

## Getting started with Unicleo-GUI for motion MEMS and environmental sensor software expansion for STM32Cube

### Introduction

Unicleo-GUI is a graphical user interface (GUI) for the [X-CUBE-MEMS1](#) and [X-CUBE-MEMS-XT1](#) software expansions and STM32 Nucleo expansion boards ([X-NUCLEO-IKS01A1](#), [X-NUCLEO-IKS01A2](#), [X-NUCLEO-IKS01A3](#) and [X-NUCLEO-IKS02A1](#)).

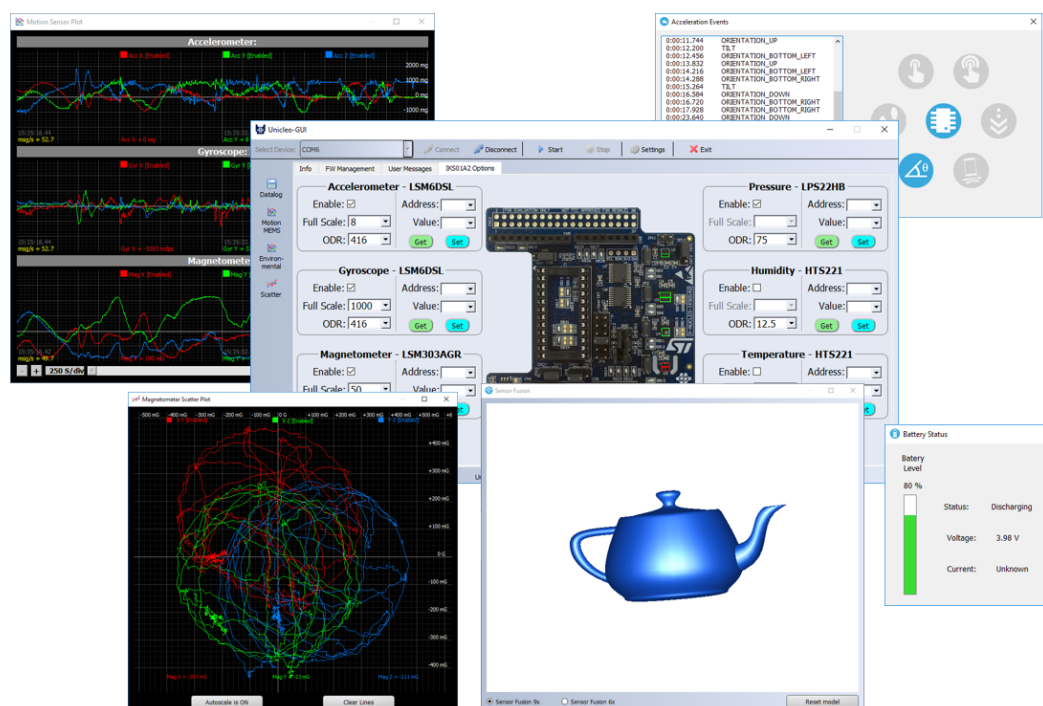
The main objective of this application is to demonstrate the functionality of ST sensors and algorithms.

Unicleo-GUI is able to cooperate with firmware created by [AlgoBuilder](#) application and display data coming from the running firmware.

The application is also able to establish Bluetooth connection with BLE connectivity-equipped devices such as SensorTile ([STEVAL-STLKT01V1](#)), BlueCoin ([STEVAL-BCNKT01V1](#)), and STM32 Nucleo with [X-NUCLEO-IDB05A1](#) expansion board, BlueTile ([STEVAL-BCN002V1B](#)) or WESU1 ([STEVAL-WESU1](#)) and read data from various device characteristics.

