01A3 application based on LPS22HH component)	HAL_EXTI_DRIVER	GPIO:EXTI	PB10	PE9
MEMS_INT_PIN_A (IKS01A3 applications based on LIS2DW12 component)	HAL_EXTI_DRIVER	GPIO:EXTI	PB0	PF3

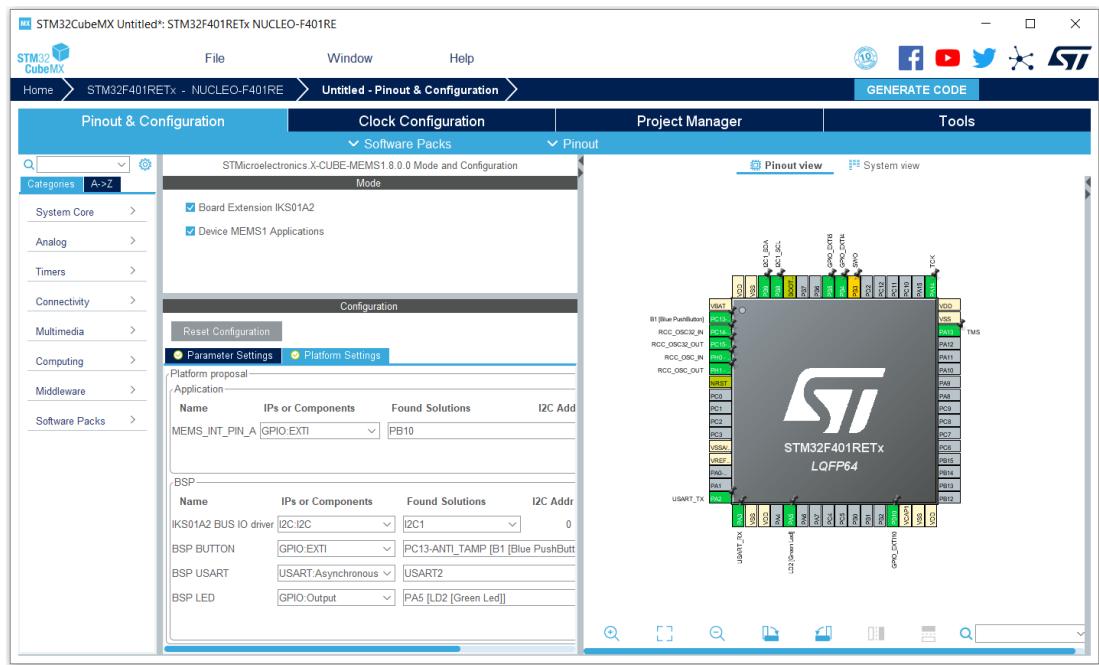
Name	BSP_Api	Supported IPs	Nucleo 64	Nucleo 144
MEMS_INT_PIN_A (IKS01A3 application based on STTS751 component)	HAL_EXTI_DRIVER	GPIO:EXTI	PC1	PF5
BSP LED	BSP_COMMON_DRIVER	GPIO:Output	PA5	PB7
BSP BUTTON	BSP_COMMON_DRIVER	GPIO:EXTI	PC13	PC13
BSP USART	BSP_COMMON_DRIVER	USART:Asynchronous	USART2	USART3

If you are using the X-NUCLEO-IKS02A1, you need to set the following Platform Settings from the “Configuration” view:

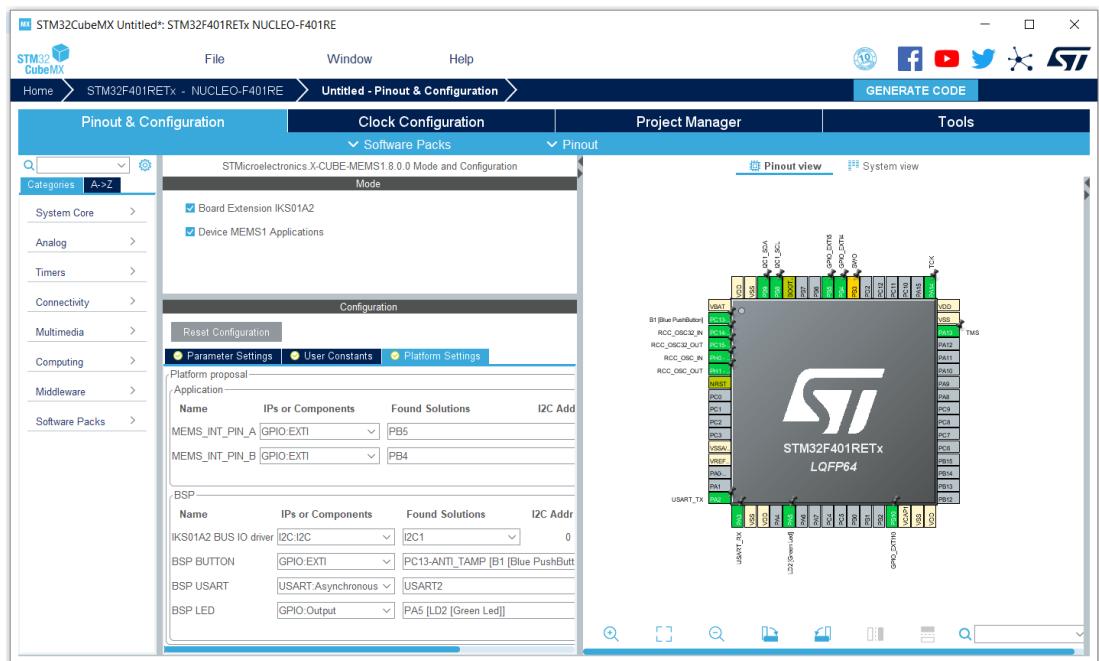
Name	BSP_Api	Supported IPs	Nucleo 64	Nucleo 144
IKS01A2 BUS IO driver	BSP_BUS_DRIVER	I2C:I2C	I2C1	I2C1
BSP LED	BSP_COMMON_DRIVER	GPIO:Output	PA5	PB7
BSP BUTTON	BSP_COMMON_DRIVER	GPIO:EXTI	PC13	PC13
BSP USART	BSP_COMMON_DRIVER	USART:Asynchronous	USART2	USART3



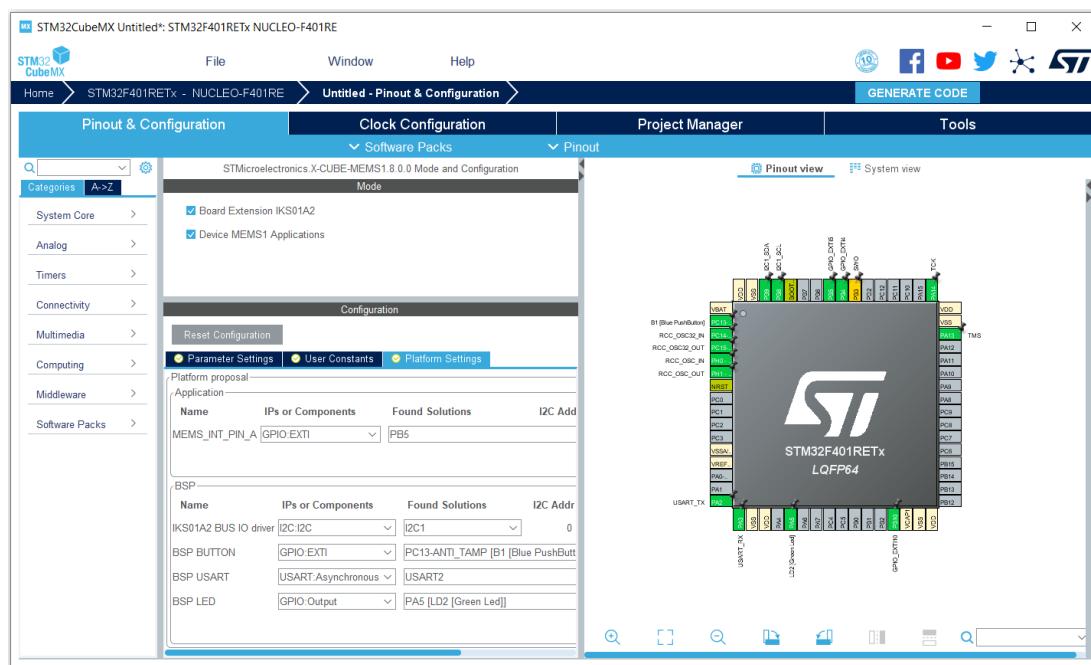
**Figure 22** STM32CubeMX Pinout & Configuration tab and Software Packs settings for IKS01A2\_DataLogTerminal and IKS01A2\_LSM6DSL\_SelfTest applications



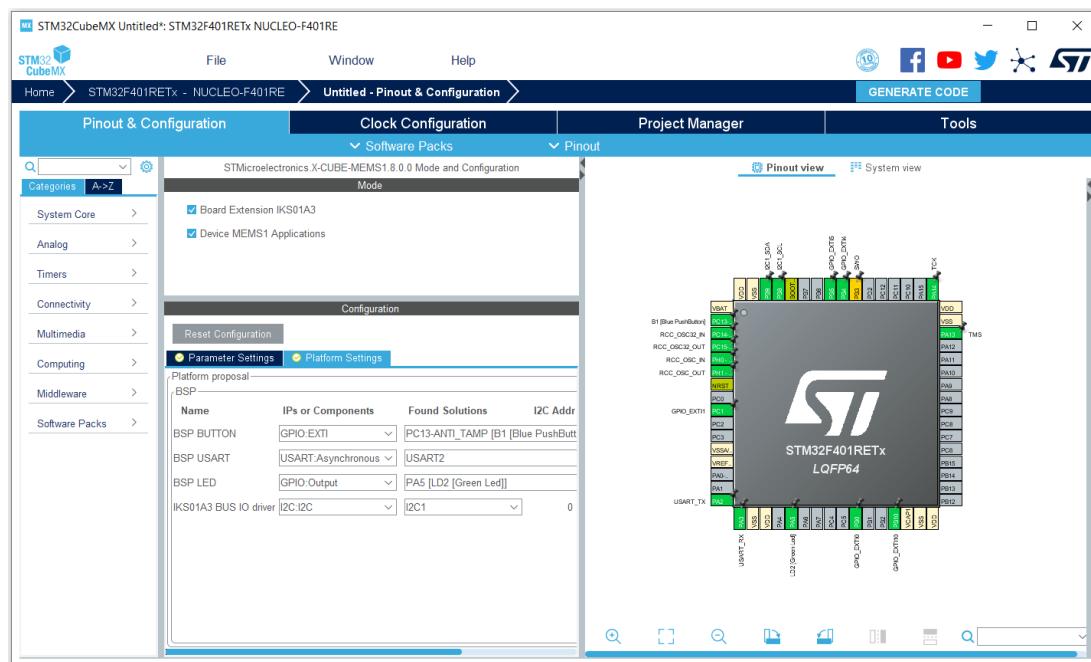
**Figure 23** STM32CubeMX Pinout & Configuration tab and Software Packs settings for IKS01A2\_LPS22HB\_FIFO Mode application



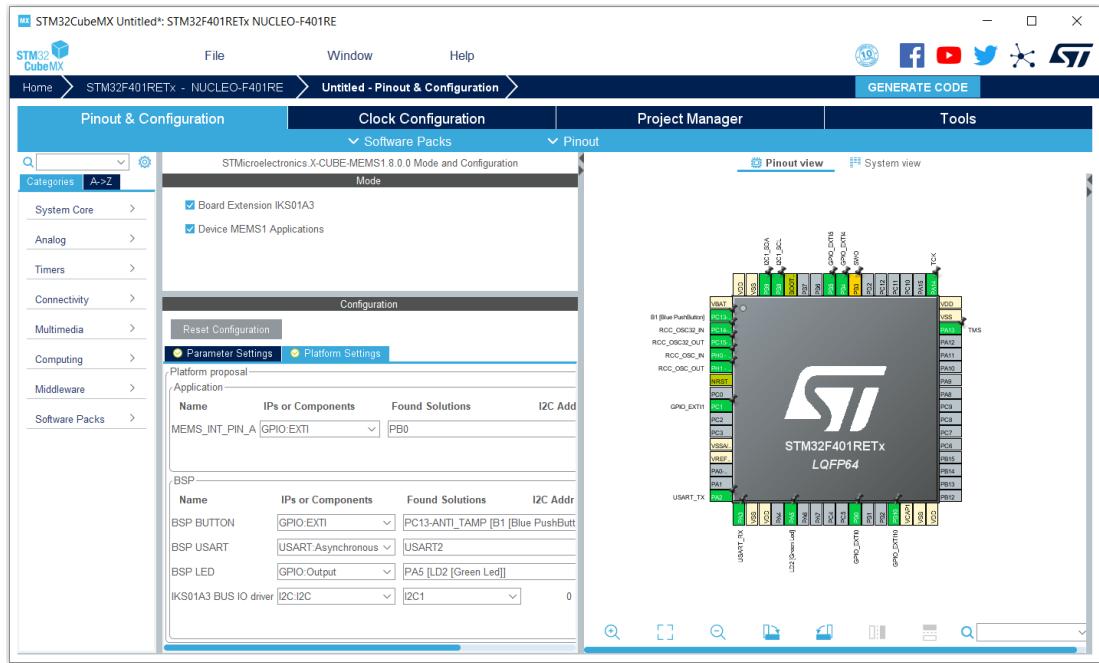
**Figure 24** STM32CubeMX Pinout & Configuration tab and Software Packs settings for IKS01A2\_LSM6DSL\_MultiEvent application



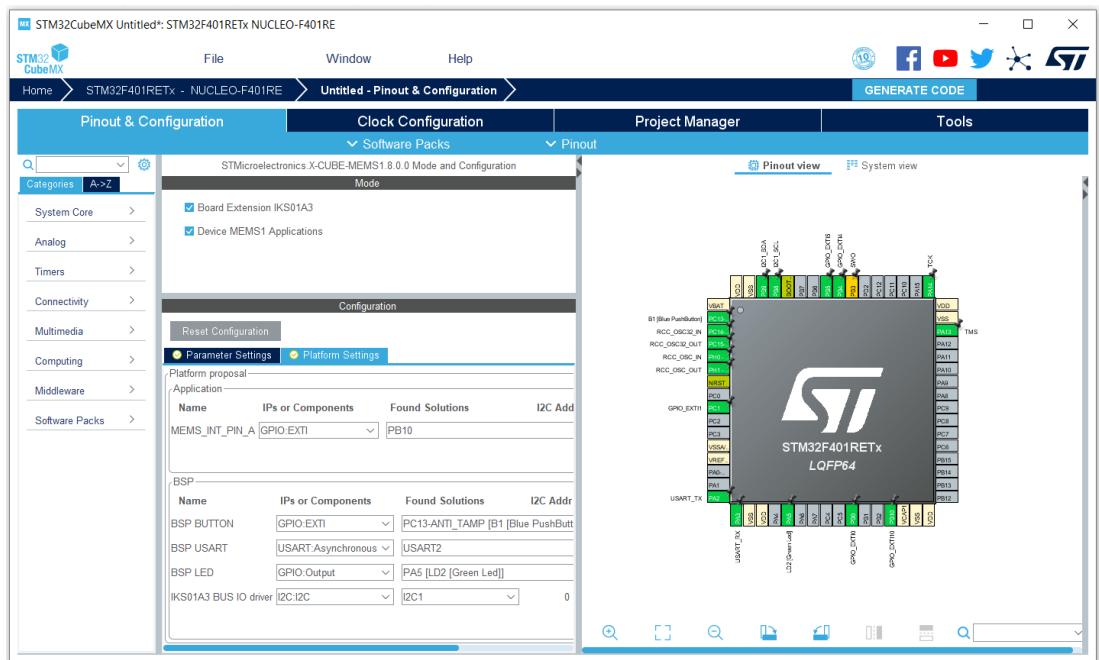
**Figure 25 STM32CubeMX Pinout & Configuration tab and Software Packs settings for all other IKS01A2 applications**



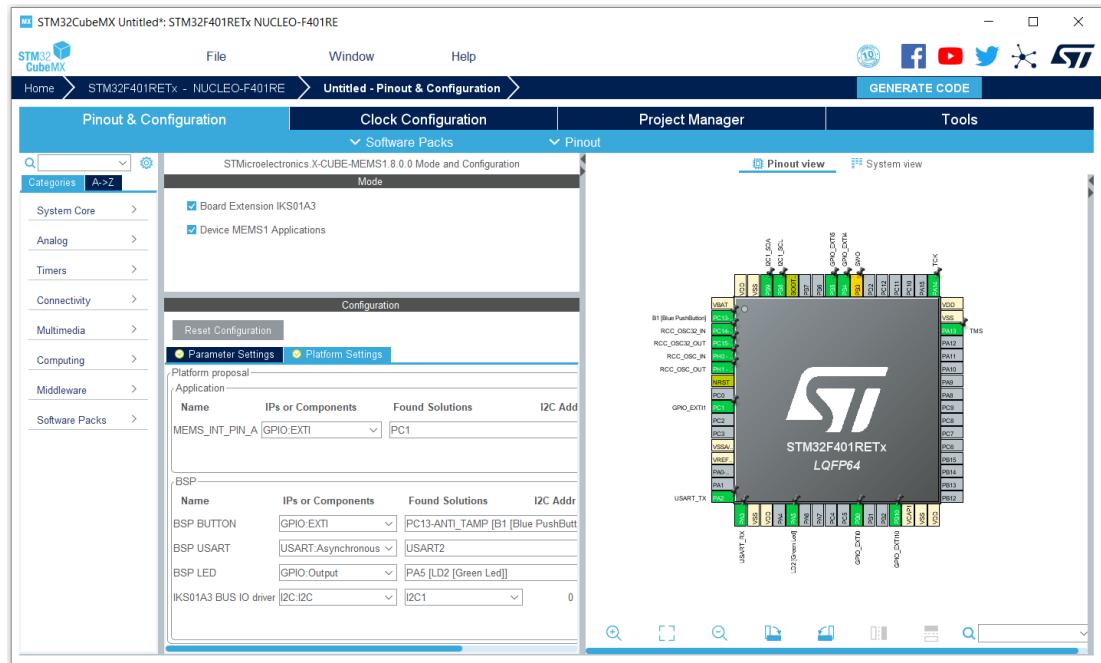
**Figure 26 STM32CubeMX Pinout & Configuration tab and Software Packs settings for IKS01A3\_DataLogTerminal, IKS01A3\_LIS2DW12\_SelfTest, IKS01A3\_LIS2MDL\_SelfTest and IKS01A3\_LSM6DSO\_SelfTest applications**



