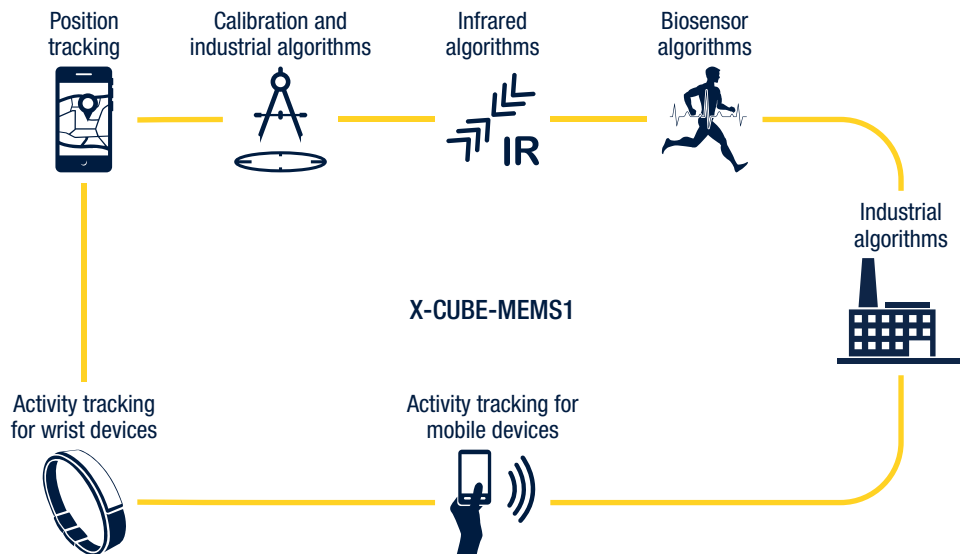




Sensor libraries software pack for STM32Cube





EXPLORE ST SENSOR SOFTWARE LIBRARIES WITH EXAMPLE CODE AND SAMPLE APPLICATIONS FOR STM32Cube ECOSYSTEM

Discover the X-CUBE-MEMS1 software expansion package, including a wide set of examples and libraries which help developers to rapidly develop and evaluate applications based on real-time data from ST's MEMS sensors.

X-CUBE software packages are part of **STM32Cube** program, and they are built on STM32Cube software technology for ease of portability across different STM32 microcontroller series, the expansion software packages provides advanced motion, environmental and, audio libraries for microcontrollers based on ARM Cortex-M3, M4, M7, M33 and M0+ architecture and also sample applications prepared for STM32 Nucleo-64 development boards with high-performance STM32F4, STM32F7 MCU or ultra-low-power STM32L0, STM32L1, STM32L4 MCU.

The X-CUBE-MEMS1 expansion software package for STM32Cube runs on the STM32 and includes drivers for configuring the sensors and collect temperature, humidity, pressure and motion data. The package also includes libraries for sensors calibration and algorithms for position and activity tracking.

KEY FEATURES

- Complete software and example code for building applications with ST's innovative sensors
- Compatible with STM32Cube MCU hardware and software ecosystem
- Easy portability across different MCU families, thanks to STM32Cube development ecosystem
- Free, user-friendly license terms

The X-CUBE-MEMS1 contains following advanced motion libraries:

