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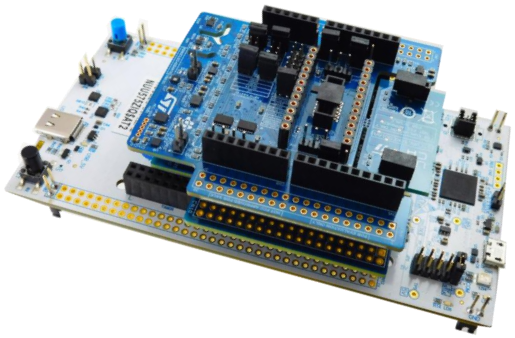

Quick Start Guide

STM32Cube function pack for IoT node with BLE connectivity, environmental and motion sensors (FP-SNS-MOTENV1)

Version 3.2 (September 16, 2025)

Agenda

1. Hardware and Software overview
2. Setup & Demo Examples
3. Documents & Related Resources
4. STM32 Open Development Environment: Overview

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1- Hardware and Software overview

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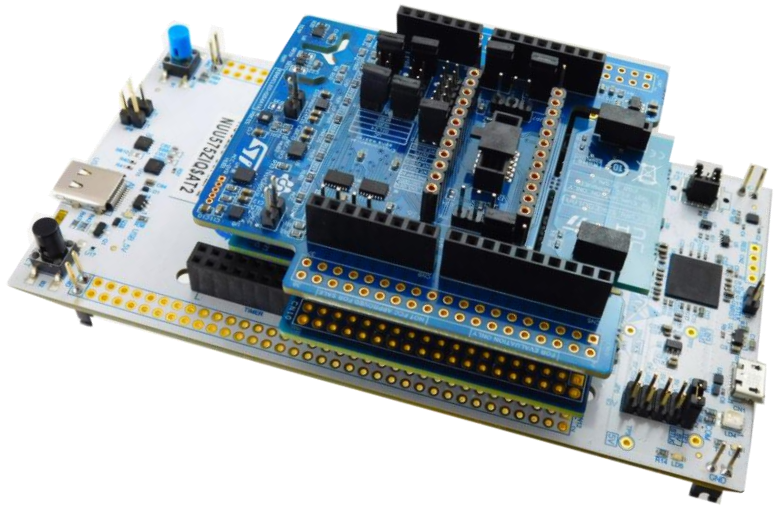
Hardware Overview

Sample implementations are available for STM32 Nucleo development boards plugged on STM32 Nucleo expansion boards:

- NUCLEO-U575ZI-Q (or NUCLEO-F401RE or NUCLEO-L476RG or NUCLEO-LO53R8) + X-NUCLEO-BNRG2A1 + X-NUCLEO-IKS4A1



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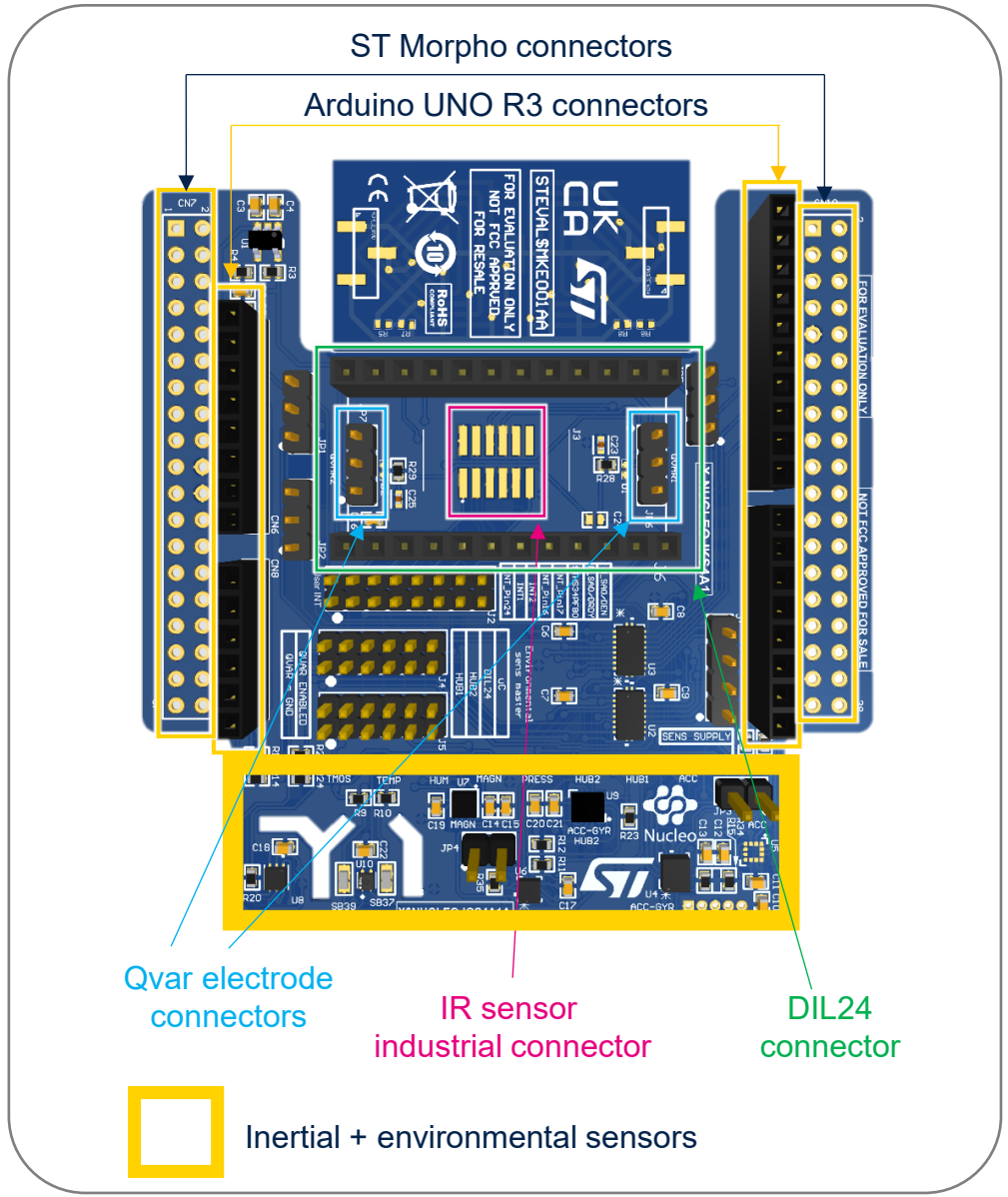
Motion MEMS and environmental sensors expansion board
Hardware Overview (1/5)

X-NUCLEO-IKS4A1 Hardware Description (1/2)

- The X-NUCLEO-IKS4A1 is a motion MEMS and environmental sensor evaluation board system.
- This expansion board allows application development with features like Sensor HUB,camera module integration and QVAR touch/ swipe gestures.
- It is compatible with the Arduino UNO R3 connector layout, and is designed around ST's latest sensors.

Key Product on board

- LMS6DSO16IS: MEMS 3D accelerometer (±2/±4/±8/±16 g) + 3D gyroscope (±125/±250/±500/±1000/±2000 dps) with ISPU (Intelligent Processing
- LIS2MDL: MEMS 3D magnetometer (±50 gauss)
- LIS2DUXS12: Ultra low-power MEMS 3D accelerometer (±2/±4/±8/±16 g) with Qvar, AI, & anti-aliasing
- LPS22DF: Low-power and high-precision MEMS pressure sensor, 260-1260 hPa absolute digital output barometer
- SHT40AD1B: humidity sensor from Sensirion
- STTS22H: Low-voltage, ultralow-power, 0.5 °C accuracy temperature sensor (–40 °C to +125 °C)
- LSM6DSV16X: MEMS 3D accelerometer (±2/±4/±8/±16 g) + 3D gyroscope (±125/±250/±500/±1000/±2000/±4000 dps) with embedded sensor fusion, AI, Qvar