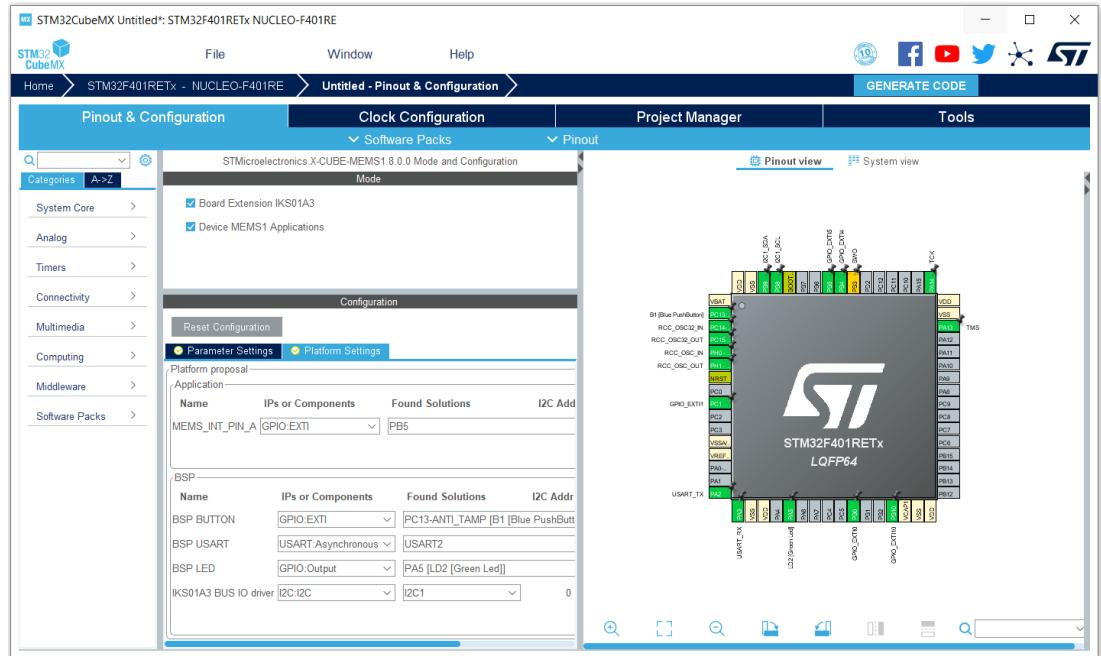
**Figure 27** STM32CubeMX Pinout & Configuration tab and Software Packs settings for IKS01A3\_LIS2DW12\_6DOrientation and IKS01A3\_LIS2DW12\_WakeUp applications



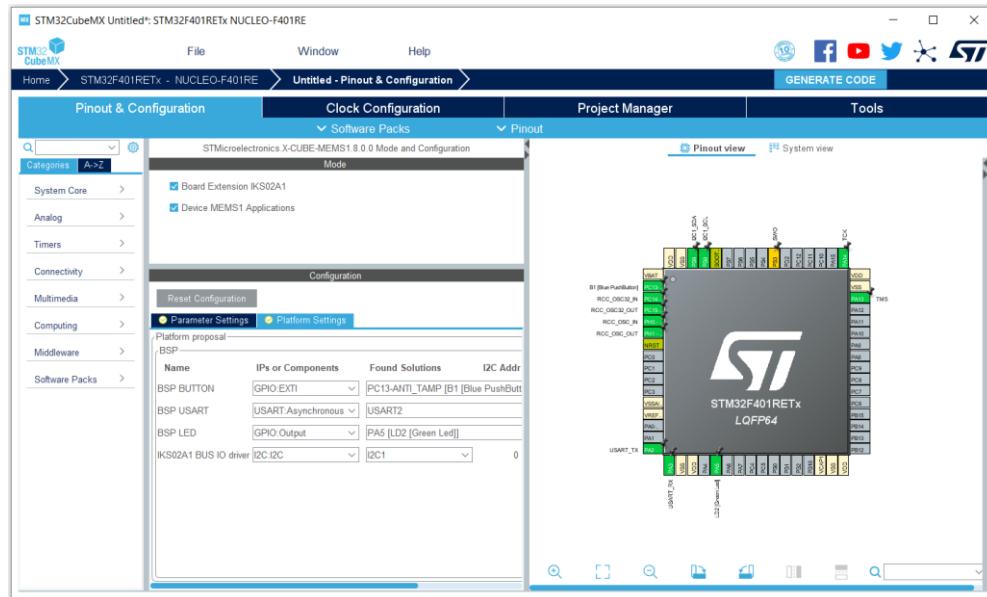
**Figure 28** STM32CubeMX Pinout & Configuration tab and Software Packs settings for IKS01A3\_LPS22HH\_FIFOMode application



**Figure 29 STM32CubeMX Pinout & Configuration tab and Software Packs settings for IKS01A3\_STTS751\_TemperatureLimit application**



**Figure 30 STM32CubeMX Pinout & Configuration tab and Software Packs settings for all other IKS01A3 applications**



**Figure 31** STM32CubeMX **Pinout & Configuration** tab and Software Packs settings for IKS02A1\_DataLogTerminal application

From the **Parameter Settings** tab, some parameters for the routing of the interrupt signals can be changed.

For all the IKS01A2, IKS01A3 and IKS02A1 sample applications, the default parameters can be used.

From the **Configuration & Pinout** tab, click on “System Core” category and then on NVIC item to enable the EXTI line interrupts when the IKS01A2 is used:

Nucleo 64	Nucleo 144
EXTI line 4 interrupt	EXTI line 11 interrupt
EXTI line 5 interrupt	EXTI line 14 interrupt
EXTI line 10 interrupt	EXTI line 9 interrupt
EXTI line 13 interrupt	EXTI line 13 interrupt

From the **Configuration & Pinout** tab, click on “System Core” category and then on NVIC item to enable the EXTI line interrupts when the IKS01A3 is used:

Nucleo 64	Nucleo 144
EXTI line 0 interrupt	EXTI line 3 interrupt
EXTI line 1 interrupt	EXTI line 5 interrupt
EXTI line 4 interrupt	EXTI line 11 interrupt
EXTI line 5 interrupt	EXTI line 14 interrupt
EXTI line 10 interrupt	EXTI line 9 interrupt
EXTI line 13 interrupt	EXTI line 13 interrupt

From the **Configuration & Pinout** tab, click on “System Core” category and then on NVIC item

to enable the EXTI line interrupts when the IKS02A1 is used:

Nucleo 64	Nucleo 144
EXTI line 13 interrupt	EXTI line 13 interrupt

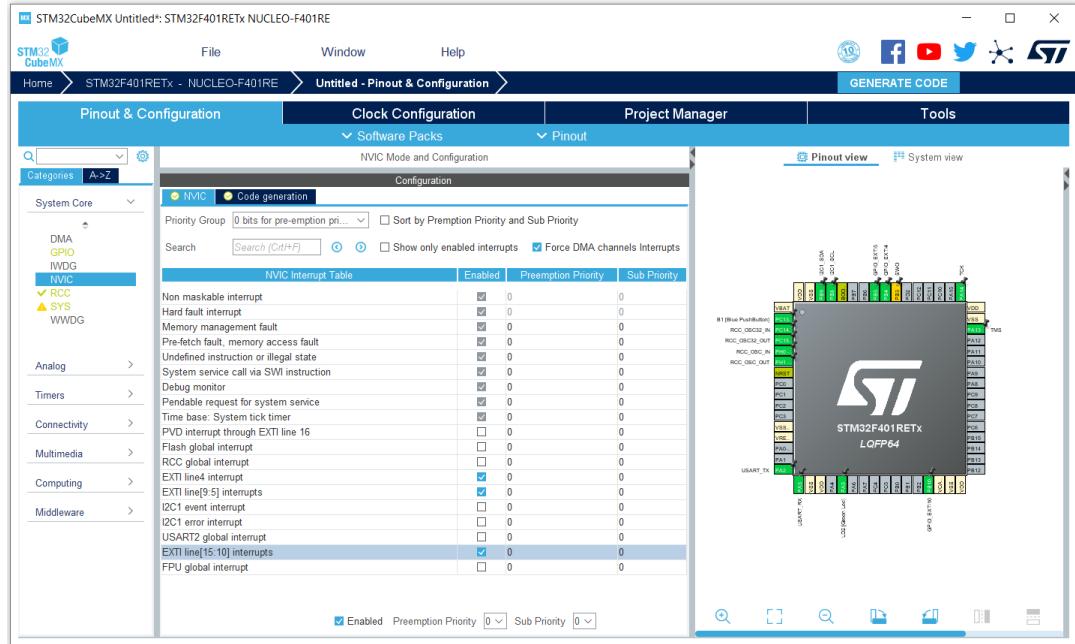


Figure 32 STM32CubeMX NVIC Configuration for IKS01A2

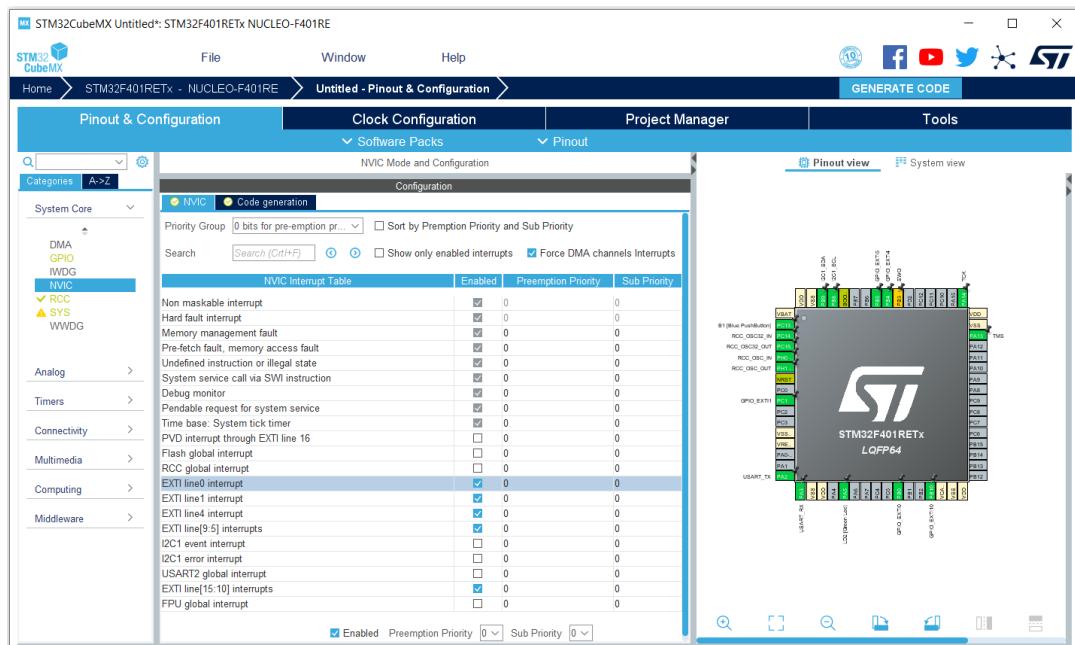
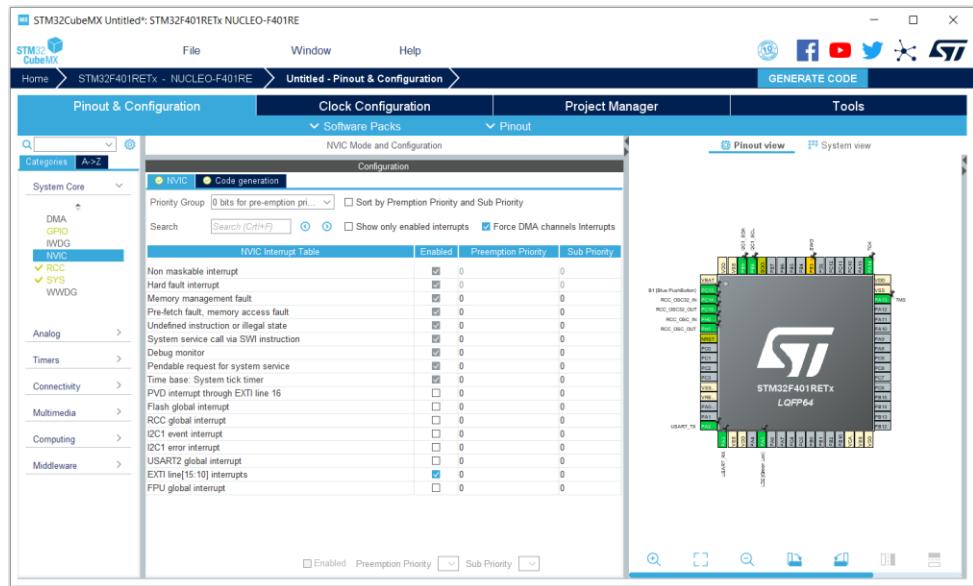
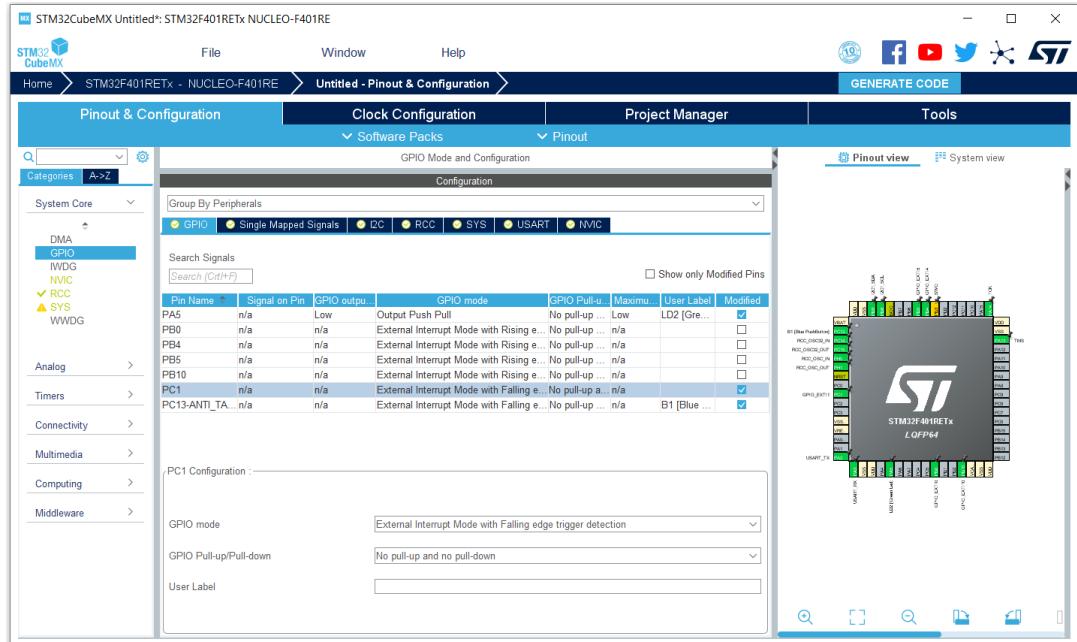


Figure 33 STM32CubeMX NVIC Configuration for IKS01A3



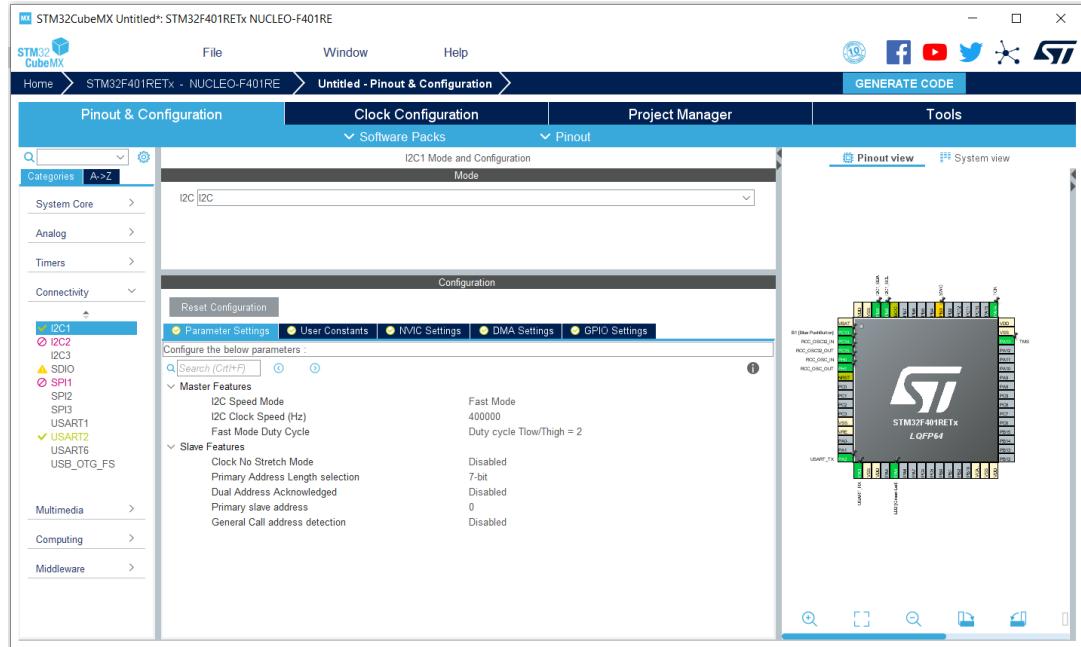
**Figure 34** STM32CubeMX NVIC Configuration for IKS02A1

Regarding the X-NUCLEO-IKS01A3, the GPIO pin that manages the interrupt of the STTS751 component must be configured in Falling mode; instead, for the interrupts of all the other components we need to use the Rising mode.