Action	Library	Description	MEMS sensor	Application
	MotionAC accelerometer calibration	Calibrates the accelerometer in real time. The library acquires data from the accelerometer and calculates the offset and scale factor coefficients together with the calibration quality value.	Accelerometer	Any
	MotionAC2 accelerometer calibration 2 axis	Calibrates the accelerometer in real time. The library acquires data from the accelerometer and calculates the offset and scale factor coefficients together with the calibration quality value.	Accelerometer	Any
	MotionAD airplane detection	Detect airplane mode from hand-held devices to automatically avoid potential hazards such as interference with wireless communication and battery explosion due to high current drawn by the airplane outlet.	Accelerometer, pressure and temperature	Mobile phone, laptop, tablet
	MotionAR activity recognition	Provides real-time information on the type of activity performed by the user including stationary, walking, fast walking, jogging, biking, or driving.	Accelerometer	Phone
	MotionAT active time	Based on type of activity, detects motion intensity and pedometer data in real time using wrist algorithms to determine the number of active seconds.	Accelerometer	Wearables
	MotionAW activity recognition for wrist	Provides real-time information on the type of activity performed by the user including stationary, standing, sitting, lying, walking, fast walking, jogging, or biking.	Accelerometer	Wearables
	MotionCP carrying position	Provides real-time information about how the user is carrying a device (e.g. 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.	Accelerometer	Phone
	MotionDI dynamic Inclinometer	Provides information about the device position (quaternions, Euler angles, linear acceleration, gravity vector).	Accelerometer and gyroscope	Phone
	MotionEC eCompass	Provides real-time information about the device orientation and movement: device orientation (quaternions, Euler angles), device rotation (virtual gyroscope functionality), gravity vector and linear acceleration.	Accelerometer and magnetometer	Any
	MotionFA fitness activities	Provides real-time information about the repetition quantity of various fitness activities performed by a user.	Accelerometer and pressure sensor	Wearables
	MotionFD fall detection library	Provides real-time information about user fall events. It is able to distinguish if the user fell or not.	Accelerometer and pressure sensor	Wearables
	MotionFX sensor fusion	Provides real-time motion-sensor data from the accelerometer, gyroscope (6-axis fusion) and magnetometer (9-axis fusion) and provides real-time motion-fusion sensing. It also performs gyroscope bias and magnetometer hard iron calibration.	Accelerometer, magnetometer and gyroscope	Any
	MotionGC gyroscope calibration	Used to calibrate the gyroscope in real time using angular zero-rate level coefficients (offset). The gyroscope sensor can have significant offset, which can cause problems when using the gyroscope output data. The MotionGC library is able to minimize the offset and solve this issue.	Accelerometer and gyroscope	Any
	MotionGR gesture recognition	Provides real-time information about the gesture just performed by the user with the device, such as a cell phone, including pick-up, glance, wake up.	Accelerometer	Phone
	MotionID motion intensity detection	Provides real-time information about the user motion intensity. It is able to distinguish motion intensity in a range from 0 (still) to 10 (sprinting).	Accelerometer	Wearables

Action	Library	Description	MEMS sensor	Application
	MotionMC magnetometer calibration	Used to calibrate the magnetometer in real time using hard iron (HI) and scale factor coefficients.	Magnetometer	Any
	MotionPE pose estimation	Provides real-time information about the user current pose such as sitting, standing and lying down.	Accelerometer	Wearables
	MotionPM pedometer for mobile	Provides real-time information about the number of steps and cadence just performed by the user carrying the device, such as a cell phone.	Accelerometer	Phone
	MotionPW pedometer for wrist	Provides real-time information about the number of steps and cadence which the user just performed wearing the device on the wrist (e.g. a smart watch).	Accelerometer	Wearables
	MotionSD standing and sitting desk detection	Provides real-time information about the user working mode: sitting at the desk or standing desk position.	Accelerometer	Wearables
	MotionSM sleep monitoring	Provides real-time information if the man wearing the device is sleeping or not.	Accelerometer	Wearables
	MotionSP vibration monitoring	Provides frequency spectrum or accelerometer signal, acceleration RMS, speed RMS and acceleration peak values.	Accelerometer	Any
	MotionTL and MotionTL2 tilt sensing	Provides real-time information about the tilt angles of the user carrying the device, i.e. cell phone. The library is also able to perform 6-position accelerometer calibration.	Accelerometer	Any
	MotionVC Vertical Context	It provides real-time information about vertical movement. The library is able to detect a change of altitude and distinguish the type of vertical movement: stairs, elevator, and escalator.	Accelerometer and pressure	Any
	BioVSM	Library for vital signs monitoring	Biosensor	Healthcare
	InfraredAL	Provides real-time information about the presence of a person in the field of view of the sensor	Infrared	Presence detection
	InfraredPD	Provides real-time information about the presence and motion of a person in the field of view of the sensor	Infrared	Presence and motion detection
	MotionGT	Provides real-time temperature-compensated gyroscope calibration parameters across the temperature (angular zero-rate level coefficients offset) used to correct gyroscope data.	Gyroscope	Calibration
	MotionXLF	Fuses data from the low-g accelerometer and high-g accelerometer	IMU with high-g accelerometer	Fusion

STM32Cube ecosystem

FAST, AFFORDABLE PROTOTYPING AND DEVELOPMENT

The **STM32Cube Ecosystem** 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.

