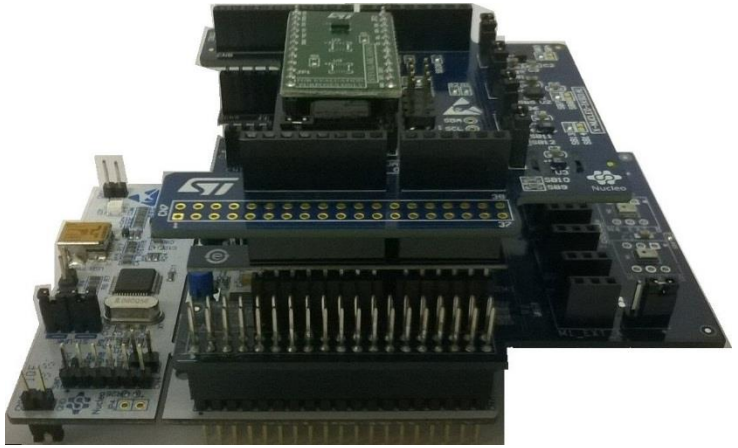
# Quick Start Guide

## Bluetooth low energy and sensor software expansion for STM32Cube (BLUEMICROSYSTEM2)



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Version 2.1.2 (October 24, 2016)

# Quick Start Guide Contents



BLUEMICROSYSTEM2: Bluetooth low energy and sensor software
Hardware and Software overview

Setup & Demo Examples
Documents & Related Resources

STM32 Open Development Environment: Overview

# Motion MEMS and environmental sensors expansion board

## Hardware Overview (1/7)



### X-NUCLEO-IKS01A1 Hardware Description

- The X-NUCLEO-IKS01A1 is a motion MEMS and environmental sensor evaluation board system.
- It is compatible with the Arduino UNO R3 connector layout, and is designed around ST's latest sensors.

**Key Product on board**

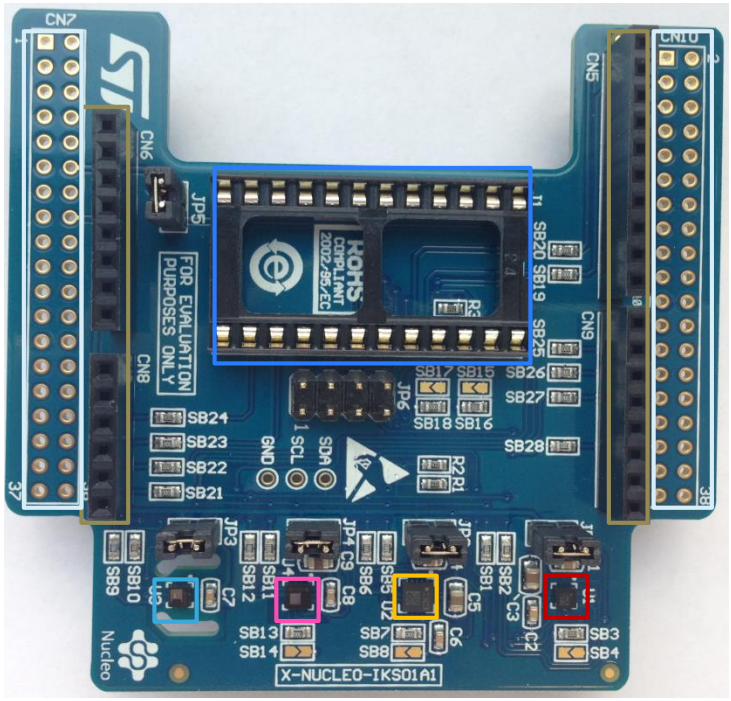
**LSM6DS0:** MEMS 3D accelerometer (±2/±4/±8 g) + 3D gyroscope (±245/±500/±2000 dps)

**LIS3MDL:** MEMS 3D magnetometer (±4/ ±8/ ±12/±16 gauss)

**LPS25HB:** MEMS pressure sensor, 260-1260 hPa absolute digital output barometer

**HTS221:** capacitive digital relative humidity and temperature

**DIL 24-pin:** socket available for additional MEMS adapters and other sensors (UV index)




HTS221 LSM6DS0 ST morpho connector**

LPS25HB LIS3MDL Arduino UNO R3 connector

DIL 24-pin

Latest info available at www.st.com
**X-NUCLEO-IKS01A1**

** Connector for the STM32 Nucleo Board

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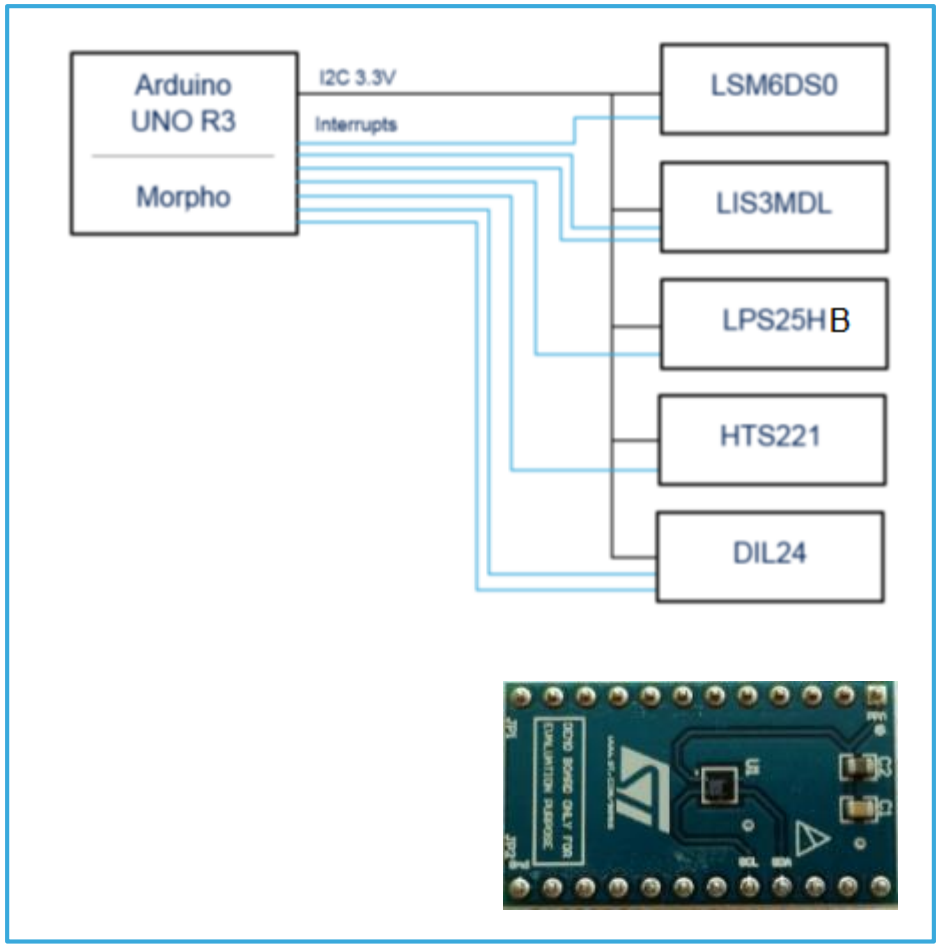
# Motion MEMS and environmental sensors expansion board

## Hardware Overview (2/7)



### X-NUCLEO-IKS01A1 Key Features

- The X-NUCLEO-IKS01A1 is a motion MEMS and environmental sensor evaluation board system.
- All sensor sensors are connected on a single I²C bus
- Sensor I²C address selection
- Each sensor has separate power supply lines allowing power consumption measurement
- Sensor disconnection (disconnect the I²C bus as well as the power supply)
- Interrupt and DRDY signals from sensors
- DIL24 socket (Compatible to STEVAL-MKI***V* MEMS adapter boards)




* is used as a wildcard character for related part number

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# Bluetooth Low Energy Expansion Board
## Hardware Overview (3/7)



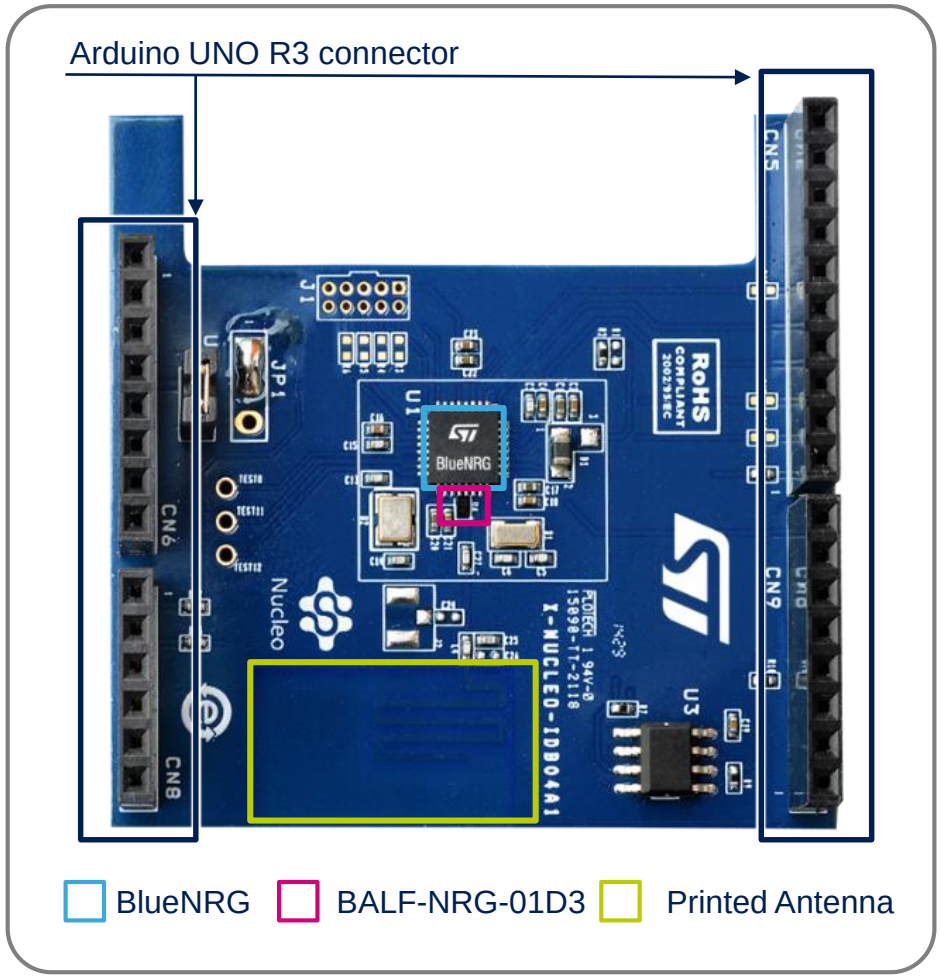
### X-NUCLEO-IDB04A1 Hardware Description

- The X-NUCLEO-IDB04A1 is a Bluetooth Low Energy (BLE) evaluation and development board system, designed around ST's BlueNRG BLE network processor.
- The BlueNRG processor communicates with STM32 Nucleo developer board host microcontroller though an SPI link available on the Arduino UNO R3 connector.

### Key Products on board

**BlueNRG**
ST Bluetooth® Low Energy wireless network processor, BLE4.0 compliant

**BALF-NRG-01D3**
50 Ω nominal input / conjugate match balun to BlueNRG transceiver, with integrated harmonic filter, insuring matching and filtering




Latest info available at www.st.com
**X-NUCLEO-IDB04A1**

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# Bluetooth Low Energy Expansion Board
# Hardware Overview (4/7)



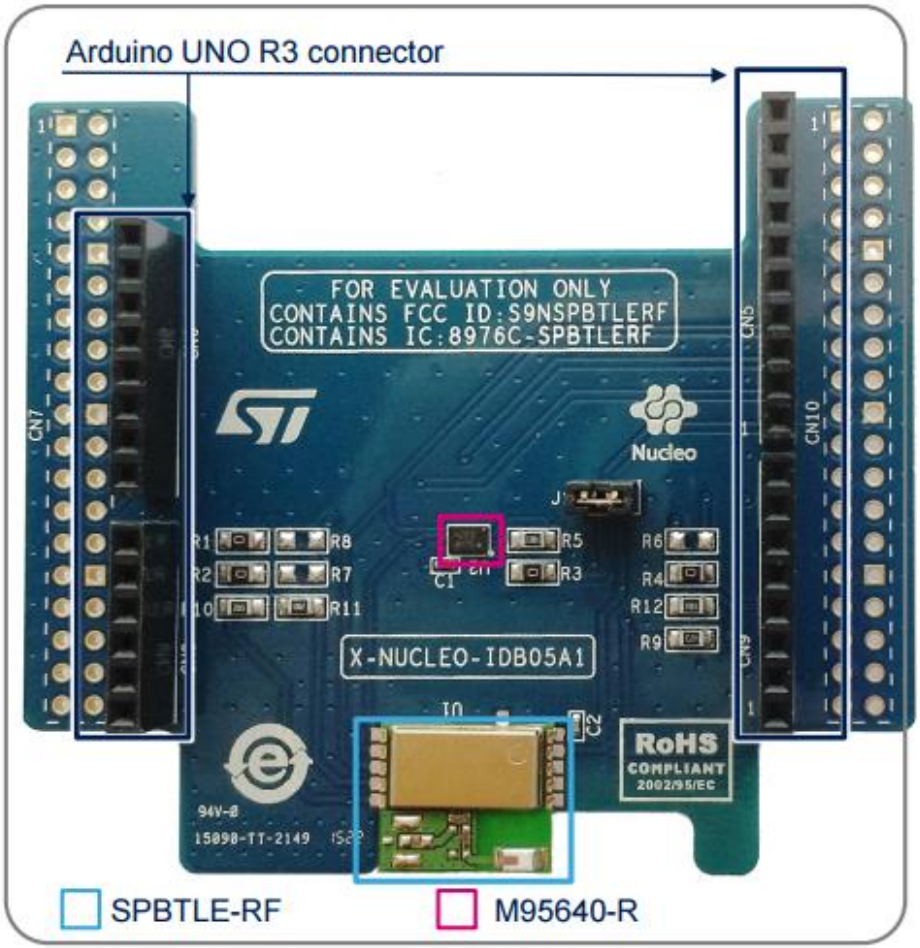
## X-NUCLEO-IDB05A1 Hardware Description

- The X-NUCLEO-IDB05A1 is a Bluetooth Low Energy (BLE) evaluation and development board system, designed around ST's SPBTLE-RF Bluetooth Low Energy module based on BlueNRG-MS.
- The BlueNRG-MS processor hosted in the SPBTLE-RF module communicates with the STM32 Nucleo developer board host microcontroller though an SPI link available on the Arduino UNO R3 connector.