**Figure 35** STM32CubeMX GPIO Configuration for IKS01A3

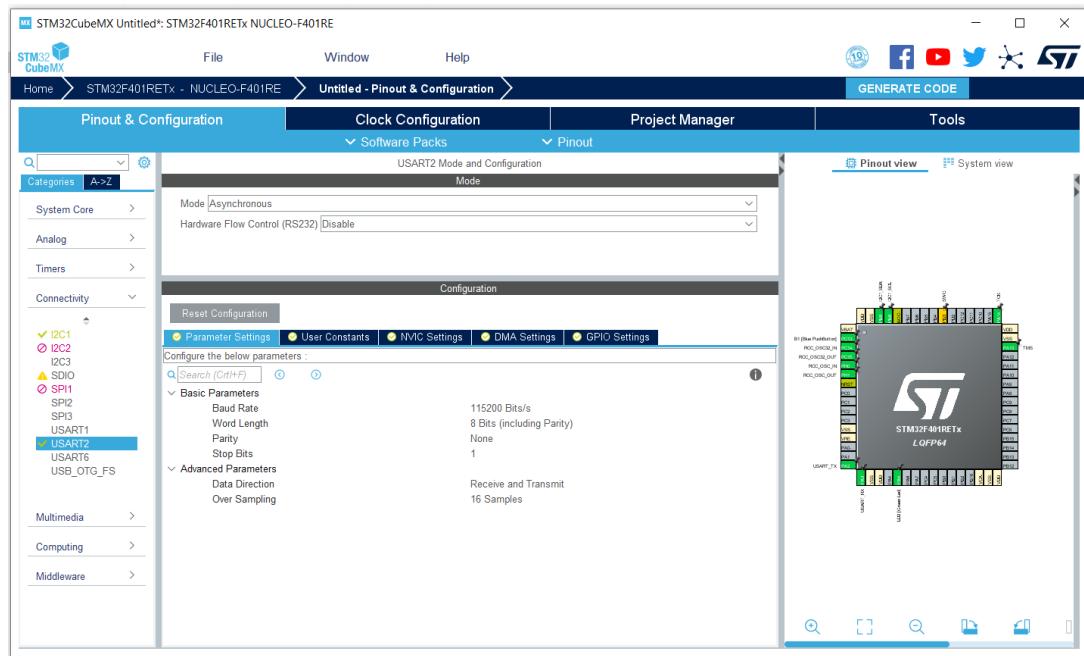
From the **Configuration & Pinout** tab, click on “Connectivity” category and then on I2C1 item to set the I2C speed at 400KHz (Fast Mode):



**Figure 36** STM32CubeMX I2C Configuration

From the **Configuration & Pinout** tab, click on “Connectivity” category and then on USART2 item and check that the following configuration is set:

Baud Rate	115200 Bits/s
Word Length	8 Bits (including Parity)
Parity	None
Stop Bits	1

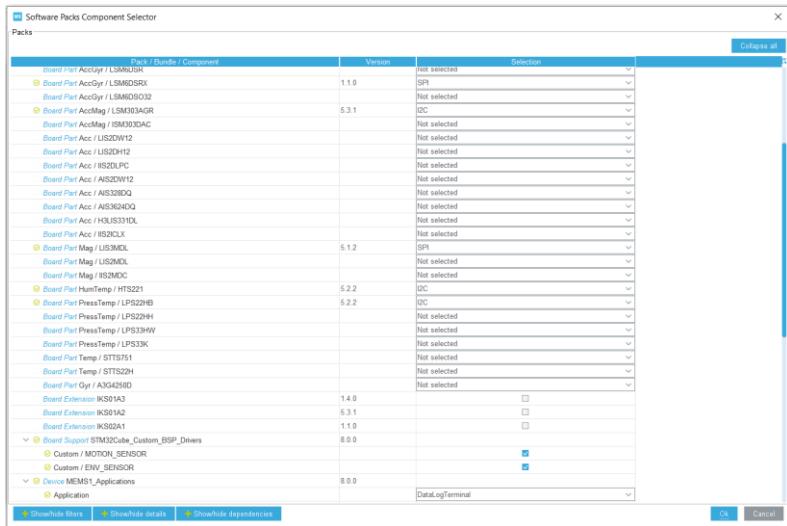


**Figure 37 STM32CubeMX USART Configuration**

Once all the above described steps have been performed, the sample applications for IKS01A2 or IKS01A3 or IKS02A1 using the **STMicroelectronics X-CUBE-MEMS1** software can be generated clicking the “GENERATE CODE” button.

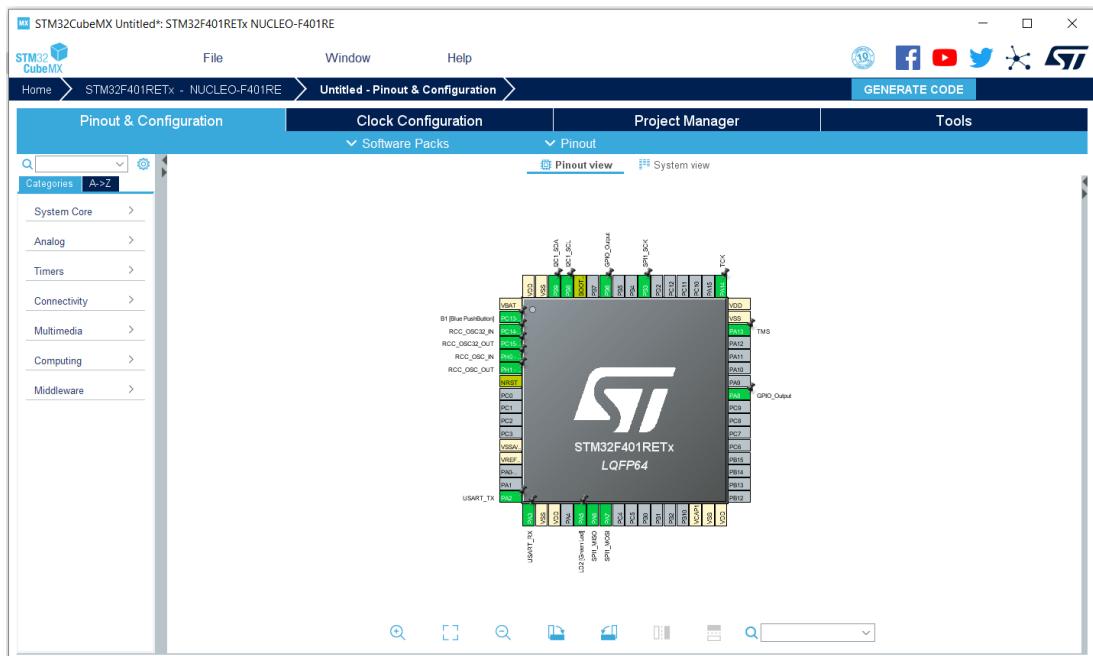
## 7.3 Use of MEMS Library with sample applications for custom boards

This section outlines how to configure STM32CubeMX with a custom board that mounts MEMS devices when the use of the sample applications is required. In this case you can configure the MEMS device in order to be used via I2C bus or via SPI bus (only 4-Wires).



**Figure 38 STM32CubeMX Software Packs Component Selector window**

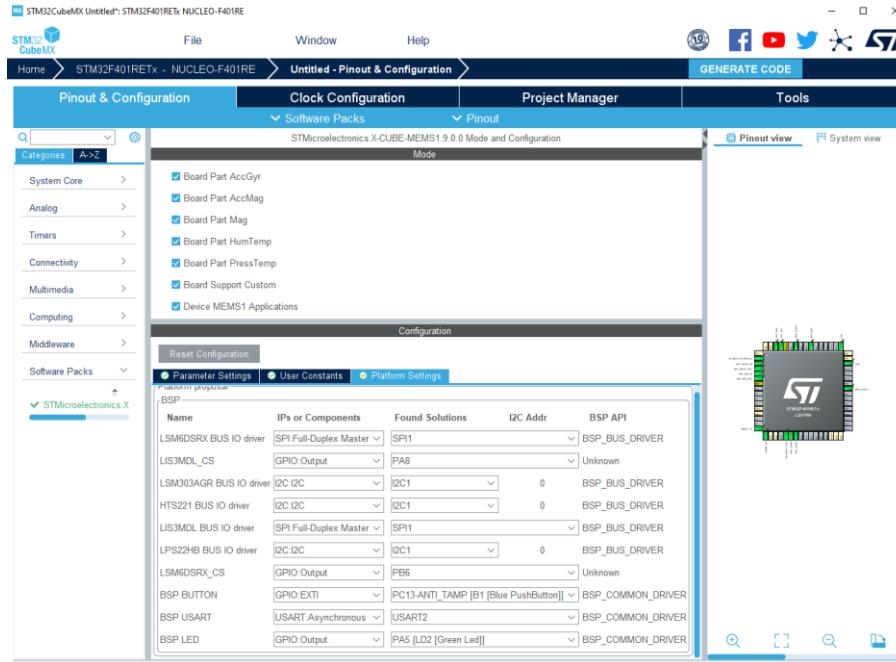
You can see below an example of the **Pinout** scheme. In this example, we have configured SPI1 and I2C1, the Chip Select for LSM6DSRX (PB6) and the Chip Select for LIS3MDL (PA8) as GPIO Output pins; we have configured USART2 connected to the hyperterminal; we have configured PA5 as LED pin; finally, we have configured PC13 as GPIO Input pin (User Button). Eventually, you need to configure the EXTI pins for the applications that use interrupts like the ones based on Hardware Events of the accelerometers.



**Figure 39 STM32CubeMX Pinout & Configuration tab**

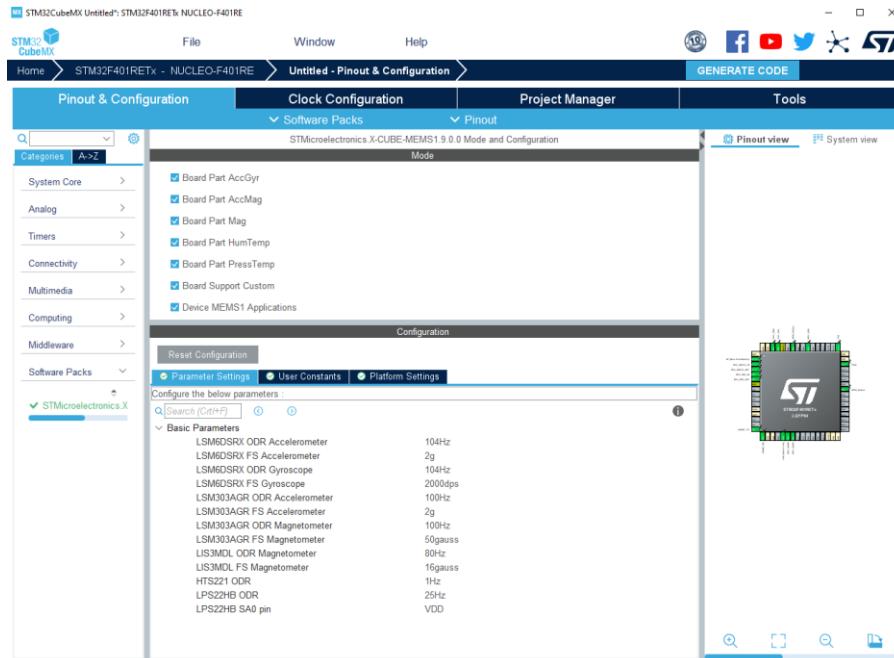
From the **Pinout and Configuration** tab, click on the **Software Packs** category, press the 'STMicroelectronics.X-CUBE-MEMS1.x.x.x' item, enable all the "Board Part" elements, the "Board Support Custom" and the "Device MEMS1 Applications" checkboxes from the "Mode"

view and set the following Platform Settings from the “Configuration” view according your custom board (take into account that according the example chosen some settings can appear or not). A sample of configuration is shown below.



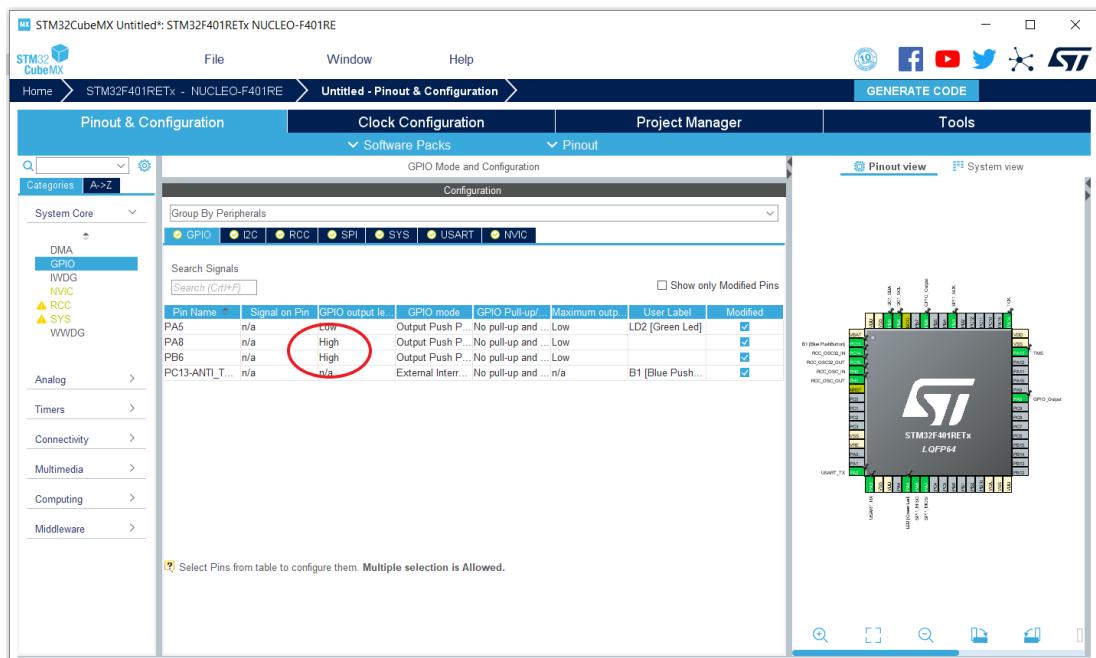
**Figure 40** STM32CubeMX Pinout & Configuration tab and Software Packs settings for DataLogTerminal application of a custom board

From the **Parameter Settings** tab, some parameters of the MEMS devices can be changed. For example, the user can decide if the SA0 pin is connected to VDD or GND in order to associate the correct I2C address to the MEMS device; the Output Data Rate and the Full Scale of the MEMS sensors can be selected (only for DataLogTerminal application); some parameters for the routing of the interrupt signals can be changed. You can see an example of configuration below.



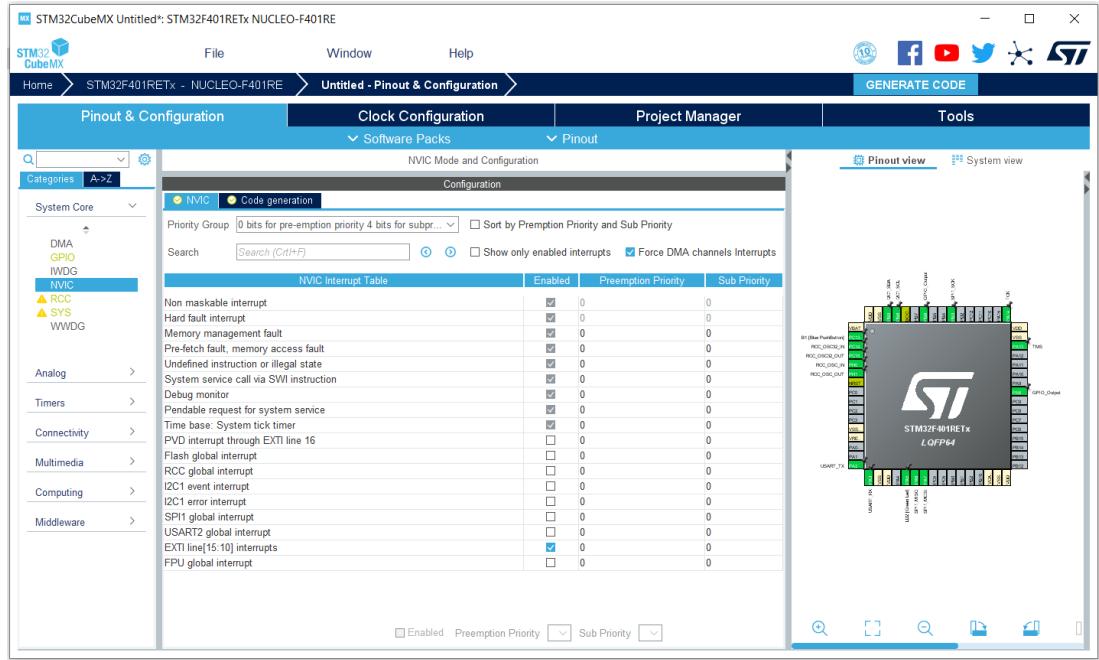
**Figure 41 STM32CubeMX Parameter Settings** for DataLogTerminal application of a custom board

From the **Pinout & Configuration** tab, click on “System Core” category and then on GPIO item and check that the Chip Select pins are initialized as HIGH level.



**Figure 42 STM32CubeMX GPIO Configuration**

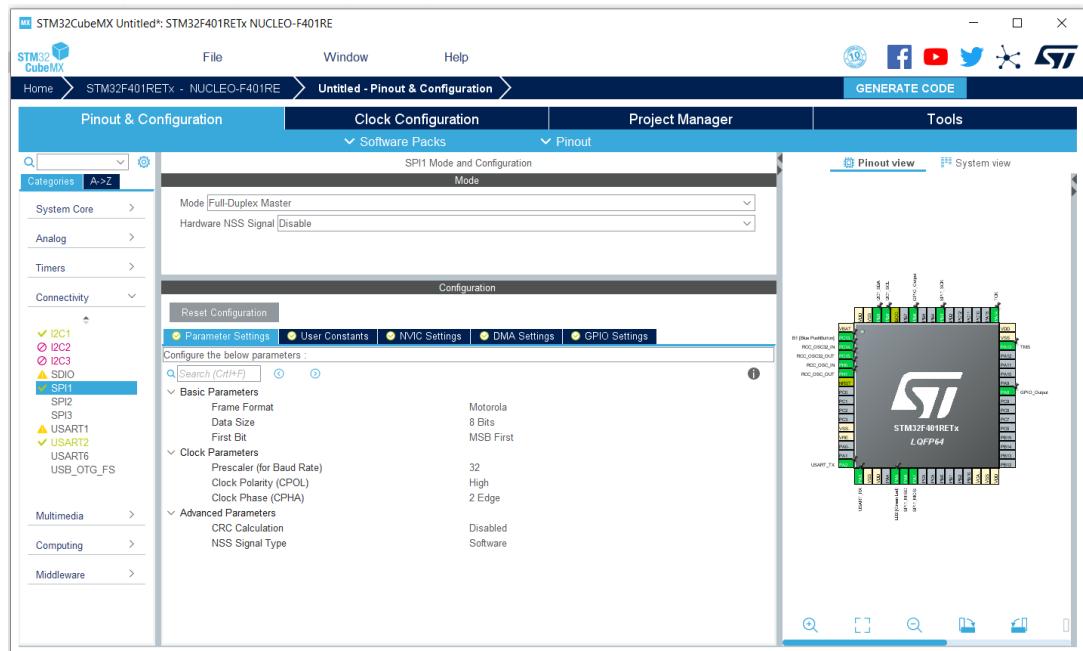
From the **Configuration & Pinout** tab, click on “System Core” category and then on NVIC item to enable the EXTI line interrupts.