The STM32Cube Ecosystem includes the following five elements:

- STM32 Nucleo development boards. A comprehensive range of affordable development boards for all STM32 microcontroller series, with unlimited unified expansion capability, and with integrated debugger/programmer
- STM32 Nucleo expansion boards. Boards with additional functionality to add sensing, control, connectivity, power, audio or other functions as needed. The expansion boards are plugged on top of the STM32 Nucleo development boards. More complex functionalities can be achieved by stacking additional expansion boards
- STM32Cube software. A set of free-of-charge tools and embedded software bricks to enable fast and easy development on the STM32, including a Hardware Abstraction Layer, middleware and the STM32CubeMX PC-based configurator and code generator
- STM32Cube expansion software. Expansion software provided free of charge for use with STM32 Nucleo expansion boards, and compatible with the STM32Cube software framework
- STM32Cube Function Packs. Set of function examples for some of the most common application cases built by leveraging the modularity and interoperability of STM32 Nucleo development boards and expansions, with STM32Cube software and expansions.

The STM32Cube Ecosystem is compatible with a wide range of development environments including STM32CubeIDE, IAR EWARM, Keil MDK-ARM and GCC/LLVM-based IDEs, with the possibility to integrate the various components such as STM32CubeMX, STM32CubeProgrammer or STM32CubeMonitor.



STM32 Nucleo
development boards



STM32Cube
development software

STM32 Nucleo
expansion boards (X-NUCLEO)

STM32Cube
expansion software (X-CUBE)

Function packs (FP)



FIND OUT MORE

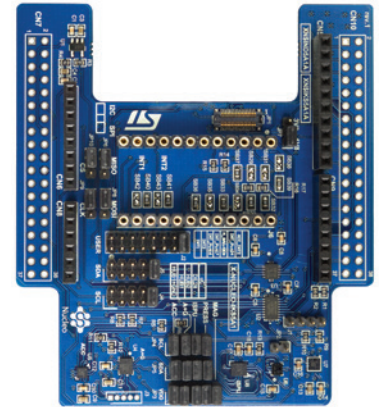
www.st.com/content/st_com/en/stm32-mcu-developer-zone.html

EXPANSION BOARDS FOR MOTION SENSOR ALGORITHMS

For quick and easy testing, the X-CUBE-MEMS1 contains examples to test sensor's features and sample applications for libraries. These examples and application are available in source code with projects for most common IDE. Already compiled binaries are available for even easier testing. The samples and application are prepared for the expansion boards: X-NUCLEO-IKS4A1 and X-NUCLEO-IKS5A1.

X-NUCLEO-IKS5A1

- Wide range of industrial motion and environmental sensors:
 - ISM6HG256X: intelligent IMU with simultaneous low-g and high-g acceleration detection
 - ISM330IS: 6-axis IMU, always-on 3-axis accelerometer and 3-axis gyroscope with IPU
 - IIS2DULPX: intelligent ultralow power accelerometer for industrial applications
 - ILPS22QS: dual full-scale, 1260 hPa and 4060 hPa, absolute digital output barometer
 - IIS2MDC: high accuracy, ultralow power, 3-axis digital output magnetometer
- DIL24 socket and industrial connectors for external sensors
- Compatible with X-CUBE-MEMS1, an expansion software package for STM32Cube
- I²C sensor hub features on ISM330IS and ISM6HG256X available
- Supported by MEMS-Studio, a software solution for MEMS sensors with graphical no-code design of algorithms and development of embedded AI features
- Compatible with STM32 Nucleo boards
- Equipped with Arduino® UNO R3 connector
- RoHS compliant and WEEE compliant