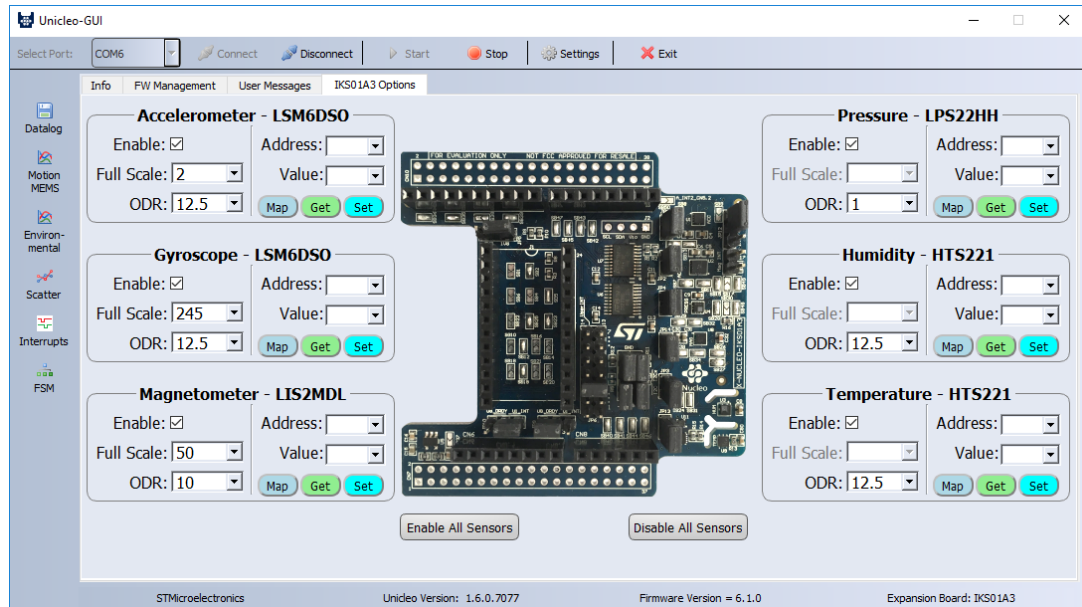
The supported firmware for these devices can be found at [FP-SNS-ALLMEMS1](#), [FP-SNS-ALLMEMS2](#), [FP-SNS-MOTENV1](#), [FP-SNS-MOTENVWB1](#), [STSW-BLUETILE-DK](#) and [STSW-WESU1](#).

Figure 1. Unicleo-GUI graphical user interface



## 1 Unicleo-GUI overview

Figure 2. Unicleo-GUI overview



The [Unicleo-GUI](#) key features are:

- Displays data from connected sensors in various views (time plot, scatter plot, 3D plot)
- Saves data to tab separated (TSV) or comma separated (CSV) files
- Configurable output data rate and full scale
- Directly reads from and writes to sensor registers
- Demonstrate sensor Finite State Machine (FSM) and Machine Learning Core (MLC) embedded features
- Performs Fast Fourier Transform (FFT) analysis of the accelerometer data
- Works with [X-CUBE-MEMS1](#) and [X-CUBE-MEMS-XT1](#) sensor sample applications (Datalog, DatalogExtended, FFT Demo, DatalogLite)
- Works with sample applications for algorithms (Activity Recognition, Carry Position, Gesture Recognition, Sensor Fusion, Pedometer, Magnetometer Calibration, Accelerometer Calibration, Gyroscope Calibration, Activity Recognition for Wrist, Pose Estimation, Motion Intensity Detection, Fitness Activity, eCompass, Active Time, Fall Detection, Pedometer for Wrist, Standing vs Sitting Desk Detection, Tilt Sensing, Vertical Context)
- Works with firmware created by [AlgoBuilder](#)
- Windows®-based application

Table 1. Unicleo-GUI modes

Mode	Description
Datalog	Displays data from connected sensors in various views and saves logs
Extended datalog	Datalog mode with configuration of sensor output data rate and full scale
Custom datalog	Datalog mode with support of custom data fields
Custom Lite datalog	Fully configurable mode without dependency on MEMS sensors
FFT	Fast Fourier Transform (FFT) algorithm for vibration analysis
AlgoBuilder	Displays data from running firmware created in <a href="#">AlgoBuilder</a>