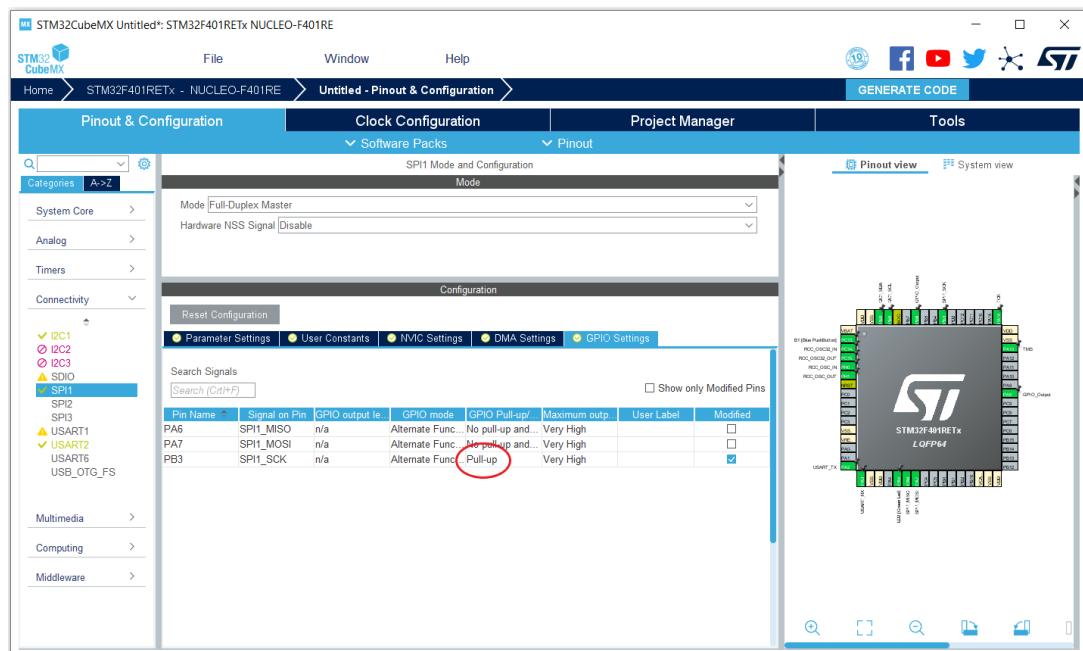
**Figure 43** STM32CubeMX NVIC Configuration

From the **Configuration & Pinout** tab, click on “Connectivity” category and then on SPI1 item and:

- check that the Data Size is 8 Bits
- set the Prescaler (for Baud Rate) to a value so that HCLK/Prescaler is less or equal to 10MHz (the maximum supported SPI speed by MEMS devices)
- Set the Clock Polarity to “HIGH” and the Clock Phase to “2 Edge”
- Set the GPIO pin of the SPI clock with a Pull-Up state

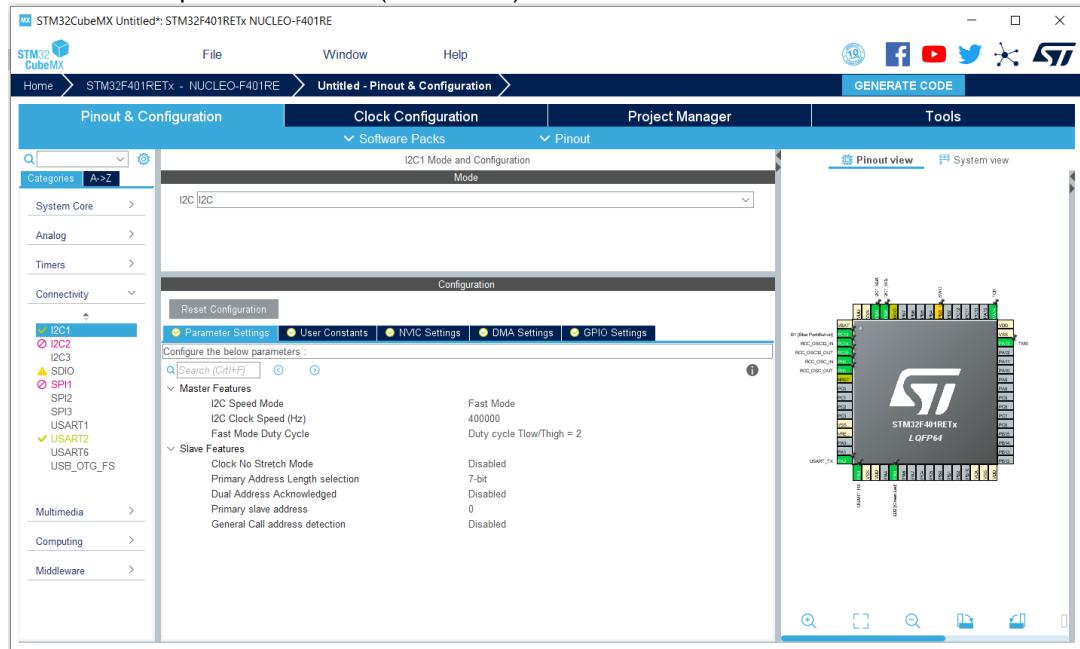


**Figure 44** STM32CubeMX SPI Configuration



**Figure 45** STM32CubeMX SPI Clock GPIO

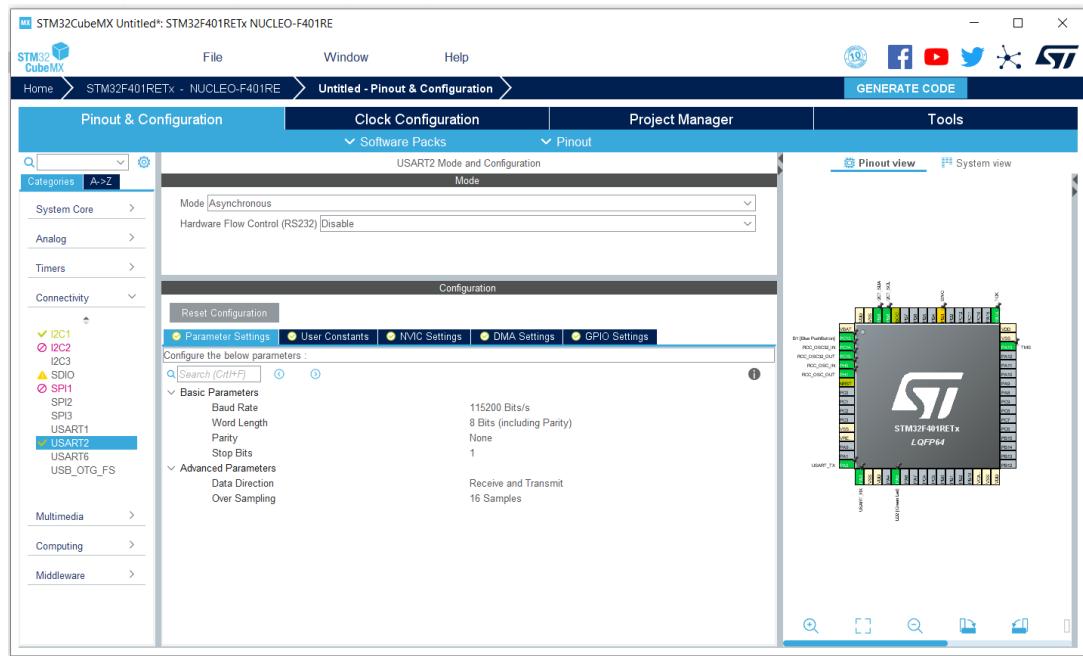
From the **Configuration & Pinout** tab, click on “Connectivity” category and then on I2C1 item to set the I2C speed at 400KHz (Fast Mode):



**Figure 46** STM32CubeMX I2C Configuration

From the **Configuration & Pinout** tab, click on “Connectivity” category and then on USART2 button and check the following configuration is set:

Baud Rate	115200 Bits/s
Word Length	8 Bits (including Parity)
Parity	None
Stop Bits	1



**Figure 47 STM32CubeMX USART Configuration**

Once all the above described steps have been performed, the sample applications for a custom board using the **STMicroelectronics X-CUBE-MEMS1** software can be generated clicking the “GENERATE CODE” button.

## 7.4

### Use of MEMS Library with middleware applications for X-NUCLEO-IKS01A2 or X-NUCLEO-IKS01A3 or X-NUCLEO-IKS02A1

This section outlines how to configure STM32CubeMX with X-NUCLEO-IKS01A2 or X-NUCLEO-IKS01A3 or X-NUCLEO-IKS02A1 when the use of the middleware applications is required. With such setup, all the components of the expansion software package, including applications, will be properly configured.

To add the X-CUBE-MEMS1 software pack to the project, the “Software Packs” button and then the “Select Components” item must be clicked. From the “Software Packs Component Selector” window, the user has to select the “Board Extension” class, an application from the “Device” class and “Sensors” class as shown in the figure below.

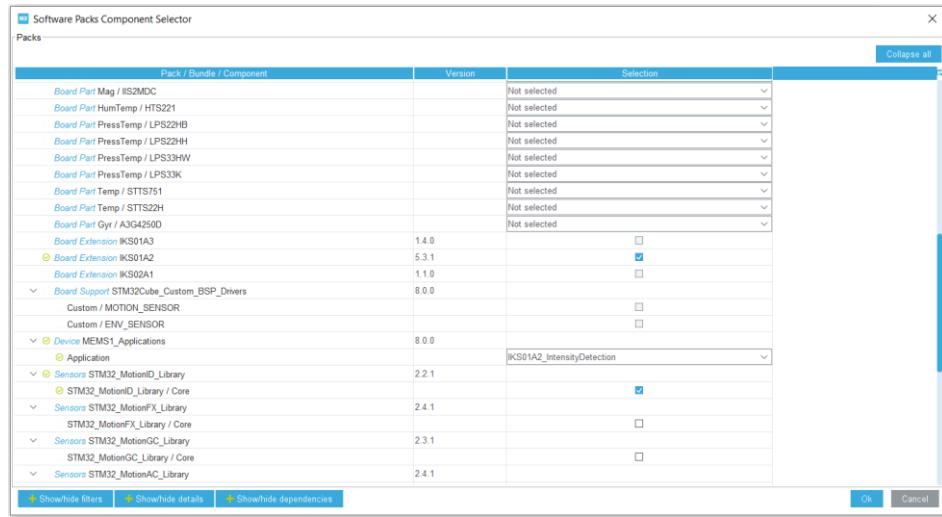


Figure 48 STM32CubeMX Software Packs Component Selector window example for the IKS01A2

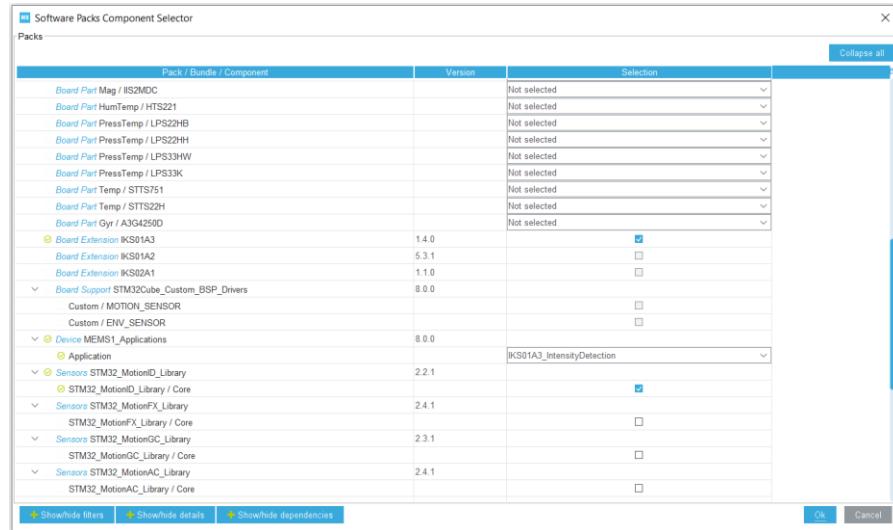
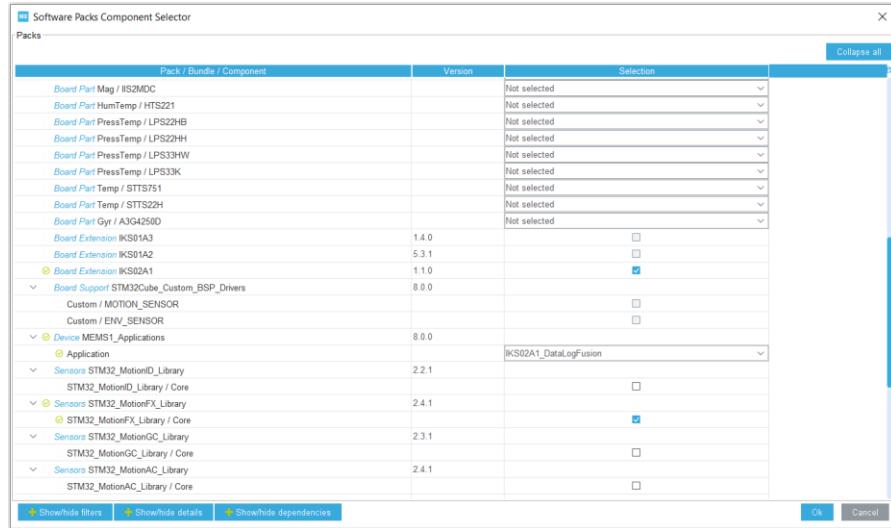


Figure 49 STM32CubeMX Software Packs Component Selector window example for the IKS01A3



**Figure 50 STM32CubeMX Software Packs Component Selector** window example for the IKS02A1

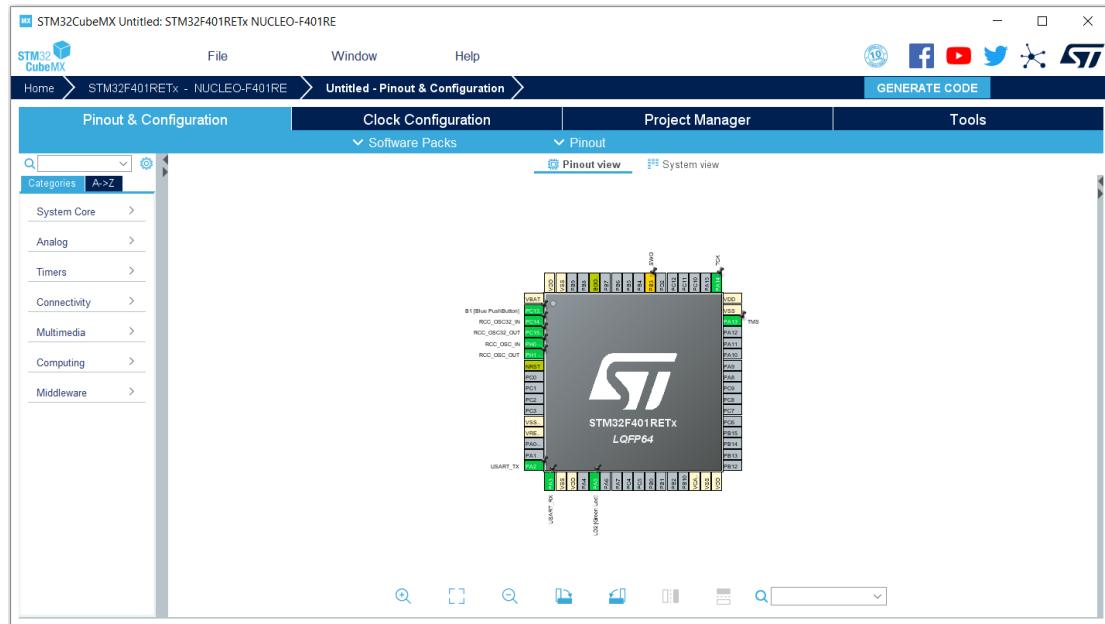
From the **Pinout & Configuration** tab:

- from the **Pinout** scheme, click on PB8 and set it as I2C1\_SCL;
- from the **Pinout** scheme, click on PB9 and set it as I2C1\_SDA;
- enable the I2C1 as I2C from the “Connectivity” category;
- if not enabled yet:
  - a. enable the USART2 in Asynchronous mode (for Nucleo 64) from the “Connectivity” category
  - b. enable the USART3 in Asynchronous mode (for Nucleo 144) from the “Connectivity” category

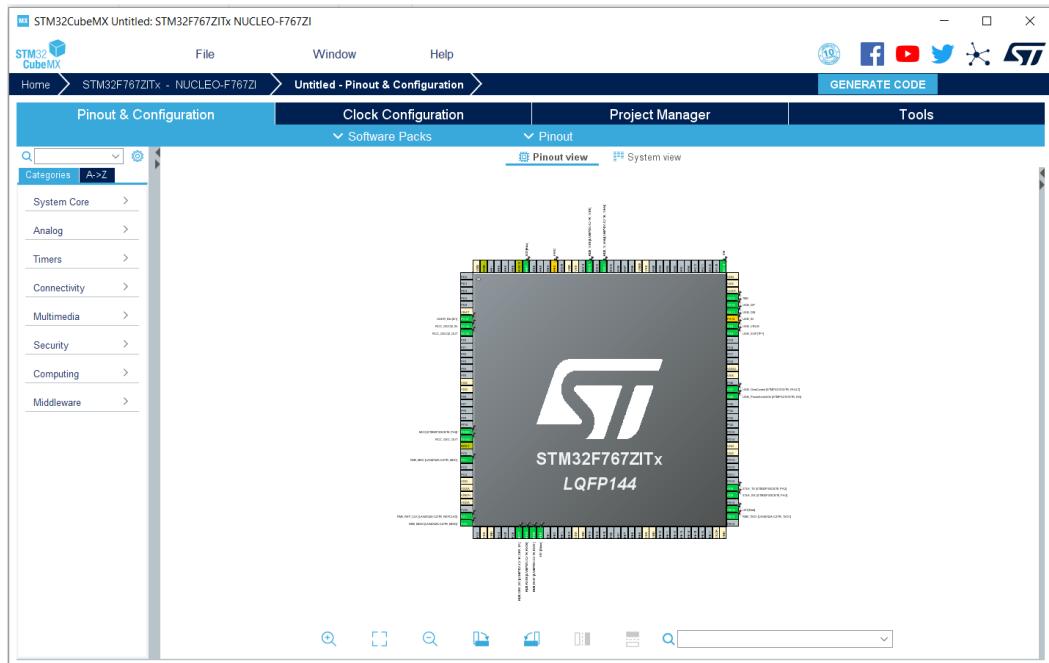
Note: The peripherals might be different, please check schematic of your board.