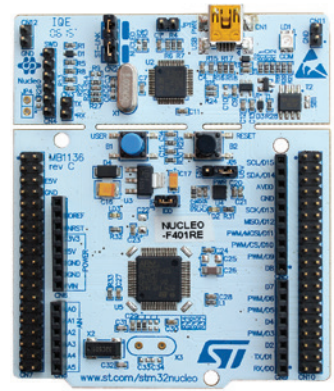
X-NUCLEO-IKS4A1

- Wide range of motion and environmental sensors:
 - LSM6DSO16IS: MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8/\pm 16$ g) + 3D gyroscope ($\pm 125/\pm 250/\pm 500/\pm 1000/\pm 2000$ dps) with IPU (Intelligent Processing Unit)
 - LIS2MDL: MEMS 3D magnetometer (± 50 gauss)
 - LIS2DUXS12: Ultra low-power MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8/\pm 16$ g) with Qvar, AI, & anti-aliasing
 - LPS22DF: Low-power and high-precision MEMS pressure sensor, 260-1260 hPa absolute digital output barometer
 - SHT40AD1B: High-accuracy, ultra-low-power relative humidity and temperature sensor (by Sensirion)
 - STTS22H: Low-voltage, ultralow-power, 0.5 °C accuracy temperature sensor (-40 °C to $+125$ °C)
 - LSM6DSV16X: MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8/\pm 16$ g) + 3D gyroscope ($\pm 125/\pm 250/\pm 500/\pm 1000/\pm 2000/\pm 4000$ dps) with embedded sensor fusion, AI, Qvar
- DIL 24-pin socket available for additional MEMS adapters and other sensors
- Compatible with X-CUBE-MEMS1, an expansion software package for STM32Cube
- Equipped with Qvar touch/swipe electrode
- I²C sensor hub features on LSM6DSO16IS and LSM6DSV16X available
- Supported by MEMS-Studio, a software solution for MEMS sensors with graphical no-code design of algorithms and development of embedded AI features
- MIPI I3C® compatibility for communication with LIS2DUXS12, LSM6DSV16X and LPS22DF
- Compatible with STM32 Nucleo boards
- Equipped with Arduino UNO R3 connector
- Equipped with industrial connector for IR sensor (STHS34PF80) application development. It can be connected at the same time of external MEMS through DIL24 adapter
- Available interface for external camera module applications coupled with LSM6DSV16X through aux SPI (3/4 w)
- RoHS compliant
- WEEE compliant
- UKCA compliant



EXAMPLES AVAILABLE IN X-CUBE-MEMS1 FOR:

- NUCLEO-F401RE STM32F401RE (ARM Cortex-M4)
- NUCLEO-L152RE STM32L152RE (ARM Cortex-M3)
- NUCLEO-U575ZI-Q STM32U575ZI (ARM Cortex-M33)
- NUCLEO-L073RZ STM32L073RZ (ARM Cortex-M0+)



To learn more and to download the X-CUBE-MEMS1 Sensor and motion algorithm software expansion pack for STM32Cube, visit: <https://www.st.com/en/embedded-software/x-cube-mems1.html>

	Available for STM32 with architecture					Application out of the box availability	
	ARM Cortex M0+	ARM Cortex M3	ARM Cortex M4	ARM Cortex M7	ARM Cortex M33	X-NUCLEO-IKS4A1	X-NUCLEO-IKS5A1
BioVSM	X	X	X	X	X		
InfraredAL	X	X	X	X	X		
InfraredPD	X	X	X	X	X		
MotionGT	X	X	X				
MotionXLF	X	X	X	X	X		X
MotionSM		X	X	X	X		
MotionAC		X	X	X	X	X	X
MotionAC2	X	X	X	X	X		
MotionAD		X	X	X	X	X	
MotionAR		X	X	X	X	X	
MotionAT		X	X	X	X	X	
MotionAW		X	X	X	X	X	
MotionCP		X	X	X	X	X	
MotionDI		X	X	X	X	X	X
MotionEC	X	X	X	X	X	X	X
MotionFA		X	X	X	X	X	
MotionFD		X	X	X	X	X	
MotionFX	X	X	X	X	X	X	X
MotionGC	X	X	X	X	X	X	X
MotionGR		X	X	X	X	X	
MotionID	X	X	X	X	X	X	
MotionMC	X	X	X	X	X	X	X
MotionPE		X	X	X	X	X	
MotionPM		X	X	X	X	X	
MotionPW		X	X	X	X	X	
MotionSD		X	X	X	X	X	
MotionSP			X	X	X		
MotionTL	X	X	X	X	X	X	X
MotionTL2	X	X	X	X	X		
MotionVC		X	X	X	X	X	

