UM2696

User manual

Getting started with the FP-ATR-BLE1 STM32Cube function for asset tracking using BLE connectivity for SensorTile.box

Introduction

FP-ATR-BLE1 is an STM32Cube function pack for asset tracking using BLE connectivity for the SensorTile.box wireless multi sensor development kit, which helps you to build custom applications.

The package includes pressure, relative humidity, temperature and accelerometer sensors and the SPBTLE-1S Bluetooth low energy system-on-chip application processor.

With the STEVAL-MKSBOX1V1 kit with BLE connectivity, you can monitor and log the sensor data using the ST Asset Tracking app.

The software runs on the STM32 microcontroller and includes all the necessary drivers for the STEVAL-MKSBOX1V1 evaluation kit.

RELATED LINKS

Visit the STM32Cube ecosystem web page on www.st.com for further information

1 FP-ATR-BLE1 software expansion for STM32Cube

1.1 Overview

FP-ATR-BLE1 key features are:

- Complete example on how to create an asset tracking application controlled by a mobile device using BLE
- Ultra-low power implementation based on RTOS
- Wake-up, tilt and orientation detection by the on-board accelerometer
- Middleware Bluetooth connectivity using the X-CUBE-BLE2 software package
- Environmental sensor data and inertial data saved on SD card using FatFs middleware
- Compatible with ST Asset Tracking client application for Android/iOS to set up firmware via Bluetooth connectivity and to read the data log created
- Sample implementation available for the STEVAL-MKSBOX1V1 evaluation kit
- Easy portability across different MCU families, thanks to STM32Cube
- Free, user-friendly license terms

The software gathers the temperature, humidity, pressure, motion sensor drivers for the HTS221, LPS22HH, STTS751, LIS2DW12, LIS2MDL, LIS3DHH and LSM6DSOX devices for the STEVAL-MKSBOX1V1.

1.2 Architecture

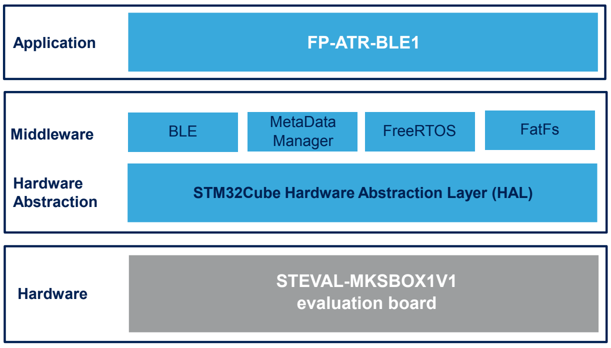
This software is based on the STM32CubeHAL. It extends STM32Cube by providing a board support package (BSP) for the BLE, sensors and middleware components for communication with other BLE devices.

It also provides an application to demonstrate how to implement your own low power, BLE-controlled asset tracking application using the SensorTile.box Pro Mode.

The software layers used by the application software to access and use the SensorTile.box are:

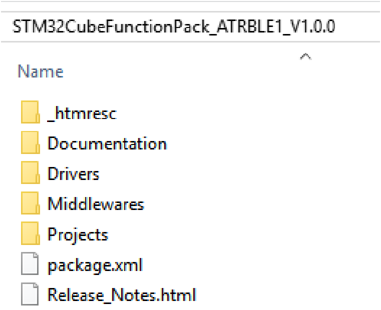
- the **STM32Cube HAL layer**, which provides a simple, generic, multi-instance set of application programming interfaces (APIs) to interact with the upper application, library and stack layers. It has generic and extension APIs and is directly built around a generic architecture and allows successive layers like the middleware layer to implement functions without requiring specific hardware configurations for a given microcontroller unit (MCU). This structure improves library code reusability and guarantees an easy portability on other devices.
- the **board support package** (BSP) layer, which supports all the peripherals on the STM32 Nucleo except the MCU. This limited set of APIs provides a programming interface for certain board-specific peripherals like the LED, the user button, etc. This interface also helps in identifying the specific board version.

Figure 1. **FP-ATR-BLE1 software architecture**



1.3 Folder structure

Figure 2. **FP-ATRE1 package folder structure**



STM32CubeFunctionPack_ATRBLE1_V1.0.0

Name

- _htmresc
- Documentation
- Drivers
- Middlewares
- Projects
- package.xml
- Release_Notes.html

The following folders are included in the software package:

- **Documentation** contains a compiled HTML file generated from the source code which details the software components and APIs.
- **Drivers** contains the HAL drivers and the board-specific drivers for each supported board or hardware platform, including the on-board components and the CMSIS vendor-independent hardware abstraction layer for ARM Cortex-M processor series.
- **Middlewares** contains libraries and protocols for BlueNRG-2 Bluetooth low energy, FreeRTOS real-time operating systemand FATfs DOS/Windows compatible with FAT/exFAT filesystem.
- **Projects** contains one example application for creating a customized low power asset tracking applicationcontrolled by Bluetooth for the SensorTile.box wireless multi sensor development kit (STEVAL-MKSBOX1V1).