From the **Pinout** scheme, if not already set:

Nucleo 64			Nucleo 144		
PIN	Mode	Label	PIN	Mode	Label
PA2	USART2_TX	USART_TX	PD8	USART3_TX	STLK_RX
PA3	USART2_RX	USART_RX	PD9	USART3_RX	STLK_TX
PA5	GPIO_Output	LD2 [Green Led]	PB7	GPIO_Output	LD2[Blue]
PC13	GPIO_EXTI13	B1 [Blue PushButton]	PC13	GPIO_EXTI13	USER_Btn [B1]



**Figure 51 STM32CubeMX Pinout & Configuration tab for Nucleo 64**



**Figure 52 STM32CubeMX Pinout & Configuration tab for Nucleo 144**

From the **Software Packs** category, press the ‘STMicroelectronics.X-CUBE-MEMS1.x.x.x’ item, enable the “Board Extension IKS0XAX”, the “Device MEMS1 Applications” and all the “Sensors STM32 MotionXX Library” checkboxes from the “Mode” view.

Set the following “Platform Settings” from the “Configuration” view for Nucleo 64:

Name	IPs or Components	Found Solutions	BSP API
TIMER	TIM1_8:Internal Clock	TIM3	Unknown
BSP USART	USART:Asynchronous	USART2	BSP_COMMON_DRIVER
IKS0XAX BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
BSP LED	GPIO:Output	PA5	BSP_COMMON_DRIVER

Set the following “Platform Settings” from the “Configuration” view for Nucleo 144:

Name	IPs or Components	Found Solutions	BSP API
TIMER	TIM1_8F77:Internal Clock	TIM3	Unknown
BSP USART	USART:Asynchronous	USART3	BSP_COMMON_DRIVER
IKS0XAX BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
BSP LED	GPIO:Output	PB7	BSP_COMMON_DRIVER

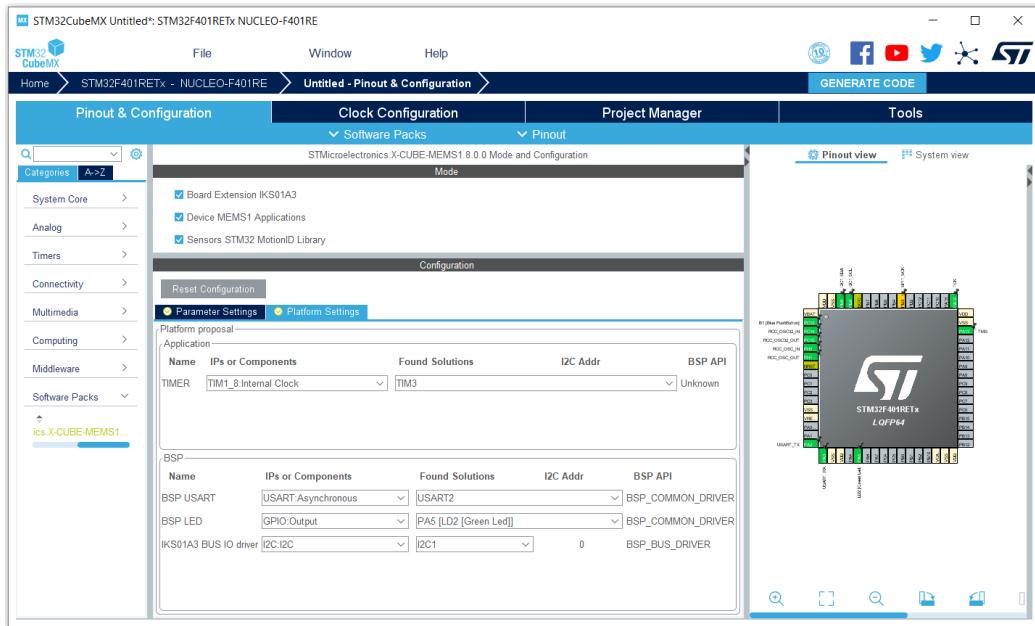
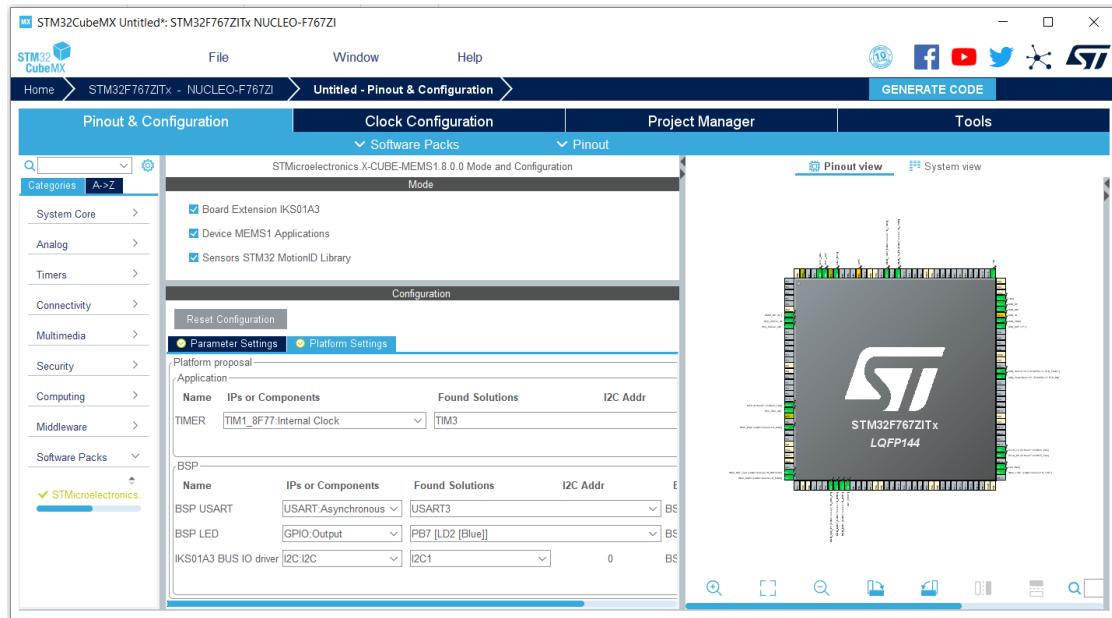


Figure 53 STM32CubeMX Pinout & Configuration tab and Software Packs settings for Nucleo 64

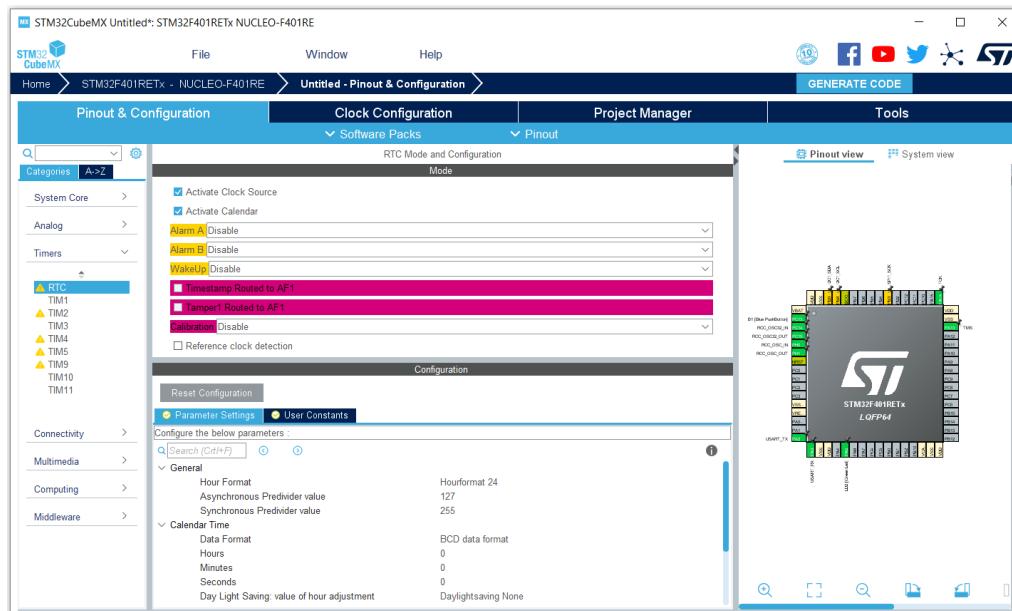


**Figure 54** STM32CubeMX Pinout & Configuration tab and Software Packs settings for Nucleo 144

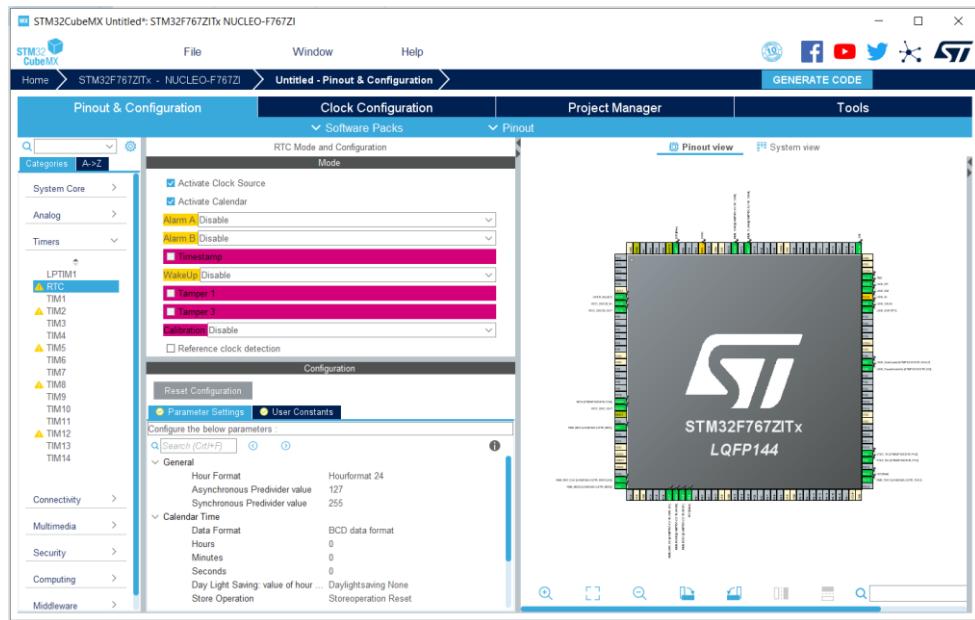
Setup RTC to use real time clock and date stamp in data stream sent from application to Unicleo-GUI. From the **Pinout & Configuration** tab, click on “Timers” category and then on RTC item:

- Check “Activate Clock Source”
- Check “Activate Calendar”

No need to fill the initial time and date since the FW will receive this information from Unicleo-GUI during startup connection.



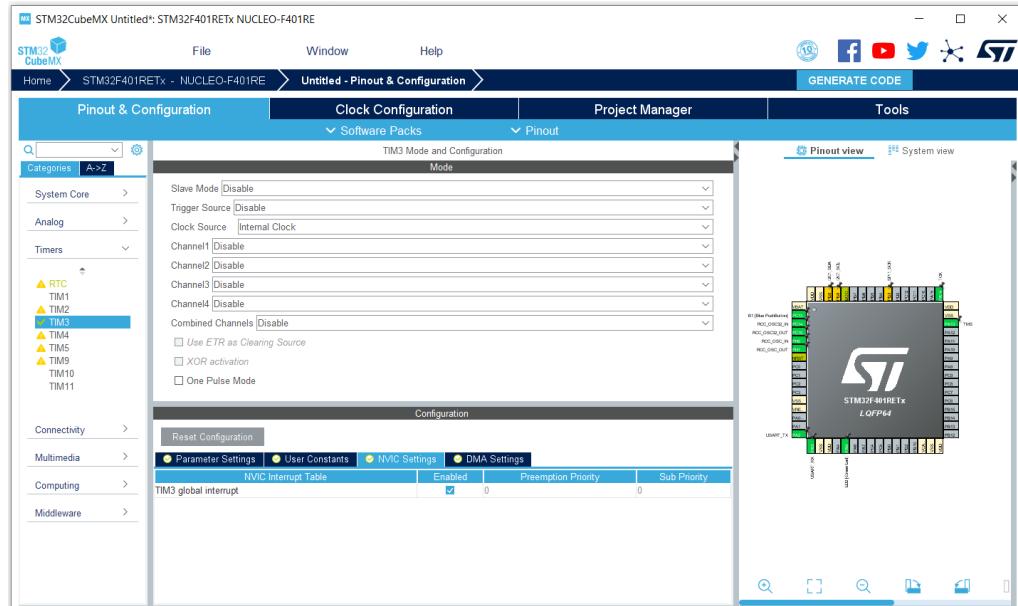
**Figure 55** STM32CubeMX RTC Configuration for Nucleo 64



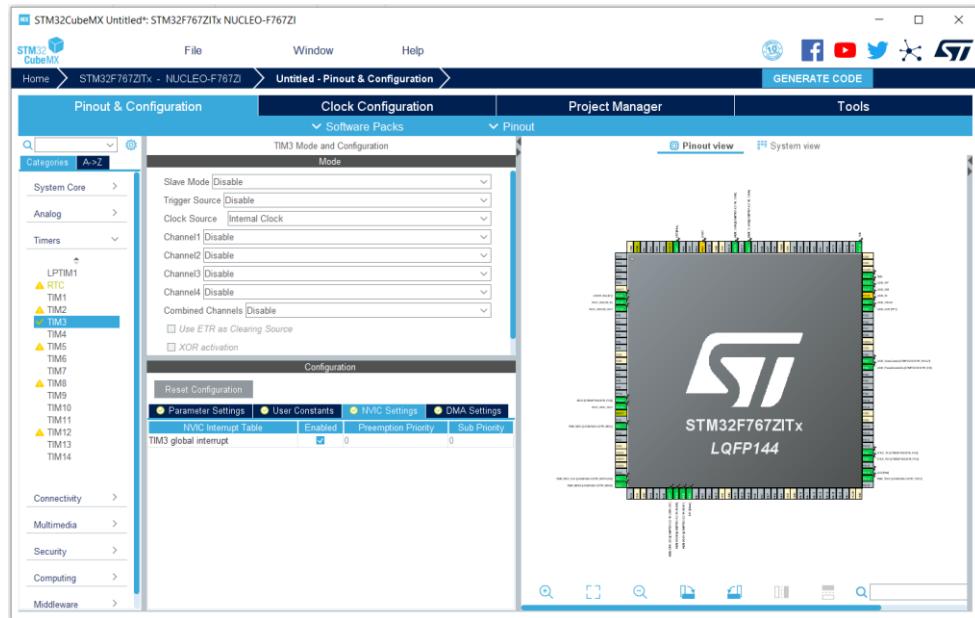
**Figure 56** STM32CubeMX RTC Configuration for Nucleo 144

Setup Timer for data acquisition precise timing. The selected Timer instance has to be able to raise the interrupt after counting to the desired value. From the **Pinout & Configuration** tab, click on “Timers” category and then on TIM3 item:

- Set “Clock Source” to “Internal Clock”
- In “NVIC Settings” tab check “TIM3 global interrupt”



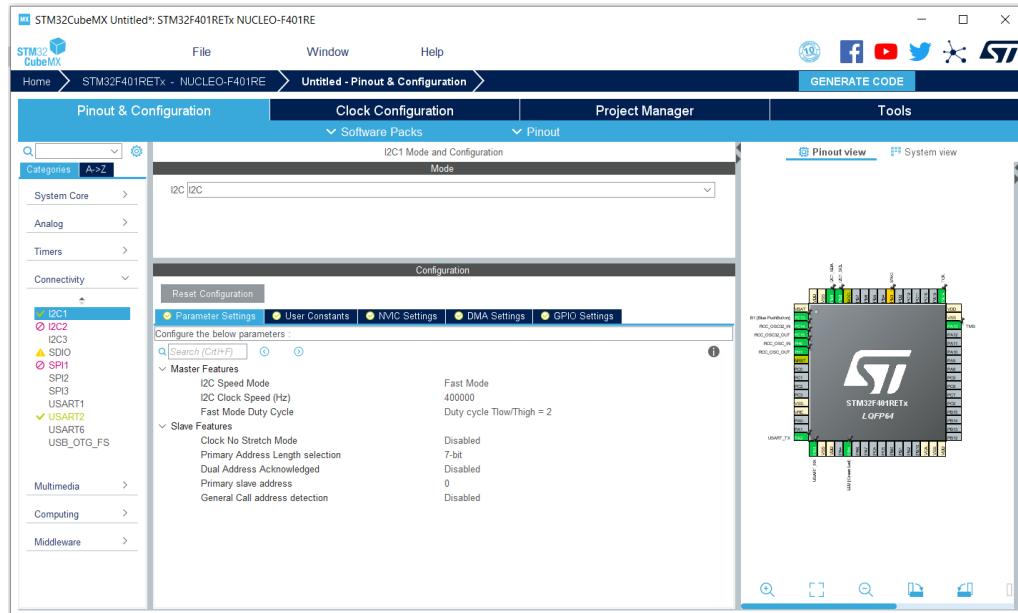
**Figure 57** STM32CubeMX TIM3 Configuration for Nucleo 64



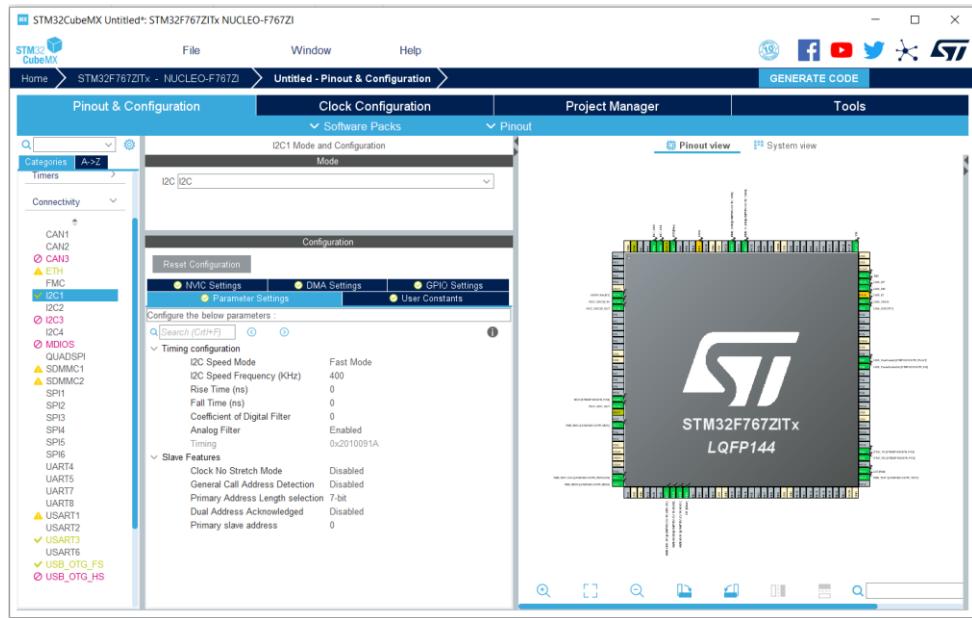
**Figure 58** STM32CubeMX TIM3 Configuration for Nucleo 144