### Key Products on board

**SPBTLE-RF**
Bluetooth Low Energy, FCC and IC certified, module based on Bluetooth® Low Energy wireless network processor BlueNRG-MS, BLE4.1 compliant. SPBTLE-RF integrates a BALF-NRG-01D3 balun and a chip antenna. It embeds 32 MHz and 32.768 kHz crystal oscillators for the BlueNRG-MS.

**M95640-R**
64-Kbit serial SPI bus EEPROM with high-speed clock interface

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**X-NUCLEO-IDB05A1**

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# Digital MEMS microphone expansion board
## Hardware Overview (5/7)



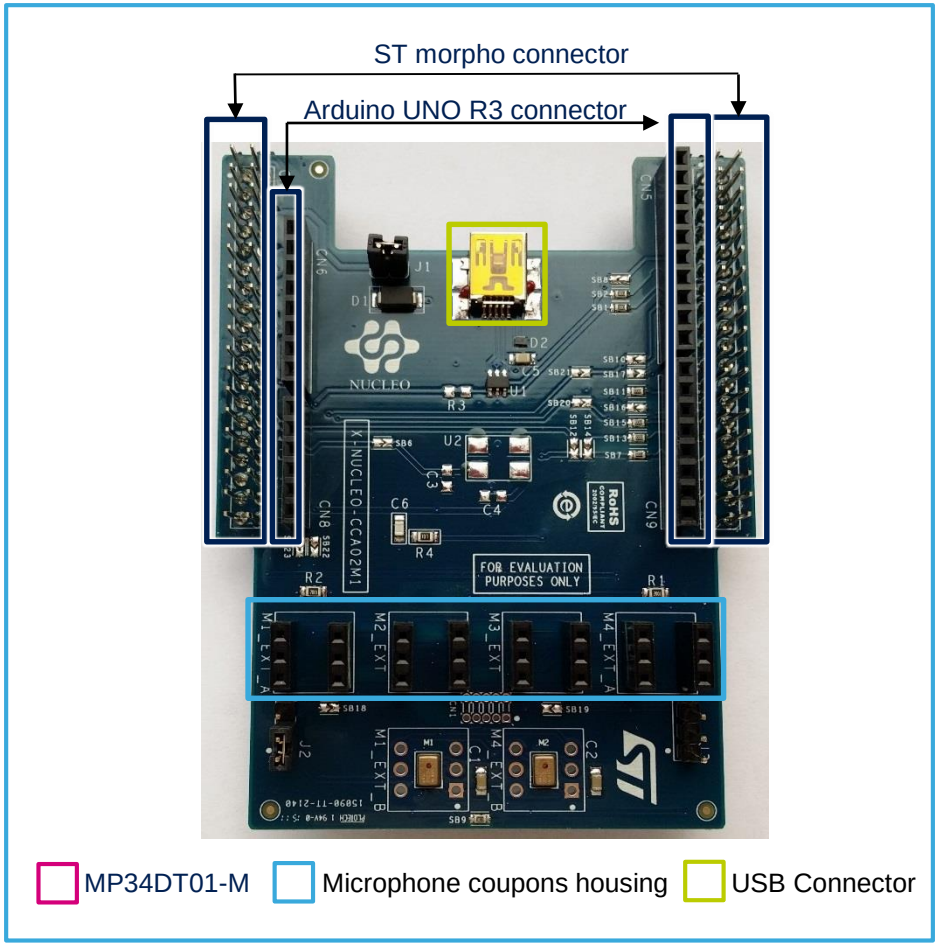
### X-NUCLEO-CCA02M1 Hardware Description

- The X-NUCLEO-CCA02M1 is an evaluation board based on digital MEMS microphones. It has two MP34DT01–M microphones soldered on board and it offers the possibility to plug additional microphones using MP34DT01 based coupon evaluation boards (**STEVAL-MKI129V*** or **STEVAL-MKI155V*** ).
- The X-NUCLEO-CCA02M1 enables the acquisition and streaming of up 4 microphones using both $I^2S$ and SPI bus available on ST morpho connector.

**Key Products on board**

**MP34DT01-M**

Ultra-compact, low-power, omnidirectional, digital MEMS microphone built with a capacitive sensing element and an IC interface.




Latest info available at www.st.com
**X-NUCLEO-CCA02M1**

* is used as a wildcard character for related part number

# Important Hardware Additional Information

## Hardware Overview (6/7)



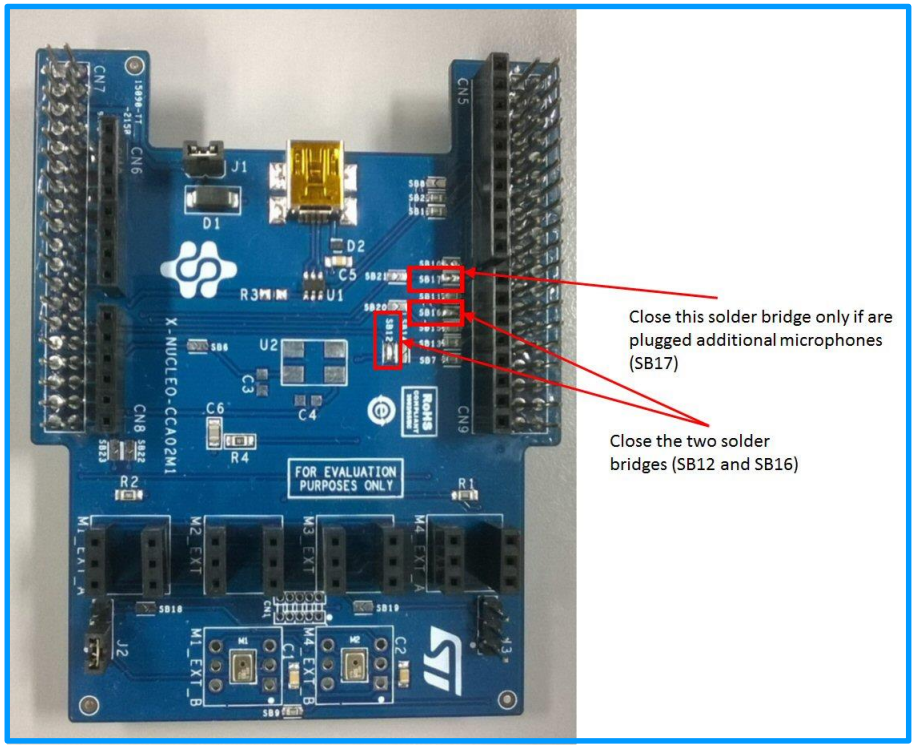



**Figure 1 – Modifications of the X-NUCLEO-CCA02M1 board**

- Before connecting the X-NUCLEO-CCA02M1 expansion board with the STM32 Nucleo board through the ST morpho connector - and only when using a NUCLEO-L476RG board - close the three solder bridges SB12, SB16 and SB17, as shown Figure 1. This is to be done only in case additional microphones are plugged.
- Before connecting the X-NUCLEO-IKS01A1 board with the X-NUCLEO-IDB04A1 (or X-NUCLEO-IDB05A1) expansion board through the Arduino UNO R3 extension connector, remove the three 0-Ohm resistors SB25, SB26 and SB27, as shown in Figure 2

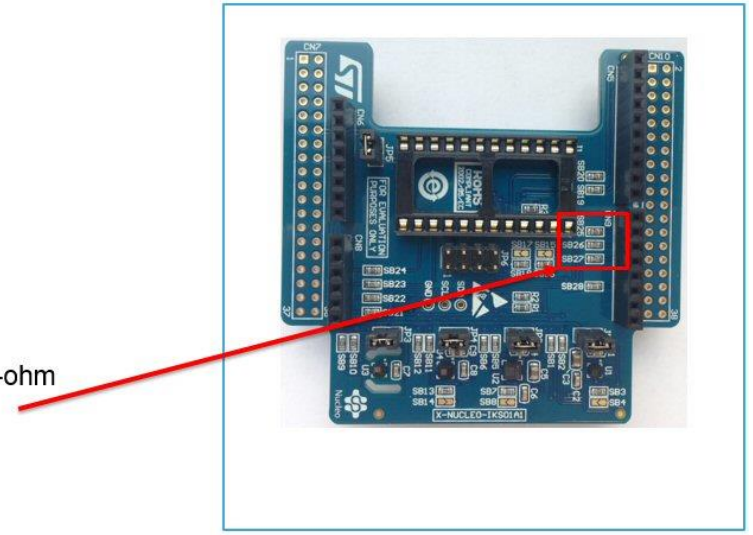



**Figure 2 – Modifications on the X-NUCLEO-IKS01A1 board**

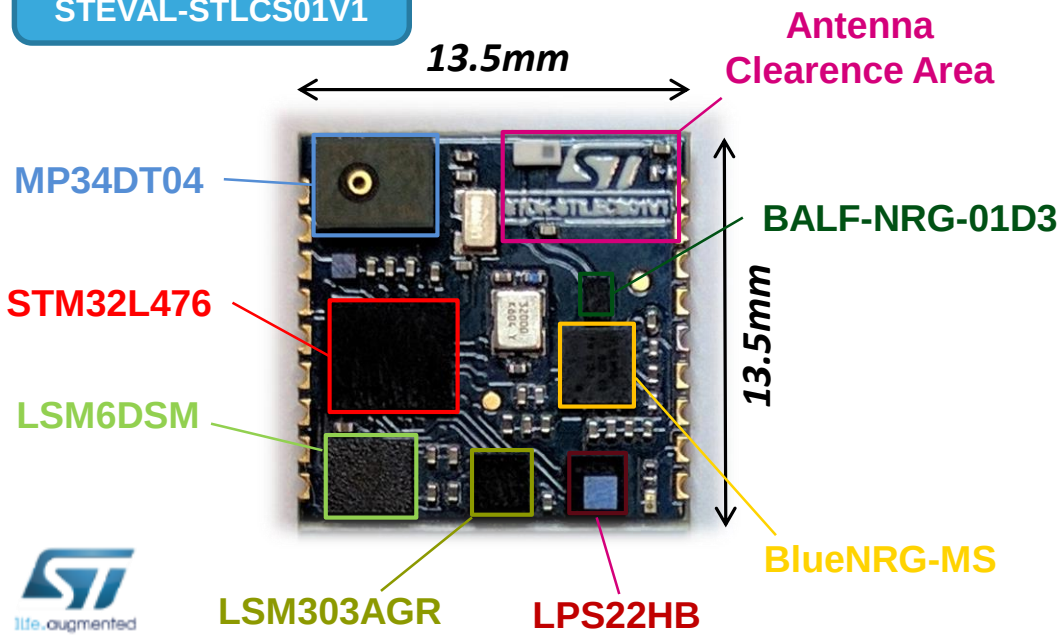
# Hardware Overview (7/7)