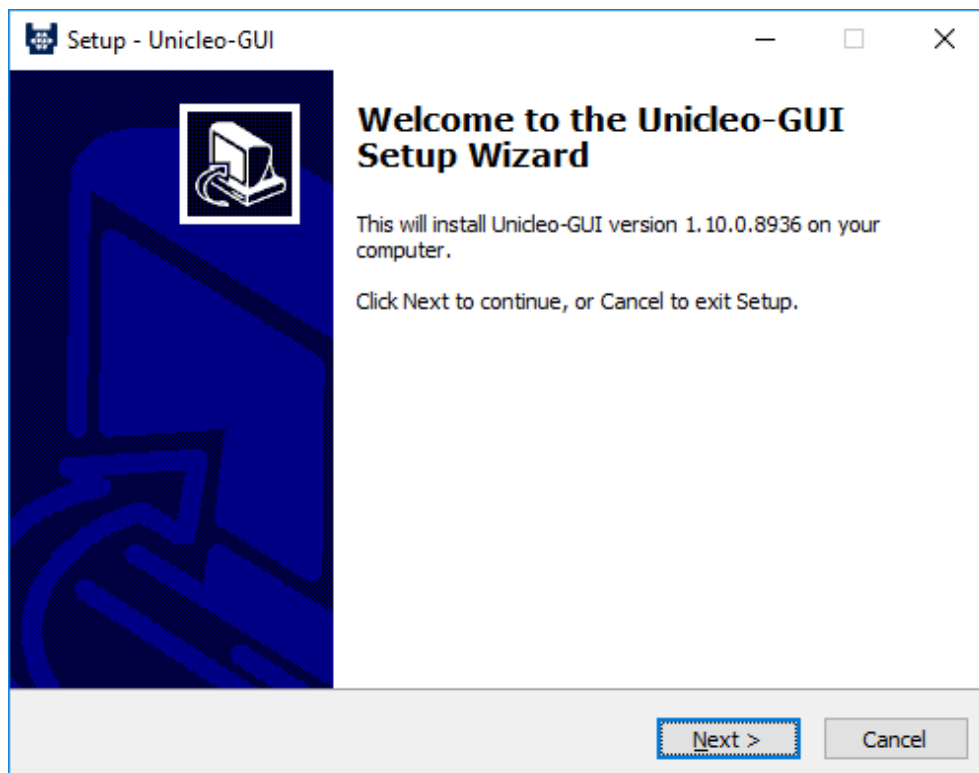
Mode	Description
MotionAR	Datalog mode with support for activity recognition algorithm
MotionCP	Datalog mode with support for carry position algorithm
MotionGR	Datalog mode with support for gesture recognition algorithm
MotionFX	Datalog mode with support for sensor fusion algorithm
MotionPM	Datalog mode with support for pedometer algorithm
MotionAC	Datalog mode with support for accelerometer calibration algorithm
MotionMC	Datalog mode with support for magnetometer calibration algorithm
MotionGC	Datalog mode with support for gyroscope calibration algorithm
MotionAW	Datalog mode with support for activity recognition for wrist algorithm
MotionPE	Datalog mode with support for pose estimation algorithm
MotionID	Datalog mode with support for intensity detection algorithm
MotionFA	Datalog mode with support for fitness activity algorithm
MotionEC	Datalog mode with support for eCompass algorithm
MotionAT	Datalog mode with support for Active Time algorithm
MotionFD	Datalog mode with support for Fall Detection algorithm
MotionPW	Datalog mode with support for Pedometer For Wrist algorithm
MotionSD	Datalog mode with support for Standing vs Sitting Desk Detection algorithm
MotionTL	Datalog mode with support for Tilt sensing algorithm
MotionVC	Datalog mode with support for Vertical Context algorithm

## 2 Installing the software

The Unicleo-GUI software is designed to run on Microsoft® Windows.