Setup I2C for communication between sensor and MCU. From the **Pinout & Configuration** tab, click on “Connectivity” category and then on I2C1 item:

- Set I2C to I2C
- Configure the I2C1 settings with I2C speed at 400KHz (Fast Mode) from the “Configuration” view



**Figure 59** STM32CubeMX I2C1 Configuration for Nucleo 64



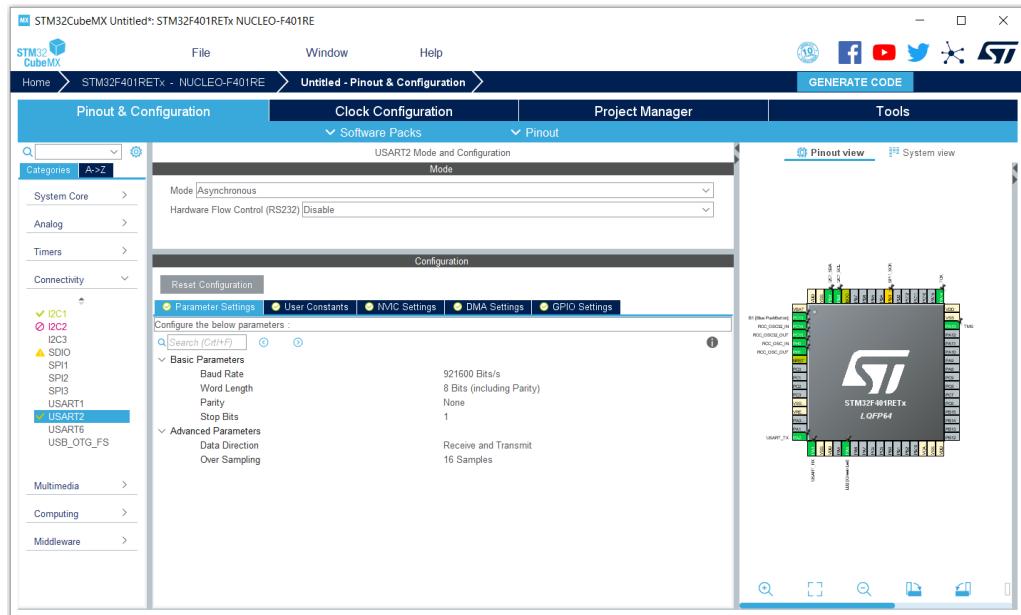
**Figure 60 STM32CubeMX I2C1 Configuration for Nucleo 144**

Setup USART for communication between MCU (FW) and PC (Unicleo-GUI). From the **Pinout & Configuration** tab, click on “Connectivity” category and then on USART2 item (Nucleo 64) or USART3 item (Nucleo 144):

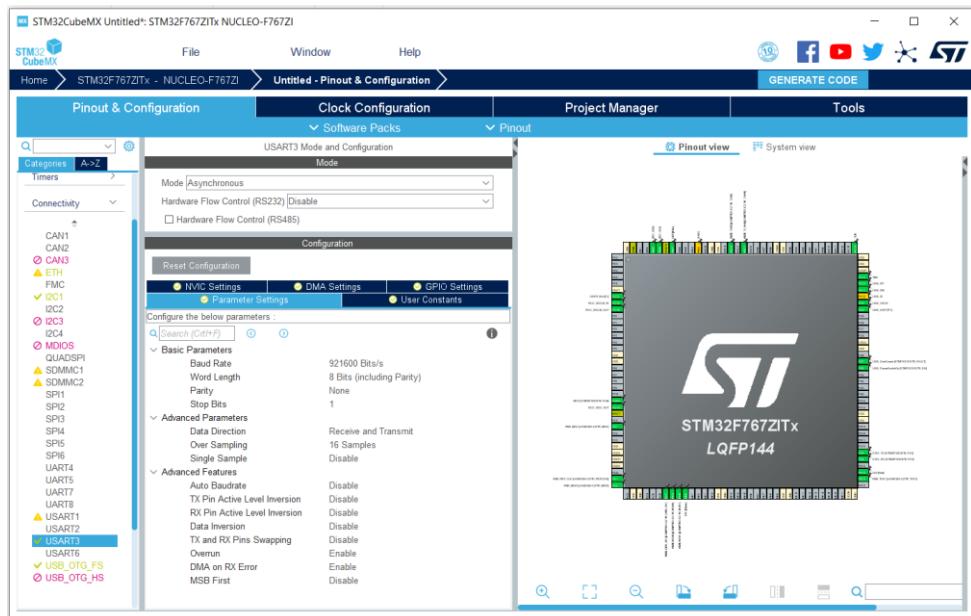
- Select Asynchronous Mode

At “Parameter Settings” tab:

- Set Baud Rate to 921600 Bits/s
- Set Word Length to 8 Bits (including Parity)
- Set Parity to None
- Set Stop Bits to 1
- The rest is filled automatically



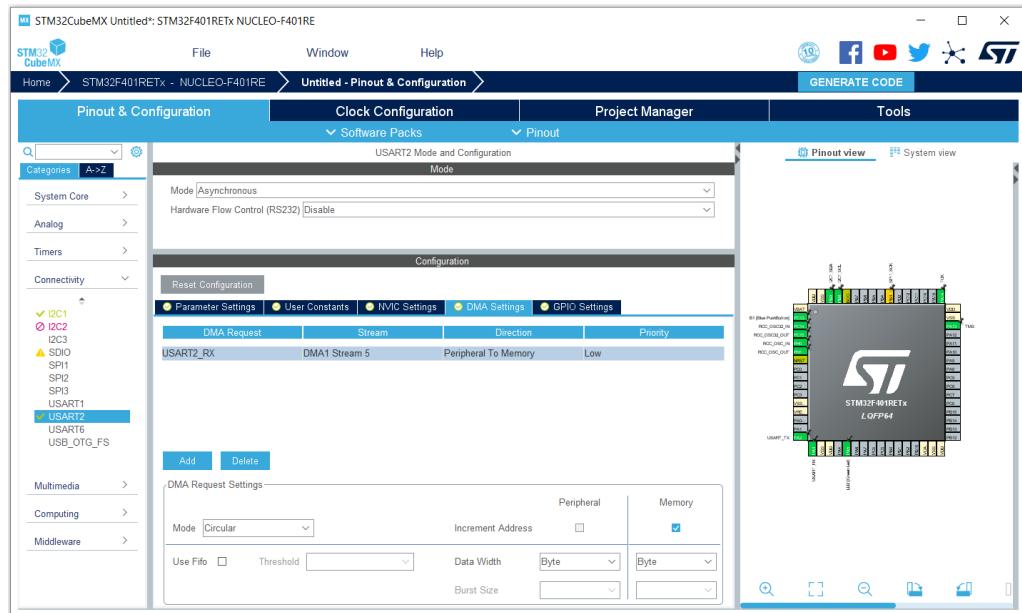
**Figure 61** STM32CubeMX USART2 Configuration for Nucleo 64



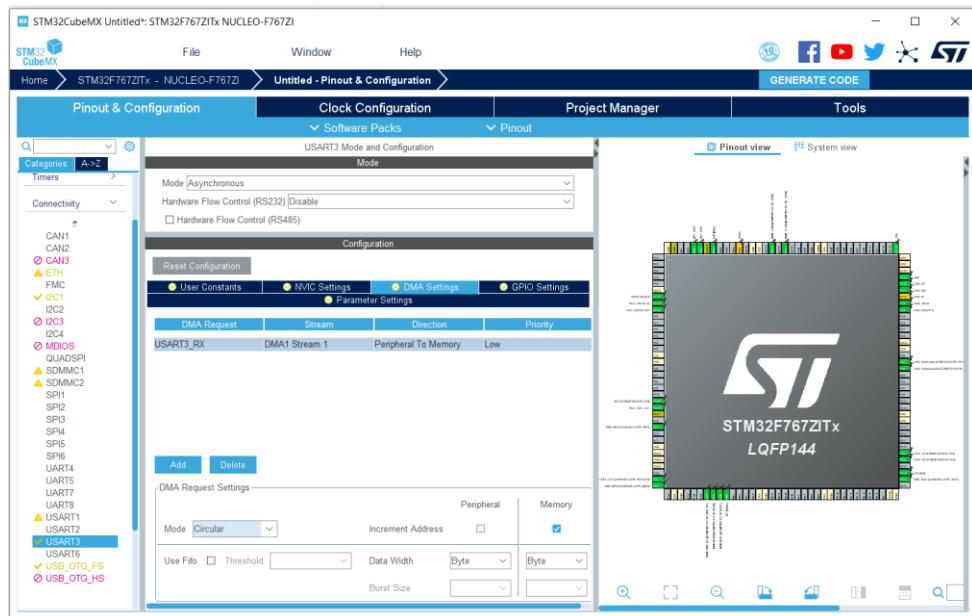
**Figure 62** STM32CubeMX USART3 Configuration for Nucleo 144

Setup USART DMA for receiving data from Unicoleo-GUI. At “DMA Settings” tab:

- Click Add button and select USART2\_RX for Nucleo 64 or USART3\_RX for Nucleo 144
- Select Circular Mode
- Check Memory Increment Address
- The rest is filled automatically



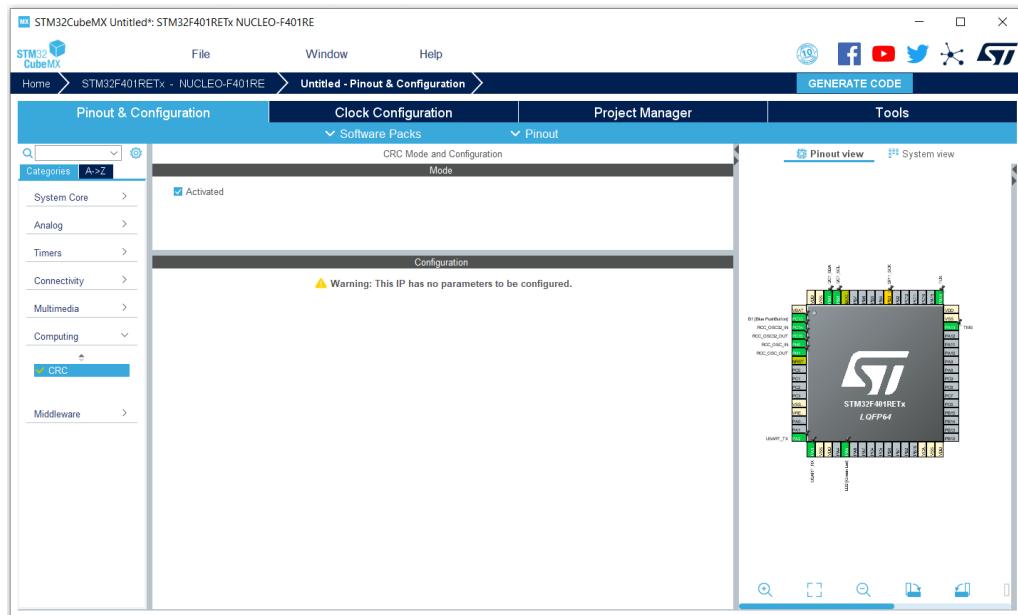
**Figure 63** STM32CubeMX USART2\_RX DMA Configuration for Nucleo 64



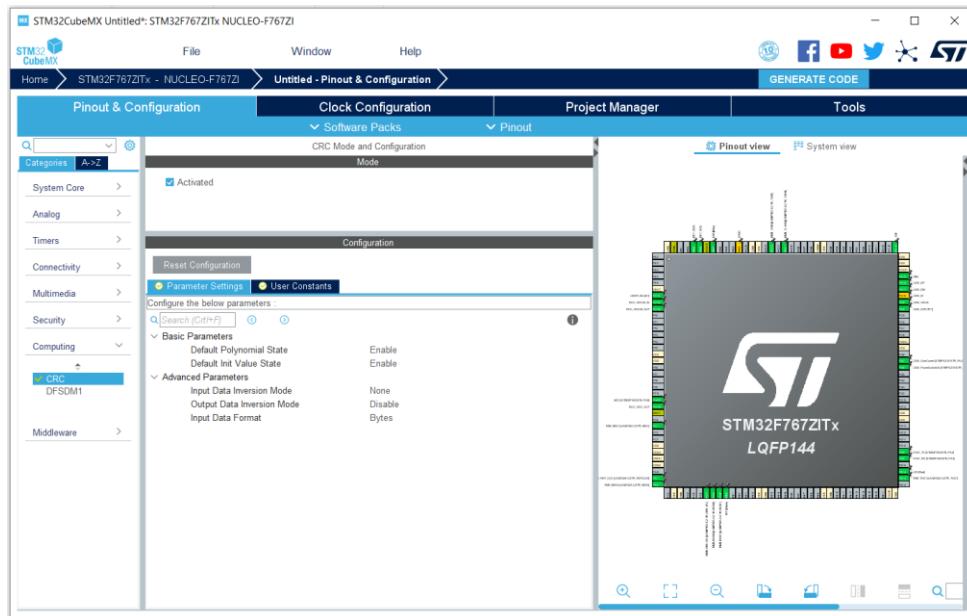
**Figure 64** STM32CubeMX USART3\_RX DMA Configuration for Nucleo 144

Setup CRC for Cyclic Redundancy Check used for library integrity verification. From the **Pinout & Configuration** tab, click on “Computing” category and then on CRC item:

- Check Activated Mode



**Figure 65** STM32CubeMX CRC Configuration for Nucleo 64



**Figure 66** STM32CubeMX CRC Configuration for Nucleo 144

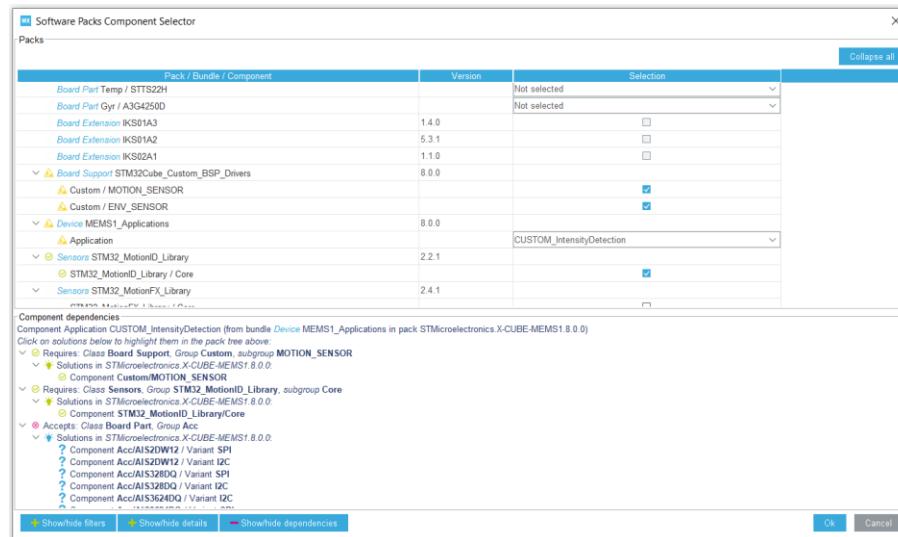
Once all the above described steps have been performed, the middleware applications for IKS01A2 or IKS01A3 or IKS02A1 using the **STMicroelectronics X-CUBE-MEMS1** software can be generated clicking the “GENERATE CODE” button.

## 7.5

## Use of MEMS Library with middleware applications for custom boards

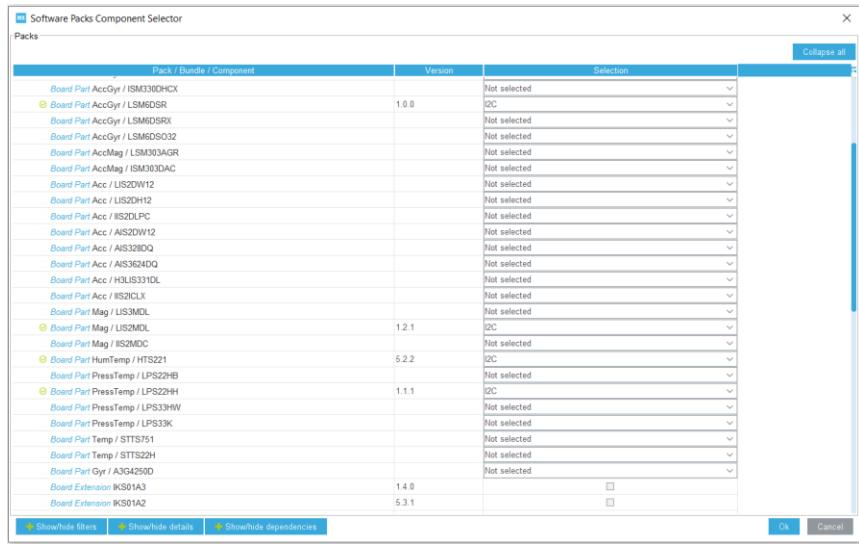
This section outlines how to configure STM32CubeMX with a custom board that mounts MEMS devices when the use of the middleware applications is required. In this case you can configure the MEMS device in order to be used via I2C bus or via SPI bus (only 4-Wires).

To add the X-CUBE-MEMS1 software pack to the project, the “Software Packs” button and then the “Select Components” item must be clicked. From the “Software Packs Component Selector” window, the user has to select the “Board Support” class, an application from the “Device” class and “Sensors” class as shown in the figure below.



**Figure 67 STM32CubeMX Software Packs Component Selector window example for a custom board - Step 1**

Then user has to select the “Board Part” class and add all sensors according to real custom board configuration.