## STEVAL-STLKT01V1 Hardware Description

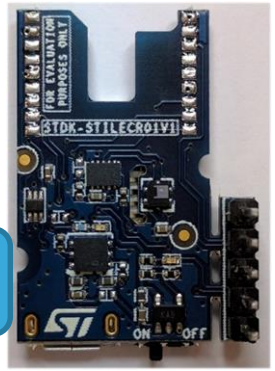
- STEVAL-STLKT01V1 is the development kit for the SensorTile board (STEVAL-STLCS01V1), a highly Integrated Development Platform with a broad range of functionalities aiming to improve system design cycle and accelerate delivery of results
- Two host boards are also provided as part of the kit, both featuring SWD programming interface
  - Cradle expansion has a plugin connection for SensorTile Core System and an Arduino interface
  - The Cradle is a small host featuring battery charger and SD card interface that supports on-the-field testing and data acquisition campaigns

SensorTile Core System
**STEVAL-STLCS01V1**




SensorTile Cradle expansion
**STEVAL-STLCX01V1**

SensorTile Cradle
**STEVAL-STLCR01V1**



# Bluetooth low energy and sensors software
## Software Overview



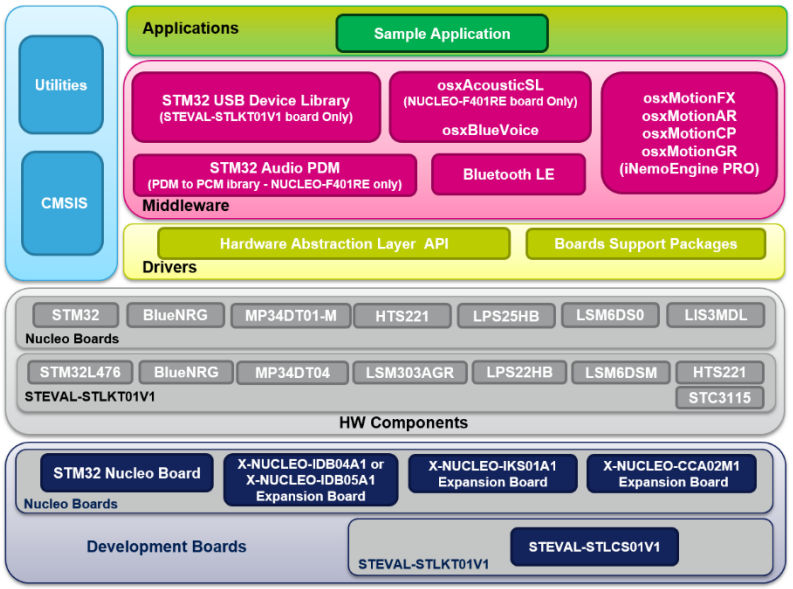
### BLUMICROSYSTEM2 Software Description

BLUMICROSYSTEM2 is an expansion software package for STM32Cube

### Key feature

- Complete middleware to build applications using
  - for STM32 Nucleo expansion boards:
    - temperature and humidity sensor (HTS221)
    - temperature and pressure sensor (LPS25HB)
    - motion sensors (LIS3MDL and LSM6DS0)
    - microphone sensor (2x MP34DT01).
    - The package is compatible with the motion sensor LSM6DS3 DIL24 expansion component.
  - for STEVAL-STLKT01V1:
    - temperature and pressure sensor (LPS22HB)
    - temperature and humidity sensor (HTS221)
    - motion sensors (LSM303AGR and LSM6DSM)
    - microphone sensor (MP34DT04).
    - Gas Gauge (STC3115)
- Very low power Bluetooth low energy (BlueNRG) single-mode network processor for transmitting information to one client.
- Real-time motion sensor data fusion (osxMotionFX) under OPEN.MEMS license.
- Real-Time recognition algorithms under OPEN.MEMS license (Accelerometer-only):
  - (osxMotionAR) activity
  - (osxMotionCP) carry position
  - (osxMotionGR) recognition
- Real-time sound source localization (osxAcousticSL for only NUCLEO-F401RE) and voice communication over Bluetooth Low Energy (osxBlueVoice) under OPEN.AUDIO license.
- Based on STM32Cube framework
- BlueMS compatible application for Android/iOS (version 2.0.0 or higher) for visualizing information sent via Bluetooth.

### Overall Software Architecture




- Over-The-Air firmware update using the BlueMS application (Version 3.0.0 or higher, and only when using the X-NUCLEO-IDB05A1 Bluetooth Low energy expansion board)
- Option to request and enable the OPEN.MEMS and OpenAudio licenses using the BlueMS application (Ver. 3.0.0 or higher)
- Gas Gouge battery Information visible only using the BlueMS application (Ver. 3.2.0 or higher)
- Free user-friendly license terms
- Sample implementation available on:
  - X-NUCLEO-CCA02M1, X-NUCLEO-IKS01A1 and X-NUCLEO-IDB04A1 (or X-NUCLEO-IDB05A1) when they are connected to NUCLEO-F401RE or NUCLEO-L476RG
  - STEVAL-STLKT01V1 board.

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Latest info available at www.st.com
**BLUEMICROSYSTEM2**

# Quick Start Guide Contents



BLUEMICROSYSTEM2: Bluetooth low energy and sensor software
Hardware and Software overview

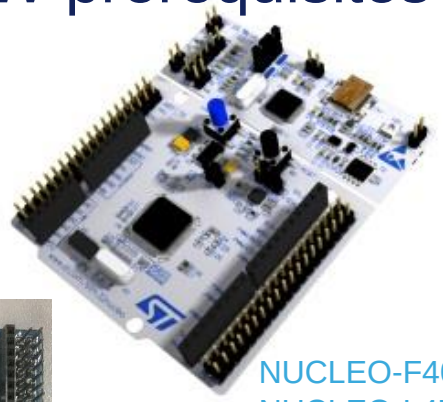
Setup & Demo Examples
Documents & Related Resources

STM32 Open Development Environment: Overview

# Setup & Demo Examples
## HW prerequisites



- 1 x STM32 Nucleo Development Board **(NUCLEO-F401RE** or **NUCLEO-L476RG)**
- 1 x Bluetooth Low Energy Expansion Board (**X-NUCLEO-IDB05A1** or **X-NUCLEO-IDB04A1**)
- 1 x Motion MEMS and Environmental Sensor Expansion Board (**X-NUCLEO-IKS01A1**)
- 1 x Digital MEMS Microphone Expansion Board (**X-NUCLEO-CCA02M1**)
- 1 x Android™ or iOS™ device
- 1 x Windows 8/7 - Laptop/PC
- 1 x USB type A to Mini-B USB cable



NUCLEO-F401RE
NUCLEO-L476RG

X-NUCLEO-CCA02M1

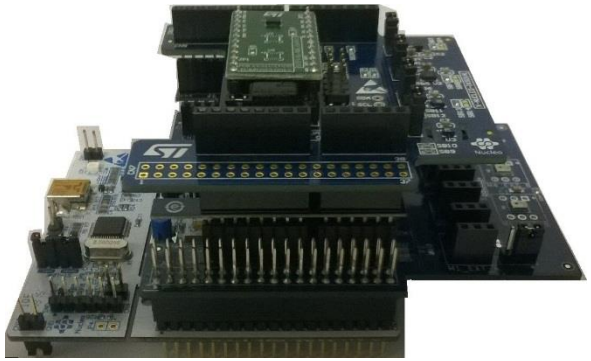
X-NUCLEO-IKS01A1

X-NUCLEO-IDB05A1

Mini USB

X-NUCLEO-IDB04A1

It is necessary to connect the boards in the order shown in this picture



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# HW prerequisites and setup with SensorTile (1/2)

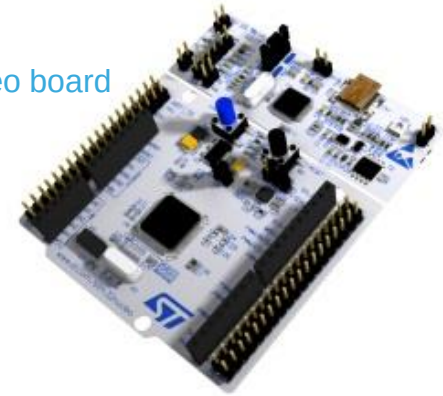


- 1 x SensorTile Kit **(STEVAL-STLKT01V1):**
  - SensorTile Core System: STEVAL-STLCS01V1
  - SensorTile Cradle eXpansion: STEVAL-STLCX01V1
  - SensorTile Cradle: STEVAL-STLCR01V1
  - Battery
  - Programming cable
- 1 x Android™ or iOS™ device
- 1 x Windows 8/7 - Laptop/PC
- 1 x STM32-Nucleo or ST-Link programmer
- 1 x USB type A to Mini-B USB cable for the ST-Link
- 1 x USB type A to Micro-B USB cable for SensorTile Cradles

Mini USB

Micro USB

STM32 Nucleo board



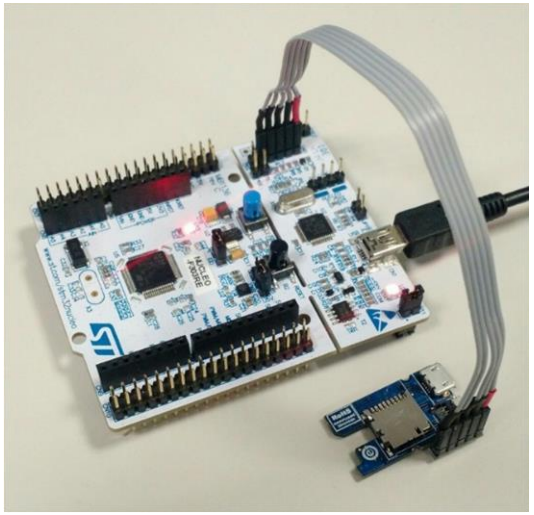

SensorTile Kit

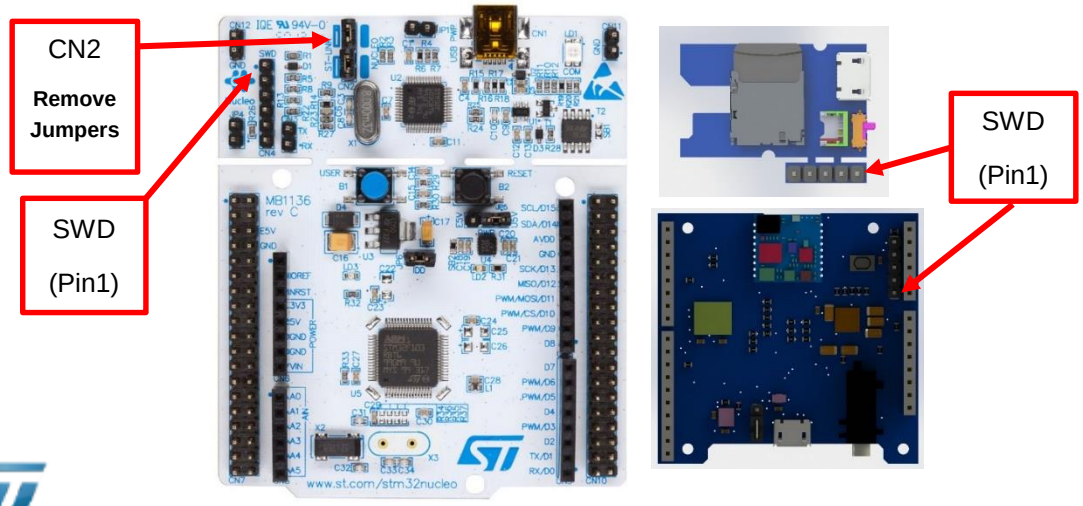
# HW prerequisites and setup with SensorTile (2/2)



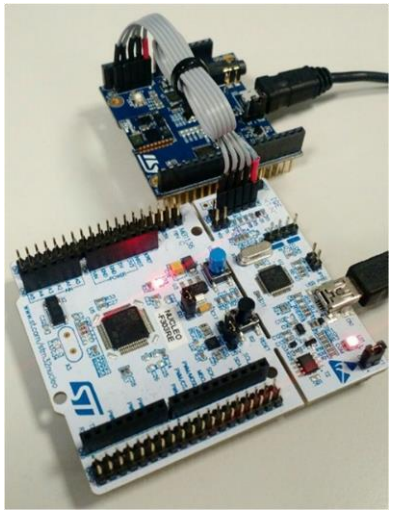
- In order to program the board you need to connect an external ST-Link to the SWD connector on the cradles, a 5pin flat cable is provided within the SensorTile Kit package.
- The easiest way is to get an STM32 Nucleo board which includes an ST-Link V2.1 programmer.
- Be sure that CN2 Jumpers are OFF and connect your STM32 Nucleo board to the SensorTile Cradle through the provided cable paying attention to the polarity of the connectors. Pin 1 can be identified by a little circle on the pcb silkscreen (STM32 Nucleo board and SensorTile Cradle Expansion) or by the square shape of the soldering pad of the connector (SensorTile Cradle).