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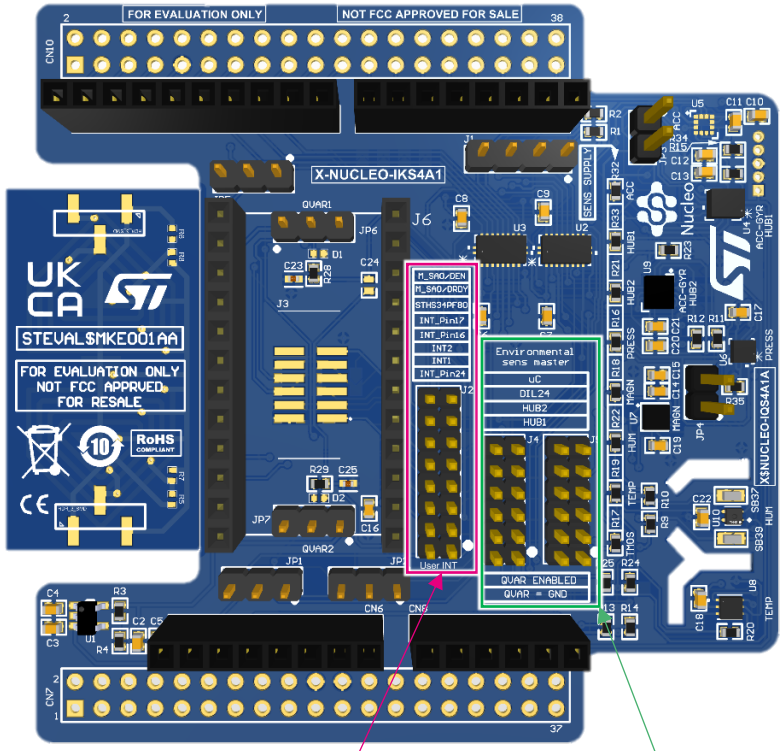
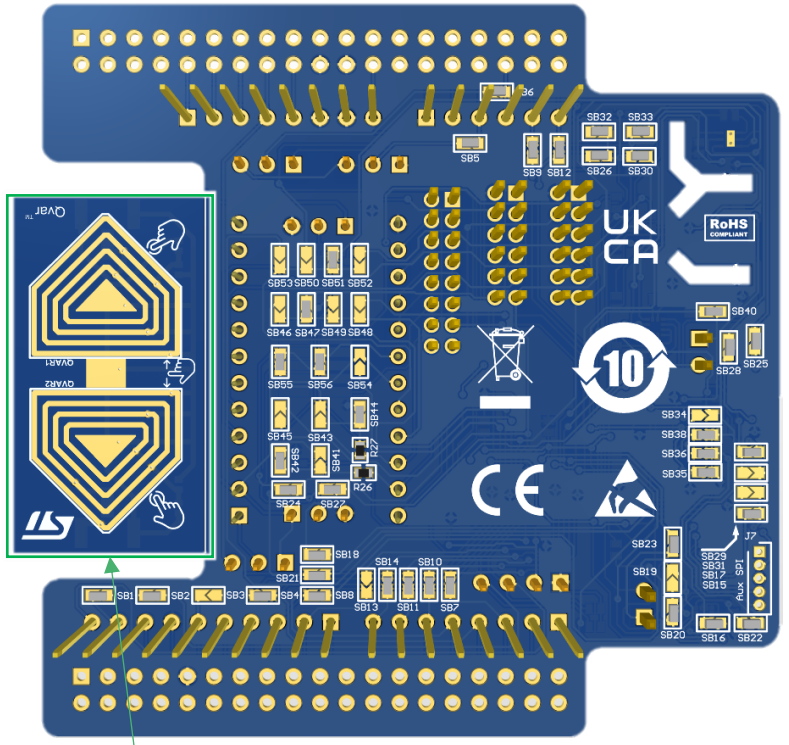
Motion MEMS and environmental sensors expansion board
Hardware Overview (2/5)

X-NUCLEO-IKS4A1 Hardware Description (2/2)

Top view



Bottom view



DIL24 + humidity sensor INT selelctor

I2C bus + Qvar enable selector

Detachable Qvar electrode

Latest info available at www.st.com
X-NUCLEO-IKS4A1

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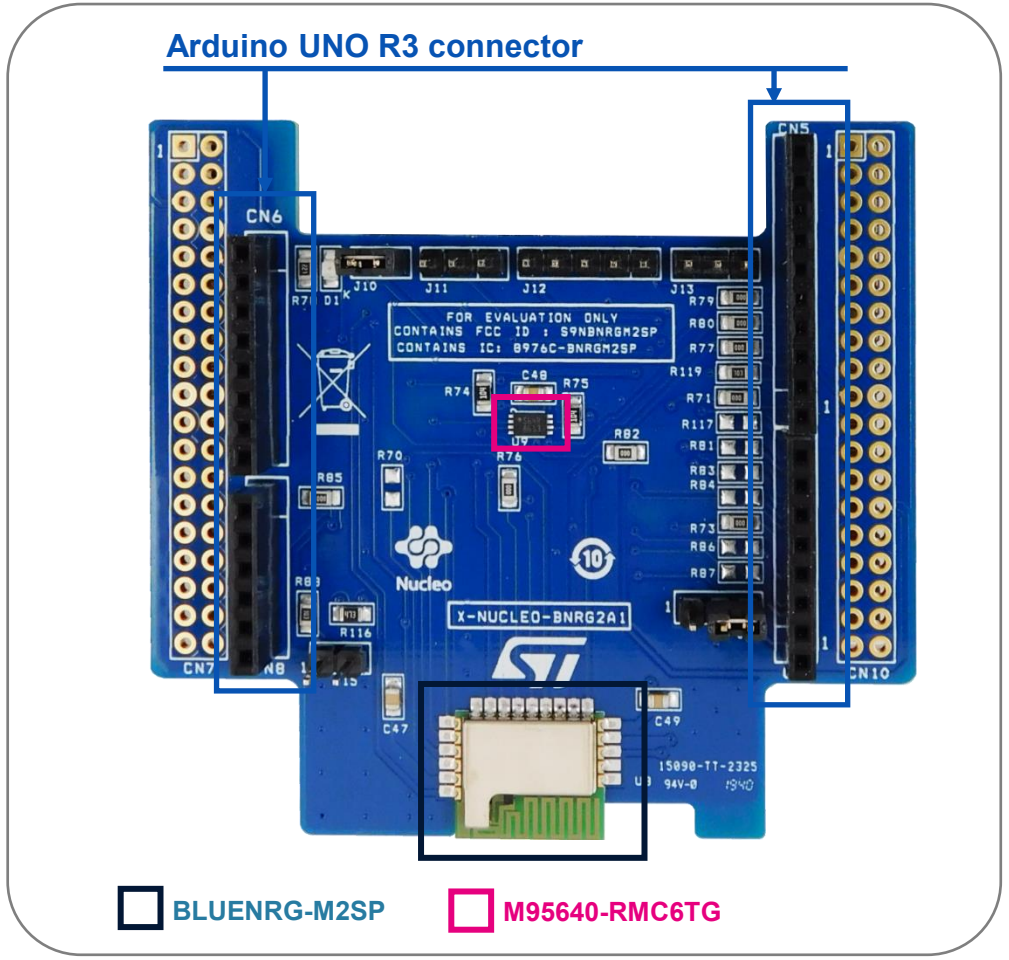
Bluetooth Low Energy Expansion Board
Hardware Overview (3/5)

Hardware Description

- The X-NUCLEO-BNRG2A1 is a Bluetooth Low Energy (BLE) evaluation and development board system, designed around ST's BLUENRG-M2SP Bluetooth Low Energy module based on BlueNRG-2.
- The BlueNRG-2 processor hosted in the BLUENRG-M2SP module communicates with the STM32 microcontroller, hosted on the Nucleo development board, through an SPI link available on the Arduino UNO R3 connector.

Key Product on board

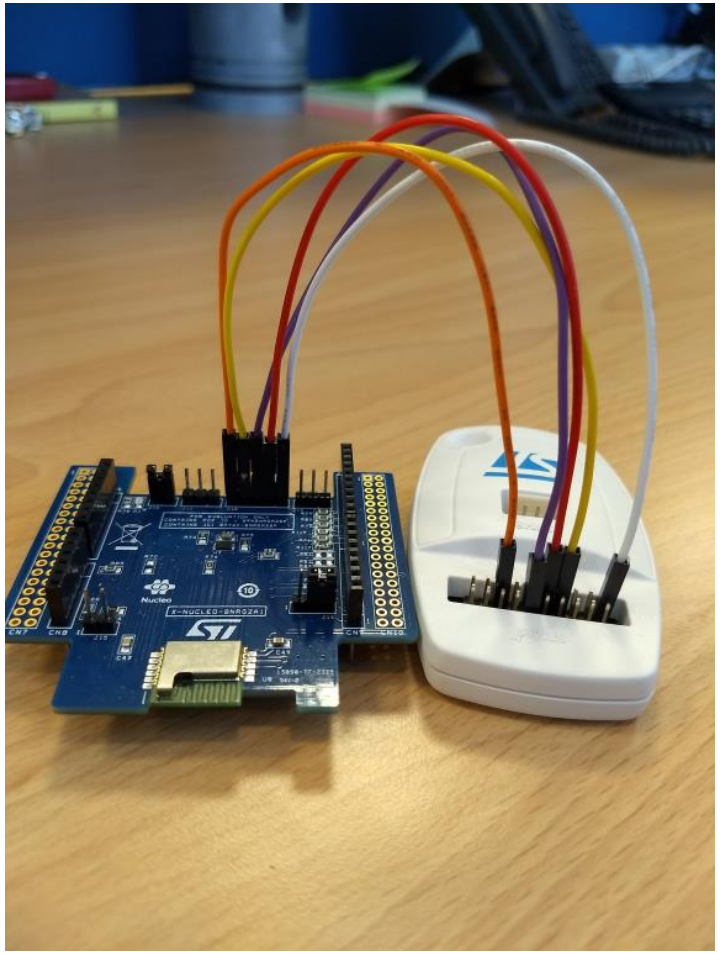
- BLUENRG-M2SP Bluetooth Low Energy, FCC and IC certified (FCC ID: S9NBNRGM2SP, IC: B976C-BNRGM2SP), module based on Bluetooth® Low Energy wireless network processor BlueNRG-2, BLE v5.0 compliant.
- BLUENRG-M2SP integrates a BALF-NRG-02D3 balun and a PCB antenna. It embeds 32 MHz crystal oscillator for the BlueNRG-2.
- M95640-RMC6TG 64-Kbit serial SPI bus EEPROM with high-speed clock interface



Latest info available at www.st.com
X-NUCLEO-BNRG2A1

Important Hardware Additional Information

Hardware Overview (4/5)



BlueNRG-2 library does not work with the stock firmware that is loaded in the BLE module of X-NUCLEO-BNRG2A1 expansion board.