  The application is available for IAR Embedded Workbench for ARM, RealView Microcontroller Development Kit (MDK-ARM-STR) and STM32CubeIDE multi-OS development tool.

1.4 APIs

Detailed technical information with full user API function and parameter description are in a compiled HTML file in the “Documentation” folder.

2 Sample ATRBLE application project

FP-ATR-BLE1 contains an application project in the *Projects\STM32L4R9ZI-SensorTile.box\Applications* directory that implements a low power asset tracking application controlled via Bluetooth.

The sample application is able to log:

- inertial events: wake up (above a threshold), orientation and tilt;
- environmental values (above and/or below some thresholds): temperature, relative humidity and pressure.

You can select which inertial/environmental events to log and also the thresholds values using the ST Asset Tracking application (version 2.0.0 or above). Using the same app, you can also control the tracking log (pause/stop/start/resume) and read the log saved on SD card.

The application project is available for the STEVAL-MKSBOX1V1 evaluation board together with ready-to-build projects for multiple IDEs (IAR V8.32.3, Keil V5.27.1 and STM32CubeIDE V1.3.2).

In the *STATRBLE1_config.h* configuration file, you can enable/disable some compilation defines to customize the sample application. The main defines are:

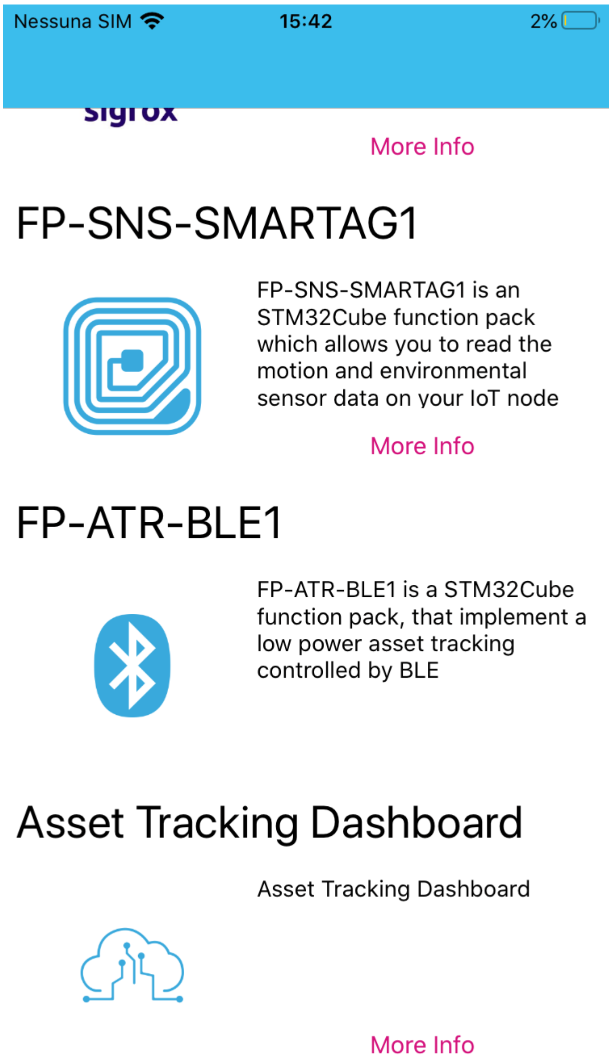
- `#define STATRBLE1_POS_LOG_FILE_NAME` - to choose the name where the application will save the GPS position received from the ST Asset Tracking application
- `#define STATRBLE1_EVN_REG_LED_BLINKING` - if enabled (by default), the blue and the green LED on the SensorTile.box blinks for each event saved (blue for inertial event and green for environmental events). Disable this define to reduce power consumption.
- `#define STATRBLE1_DISABLE_PM` - if enabled (not by default), the STM32 does not enter Stop mode to debug the application. Do not enable this define during normal operation to allow low power consumption.
- `#define STATRBLE1_WRITE_CONFIGURATION` - if enabled (not by default), the STM32 writes the tracking configuration on a .csv file.

Important:
If you enable the last define, ST Asset Tracking is not able to read the log, even if it still lets you choose the events to log and start. As the BLE application is controlled by sending commands to the Bluetooth debug console service, the ST BLE Sensor app can instead be used to control and read the log. To view the related commands, write the message "help" on the ST BLE Sensor debug console.

When the board is powered up, the LEDs (blue and green) flash quickly to show the board is active. To reduce power consumption, Bluetooth is always disabled, so you need to press the user button to enable it before using the ST Asset Tracking application.

After pressing the power button, the blue LED blinks to signal the Bluetooth is on and the SensorTile.box is waiting for connection.