Cradle SWD connection






Cradle expansion SWD connection



# SW prerequisites



- **STSW-LINK009**
  - ST-LINK/V2-1 USB driver
- **STSW-LINK007**
  - ST-LINK/V2-1 firmware upgrade
- **BLUEMICROSYSTEM2**
  - Copy the .zip file content into a folder on your PC
    - the package contains source code examples (and projects for Keil-MDK, IAR, System Workbench IDEs) based only on **NUCLEO-F401RE**, **NUCLEO-L476RG** or **STEVAL-STLKT01V1** development boards.
- **BlueMS** Application for **Android**/**iOS** to download from Google Store / iTunes

# Bluetooth low energy and sensor software



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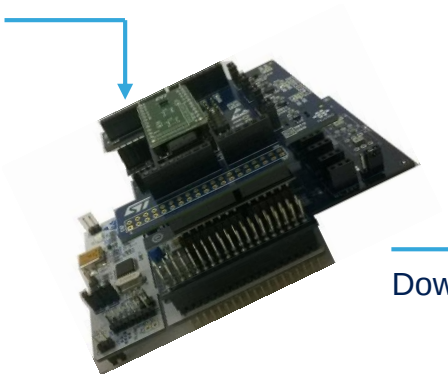
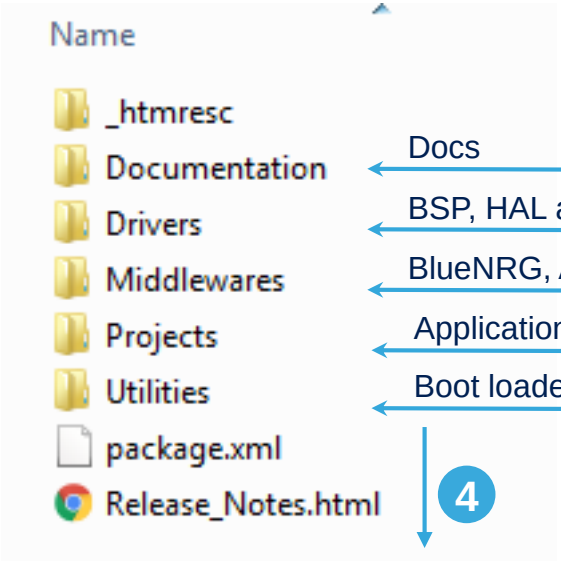
1 www.st.com/x-nucleo



2 Select BLUEMICROSYSTEM2

3 Download & unpack

BLUEMICROSYSTEM2 package structure

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Android™/iOS™ smartphone and ST BlueMS application

6


Open STM32 Tools

KEIL™ Tools by ARM

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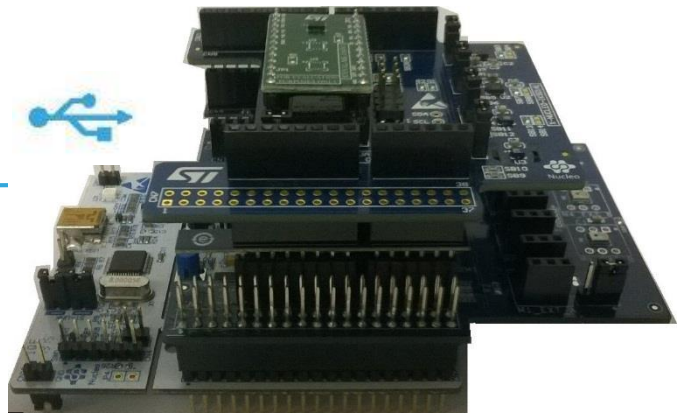
Compile/Flash and Run the project 5



**IMPORTANT:**
Read the chapter **"The Boot Process"** on user manual for understanding how to install the Boot Loader on the board

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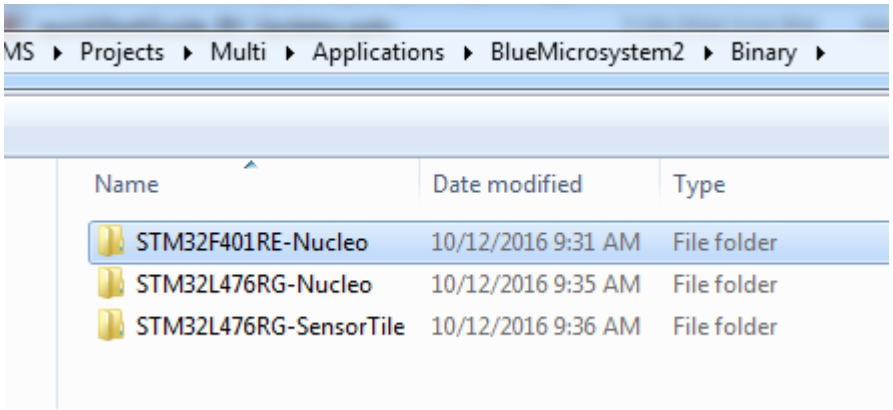
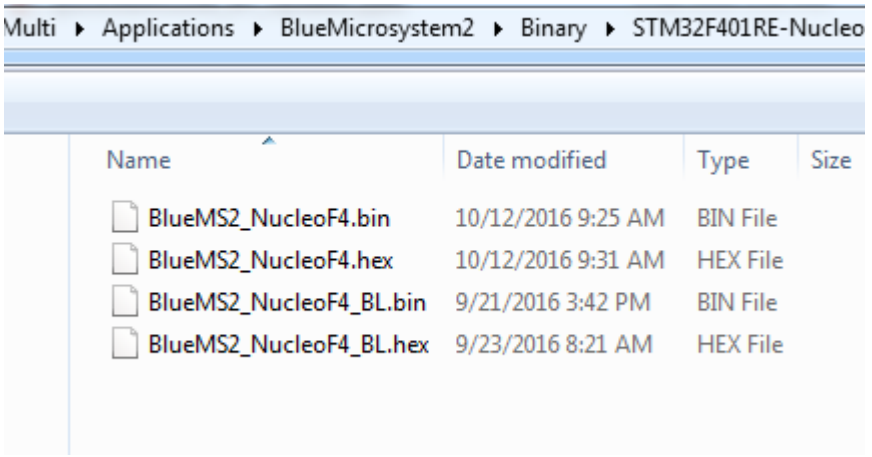
# 1. How to install the pre-compiled binary:

- There is inside the package one folder called “Binary”



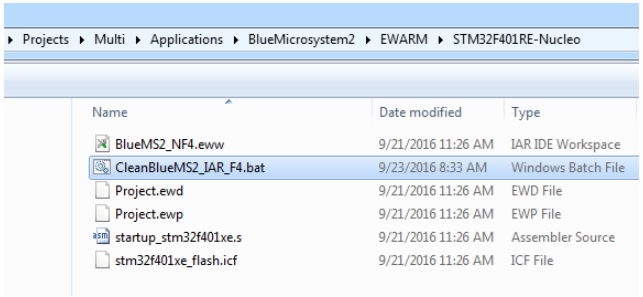

- It contains:
  - pre-compiled BLUEMICROSYSTEM2 FW that could be flashed to a supported STM32 Nucleo or SensorTile Board using the ST-Link at the right position (0x08004000)
    - **Important Note: this pre-compiled binary is compatible with the FOTA update procedure**
  - pre-compiled BLUEMICROSYSTEM2+BootLoader FW that could be directly flashed to a supported STM32 Nucleo or SensorTile Board using the ST-Link or by doing “Drag & Drop” (the latter only for STM32 Nucleo boards)
    - **Important Note: this pre-compiled binary is not compatible with the FOTA update procedure**

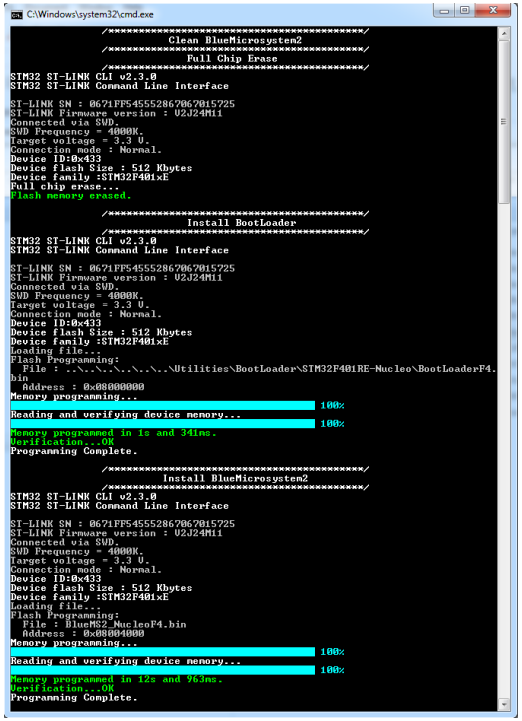
## 2. How Install the code after compiling the project:

- Compile the project with your preferred IDE

- On Windows: for each IDE and for each platform there is one batch script:
  - IAR toolchain Embedded Workbench V7.70.1: (CleanBlueMS2_IAR_F4.bat, CleanBlueMS2_IAR_L4.bat CleanBlueMS2_IAR_ST.bat)
  - System Workbench for STM32 Version 1.10.0.201607261143: (CleanBlueMS2_SW4STM32_F4.bat, CleanBlueMS2_SW4STM32_L4.bat CleanBlueMS2_SW4STM32_ST.bat)
  - µVision toolchain - MDK-ARM Professional Version: 5.17.0: (CleanBlueMS2_MDK-ARM_F4.bat, CleanBlueMS2_MDK-ARM_L4.bat CleanBlueMS2_MDK-ARM_ST.bat)
- For Linux/iOS: only for Openstm32 IDE and for each platform there is one OpenOCD called:
  - CleanBlueMS2_SW4STM32_F4.sh
  - CleanBlueMS2_SW4STM32_L4.sh.
  - CleanBlueMS2_SW4STM32_ST.sh

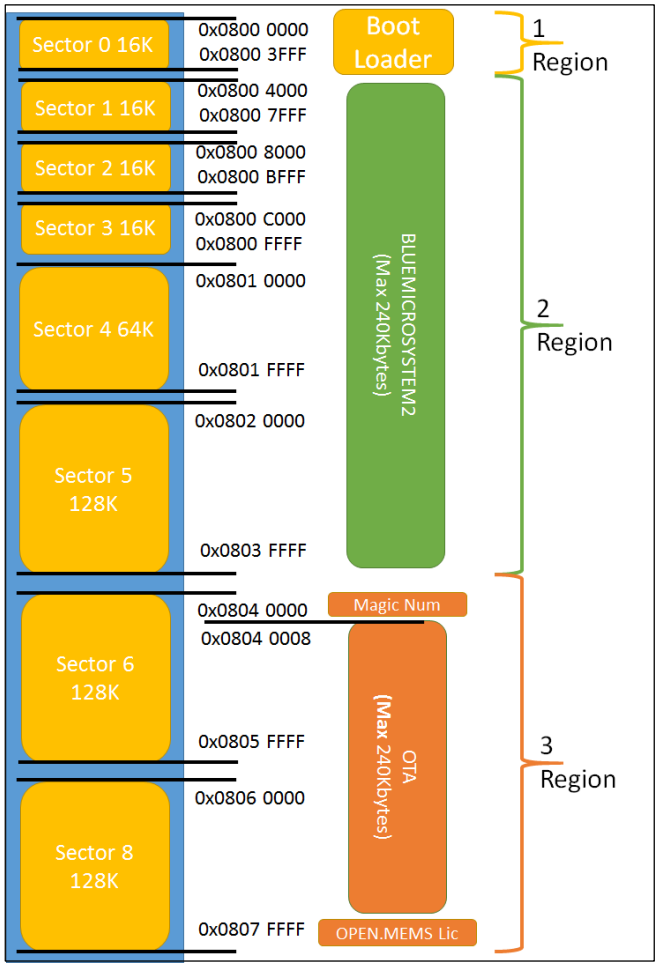
  *It's necessary to edit this file for setting the right installation and Library path*
- These scripts perform the following steps:
  1. Full Flash Erase
  2. Flash the right BootLoader at the right position (0x08000000)
  3. Flash the BLUEMICROSYSTEM2 firmware at the right position (0x08004000)
     - This is the firmware that was compiled with the IDE
     - **This firmware is compatible with the FOTA update procedure**
  4. Save a complete Binary FW that includes both BLUEMICROSYSTEM2 and the BootLoader
     - This binary can be directly flashed to a supported STM32 Nucleo or SensorTile board using the ST-Link or by doing "Drag & Drop" (the latter only for STM32 Nucleo boards)
     - **Important Note:** this additional pre-compiled binary is not compatible with the FOTA update procedure