For this reason:

- first of all, it is needed to solder on X-NUCLEO-BNRG2A1, if it is not soldered, a 0 Ohm resistor at R117.
- Then you can use a standard ST-Link V2-1 with 5 jumper wires female-female together with STSW-BNRGFLASHER software tool (currently available only for Windows PC) in order to update the firmware of the BLE module of X-NUCLEO-BNRG2A1.

You need to connect the J12 pins of the X-NUCLEO-BNRG2A1 to the pins of the ST-Link V2-1 as shown in the picture and follow the steps show in the next slide.

In particular we have the following connections:

	J12	ST-Link V2-1
Pin	1	1
Pin	2	9
Pin	3	12
Pin	4	7
Pin	5	15

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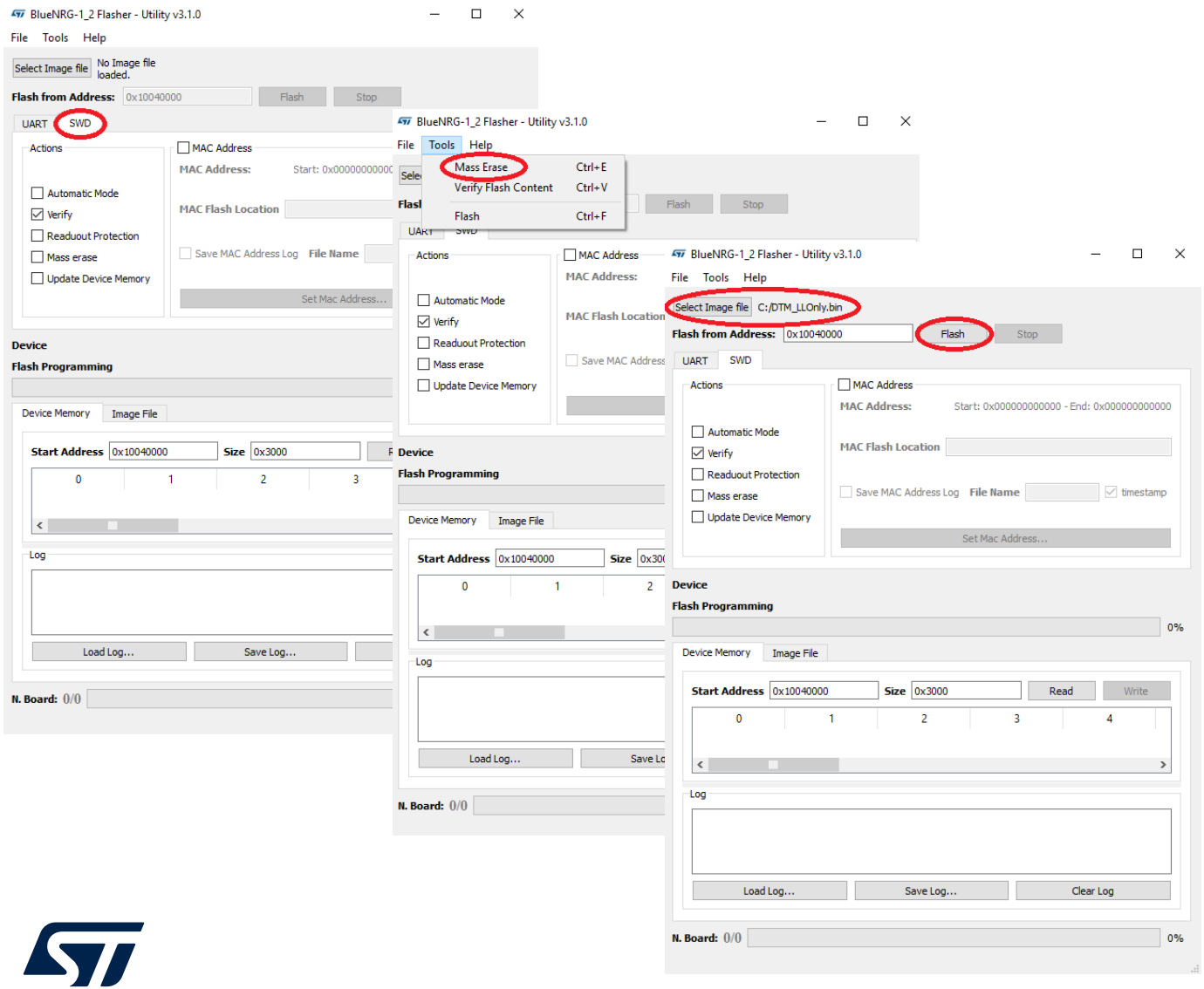
Important Hardware Additional Information

STM32 Nucleo with Expansion boards - Hardware Overview (5/5)



1. install the ST BlueNRG-1_2 Flasher Utility and open it, then select the SWD tab
2. Erase the flash memory of the BlueNRG-2 chip
3. Download the Link Layer Only firmware for the BLE module from the following link DTM_LLOnly.bin
4. Load the Link Layer Only firmware in the ST BlueNRG-1_2 Flasher Utility and then press the "Flash" button
5. If you need to restore the stock firmware of the BLE module of X-NUCLEO-BNRG2A1, you can repeat the procedure using this firmware image DTM_Full.bin
6. If you should find some issues during the update process, you can try to repeat the procedure closing the J15 jumper on the X-NUCLEO-BNRG2A1 expansion board.

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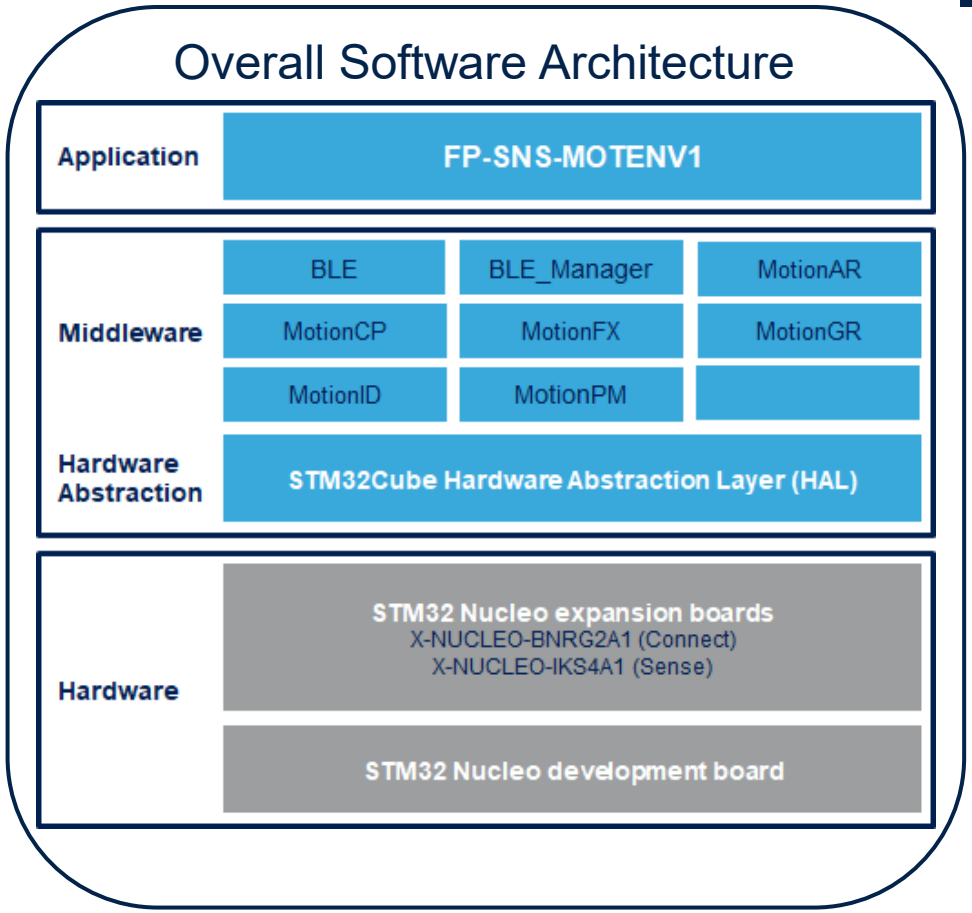
FP-SNS-MOTENV1
Software Overview

Software Description

- FP-SNS-MOTENV1 is an STM32Cube function pack, which lets you connect your IoT node to a smartphone via BLE and uses a suitable Android™ or iOS™ application, such as the ST BLE Sensor app, to view real-time motion and environmental (such as temperature, relative humidity, pressure) and sensor data.
- This package also enables advanced functions such as the sensor data fusion and accelerometer-based real-time activity recognition, carry position, gesture recognition, motion intensity recognition and real-time information about the number of steps and cadence which the user just performed with the device, i.e. cell phone.
- Together with the suggested combination of STM32 and ST devices, it can be used to develop specific wearable and environmental monitoring applications, or smart things applications in general.
- The software is available also on GitHub, where the users can signal bugs and propose new ideas through [Issues] and [Pull Requests] tabs.