Figure 3. **ST Asset Tracking application: initial page**



Nessuna SIM 15:42 2%

sigfox

More Info

FP-SNS-SMARTAG1

FP-SNS-SMARTAG1 is an STM32Cube function pack which allows you to read the motion and environmental sensor data on your IoT node

More Info

FP-ATR-BLE1

FP-ATR-BLE1 is a STM32Cube function pack, that implement a low power asset tracking controlled by BLE

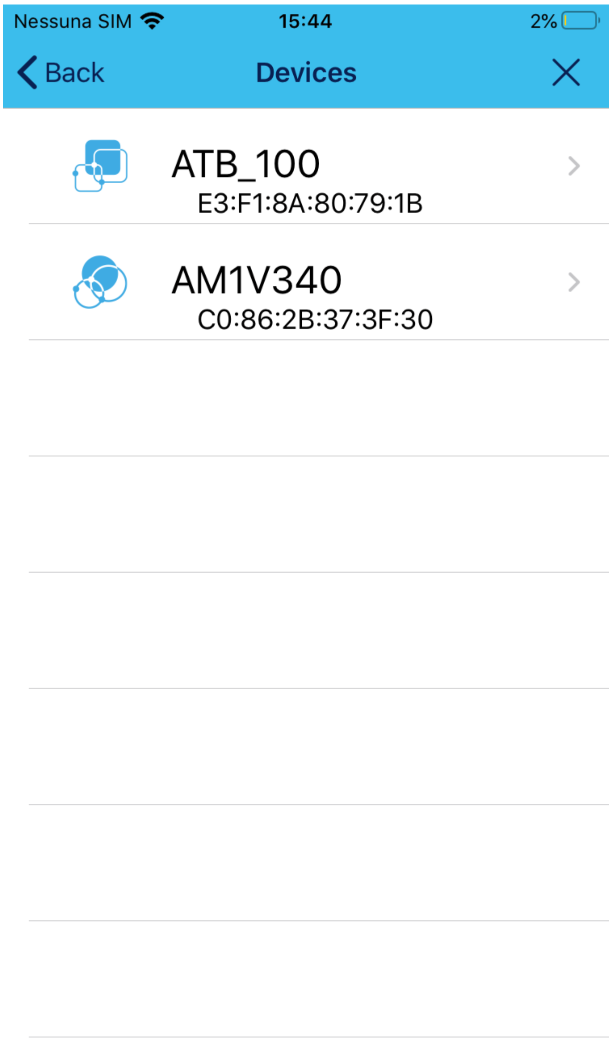
Asset Tracking Dashboard

Asset Tracking Dashboard

More Info

After choosing the right functional pack on the ST Asset Tracking application, the ATRBLE application uses the default name during Bluetooth advertising, ATB_100 (100 stands for version 1.0.0).

Figure 4. ST Asset Tracking application: scan page



Nessuna SIM 15:44 2%

Back Devices

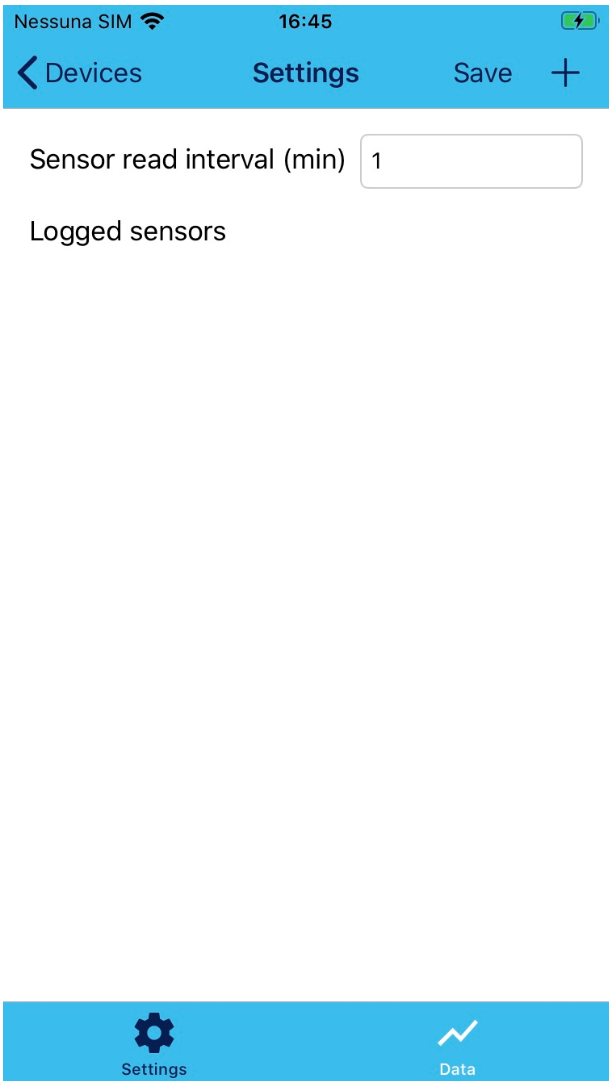
ATB_100
E3:F1:8A:80:79:1B

AM1V340
C0:86:2B:37:3F:30

To connect the SensorTile.box, you have to select the default name.