STEVAL-STWINBX1

- Multisensing wireless platform for vibration monitoring and ultrasound detection
- Built around STWIN.box core system board with processing, sensing, connectivity, and expansion capabilities
- Ultra-low power Arm® Cortex®-M33 with FPU and TrustZone at 160 MHz, 2048 KB Flash memory (STM32U585AI)
- microSD(TM) card slot for standalone data logging applications
- On-board Bluetooth® Low Energy v5.0 wireless technology (BlueNRG-M2), Wi-Fi (EMW3080), and NFC (ST25DV64K)
- Option to implement authentication and brand protection secure solution with STSAFE-A110
- Wide range of industrial IoT sensors:
 - Ultra-wide bandwidth (up to 6 kHz), low-noise, 3-axis digital vibration sensor (IIS3DWB)
 - 3-axis accelerometer + 3-axis gyroscope iNEMO inertial measurement unit (ISM330DHCX) with Machine Learning Core
 - High-performance ultra-low-power 3-axis accelerometer for industrial applications (IIS2DLPC)
 - Ultra-low power 3-axis magnetometer (IIS2MDC)
 - High-accuracy, high-resolution, low-power, 2-axis digital inclinometer with Embedded Machine Learning Core (IIS2ICLX)
 - Dual full-scale, 1.26 bar and 4 bar, absolute digital output barometer in full-mold package (ILPS22QS)
 - Low-voltage, ultra low-power, 0.5°C accuracy I²C/SMBus 3.0 temperature sensor (STTS22H)
 - Industrial grade digital MEMS microphone (IMP34DT05)
 - Analog MEMS microphone with frequency response up to 80 kHz (IMP23ABSU)
- Expandable via a 34-pin FPC connector

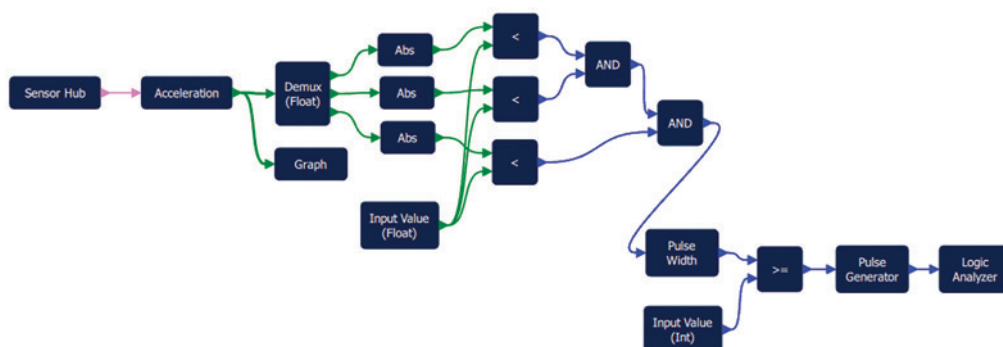
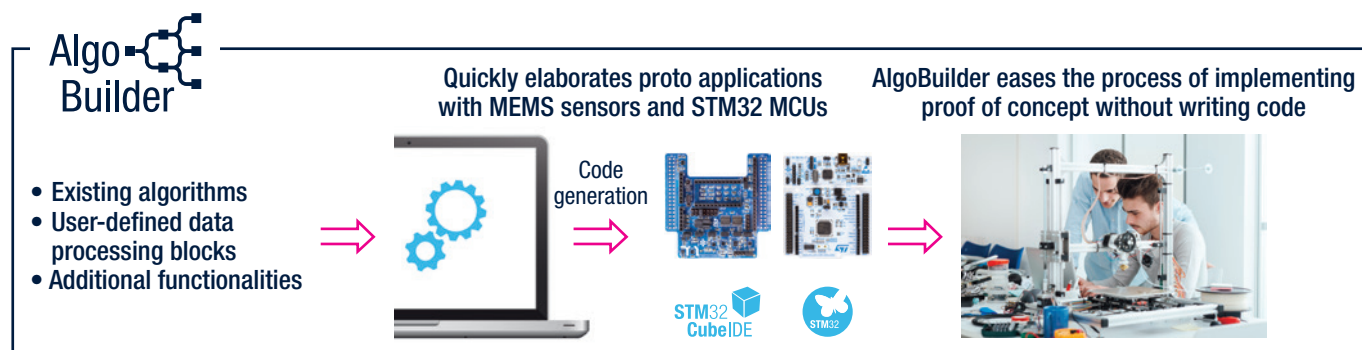