Key features

- Complete firmware to develop an IoT node with BLE connectivity, environmental and motion sensors.
- Middleware libraries for sensor data fusion and accelerometer-based real-time activity recognition, carry position, gesture recognition, motion intensity recognition and pedometer
- Compatible with ST BLE Sensor applications for Android/iOS, to perform sensor data reading, motion algorithm features demo and firmware update (FOTA)
- Compatible with STM32CubeMX, can be downloaded from st.com and installed directly into STM32CubeMX
- Easy portability across different MCU families, thanks to the STM32Cube
- Free, user-friendly license terms



Latest info available at www.st.com
FP-SNS-MOTENV1

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2- Setup & Demo Examples

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Setup & Demo Examples

Software and Other prerequisites

- **STSW-LINK004**
  - STM32 ST-LINK Utility (STSW-LINK004) is a full-featured software interface for programming STM32 microcontrollers

- **FP-SNS-MOTENV1**
  - Copy the .zip file content of the firmware package into a folder on your PC.
  - The package contains source code example (Keil, IAR, STM32CubeIDE) compatible with NUCLEO-F401RE, NUCLEO-L476RG, NUCLEO-U575ZI-Q, NUCLEO-L053R8

- **ST BLE Sensor Application for Android/iOS to download from Google Play Store / iTunes**

2.1- Setup Overview: STM32 Nucleo with Expansion boards

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Setup Overview
HW prerequisites

- 1x Bluetooth Low Energy Expansion Board (X-NUCLEO-BNRG2A1)
- 1x Motion MEMS and Environmental Sensor Expansion Board (X-NUCLEO-IKS4A1)
- 1x STM32 Nucleo Development Board (NUCLEO-U575ZI-Q, NUCLEO-F401RE or NUCLEO-L476RG or NUCLEO-L053R8)
- 1x Android™ or iOS™ device
- 1x PC with Windows 7 and above
- 1x USB type A to Mini-B USB cable for NUCLEO-F401RE, NUCLEO-L476RG and NUCLEO-L053R8
- 1x USB type A to Micro-B USB cable for NUCLEO-U575ZI-Q

NUCLEO-U575ZI-Q

NUCLEO-F401RE
NUCLEO-L476RG
NUCLEO-L053R8

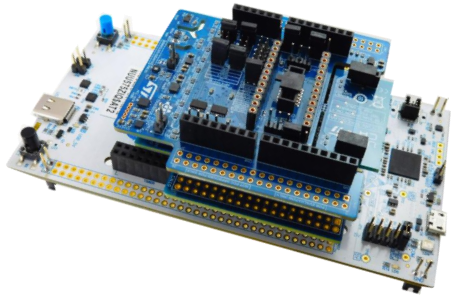
Mini USB

X-NUCLEO-IKS4A1

X-NUCLEO-BNRG2A1

Micro USB

For optimizing the performances of the SPBTLE-RF module present on X-NUCLEO-BNRG2A1 expansion board, it is necessary to follow this sequence of boards stack



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Setup Overview

Start coding in just a few minutes (1/3)

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1 www.st.com/stm32ode

2 Select Function Pack: FP-SNS-MOTENV1

3 Download & unpack

FP-SNS-MOTENV1 package structure

- _htmresc
- Documentation ← Docs
- Drivers ← BSP, HAL and drivers
- Middlewares ← BlueNRG-2, Motion Libs
- Projects ← Application example
- STM32CubeMX
- Utilities ← Boot loader binary
- en.DM00251784.pdf
- Package_License.html
- Package_License.md
- Release_Notes.html
- STMicroelectronics.FP-SNS-MOTENV1.pdsc

4

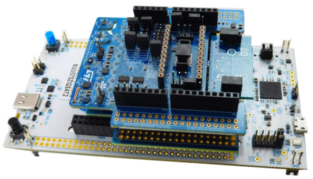
.\Projects\NUCLEO-F401RE\Applications\IKS4A1\MOTENV1
.\Projects\ NUCLEO-F401RE\Examples\BootLoader
.\Projects\ NUCLEO-L053R8\Applications\IKS4A1 \MOTENV1
.\Projects\ NUCLEO-L476RG\Applications\IKS4A1 \MOTENV1
.\Projects\ NUCLEO-L476RG \Examples\BootLoader
.\Projects\ NUCLEO-U575ZI-Q\Applications\IKS4A1 \MOTENV1

Android™/iOS™ smartphone and ST BLE Sensor application (V4.13.0/4.11.0 or higher) 6

Use the pre-compiled binaries for registering your device, or alternative re-compile the code adding your device certificate

STM32 CubeIDE | KEIL™ Tools by ARM | IAR SYSTEMS

5



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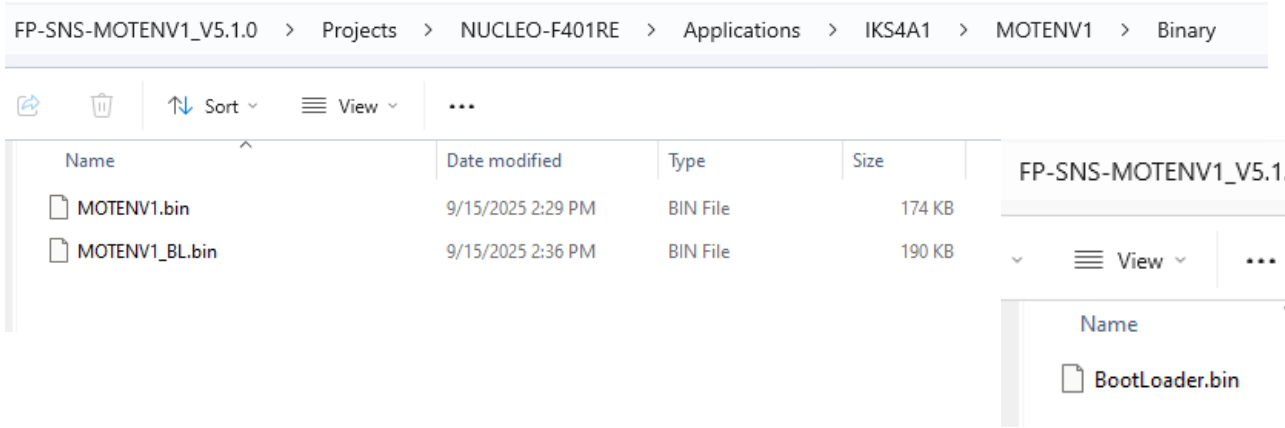
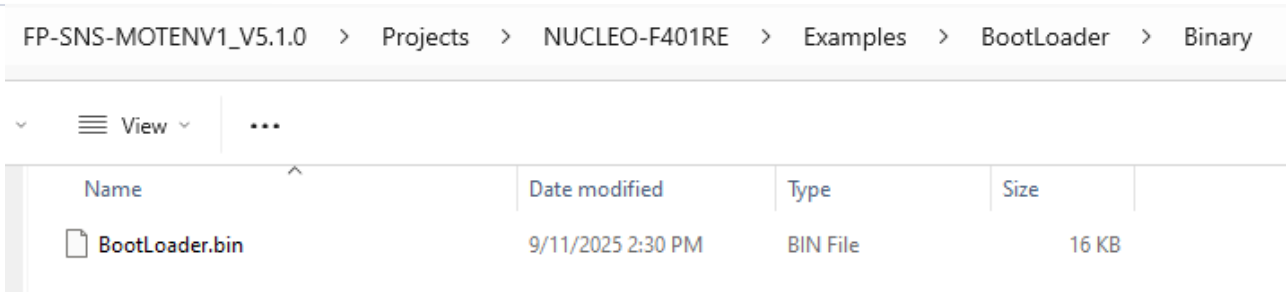
Setup Overview
Start coding in just a few minutes (2/3)

1. How to install the pre-compiled binary:

- For each applications, there is inside the package one folder called “Binary”





- For NUCLEO-F401RE and NUCLEO-L476RG:
  - pre-compiled FP-SNS-MOTENV1 FW that could be flashed to a supported STM32 Nucleo using the STM32CubeProgrammer at the right position (0x08004000)
    - Important Note: this pre-compiled binary is compatible with the FOTA update procedure
  - pre-compiled FP-SNS-MOTENV1 + BootLoader FW that could be directly flashed to a supported STM32 Nucleo using the STM32CubeProgrammer or by doing “Drag & Drop”
    - Important Note: this pre-compiled binary is not compatible with the FOTA update procedure
- For NUCLEO-L053R8:
  - pre-compiled FP-SNS-MOTENV1 could be directly flashed to a supported STM32 Nucleo using the STM32CubeProgrammer or by doing “Drag & Drop”.
- For NUCLEO-U575ZI-Q:
  - pre-compiled FP-SNS-MOTENV1 could be directly flashed to a supported STM32 Nucleo using the STM32CubeProgrammer or by doing “Drag & Drop”.
  - For the first installation, after the full flash erase (suggest procedure), use the STM32CubeProgrammer to set STM32 MCU user byte settings to use the bank 1 for flash the firmware and starts the application

Setup Overview

Start coding in just a few minutes (3/3)

2. How Install the code after compiling the project for NUCLEO-F401RE and NUCLEO-L476RG:

- Compile the project with your preferred IDE

STM32 CubeIDE IAR SYSTEMS KEIL Tools by ARM

- In the folder Utilities there is a scripts *.sh that makes the following operations:
  - Full Flash Erase
  - Flash the right BootLoader at the right position (0x08000000)
  - Flash the MOTENV1 firmware at the right position (0x08004000)
    - This is the firmware that was compiled with the IDE
    - This firmware is compatible with the FOTA update procedure
  - Save a complete Binary FW that includes both MOTENV1 and the BootLoader
    - This binary can be directly flashed to a supported STM32 board using the ST-Link or by doing “Drag & Drop”
    - Important Note: this additional pre-compiled binary is not compatible with the FOTA update procedure

Before to execute the *.sh script, it is necessary to edit it to set the installation path for STM32CubeProgrammer.