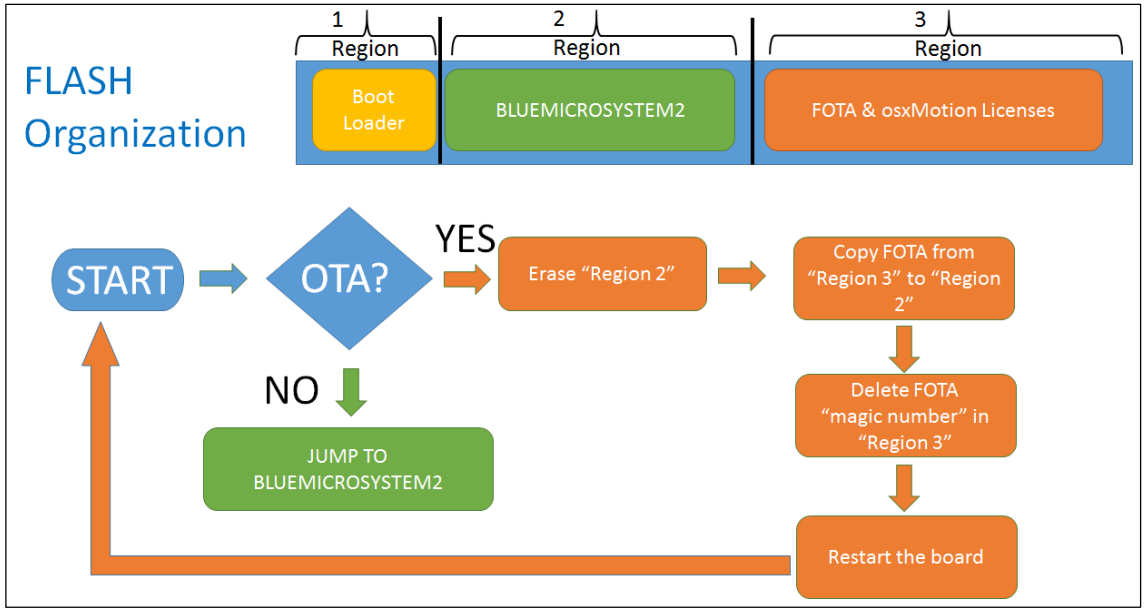



# Flash Management and Boot Process






BLUEMICROSYSTEM2 FLASH structure




BLUEMICROSYSTEM2 boot sequence

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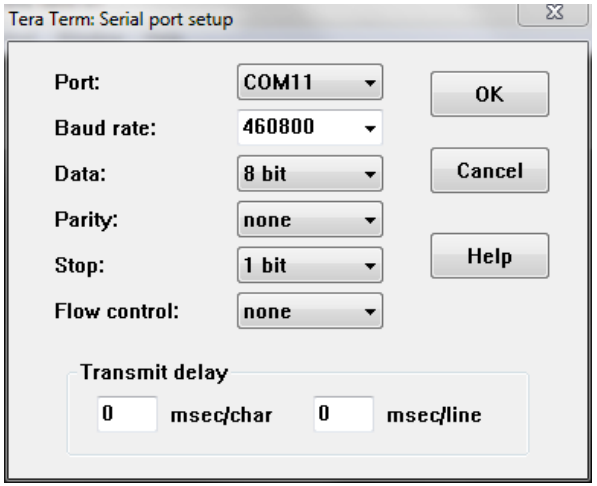
# Using serial line monitor – e.g.TeraTerm

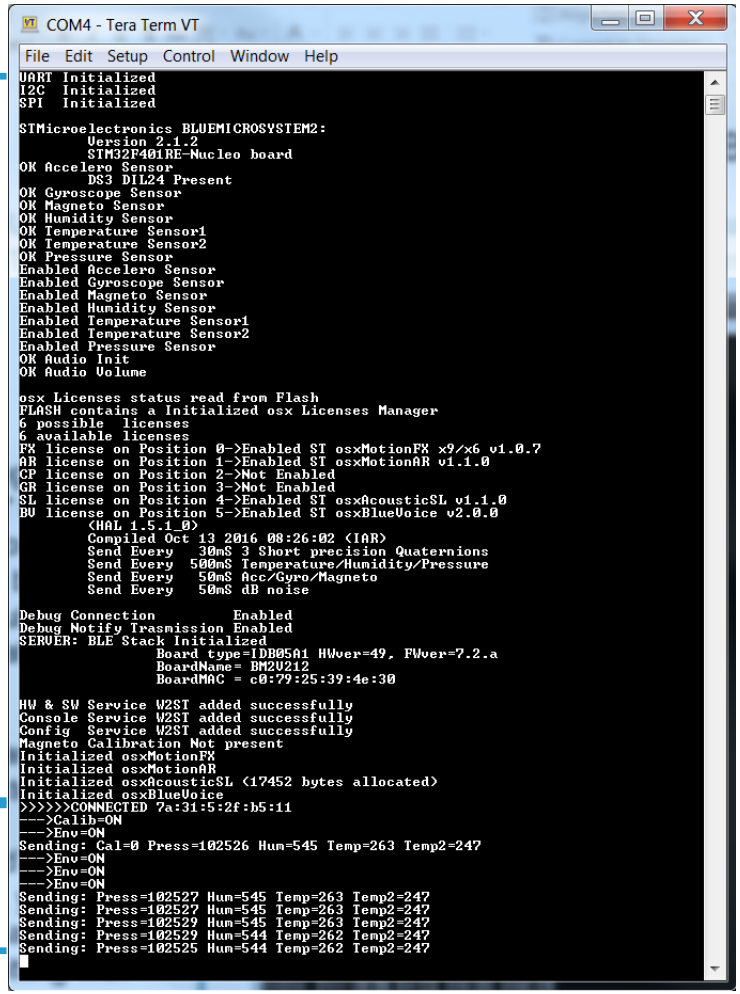


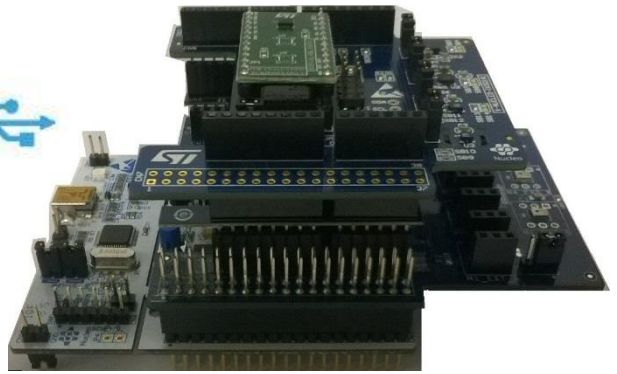
- **For NUCLEO-F401RE/NUCLEO-L476RG enabled by default**
- **For STEVAL-STLKT01V1 enabling the optional serial console**




Configure the serial line monitor (speed, LF)

- Pressing the **RESET** User button on STM32 Nucleo board You could see the initialization phase
- When are connected with one Android™/iOS™ device, you could see what are you transmitting with BLE



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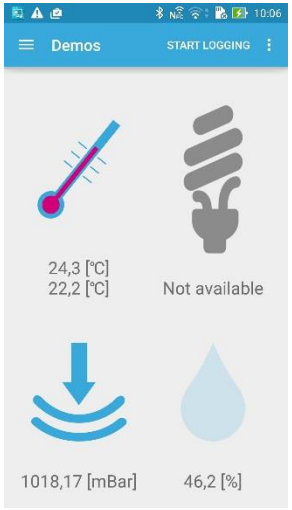
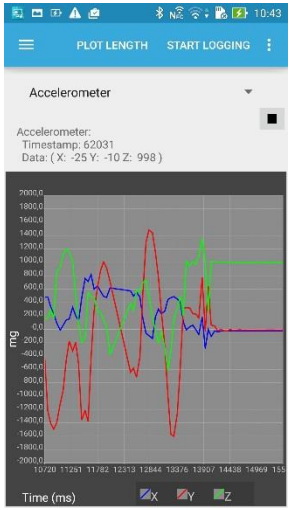
# BlueMS Application for **Android/iOS (1/6)**



Hardware Features – Android Version



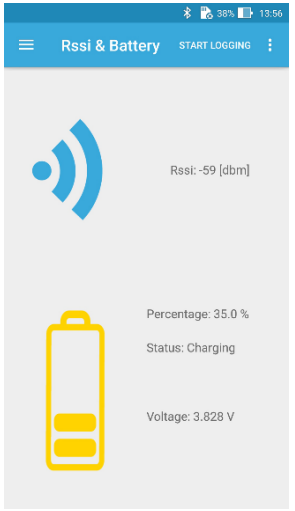

Environmental page



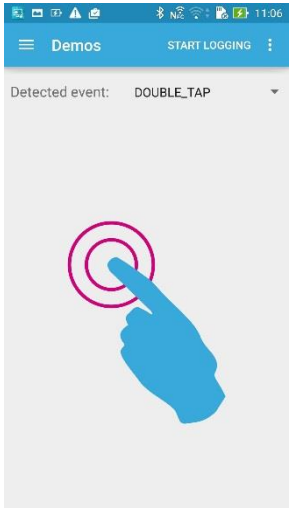

Accelerometer plot


Microphones level plot

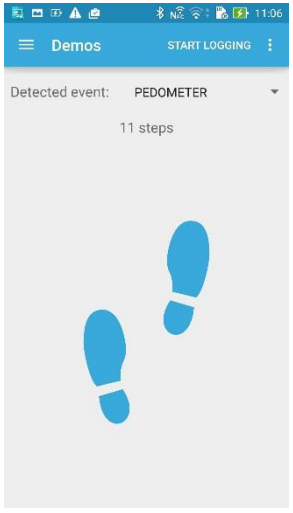

DS3/DSM Events



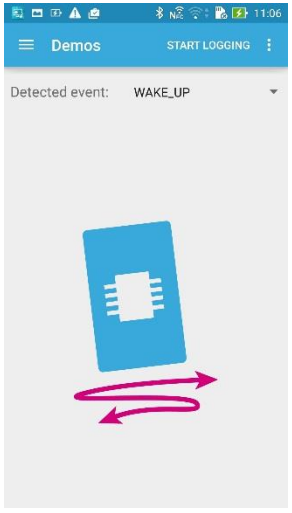

RSS & Battery Page



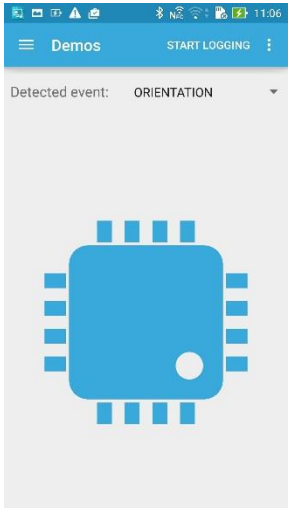

DS3/DSM Event: Double Tap




DS3/DSM Event: Pedometer




DS3/DSM Event: Wake Up




DS3/DSM Event: Orientation

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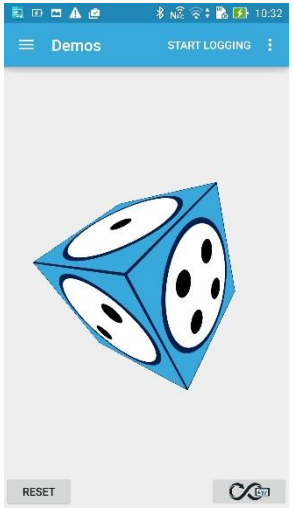
# BlueMS Application for Android/iOS (2/6)

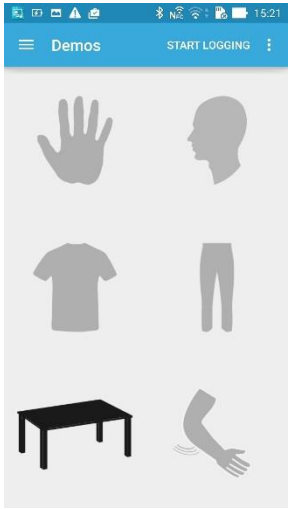


OPEN.MEMS Library
Android version

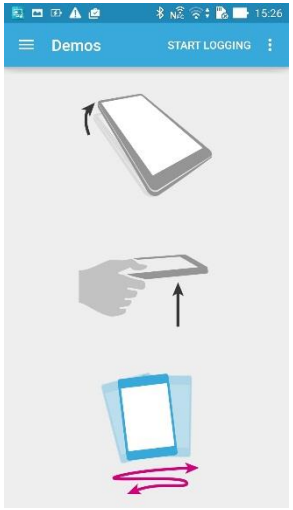



osxMotionFX sensor fusion page


osxMotionAR activity recognition page

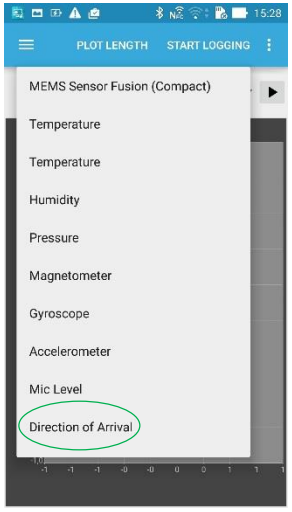


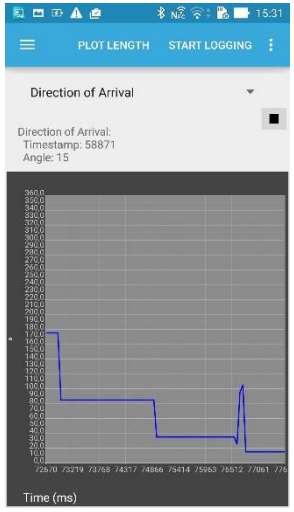

osxMotionCP carry position recognition page




osxMotionGR gesture recognition page

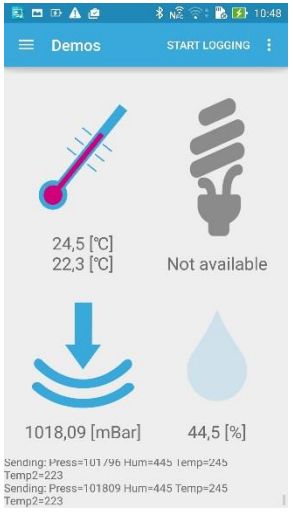
OPEN.AUDIO Library
Android version



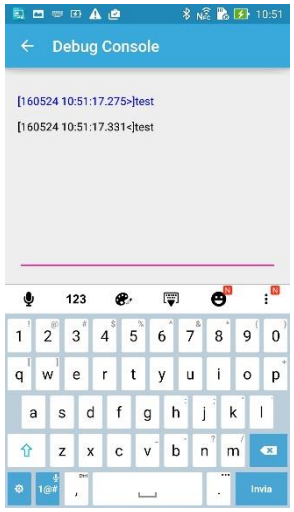




osxAcousticSL - audio source localization plot value

Console
Android version




Serial Console (stdout/stderr)