The application accepts the connection only from a paired device and, on first connection, the ST Asset Tracking application prompts you for a pin (default = "123456") to connect to the FP-ATR-BLE1.

Figure 5. **ST Asset Tracking application: setting page (without a saved configuration)**

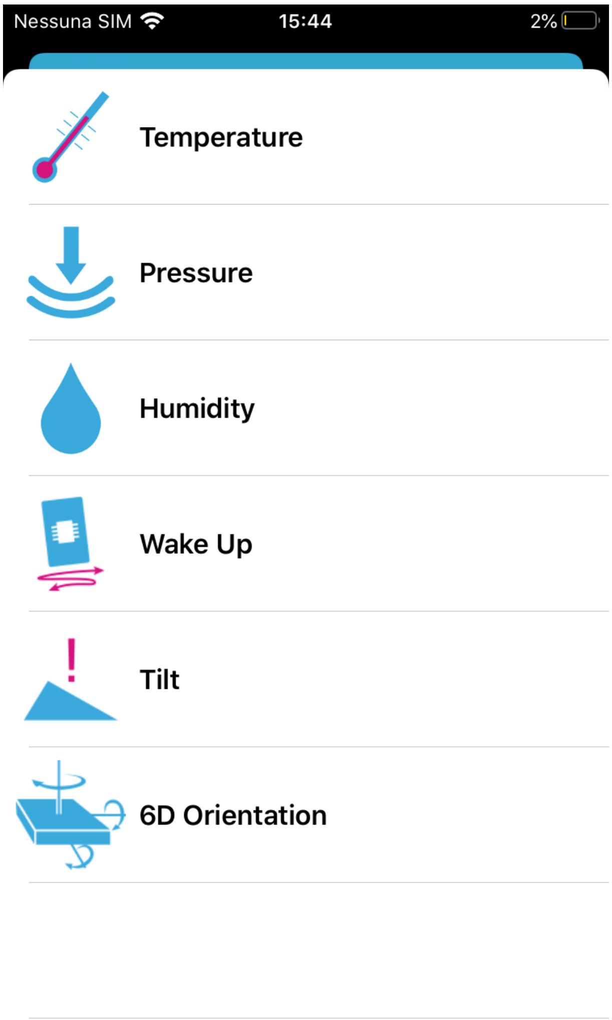


Sensor read interval (min) 1

Logged sensors

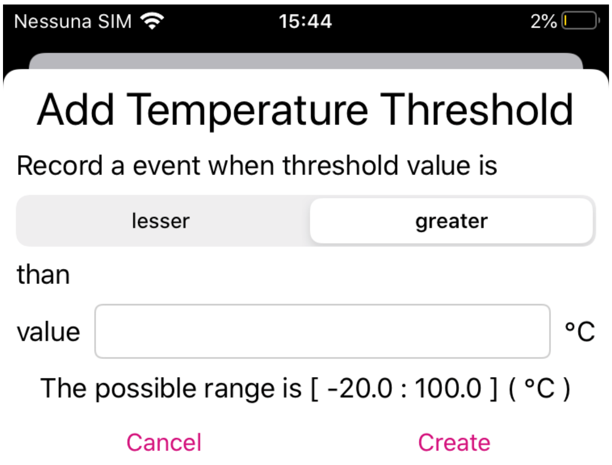
The Settings page shows the tracking configuration saved on the SensorTile.box. On the first run, there is no default configuration. Press the "+" button to choose which inertial and environmental events to log.

Figure 6. ST Asset Tracking application: add an inertial/environmental event to log



For temperature, pressure and humidity, you can select thresholds for which only events above or below these values are logged in order to reduce the file size.