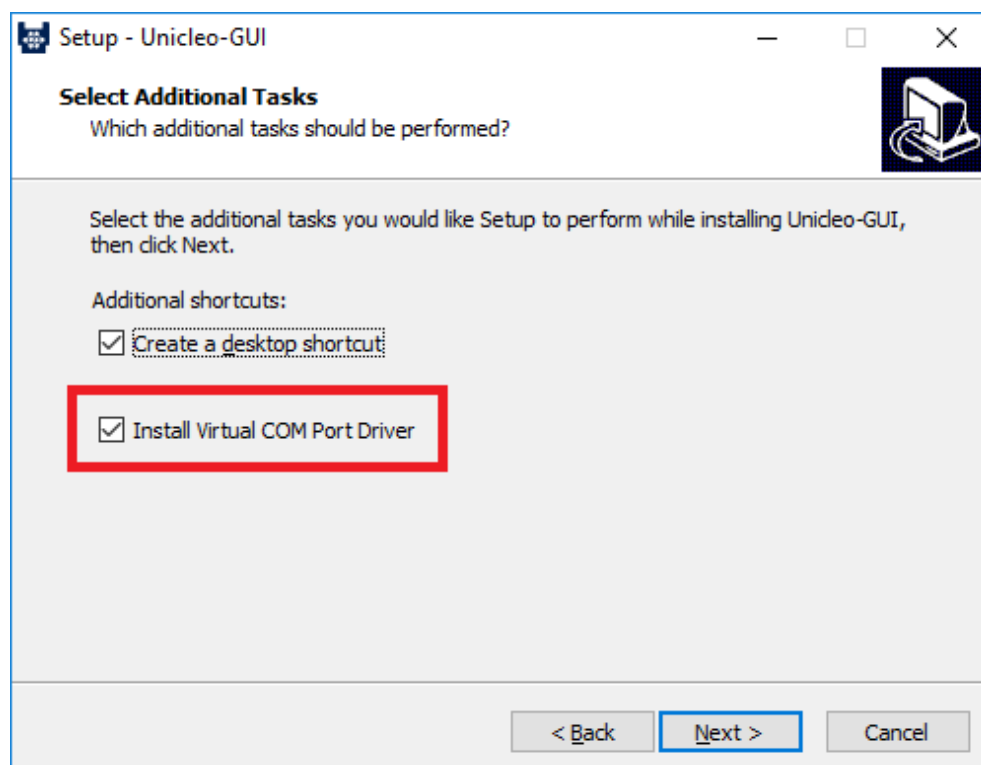
- Step 1.** To install the Unicleo-GUI, run Setup\_Unicleo.exe included in the package and follow the installation instructions.

Figure 3. Installation guide



**Step 2.** If not already installed, check the Install Virtual COM Port Driver checkbox.

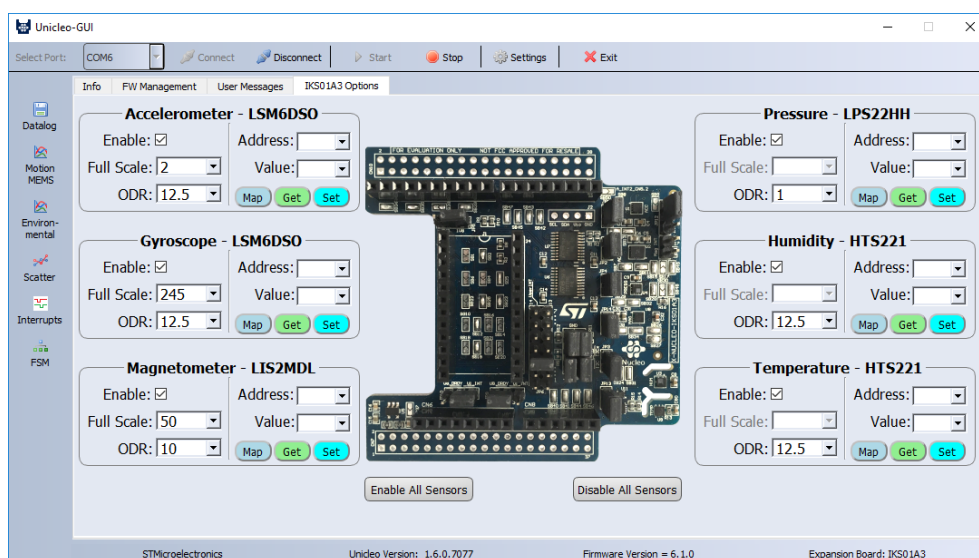
**Figure 4. Virtual COM port driver installation**