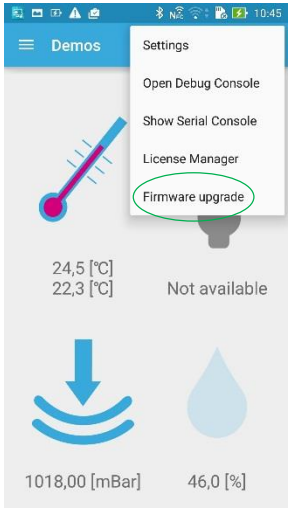



Debug Console (stdin/stdout/stderr)

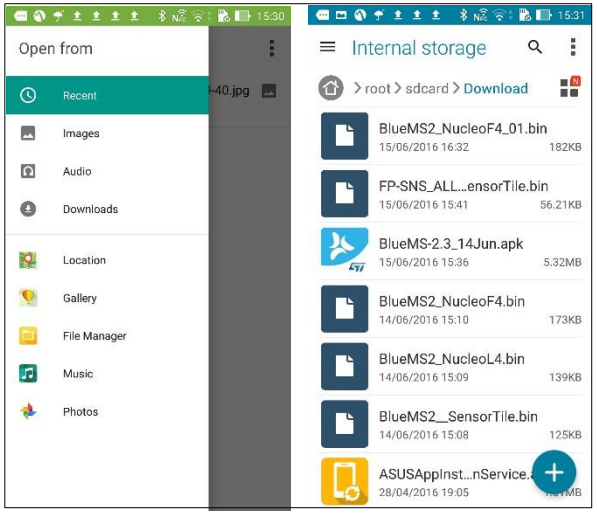
# BlueMS Application for Android/iOS (3/6)



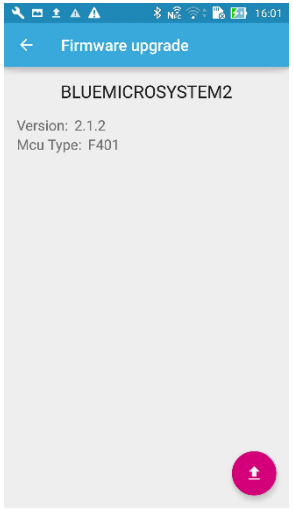
Firmware Upgrade – Android version



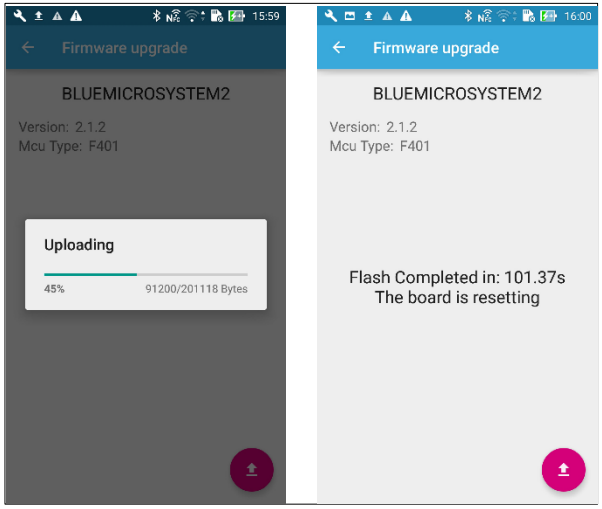

BlueMS: menu option



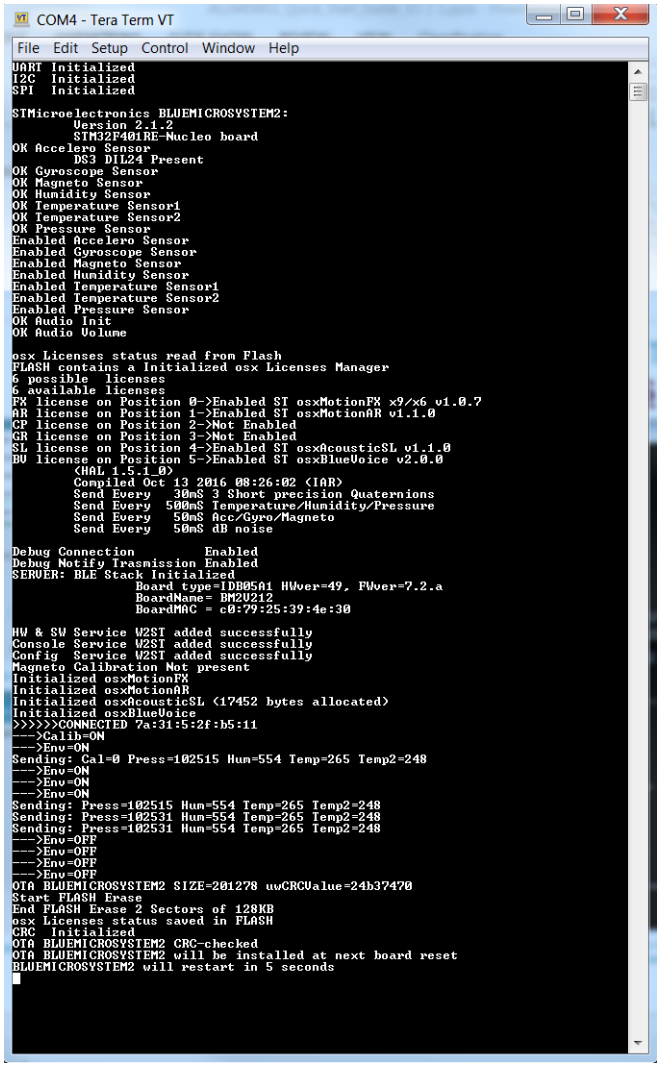

BlueMS: Firmware update file selection




BlueMS: Firmware upgrade page




BlueMS: application page during FOTA and on completion




Terminal window information during FOTA for STM32 Nucleo F4/L4 (For SensorTile only if enabled the serial console)

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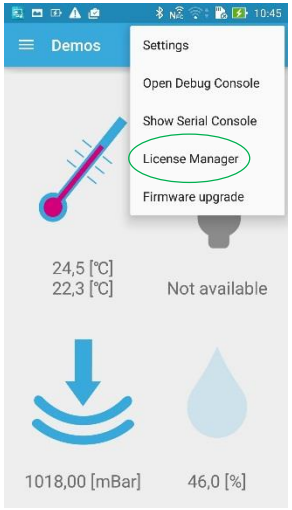
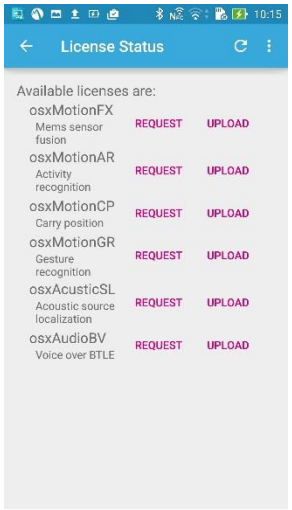
# BlueMS Application for Android/iOS (4/6)