Figure 7. ST Asset Tracking application: add environmental threshold



Add Temperature Threshold

Record a event when threshold value is

lesser | greater

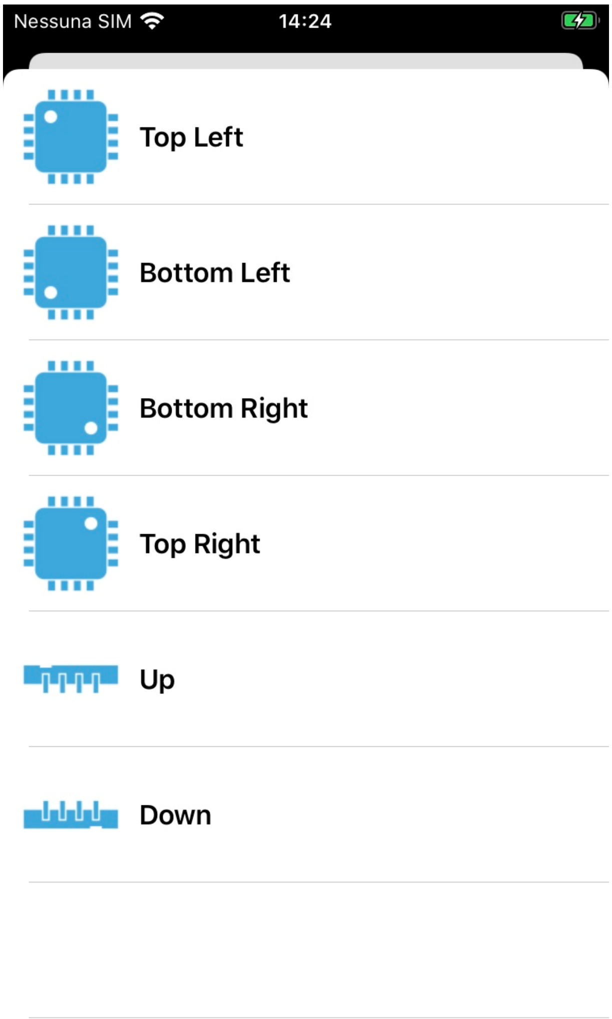
than

value °C

The possible range is [-20.0 : 100.0] (°C)

For the 6D orientation, you can select which orientation to log.

Figure 8. **ST Asset Tracking application: choosing the orientation to log**



Top Left

Bottom Left

Bottom Right

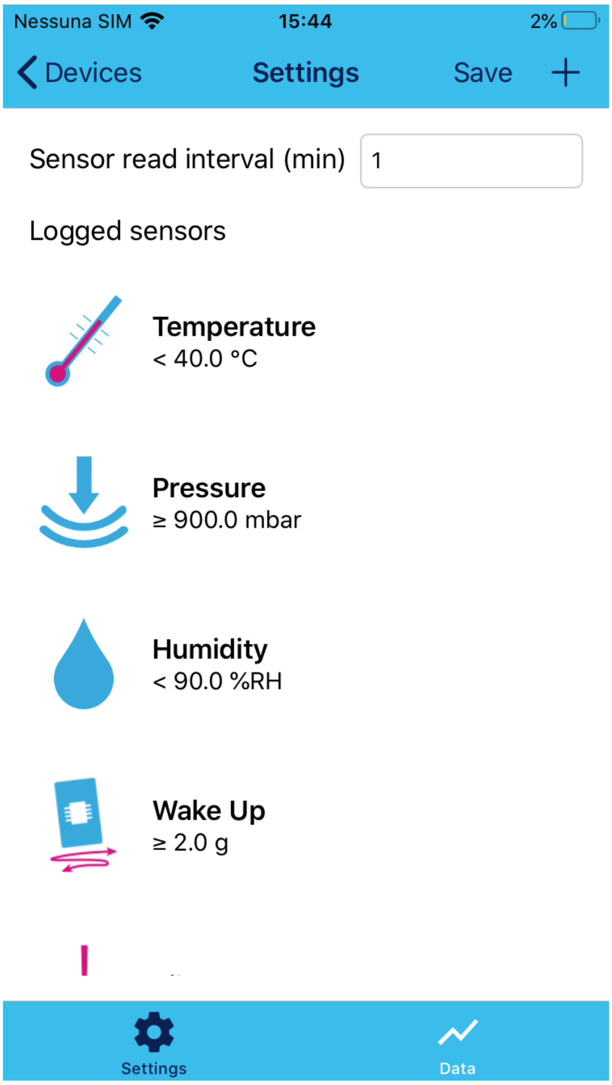
Top Right

Up

Down

After choosing the thresholds, you can commence logging by pressing the save button.