AlgoBuilder TOOL IN MEMS STUDIO

Graphical design application to build and use prepared advanced motion algorithms in the user design project for STM32 microcontrollers and MEMS sensors

AlgoBuilder quickly elaborates prototypes of applications for STM32 microcontrollers and MEMS sensors, including already existing algorithms (i.e. motion libraries, sensor fusion or pedometer), user-defined data processing blocks and additional functionalities. The application facilitates the process of implementing proof of concept using a graphical interface without writing the code.

AlgoBuilder is a tool of MEMS Studio which utilizes the **STM32Cube Ecosystem** which combines STM32 Nucleo boards (STEVAL-MKSBOX1V1 or NUCLEO-L476RG), X-NUCLEO-IKS4A1 and X-NUCLEO-IKS5A1 expansion board, or the STEVAL-STWINKT1 solution board together with the software (STM32 HAL drivers, BSP structure, low and high-level sensor drivers).



To learn more and to download **MEMS-Studio** visit: <https://www.st.com/en/development-tools/mems-studio.html>

The AlgoBuilder tool in MEMS Studio contains the following advanced motion libraries:

Action	Library	Description	MEMS sensor	Application
	MotionAC accelerometer calibration	Calibrates the accelerometer in real time. The library acquires data from the accelerometer and calculates the offset and scale factor coefficients together with the calibration quality value.	Accelerometer	Any
	MotionAW activity recognition for wrist	Provides real-time information on the type of activity performed by the user including stationary, standing, sitting, lying, walking, fast walking, jogging, or biking.	Accelerometer	Wearables
	MotionEC eCompass	Provides real-time information about the device orientation and movement: device orientation (quaternions, Euler angles), device rotation (virtual gyroscope functionality), gravity vector and linear acceleration.	Accelerometer and magnetometer	Any
	MotionFX sensor fusion	Provides real-time motion-sensor data from the accelerometer, gyroscope (6-axis fusion) and magnetometer (9-axis fusion) and provides real-time motion-fusion sensing. It also performs gyroscope bias and magnetometer hard iron calibration.	Accelerometer, magnetometer and gyroscope	Any
	MotionGC gyroscope calibration	Used to calibrate the gyroscope in real time using angular zero-rate level coefficients (offset). The gyroscope sensor can have significant offset, which can cause problems when using the gyroscope output data. The MotionGC library is able to minimize the offset and solve this issue.	Accelerometer and gyroscope	Any
	MotionID motion intensity detection	Provides real-time information about the user motion intensity. It is able to distinguish motion intensity in a range from 0 (still) to 10 (sprinting).	Accelerometer	Wearables
	MotionMC magnetometer calibration	Used to calibrate the magnetometer in real time using hard iron (HI) and scale factor coefficients.	Magnetometer	Any
	MotionPM pedometer for mobile	Provides real-time information about the number of steps and cadence just performed by the user carrying the device, such as a cell phone.	Accelerometer	Phone
	MotionPW pedometer for wrist	Provides real-time information about the number of steps and cadence which the user just performed wearing the device on the wrist (e.g. a smart watch).	Accelerometer	Wearables
	MotionTL tilt sensing	Provides real-time information about the tilt angles of the user carrying the device, i.e. cell phone. The library is also able to perform 6-position accelerometer calibration.	Accelerometer	Any

Watch our featured video to learn more about the AlgoBuilder application:

https://www.youtube.com/watch?v=5uoGSWq_9hA&list=PLTJzs51NIEIDjjXEtibeY0zQSFra0ARYG&index=8

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starts with You



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