**Figure 68 STM32CubeMX Software Packs Component Selector** window example for a custom board – Step 2

From the **Pinout & Configuration** tab:

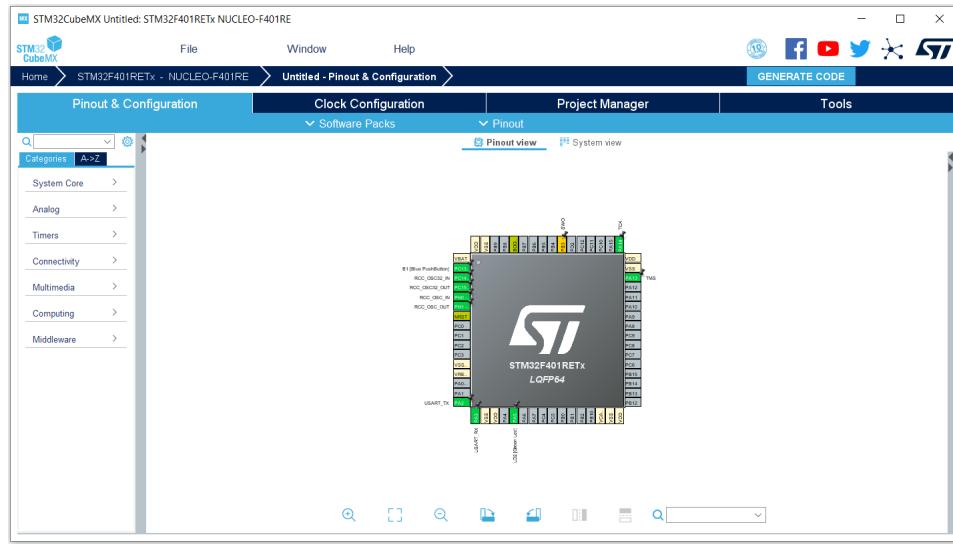
- from the **Pinout** scheme, click on PB8 and set it as I2C1\_SCL;
  - from the **Pinout** scheme, click on PB9 and set it as I2C1\_SDA;
  - enable the I2C1 as I2C from the “Connectivity” category;
  - if not enabled yet:
    - a. enable the USART2 in Asynchronous mode (for Nucleo 64) from the “Connectivity” category
    - b. enable the USART3 in Asynchronous mode (for Nucleo 144) from the “Connectivity” category

Note: The peripherals might be different, please check schematic of your board.

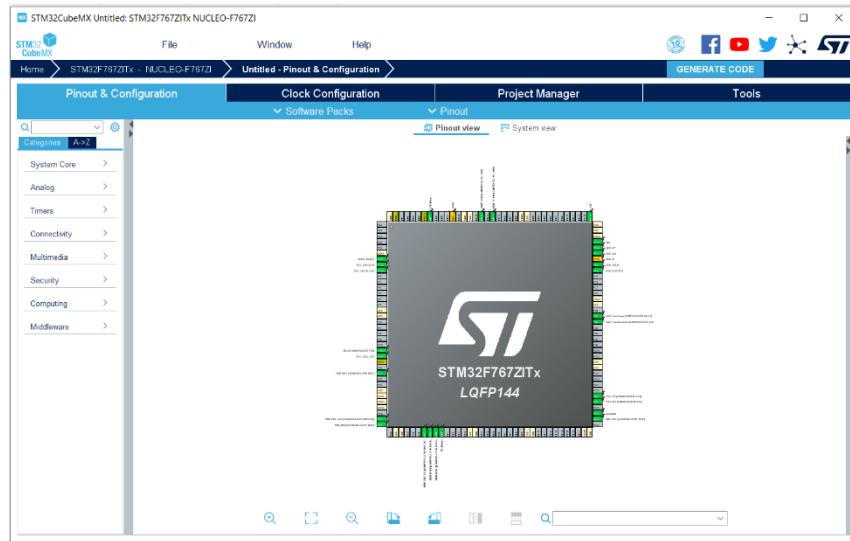
From the **Pinout** scheme, if not already set:

Nucleo 64			Nucleo 144		
<i>PIN</i>	<i>Mode</i>	<i>Label</i>	<i>PIN</i>	<i>Mode</i>	<i>Label</i>
PC0	GPIO_Input		PF10 <sup>1)</sup>	GPIO_Input	
PA2	USART2_TX	USART_TX	PD8	USART3_TX	STLK_RX
PA3	USART2_RX	USART_RX	PD9	USART3_RX	STLK_TX
PA5	GPIO_Output	LD2 [Green Led]	PB7	GPIO_Output	LD2[Blue]
PC13	GPIO_EXTI13	B1 [Blue PushButton]	PC13	GPIO_EXTI13	USER_Btn [B1]

1) Might differ for various Nucleo 144 boards – e.g.: PD13, PC5. Check with datasheet.



**Figure 69 STM32CubeMX Pinout & Configuration tab for Nucleo 64**



**Figure 70 STM32CubeMX Pinout & Configuration tab for Nucleo 144**

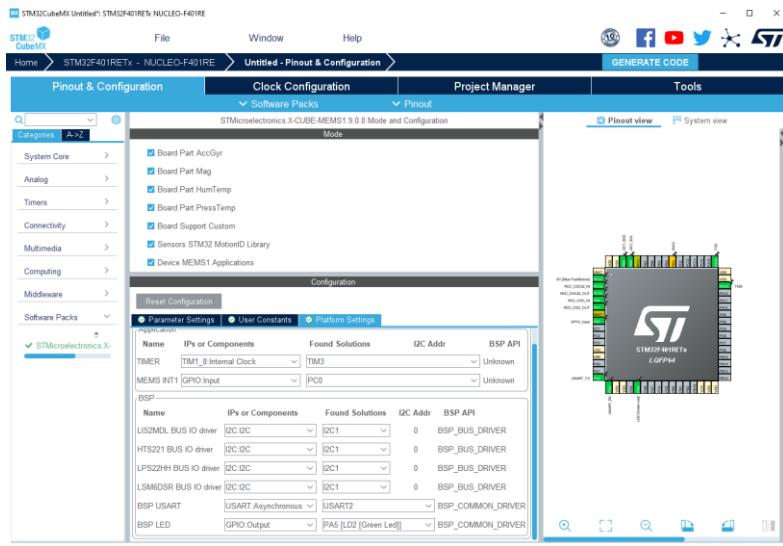
From the **Software Packs** category, press the ‘STMicroelectronics.X-CUBE-MEMS1.x.x.x’ item, enable all the “Board Part” elements, the “Board Support Custom”, the “Device MEMS1 Applications” and all the “Sensors STM32\_MotionXX\_Library” checkboxes from the “Mode” view.

Set the “Platform Settings” and the “Parameter Settings” from the “Configuration” view according your custom board (take into account that according the example chosen some settings can appear or not). A sample of configuration for Nucleo 64 is shown below:

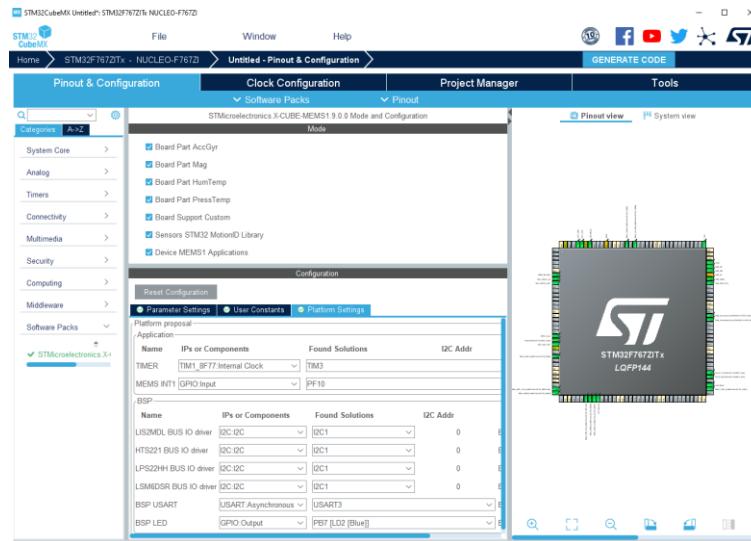
Name	IPs or Components	Found Solutions	BSP API
TIMER	TIM1_8:Internal Clock	TIM3	Unknown
MEMS INT1	GPIO:Input	PC0	Unknown
LIS2MDL BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
HTS221 BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
LPS22HH BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
LSM6DSR BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
BSP USART	USART:Asynchronous	USART2	BSP_COMMON_DRIVER
BSP LED	GPIO:Output	PA5	BSP_COMMON_DRIVER

Set the “Platform Settings” and the “Parameter Settings” from the “Configuration” view according your custom board (take into account that according the example chosen some settings can appear or not). A sample of configuration for Nucleo 144 is shown below:

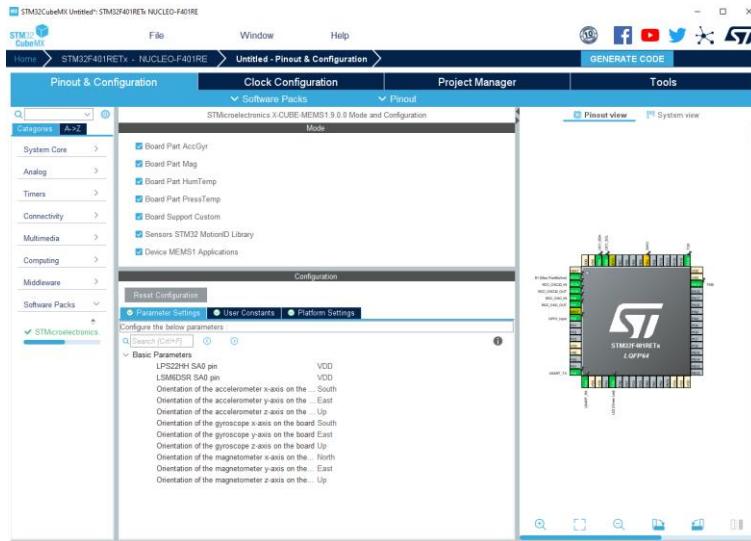
Name	IPs or Components	Found Solutions	BSP API
TIMER	TIM1_8F77:Internal Clock	TIM3	Unknown
MEMS INT1	GPIO:Input	PF10	Unknown
LIS2MDL BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
HTS221 BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
LPS22HH BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
LSM6DSR BUS IO driver	I2C:I2C	I2C1	BSP_BUS_DRIVER
BSP USART	USART:Asynchronous	USART3	BSP_COMMON_DRIVER
BSP LED	GPIO:Output	PB7	BSP_COMMON_DRIVER



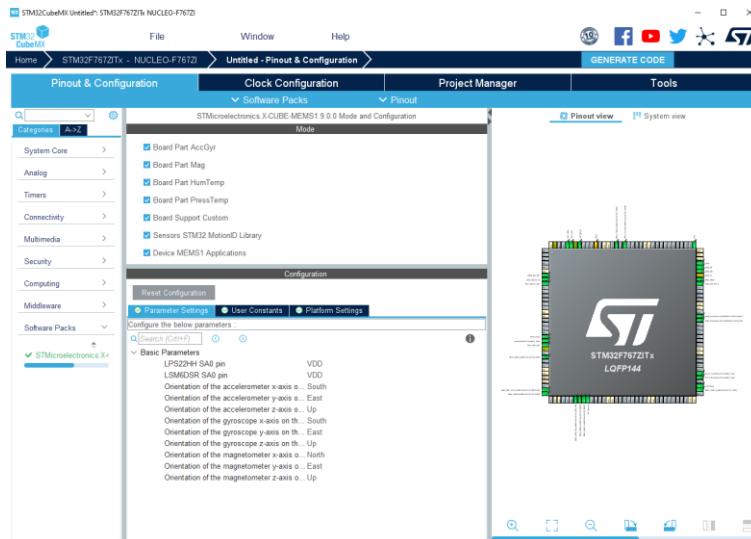
**Figure 71** STM32CubeMX Pinout & Configuration tab and “Software Packs - Platform Settings” for Nucleo 64



**Figure 72** STM32CubeMX Pinout & Configuration tab and “Software Packs - Platform Settings” for Nucleo 144



**Figure 73** STM32CubeMX **Pinout & Configuration** tab and “Software Packs - Parameter Settings” for Nucleo 64

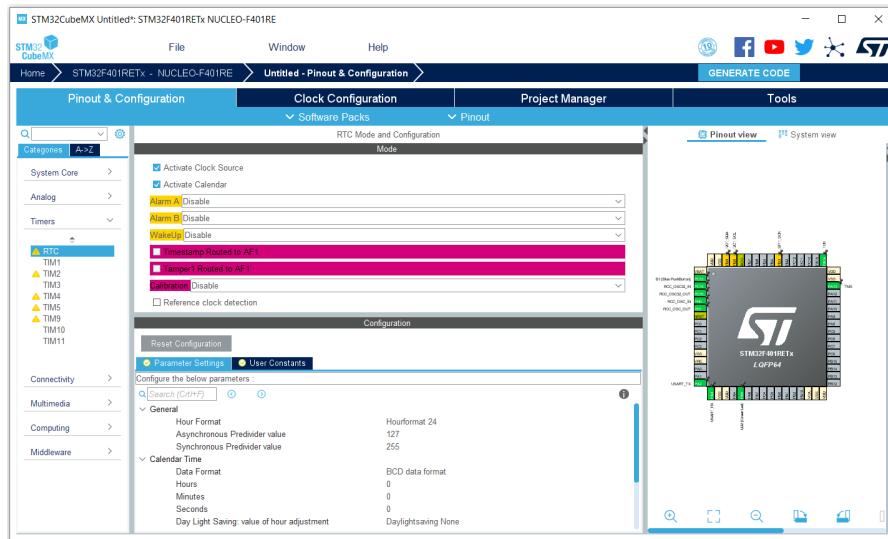


**Figure 74** STM32CubeMX **Pinout & Configuration** tab and “Software Packs - Parameter Settings” for Nucleo 144

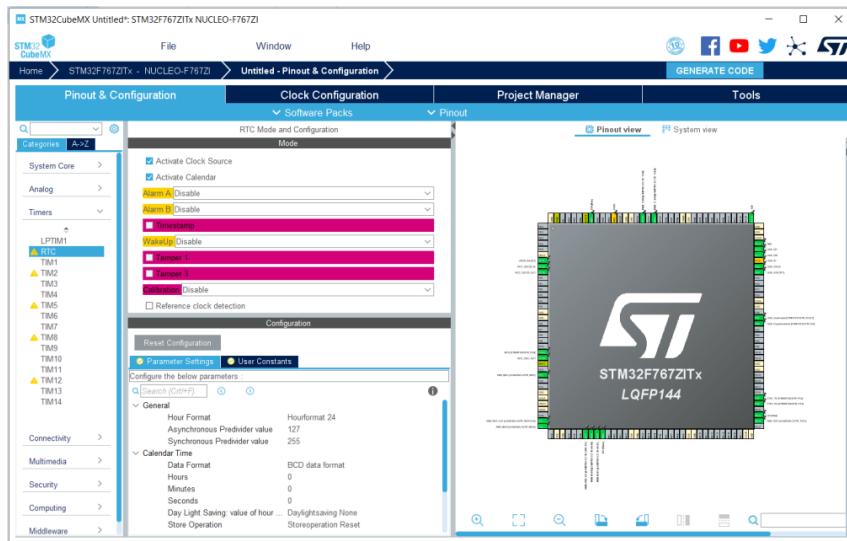
Setup RTC to use real time clock and date stamp in data stream sent from application to Unicleo-GUI. From the **Pinout & Configuration** tab, click on “Timers” category and then on RTC item:

- Check “Activate Clock Source”
- Check “Activate Calendar”

No need to fill the initial time and date since the FW will receive this information from Unicleo-GUI during startup connection.



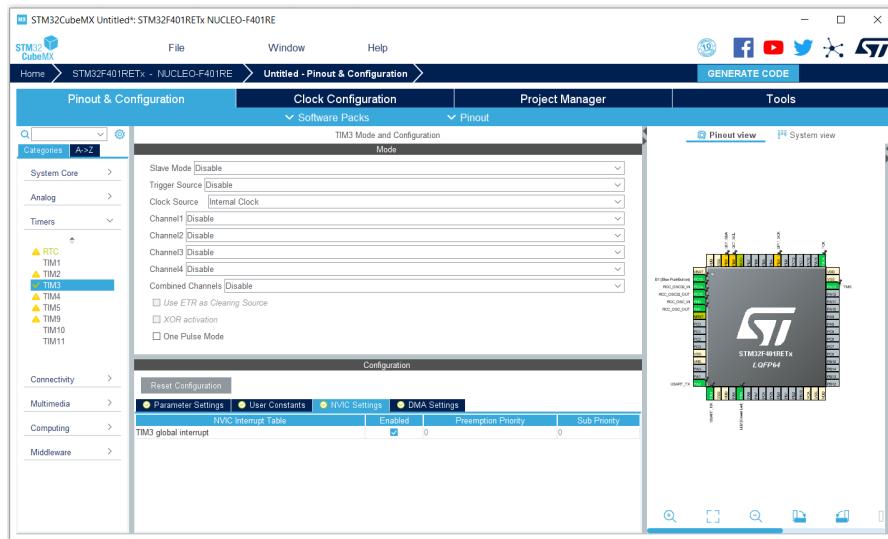
**Figure 75** STM32CubeMX RTC Configuration for Nucleo 64



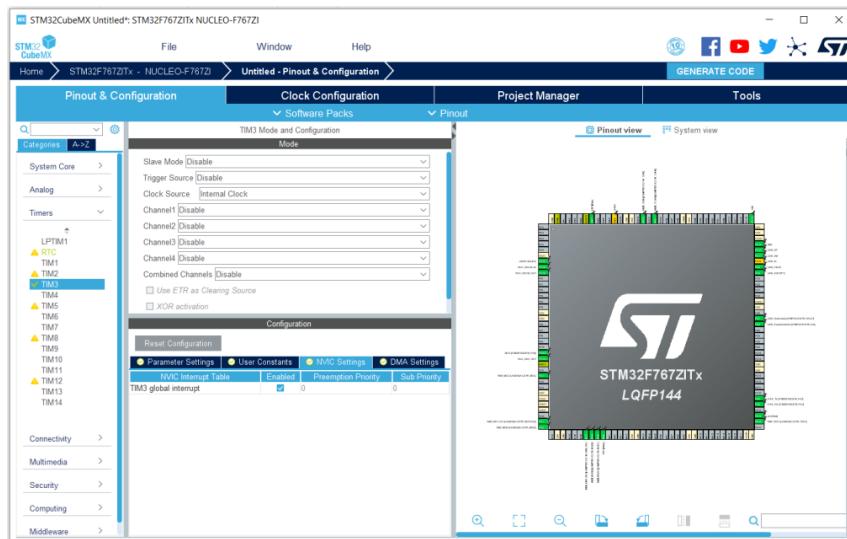
**Figure 76** STM32CubeMX RTC Configuration for Nucleo 144

Setup Timer for data acquisition precise timing. The selected Timer instance has to be able to raise the interrupt after counting to the desired value. From the **Pinout & Configuration** tab, click on “Timers” category and then on TIM3 item:

- Set “Clock Source” to “Internal Clock”
- In “NVIC Settings” tab check “TIM3 global interrupt”