### 3 Running the graphical user interface

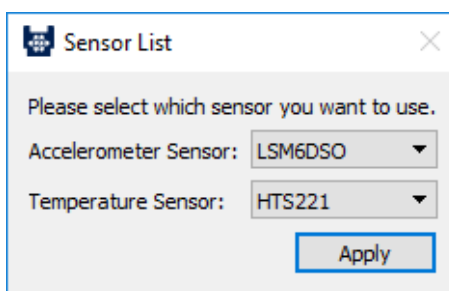
- Step 1.** Launch the installed software from Start → STMicroelectronics → Unicleo → Unicleo.exe
- If a device with supported firmware is connected to your PC when the application starts, it is automatically detected and appropriate COM port is opened.
- If multiple devices are connected to your PC, subsequent instances of the **Unicleo-GUI** application detect the other connected boards in sequence.

**Figure 5. Unicleo-GUI main window**



If connected device contains several sensors of the same type (e.g. accelerometers, temperature sensors, etc.) a Sensor List window appears during device connection. In this window, a user can select which sensor should be used.

**Figure 6. Unicleo-GUI Sensor List window**



- Step 2.** To switch boards communicating with the GUI, click Disconnect with the current board, select a new COM Port from the dropdown list and then Connect.
- The Select Port dropdown list is only populated with connected devices running supported firmware.

### 3.1 Updater settings

Figure 7. Updater setting dialog

Settings

Updater Settings Application Settings

Check and Update Settings

☒ Manual Check ☐ Automatic Check Check Now

Interval between two checks [days] 1

Proxy Server Type

☐ No Proxy ☒ Use System Proxy Parameters ☐ Manual Configuration of Proxy Server

Manual Configuration of Proxy Server

Proxy HTTP Port

Authentication

☒ Require Authentication ☒ Remember My Credentials

User Login Password

Check Connection

OK Cancel

The application is able to automatically check if new version is available. This feature can be configured in the updater settings dialog.

The settings dialog is divided into several sections.

In first section, you can set the automatic checking interval. If zero days are set, then check for updates is performed on every application start. To run an immediate check for updates, click on Check Now.

The second section contains options for proxy server type settings. If System Proxy Parameters is checked, it is often necessary to open a connection in your web browser to run all the security scripts prior to running the check for updates.

If Manual Configuration of Proxy Server is selected then the third section is enabled. Where you can select the proxy HTTP name and port number.

If authentication is required then the fourth section should be filled. Credentials may be saved in encrypted form. The check connection button can be used to verify whether the update server is accessible.

If a newer version of the application is found on the update server, a message box with update information is displayed and you are prompted to accept or decline the installation.