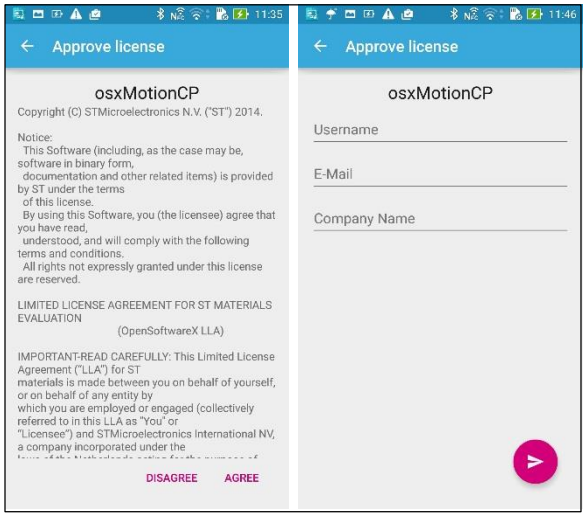
License Manager – Android version



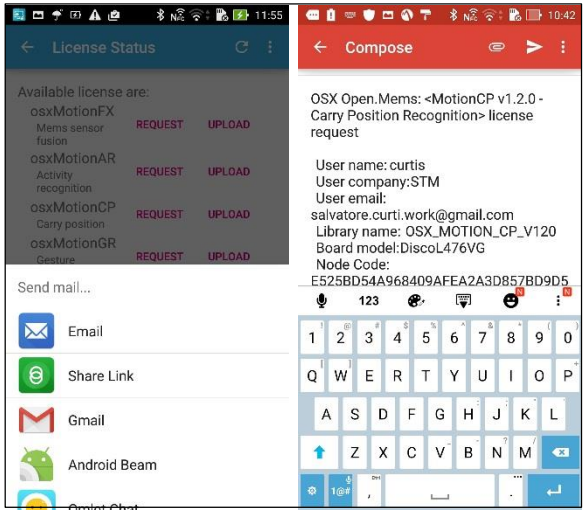

BlueMS: menu option



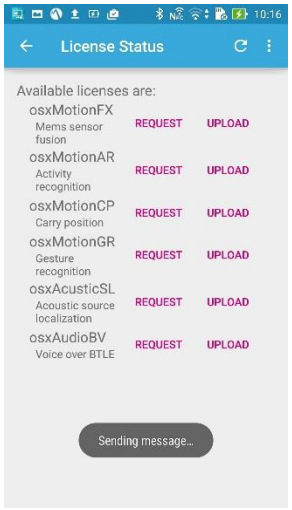

BlueMS: License status page



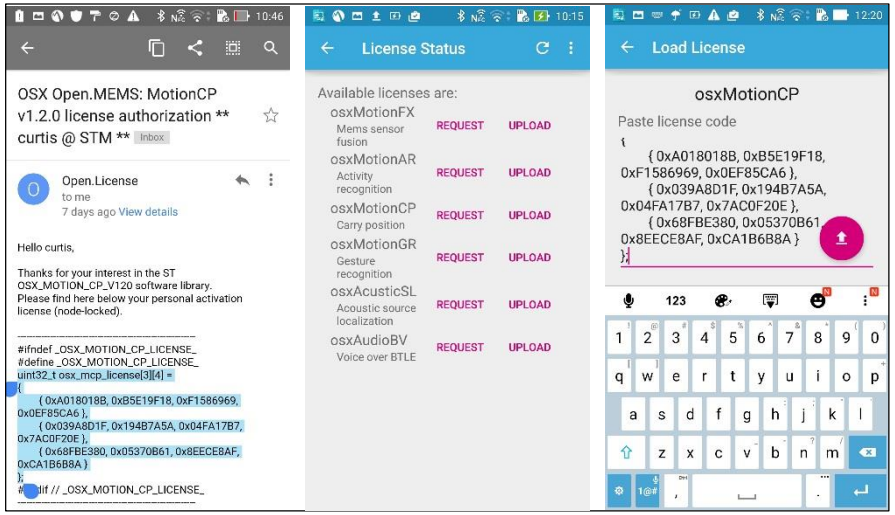

BlueMS: osxMotionCP license request



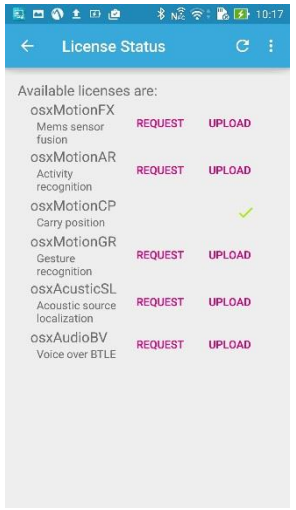

BlueMS: Generated license request email




BlueMS: Send request email




BlueMS: Copy license details, select UPLOAD and paste




BlueMS: osxMotionCP license enabled

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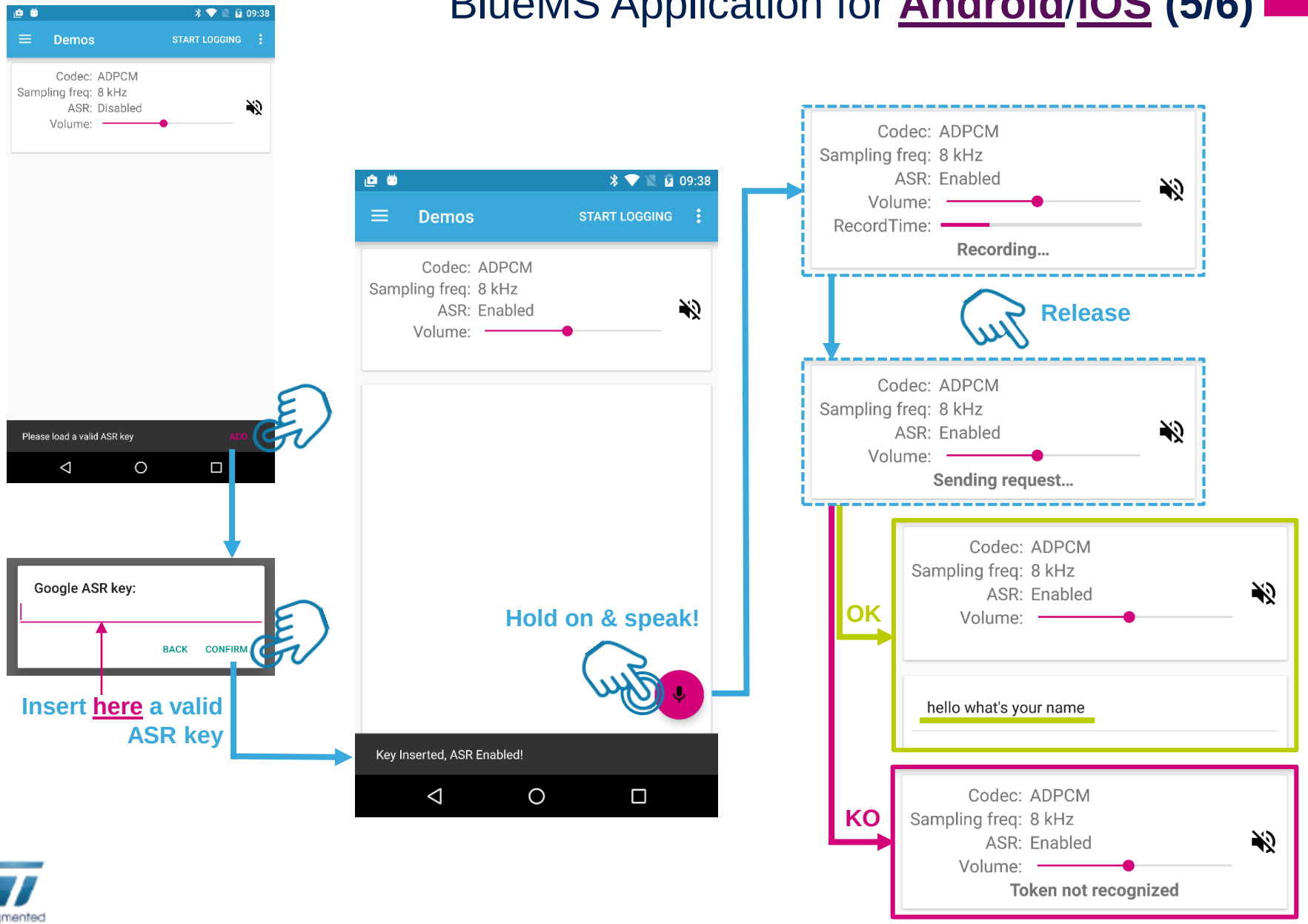
# BlueMS Application for Android/iOS (5/6)





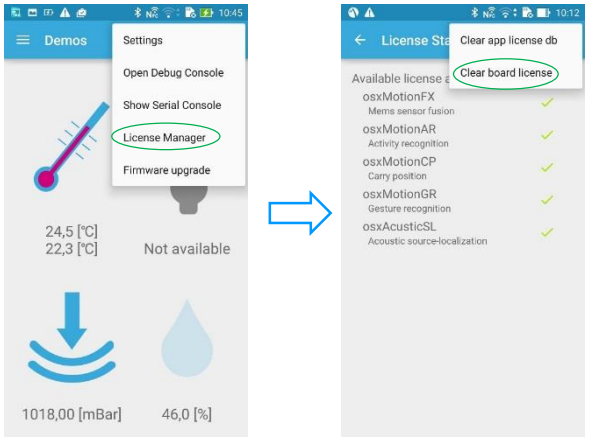


# BlueMS Application for Android/iOS (6/6)

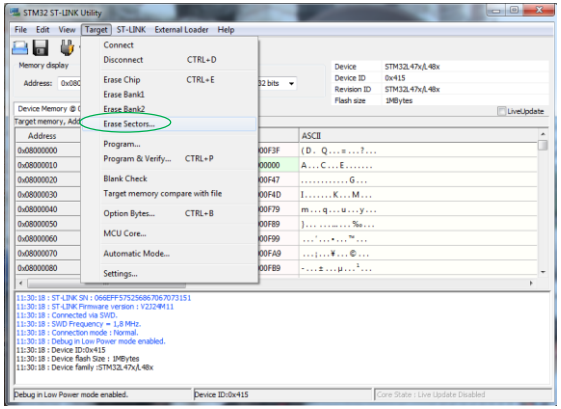


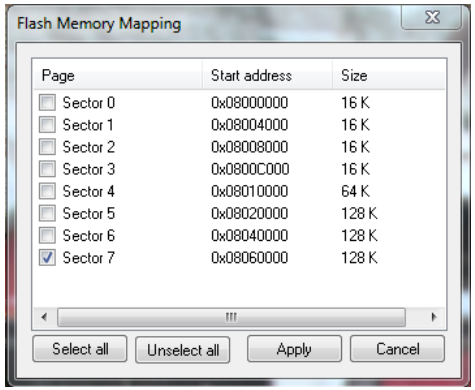
License Manager – Known Issue

- Clear licenses before load a new firmware that uses the same license manager
  - Using BlueMS application

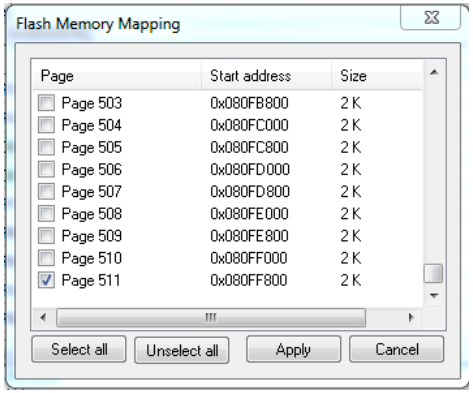



  - Flash erase using ST-LINK:




Select sector 7 for F4




Select page 511 for L4

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# Documents & Related Resources (1/2)



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

BLUEMICROSYSTEM2

- **DB2910:** Bluetooth low energy and sensor and software expansion for STM32Cube – **Data brief**
- **UM2055:** Getting started with the software package for Bluetooth low energy and sensors in BLUEMICROSYSTEM2 – **User manual**

X-NUCLEO-CCA02M1

- Gerber files, BOM, Schematic
- **DB2593:** Digital MEMS microphones expansion board based on MP34DT01-M for STM32 Nucleo – **Data brief**
- **UM1900:** Getting started with the digital MEMS microphones expansion board based on MP34DT01-M for STM32 Nucleo – **User manual**

X-NUCLEO-IDB04A1

- Gerber files, BOM, Schematic
- **DB2316:** Bluetooth Low Energy expansion board based on BlueNRG for STM32 Nucleo – **Data brief**
- **AN4642:** Overview of the BLE Profiles application for X-CUBE-BLE1 expansion for STM32Cube – **Application note**
- **UM1765:** Getting started with Bluetooth® low energy expansion board based on BlueNRG for STM32 Nucleo – **User manual**

Consult www.st.com for the complete list

# Documents & Related Resources

(2/2)



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

X-NUCLEO-IDB05A1

- Gerber files, BOM, Schematic
- **DB2592:** Bluetooth Low Energy expansion board based on SPBTLE-RF module for STM32 Nucleo – **Data brief**
- **UM1912:** Getting started with X-NUCLEO-IDB05A1 Bluetooth low energy expansion board based on SPBTLE-RF module for STM32 Nucleo – **User manual**

X-NUCLEO-IKS01A1

- Gerber files, BOM, Schematic
- **DS10619:** Motion MEMS and environmental sensor expansion board for STM32 Nucleo
- **UM1820:** Getting started with motion MEMS and environmental sensor expansion board for STM32 Nucleo – **user manual**

STEVAL-STLKT01V1

- Gerber files, BOM, Schematic
- **DB2956:** SensorTile development kit – **Data brief**
- **UM2101:** Getting started with the STEVAL-STLKT01V1 SensorTile integrated development platform – **User manual**

Consult www.st.com for the complete list

# Quick Start Guide Contents



BLUEMICROSYSTEM2: Bluetooth low energy and sensor software
Hardware and Software overview

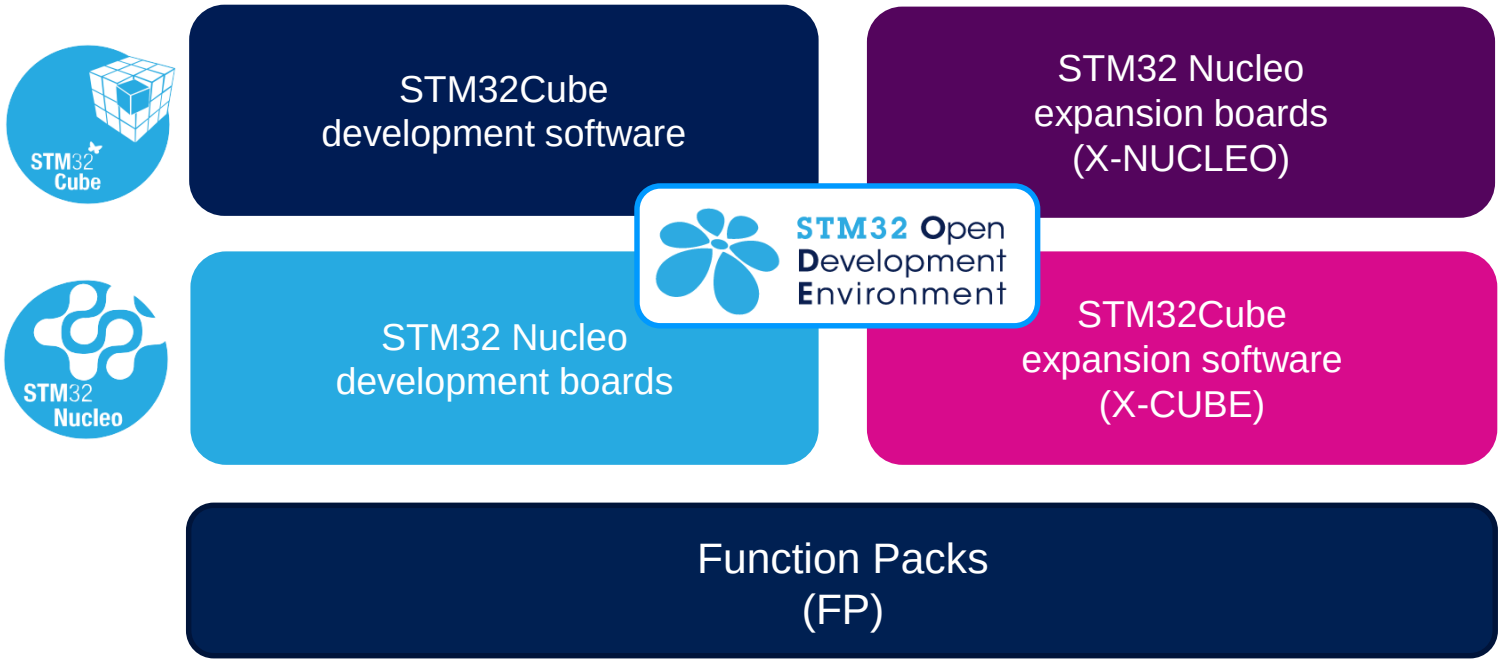
Setup & Demo Examples
Documents & Related Resources

STM32 Open Development Environment: Overview

# STM32 Open Development Environment
## Fast, affordable Prototyping and Development



- The STM32 Open Development Environment (ODE) consists of a set of stackable boards and a modular open SW environment designed around the STM32 microcontroller family.