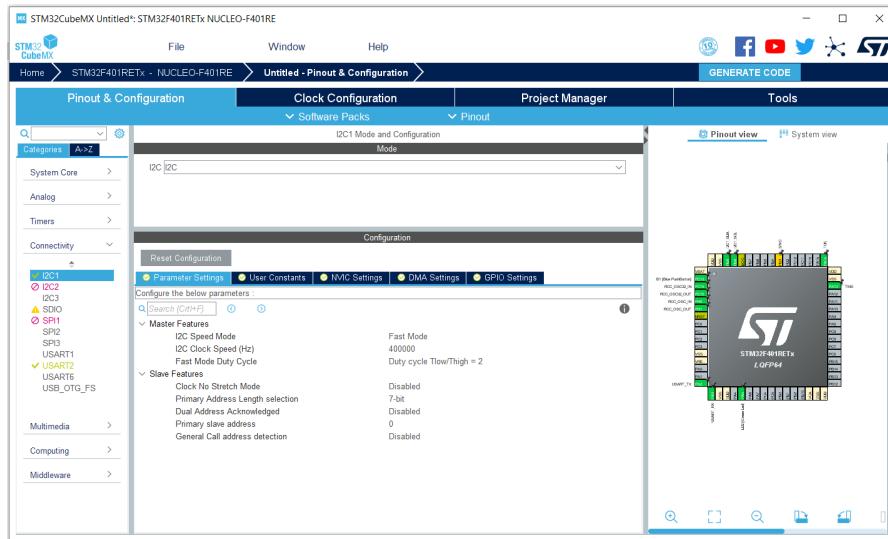
**Figure 77** STM32CubeMX TIM3 Configuration for Nucleo 64



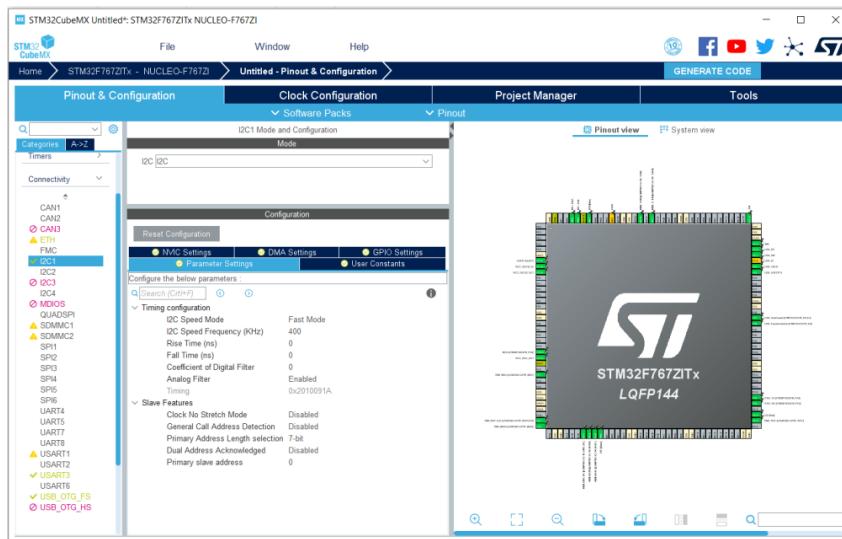
**Figure 78** STM32CubeMX TIM3 Configuration for Nucleo 144

Setup I2C for communication between sensor and MCU. From the **Pinout & Configuration** tab, click on “Connectivity” category and then on I2C1 item:

- Set I2C to I2C
- Configure the I2C1 settings with I2C speed at 400KHz (Fast Mode) from the “Configuration” view



**Figure 79** STM32CubeMX I2C1 Configuration for Nucleo 64



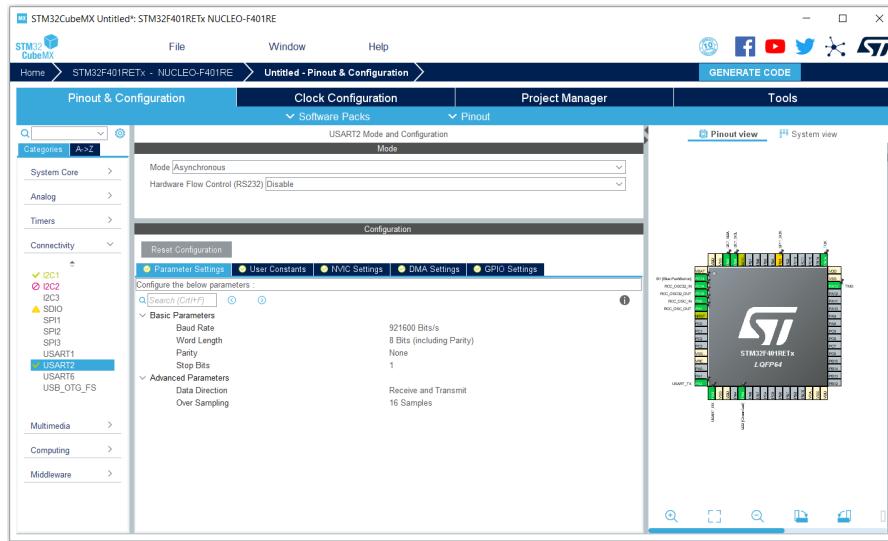
**Figure 80** STM32CubeMX I2C1 Configuration for Nucleo 144

Setup USART for communication between MCU (FW) and PC (Unicleo-GUI). From the **Pinout & Configuration** tab, click on “Connectivity” category and then on USART2 item (Nucleo 64) or USART3 item (Nucleo 144):

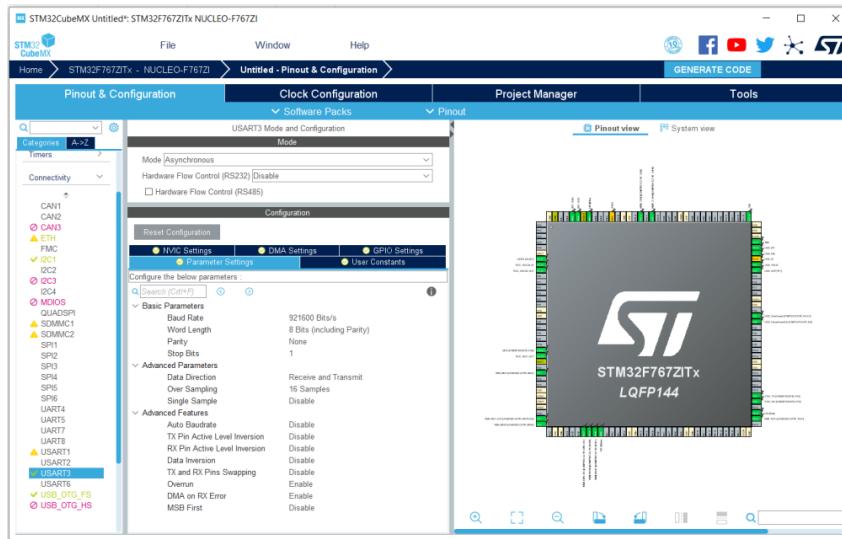
- Select Asynchronous Mode

At “Parameter Settings” tab:

- Set Baud Rate to 921600 Bits/s
- Set Word Length to 8 Bits (including Parity)
- Set Parity to None
- Set Stop Bits to 1
- The rest is filled automatically



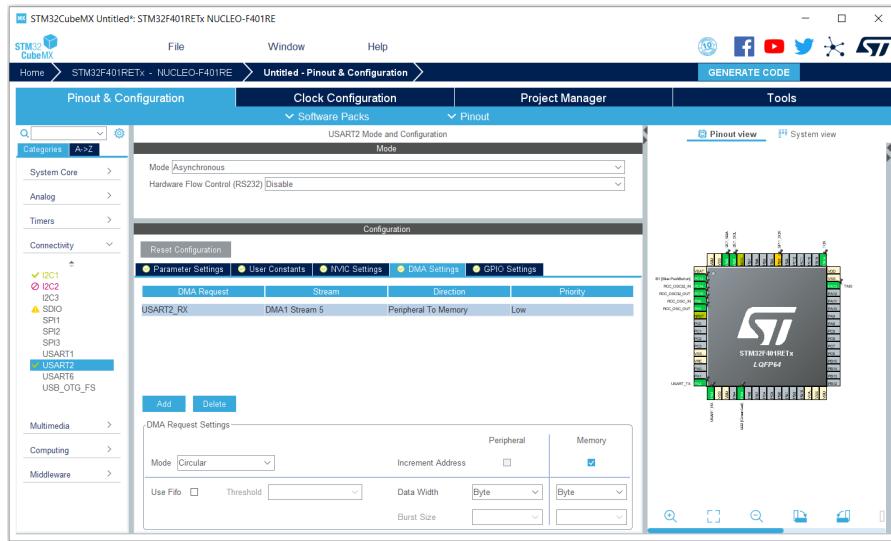
**Figure 81** STM32CubeMX USART2 Configuration for Nucleo 64



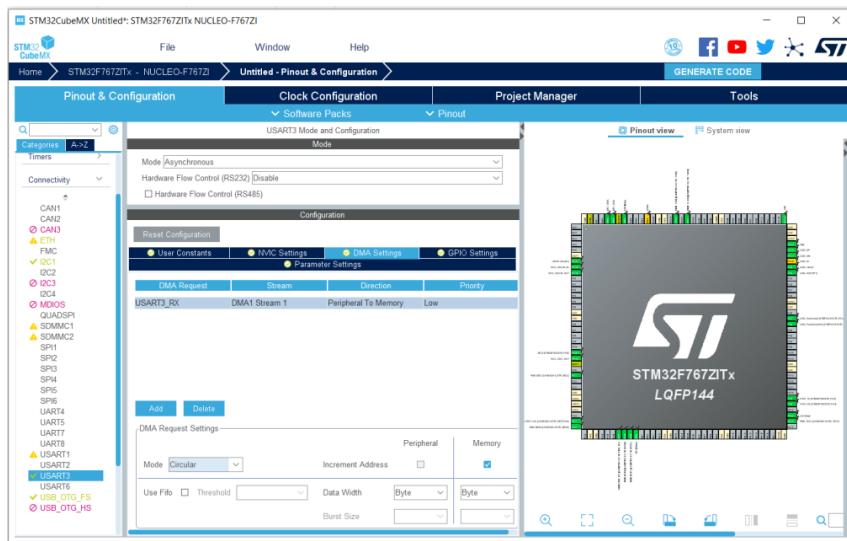
**Figure 82** STM32CubeMX USART3 Configuration for Nucleo 144

Setup USART DMA for receiving data from Unicole-GUI. At “DMA Settings” tab:

- Click Add button and select USART2\_RX for Nucleo 64 or USART3\_RX for Nucleo 144
- Select Circular Mode
- Check Memory Increment Address
- The rest is filled automatically



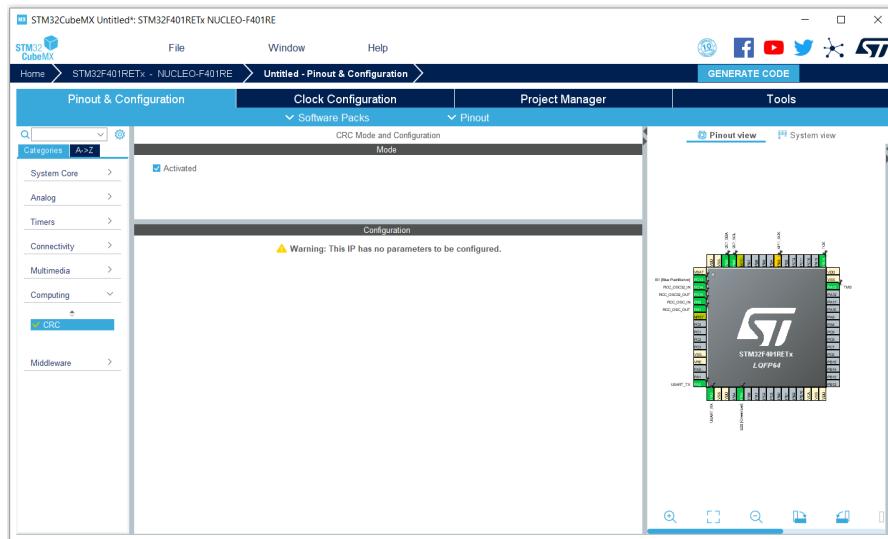
**Figure 83** STM32CubeMX USART2\_RX DMA Configuration for Nucleo 64



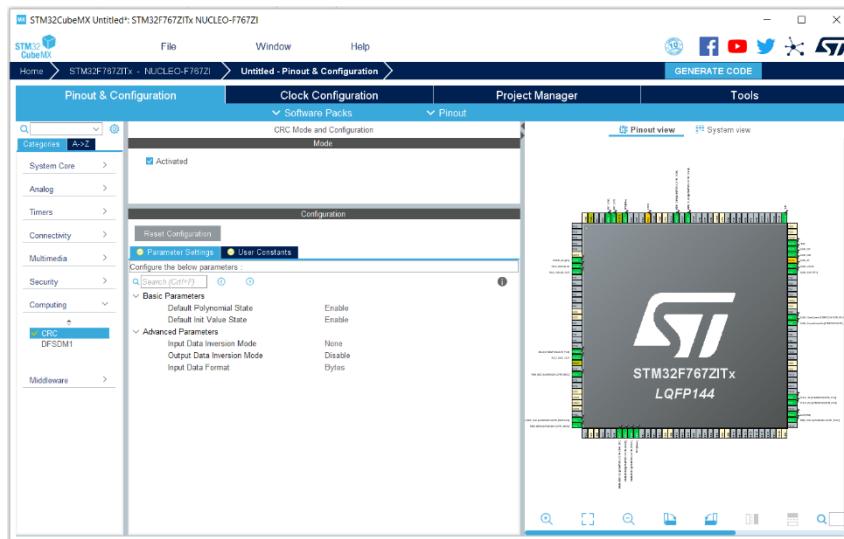
**Figure 84** STM32CubeMX USART3\_RX DMA Configuration for Nucleo 144

Setup CRC for Cyclic Redundancy Check used for library integrity verification. From the **Pinout & Configuration** tab, click on “Computing” category and then on CRC item:

- Check Activated Mode



**Figure 85** STM32CubeMX CRC Configuration for Nucleo 64



**Figure 86** STM32CubeMX CRC Configuration for Nucleo 144

Once all the above described steps have been performed, the middleware applications for custom boards using the **STMicroelectronics X-CUBE-MEMS1** software can be generated clicking the “GENERATE CODE” button.

## 8

## Generated Folders Structure

When generating a project, two models of folders structure can be adopted when using a high level firmware component (i.e. a middleware in the STM32Cube MCU package):

- **Basic Structure:** the basic structure is often used with HAL examples and single

package projects. This structure consists of having the IDE configuration folder in the same level as the sources (organized in *Inc* and *Src* subfolders).

- **Advanced Structure:** the advanced structure provides a more efficient and organized folders model that allows ease middleware applications integration when several packages are used.

In the Advanced mode *Src* and *Inc* are generated under folder *Core*.

For each package, the list of the generated files is under <*ModuleName*> (*MEMS* for the X-CUBE-MEMS1 pack), at the same level as *Core* and containing inside the *App* and the *Target* subfolder.

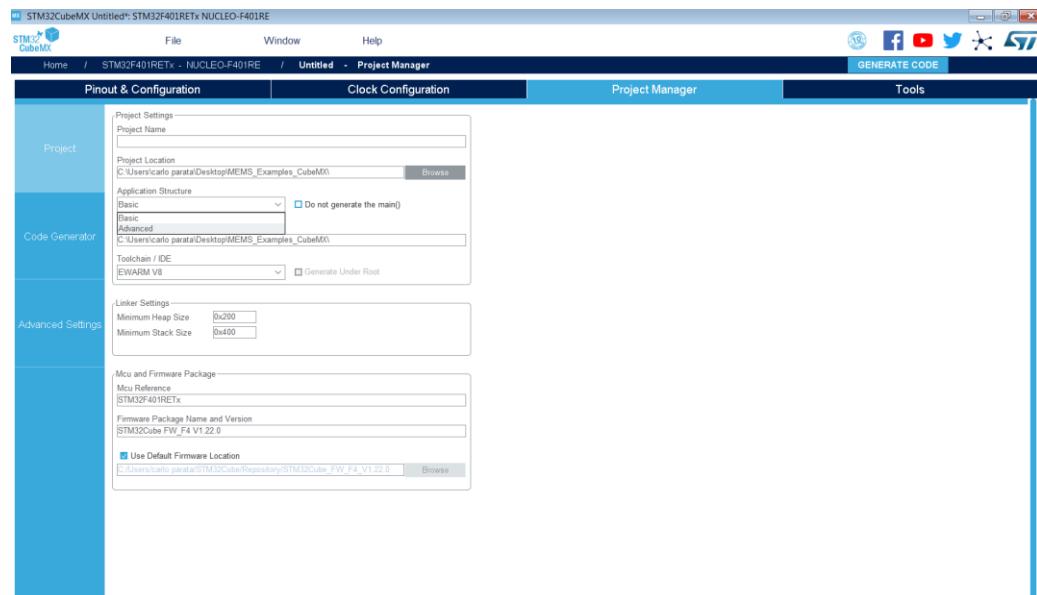


Figure 87 STM32CubeMX Application Structure Configuration

## 9

## Known Limitations and workarounds

On dual-core STM32 series this expansion software can be used on both cores but exclusively.

The projects for the MDK-ARM toolchain can be generated by default with the MicroLIB disabled for some STM32 families. In this case, some MEMS applications, that send data to the VCOM, do not work properly. To avoid this issue please check that “Use MicroLIB” option is always enabled in the MDK-ARM project options.

## 9

## References

- [1] [UM1859](#) – User Manual - *Getting started with the X-CUBE-MEMS1 Motion MEMS and environmental sensor software expansion for STM32Cube*

## 10 Revision history

Table 2: Document revision history

Date	Version	Changes
11-Sep-2018	1	Initial release
07-Nov-2018	2	Update the manual to CubeMX v5.0.0 GUI
22-Nov-2018	3	Update pack version number
14-Feb-2019	4	Add IKS01A3 support
10-Feb-2020	5	Add 10 Middleware applications description
13-May-2020	6	Add 2 Middleware applications description
23-Jun-2020	7	Add IKS02A1 Middleware applications description
16-Aug-2020	8	Add AccelCalibration2_IIS2ICLX / TiltSensing2_IIS2ICLX description
12-Sep-2020	9	Adapt to CubeMX MEMS pack v8.1.1
13-Nov-2020	10	Add 9 new applications in CubeMX MEMS pack
09-Oct-2022	11	Update known limitations
31-Mar-2023	12	Add PresenceDetection_STHS34PF80 application description

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