BootLoaderPath/BootLoader.bin and BinaryPath as input are required when execute *.sh script

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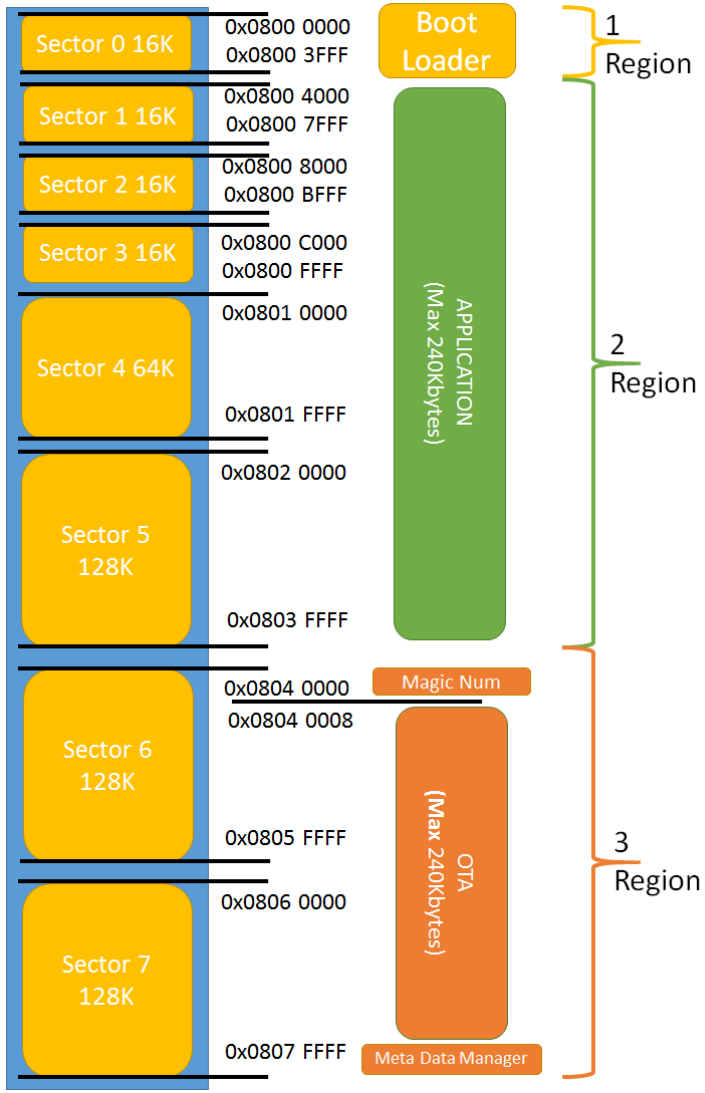
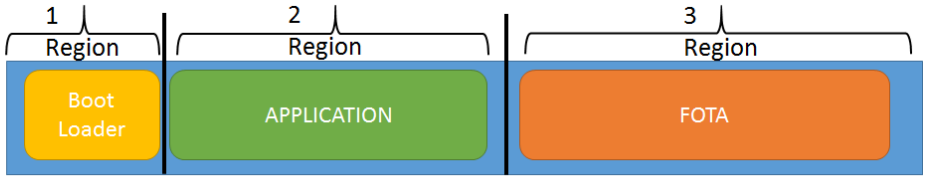
Setup Overview

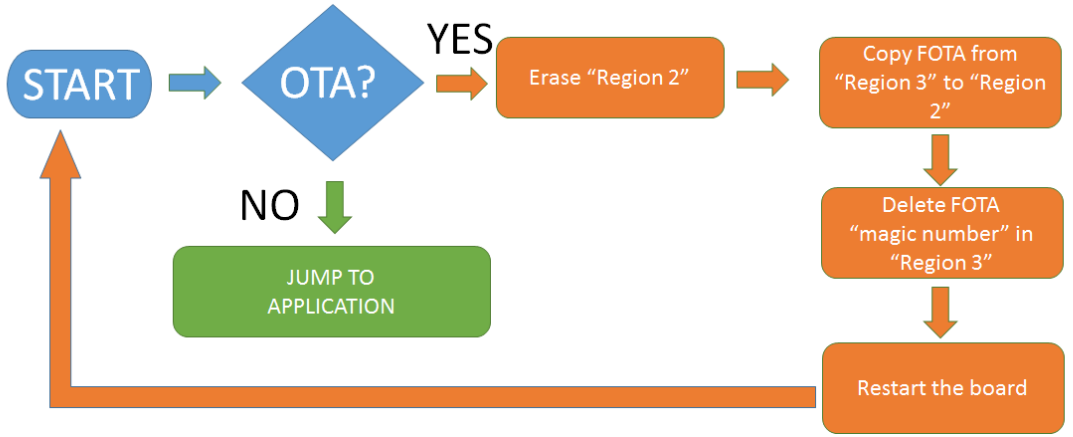
Flash Management and Boot Process



Flash Structure for STM32F401RE

FLASH Organization





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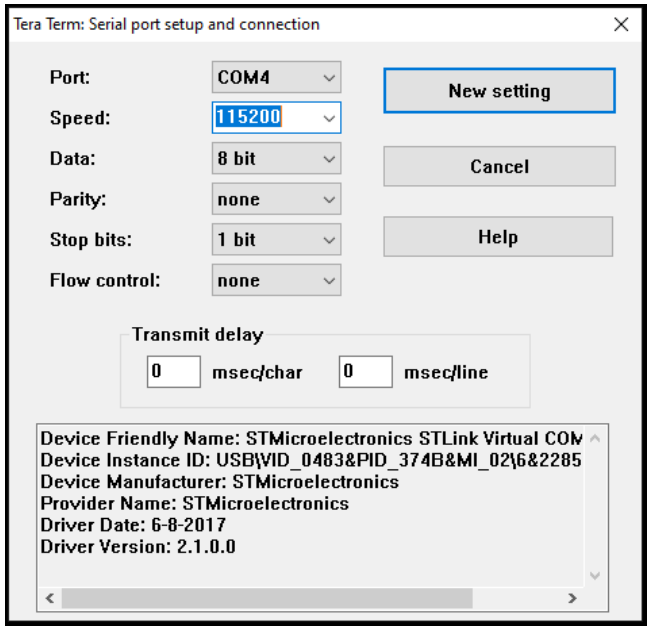
Setup Overview

Bluetooth low energy and sensors software

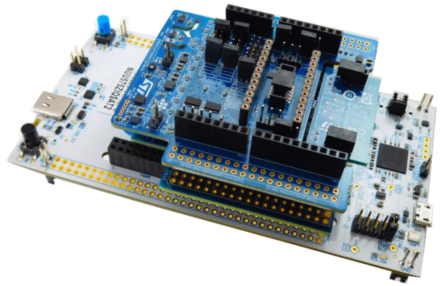
FP-SNS-MOTENV1 for NUCLEO-F401RE / NUCLEO-L476RG / NUCLEO-U575ZI-Q - Serial line monitor (e.g.Tera Term)

- Pressing the **RESET** User button on STM32 Nucleo board. You could see the initialization phase

- When the boards are connected to an Android or iOS device, you can see what is transmitted via BLE



Configure the serial line monitor (speed, LF)



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2.4- Demo Examples
ST BLE Sensor Application Overview

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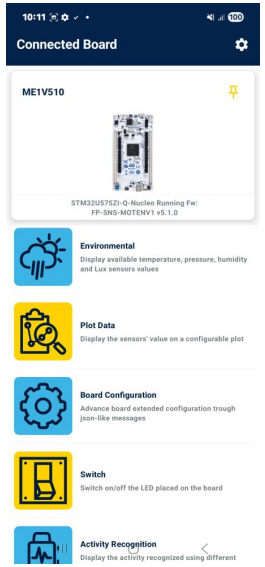
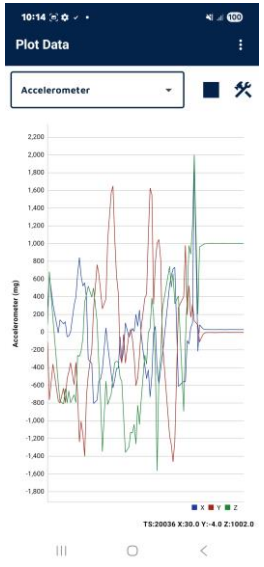
Demo Examples

ST BLE Sensor Application for Android/iOS (1/6)