Figure 9. ST Asset Tracking application: setting page filled



Sensor read interval (min) 1

Logged sensors

Temperature
< 40.0 °C

Pressure
≥ 900.0 mbar

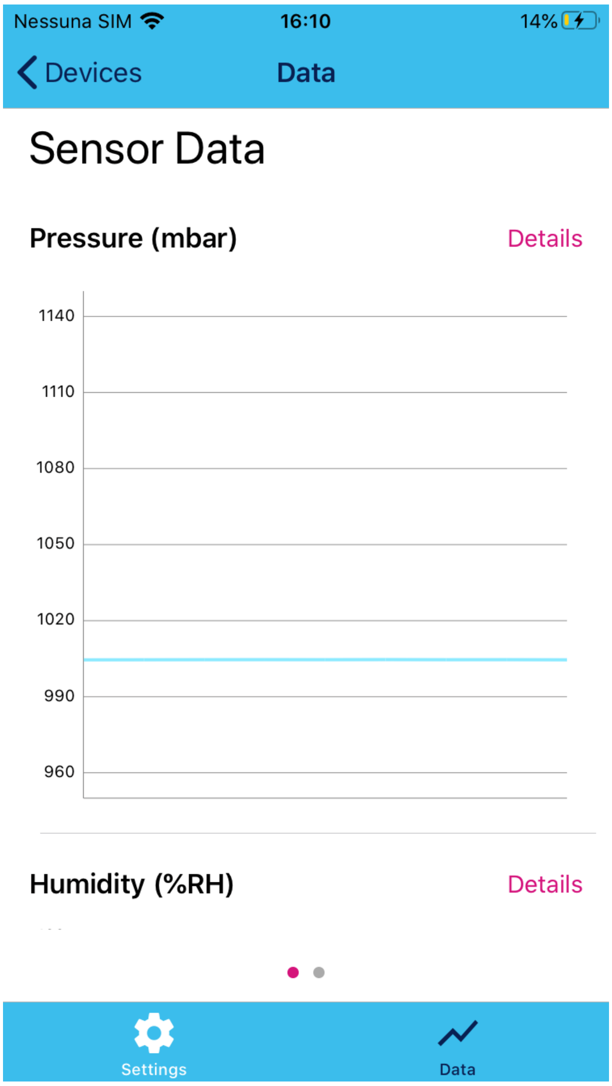
Humidity
< 90.0 %RH

Wake Up
≥ 2.0 g

The application is then disconnected from the SensorTile.box and the ATRBLE application starts the tracking session.

To reconnect to FP-ATR-BLE1, you have to press the SensorTile.box user button again to enable Bluetooth. Saved data can be read by the ST Asset Tracking application.

Figure 10. ST Asset Tracking application: read data page



Nessuna SIM 16:10 14%

Devices Data

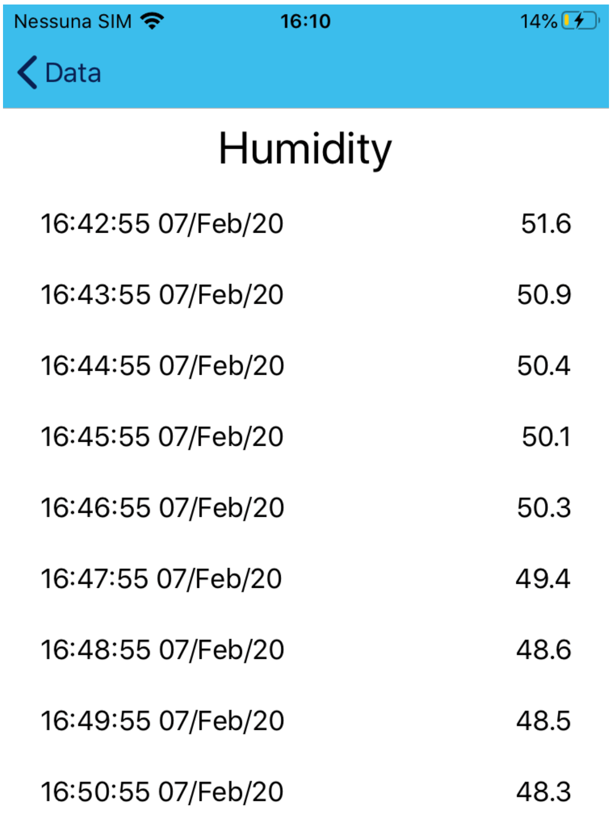
Sensor Data

Pressure (mbar) Details

Humidity (%RH) Details

The *Details* label shows all the values and their respective timestamp for each environmental measurement.

Figure 11. **ST Asset Tracking application: details on the relative humidity tracked**