www.st.com/stm32ode

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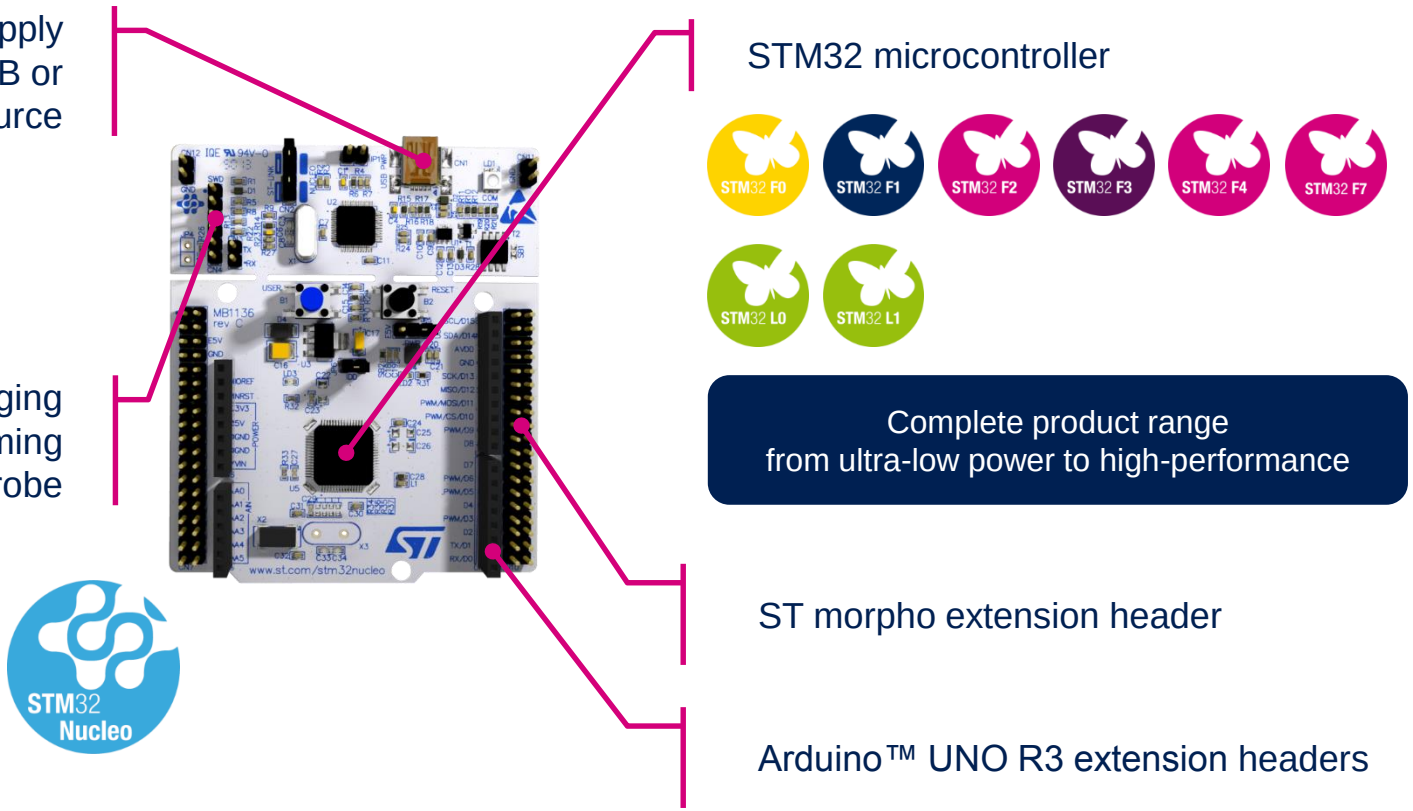
# Development Boards (NUCLEO)



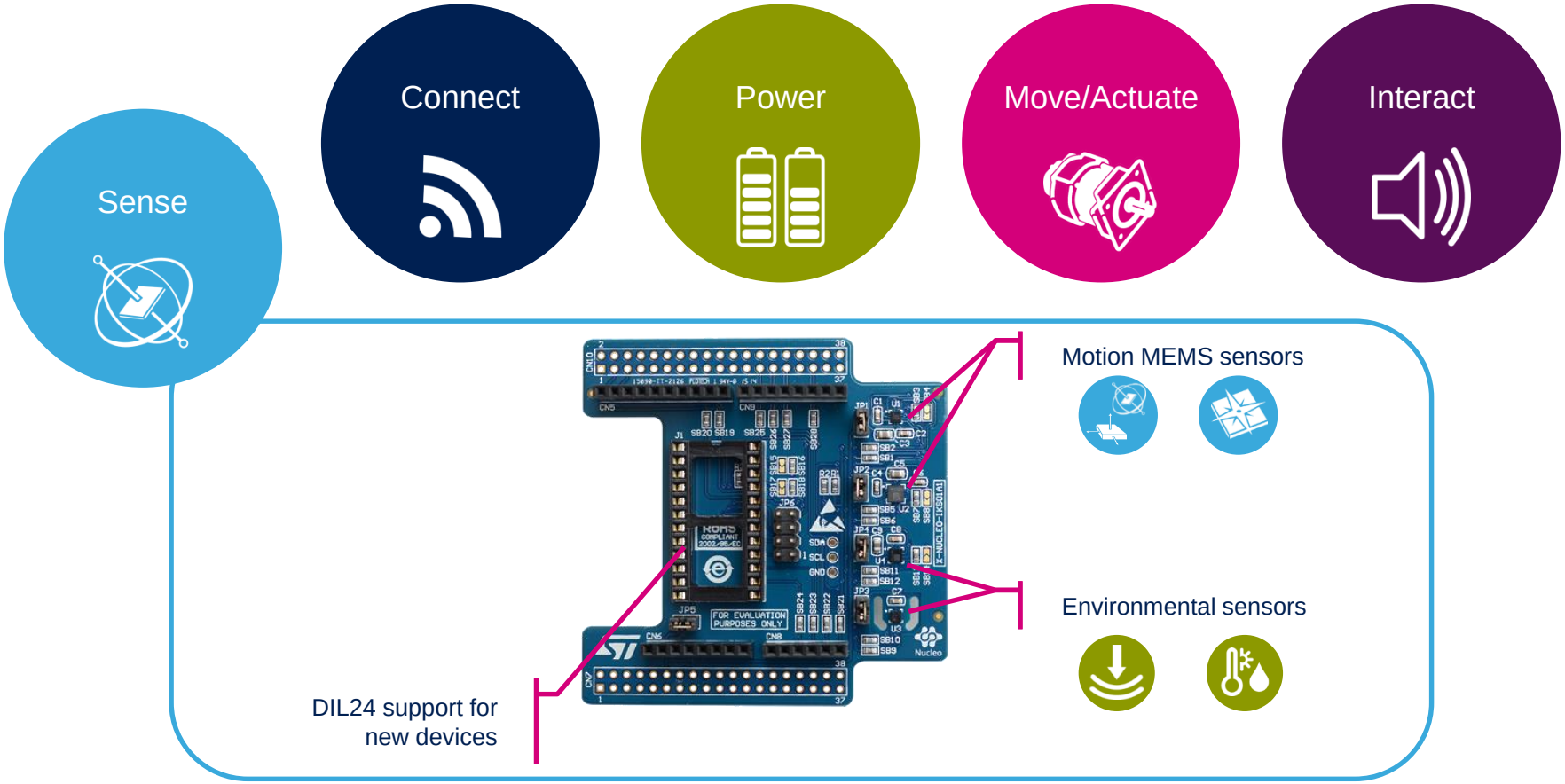
- A comprehensive range of affordable development boards for all the STM32 microcontroller series, with unlimited unified expansion capabilities and integrated debugger/programmer functionality.



# Expansion Boards (X-NUCLEO)



- Boards with additional functionality that can be plugged directly on top of the STM32 Nucleo development board directly or stacked on another expansion board.




Example of STM32 expansion board (X-NUCLEO-IKS01A1)

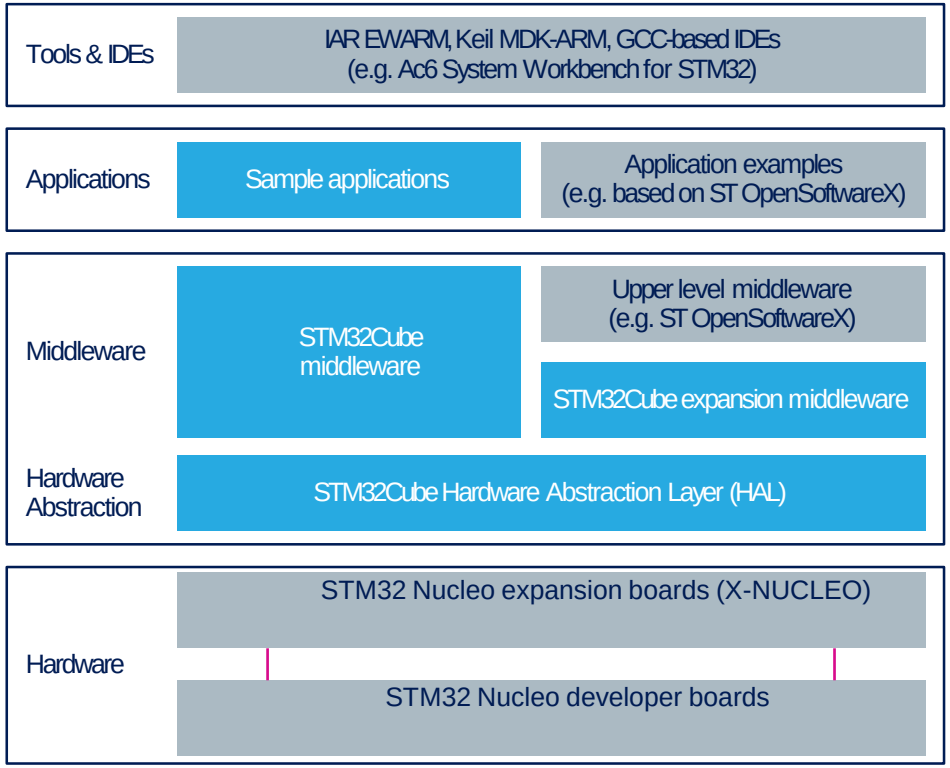
# STM32 Open Development Environment

## Software components



- **STM32Cube software (CUBE)** - A set of free tools and embedded software bricks to enable fast and easy development on the STM32, including a Hardware Abstraction Layer and middleware bricks.

- **STM32Cube expansion software (X-CUBE)** - Expansion software provided free for use with the STM32 Nucleo expansion board and fully compatible with the STM32Cube software framework. It provides abstracted access to expansion board functionality through high-level APIs and sample applications.




- **Compatibility with multiple Development Environments -** The STM32 Open Development Environment is compatible with a number of IDEs including IAR EWARM, Keil MDK, and GCC-based environments. Users can choose from three IDEs from leading vendors, which are free of charge and deployed in close cooperation with ST. These include Eclipse-based IDEs such as Ac6 System Workbench for STM32 and the MDK-ARM environment.

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**OPEN LICENSE MODELS:** STM32Cube software and sample applications are covered by a mix of fully open source BSD license and ST licenses with very permissive terms.

www.st.com/stm32cube

www.st.com/x-cube

# STM32 Open Development Environment
## Building block approach



| The building blocks | Your need | Our answer |
|---|---|---|

Accelerometer, gyroscope
Inertial modules, magnetometer
Pressure, temperature, humidity
Proximity, microphone

**Sense** — COLLECT

Bluetooth LE, Sub-GHz radio
NFC, Wi-Fi, GNSS

**Connect** — TRANSMIT

Audio amplifier
Touch controller
Operation Amplifier

**Translate** — ACCESS

Stepper motor driver
DC & BLDC motor driver
Industrial input / output

**Move / Actuate** — CREATE

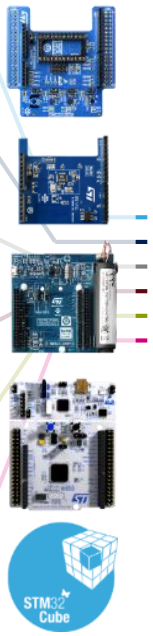
Energy management & battery

**Power** — POWER

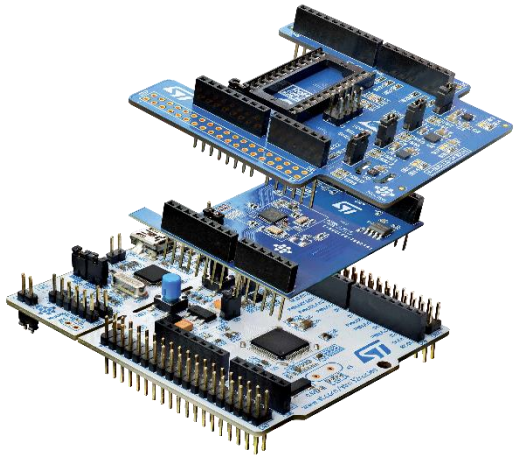
General-purpose microcontrollers
Secure microcontrollers

**Process** — PROCESS

**Software**




STM32 Open Development Environment



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