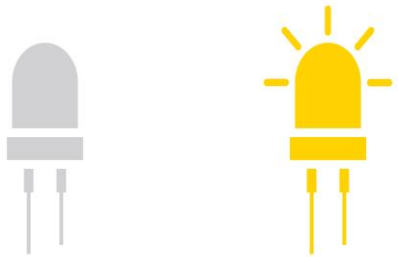
Hardware Features – Android Version



Environmental

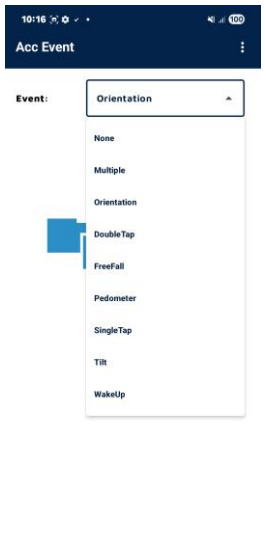


Accelerometer plot

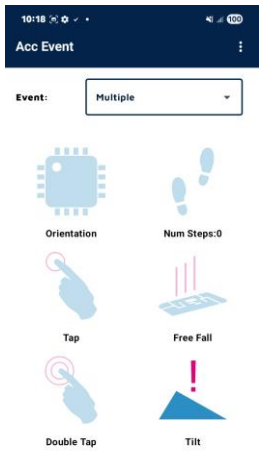


Led Status

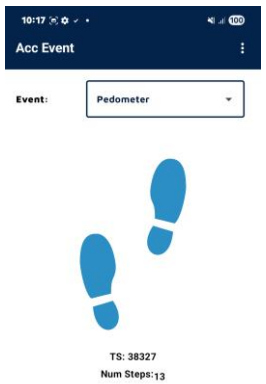
DSO/DSL Acc Event



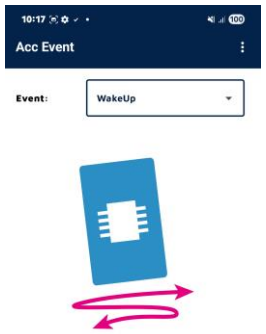
Menu Events



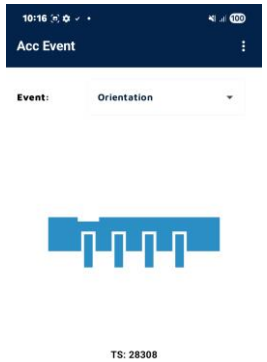
Multiple events



Pedometer



Wake Up



Orientation

Demo Examples

ST BLE Sensor Application for Android/iOS (2/6)

Middlewares – Android Version

MotionAR

Activity recognition

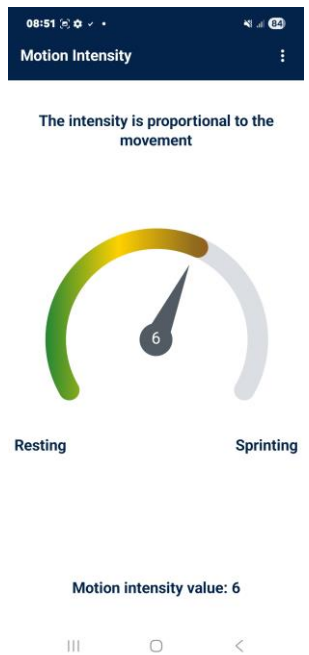
MotionGR

Mems Gesture

MotionCP

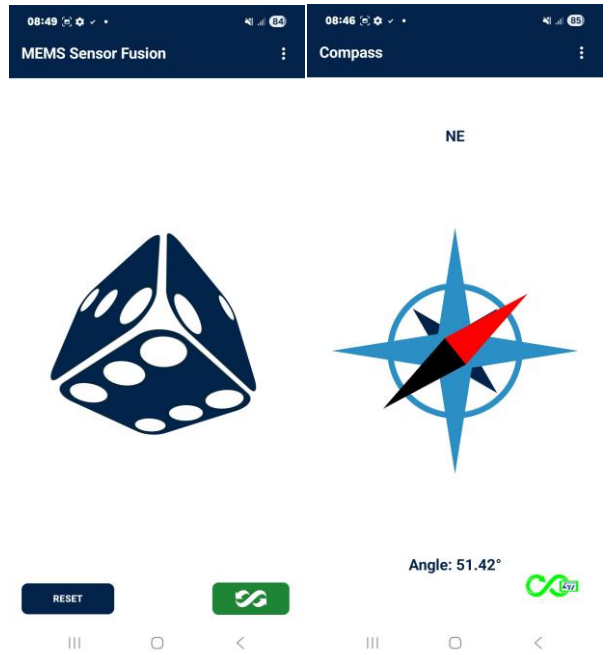
Carry position recognition

MotionID



Intensity detection

MotionFX



Sensor fusion

ecompass

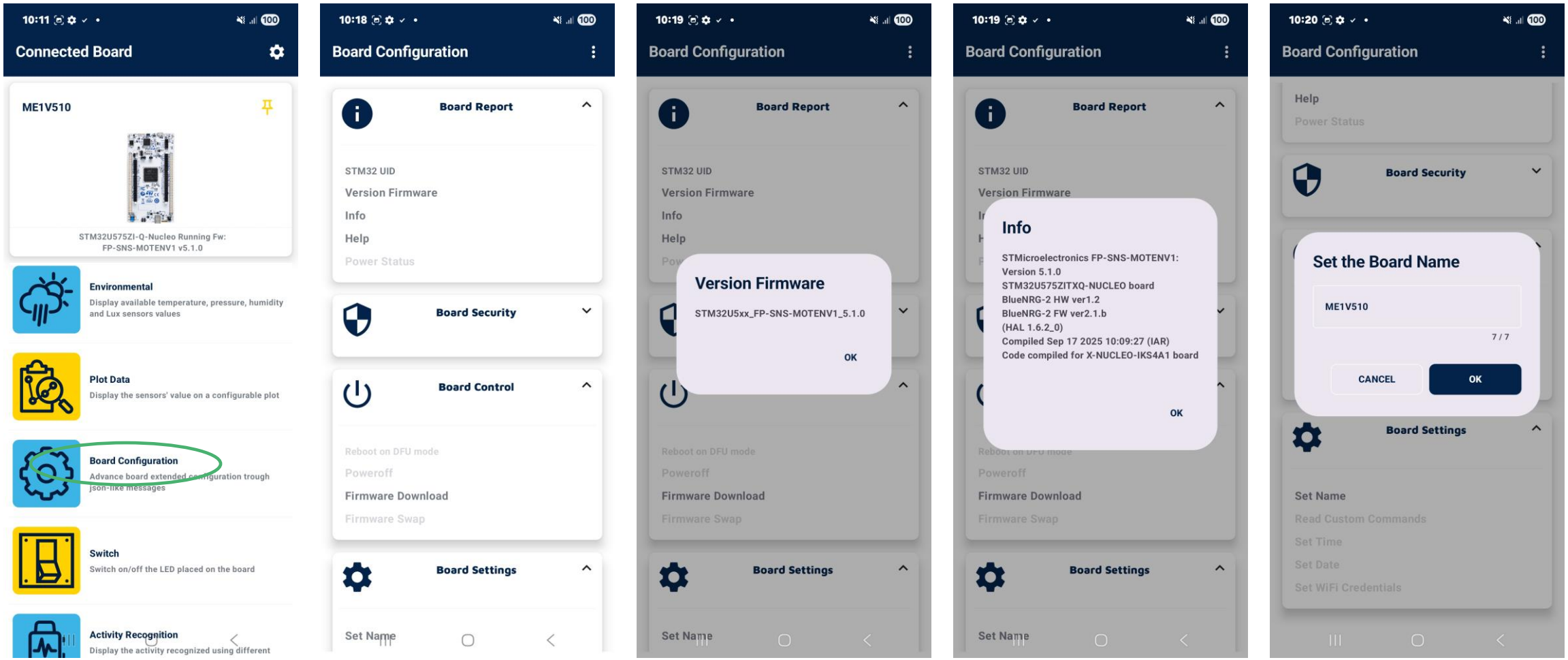
MotionPM

SW Pedometer

Demo Examples

ST BLE Sensor Application for Android/iOS (3/6)

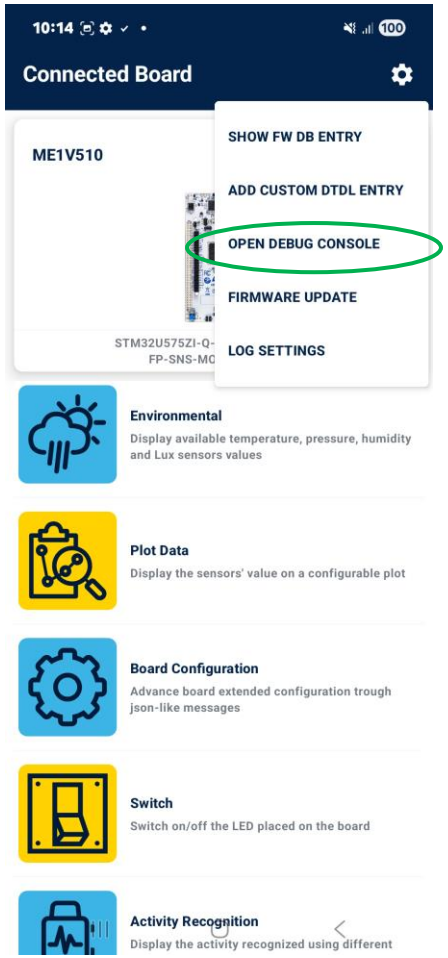
Board Configuration – Android version



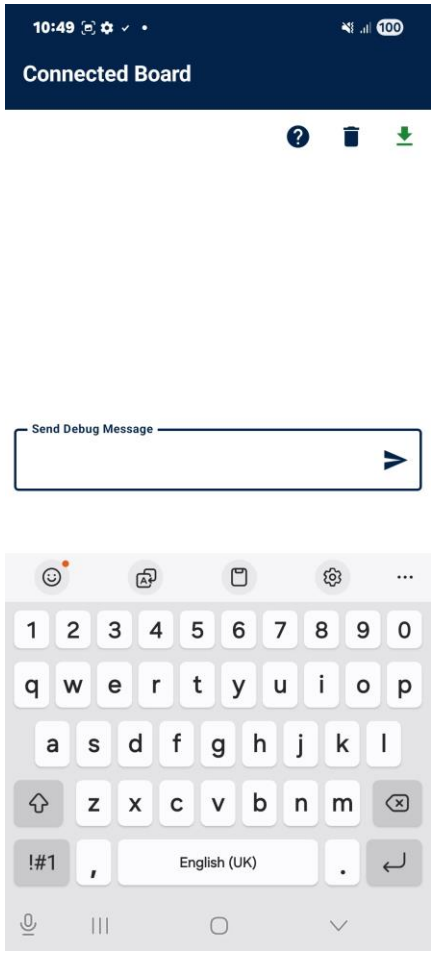
Demo Examples

ST BLE Sensor Application for Android/iOS (4/6)