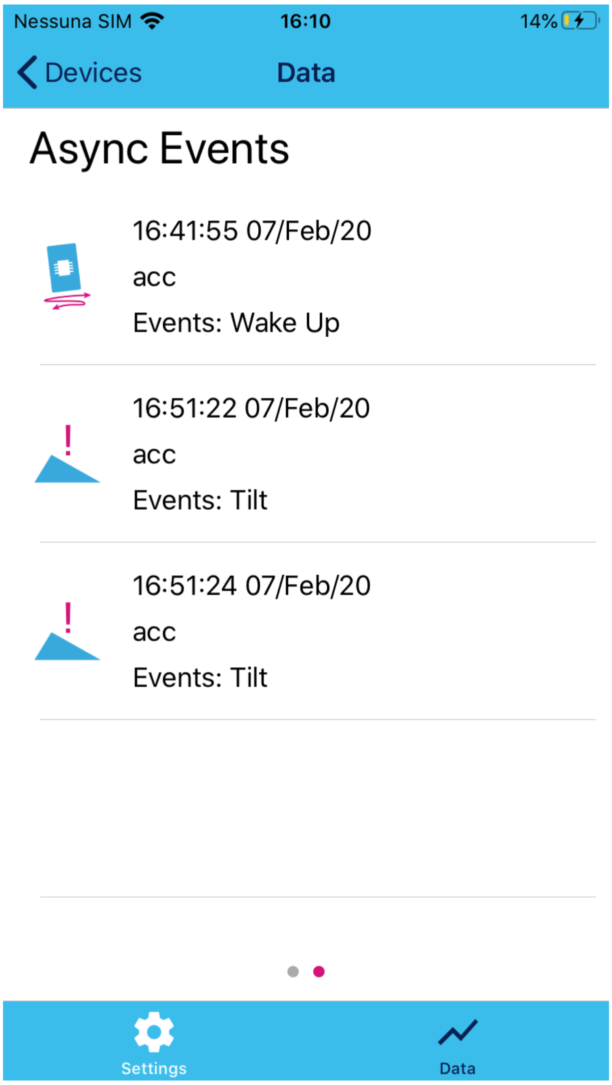


Humidity

16:42:55 07/Feb/20	51.6
16:43:55 07/Feb/20	50.9
16:44:55 07/Feb/20	50.4
16:45:55 07/Feb/20	50.1
16:46:55 07/Feb/20	50.3
16:47:55 07/Feb/20	49.4
16:48:55 07/Feb/20	48.6
16:49:55 07/Feb/20	48.5
16:50:55 07/Feb/20	48.3

The next application page shows all the inertial events logged with their respective timestamp.

Figure 12. ST Asset Tracking application: inertial event details



Async Events

16:41:55 07/Feb/20
acc
Events: Wake Up

16:51:22 07/Feb/20
acc
Events: Tilt

16:51:24 07/Feb/20
acc
Events: Tilt

2.1 Cloud dashboard

iOS

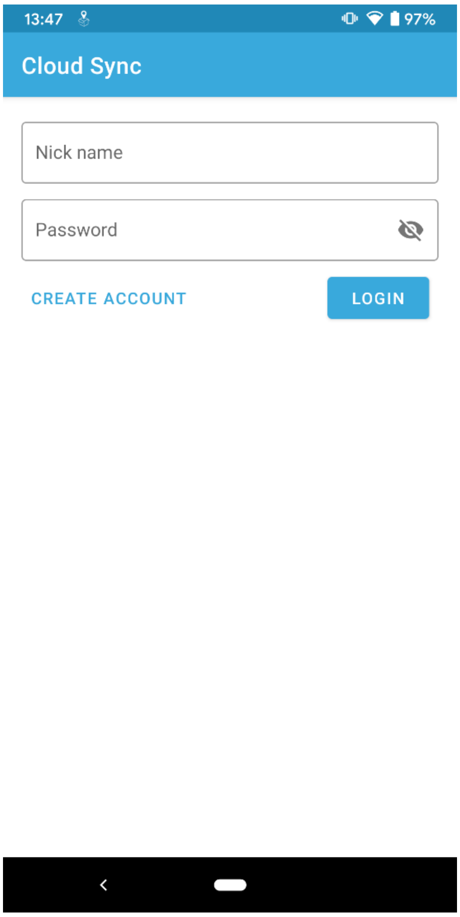
When you insert the login name and password in the cloud dashboard of the STAssetTracking application, the data and the current location of your smartphone are sent to the cloud and can be shown in the web dashboard.

If your device is not already registered in your account, the app automatically registers a new device. The procedure is completed when the [**Cloud Sync Complete**] message appears on the screen.

Android

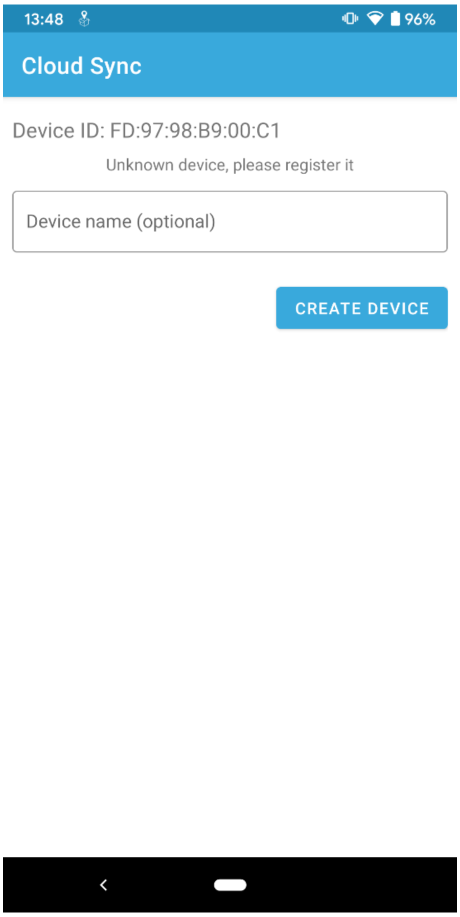
You can also create an account in the cloud dashboard for Android.

Figure 13. Cloud dashboard account creation



If your device is not already registered in your account, the app asks you to give a name to the device and create it.

Figure 14. **Cloud dashboard device creation**



Device ID: FD:97:98:B9:00:C1

Unknown device, please register it

Device name (optional)

After device creation, the app retrieves the current position and upload the data; at the end of the process, the data plots are shown again in the web dashboard.