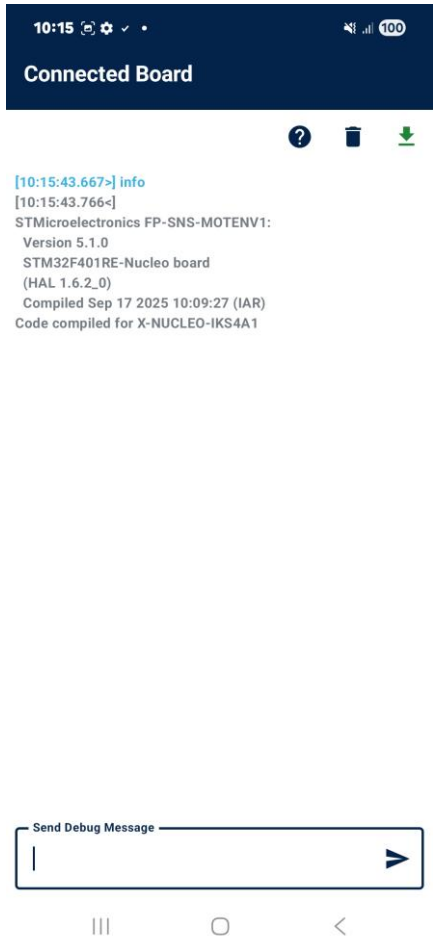
Debug Console – Android version



Menu option



Command Help



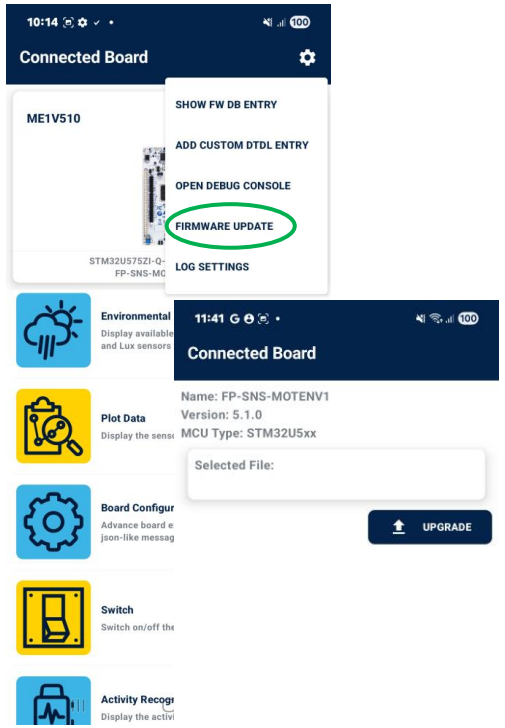
Command Info

Not Recognized Command

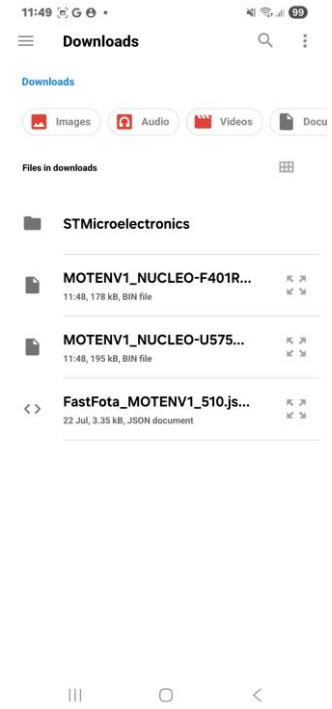
Demo Examples

ST BLE Sensor Application for Android/iOS (5/6)

Firmware Upgrade – Android version

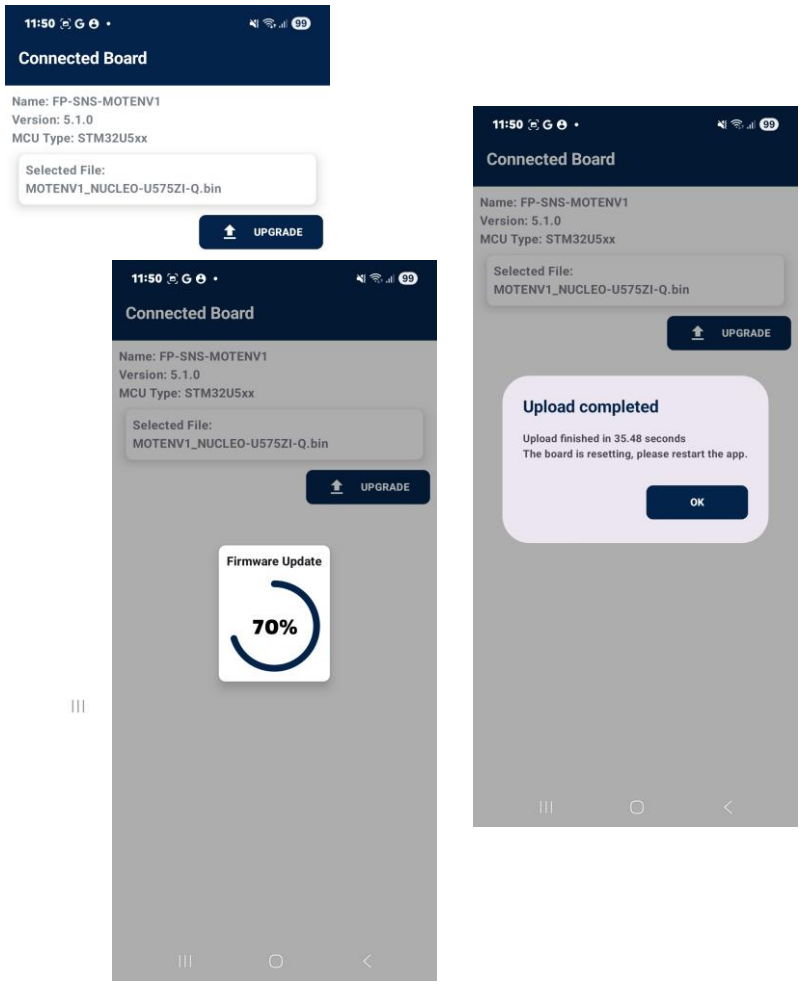


Menu option



Firmware update file selection

Firmware upgrade page



Application page during FOTA and on completion

Terminal window information during FOTA

```
UUID Rescan Forced
Sending: Press=101479 Hum=466 Temp1=210 Temp2=213
Sending: Press=101479 Hum=466 Temp1=210 Temp2=213
Sending: Press=101482 Hum=465 Temp1=210 Temp2=213
Sending: Press=101480 Hum=465 Temp1=210 Temp2=213
Sending: Press=101480 Hum=465 Temp1=210 Temp2=213
Sending: Press=101477 Hum=465 Temp1=210 Temp2=213
OTA FP-SNS-MOTENV1 SIZE=194439 OTA_crc=ab54e1aa
FP-SNS-MOTENV1 will restart after the disconnection
aci_gatt_indication_event
Nothing to do except send confirmation
<<<<<<DISCONNECTED
Call to DisconnectionCompletedFunction
->Enable DualBoot
```

NUCLEO-U575ZI-Q

```
UUID Rescan Forced
Sending: Press=101711 Hum=570 Temp1=209 Temp2=202
Sending: Press=101706 Hum=570 Temp1=209 Temp2=202
Sending: Press=101697 Hum=570 Temp1=209 Temp2=202
Sending: Press=101700 Hum=570 Temp1=209 Temp2=202
Sending: Press=101703 Hum=570 Temp1=209 Temp2=202
Sending: Press=101690 Hum=570 Temp1=209 Temp2=202
Sending: Press=101704 Hum=570 Temp1=209 Temp2=202
Sending: Press=101700 Hum=570 Temp1=209 Temp2=202
Sending: Press=101699 Hum=570 Temp1=209 Temp2=202
Sending: Press=101704 Hum=570 Temp1=209 Temp2=202
Sending: Press=101705 Hum=570 Temp1=209 Temp2=202
OTA FP-SNS-MOTENV1 SIZE=181539 OTA_crc=51472c03
FP-SNS-MOTENV1 will restart in 5 seconds
```

NUCLEO-F401RE and NUCLEO-L476RG

For NUCLEO-U575ZI-Q, after the boot the MOTENV1 firmware receives the new firmware from the STBLESensor application, saves it on one memory bank (either bank1 or bank2) and performs a reboot executing the new code saved on the other memory bank. A program related to a specific region can run in that region only. The MOTENV1 application, however, can swap among different flash banks and each program can run in any flash memory bank.