3 System setup guide

3.1 STEVAL-MKSBOX1V1 evaluation kit

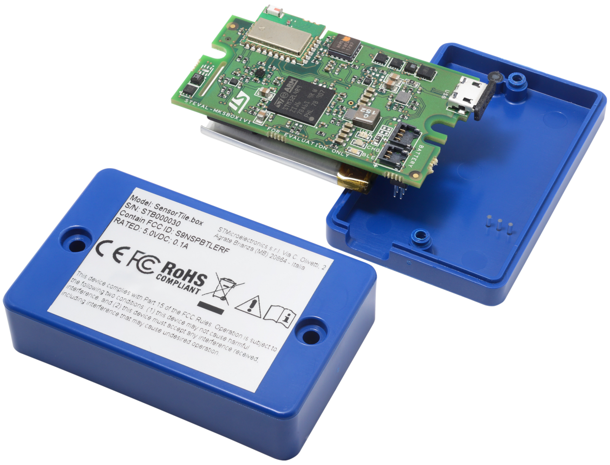
The STEVAL-MKSBOX1V1 (SensorTile.box) is a ready-to-use box kit with wireless IoT and wearable sensor platform to help you use and develop apps based on remote motion and environmental sensor data, regardless of your level of expertise.

The SensorTile.box board fits into a small plastic box with a long-life rechargeable battery, and the ST BLE Sensor app on your smartphone connects via Bluetooth to the board and allows you to immediately begin using the wide range of default IoT and wearable sensor applications.

In Expert Mode, you can build customs apps from your selection of SensorTile.box sensors, operating parameters, data and output types, and special functions and algorithms available. This multi sensor kit therefore allows you to design wireless IoT and wearable sensor applications quickly and easily, without performing any programming.

SensorTile.box includes a firmware programming and debugging interface that allows professional developers to engage in more complex firmware code development using the STM32 Open Development Environment (STM32 ODE), which includes a sensing AI function pack with neural network libraries.

Figure 15. STEVAL-MKSBOX1V1 evaluation kit

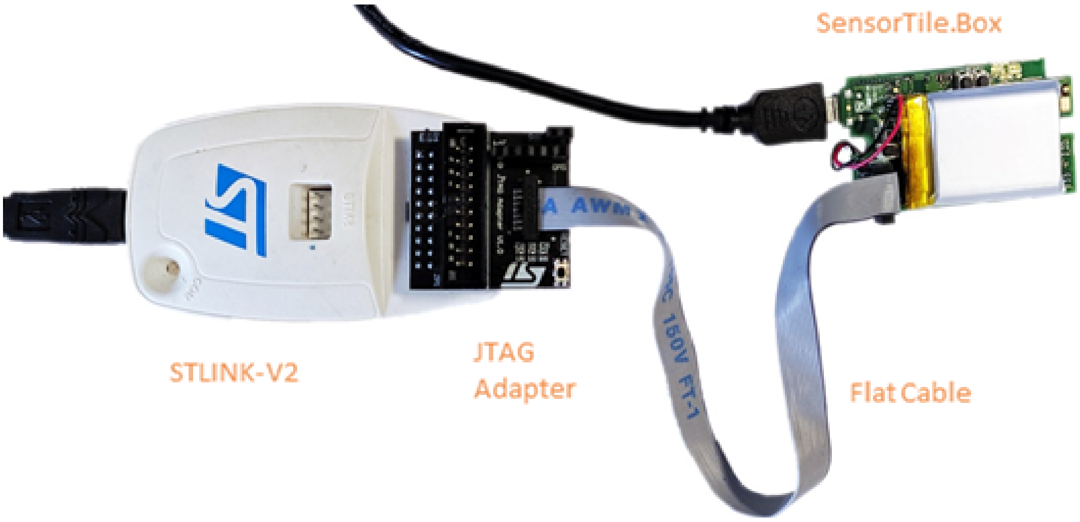


3.2 Hardware setup

The following hardware components are needed:

- One SensorTile.box evaluation kit (order code: STEVAL-MKSBOX1V1)
- One ST-LINK/V2 debugger
- One USB Micro-B cable
- One USB type A to Mini-B USB cable

Figure 16. **STEVAL-MKSBOX1V1 setup**



3.3 Software setup

The following software components are required for the setup of a suitable development environment to create applications for the STEVAL-MKSBOX1V1 evaluation board:

- FP-ATR-BLE1 firmware
- a standard user terminal as Putty or Tera Term (v. 4.97 or higher)
- ST Asset Tracking application version 2.0.0 or above
- Development tool-chain and Compiler. The STM32Cube expansion software supports the three following environments to select from:
  - IAR Embedded Workbench for ARM® (release 8.32.3) toolchain + ST-LINK
  - RealView Microcontroller Development Kit (release 5.27.1) toolchain + ST-LINK
  - STM32CubeIDE (release 1.3.2) + ST-LINK

Revision history

Table 1. **Document revision history**

Date	Version	Changes
25-Feb-2020	1	Initial release.
23-Apr-2020	2	Added Section 2.1 Cloud dashboard.

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List of figures

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