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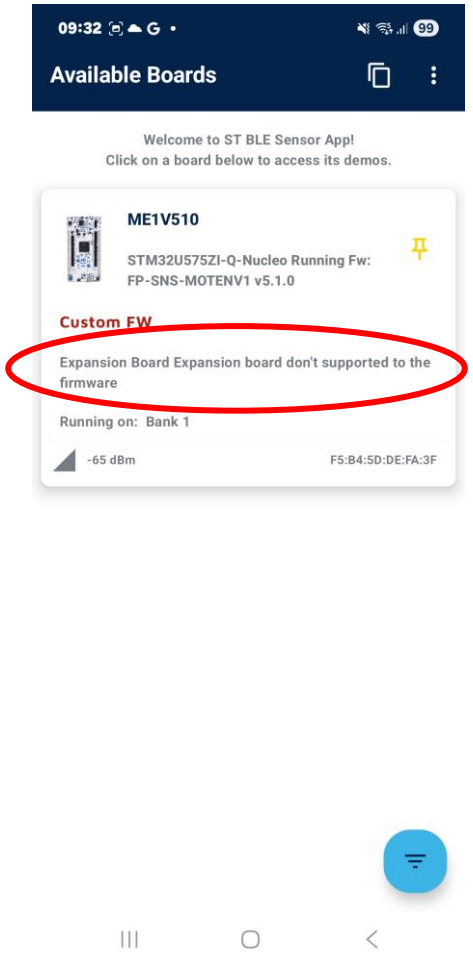
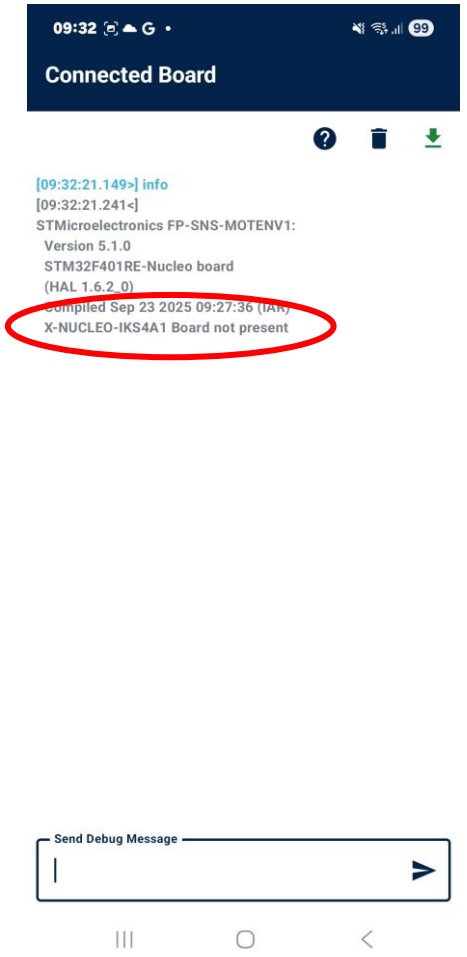
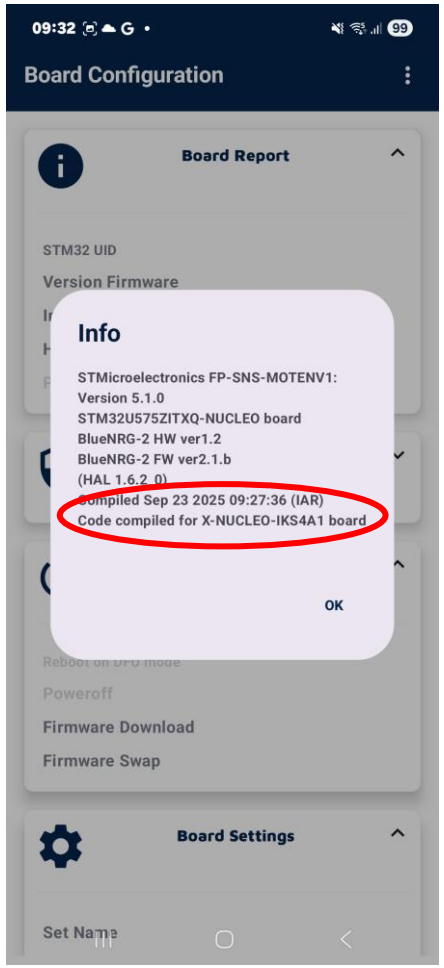
Demo Examples

ST BLE Sensor Application for Android/iOS (6/6)





Debug Console: Command Info



Board Configuration: Command Info

NOTE: If the mems expansion board used is not compliant with the firmware or not mounted

3- Documents & Related Resources

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Documents & Related Resources

All documents are available in the DESIGN tab of the related products webpage

FP-SNS-MOTENV1

- **DB2852:** STM32Cube function pack for IoT node with BLE connectivity, environmental and motion sensors – **data brief**
- **UM2016:** Getting started with the STM32Cube function pack for IoT node with BLE connectivity, environmental and motion sensors – **user manual**
- **Software setup file**

X-NUCLEO-BNRG2A1

- **Gerber files, BOM, Schematic**
- **DB4086:** Bluetooth Low Energy expansion board based on the BLUENRG-M2SP module for STM32 Nucleo – **data brief**
- **UM2667:** Getting started with the X-NUCLEO-BNRG2A1 BLE expansion board based on BLUENRG-M2SP module for STM32 Nucleo – **user manual**

X-NUCLEO-IKS4A1

- **Gerber files, BOM, Schematic**
- **DB5091:** Motion MEMS and environmental sensor expansion board for STM32 Nucleo – **data brief**
- **UM3250:** Getting started with motion MEMS and environmental sensor expansion board for STM32 Nucleo – **user manual**

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Consult www.st.com for the complete list

4- STM32 Open Development Environment: Overview

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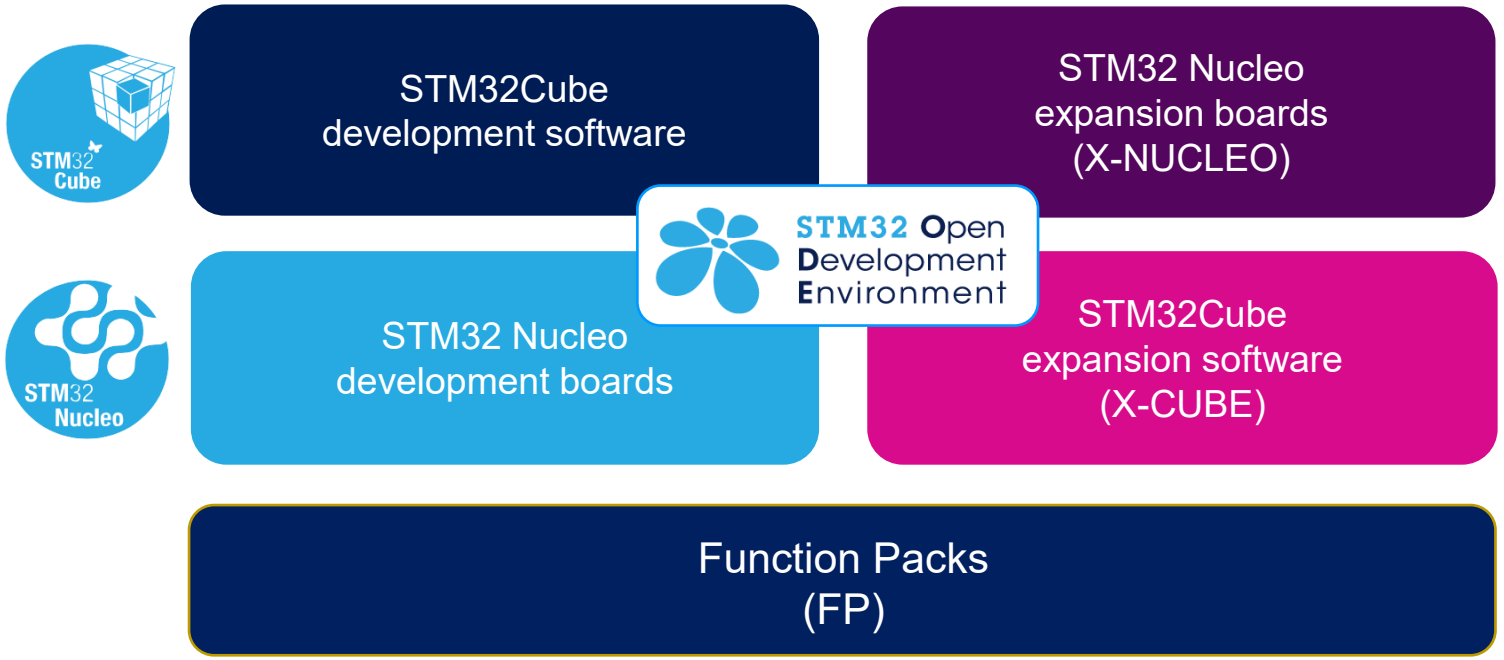
STM32 Open Development Environment
Fast, affordable Prototyping and Development

- The STM32 Open Development Environment (STM32 ODE) is an open, flexible, easy, and affordable way to develop innovative devices and applications based on the STM32 32-bit microcontroller family combined with other state-of-the-art ST components connected via expansion boards. It enables fast prototyping with leading-edge components that can quickly be transformed into final designs



For further information, please visit www.st.com/stm32ode

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