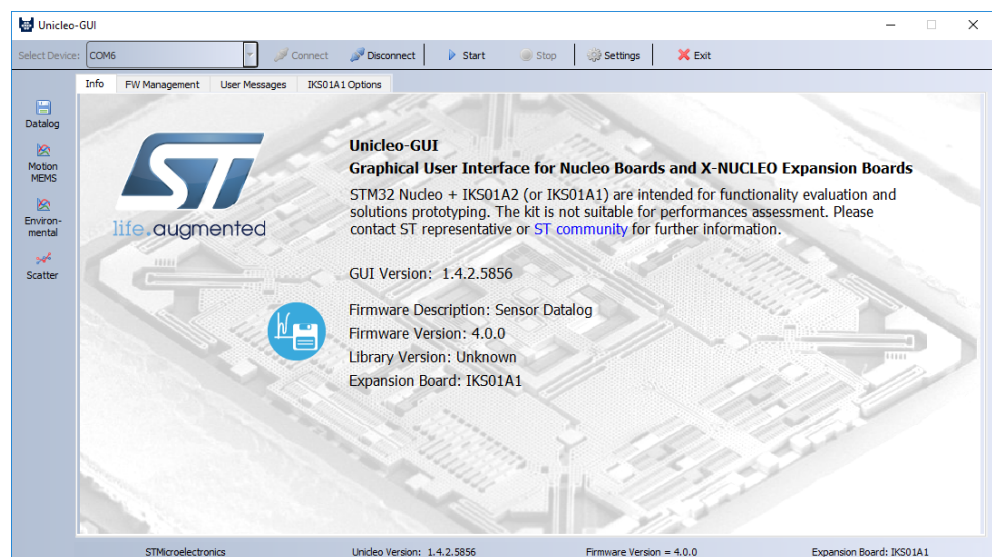
## 3.2 The Info tab

**Step 1.** Select the Info tab to view basic hardware and software version information.

This tab contains information regarding:

- Application version
- Firmware description and version
- Library version
- X-NUCLEO expansion board connected to [STM32 Nucleo](#) board

**Figure 8. Info tab**



## 3.3 FW Management tab

Select the FW management tab to change firmware in the [STM32 Nucleo](#) board and display information about the currently selected firmware.

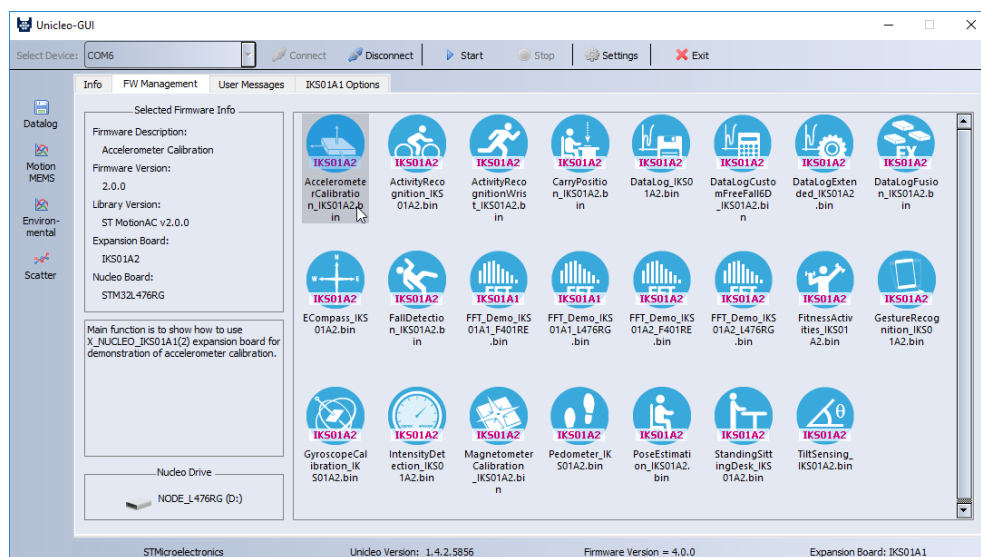
A list view window contains a list of all the firmware in the Firmwares subdirectory in the main application directory. Icon view or column view styles are available.

You can easily copy binary files from other applications there or drag & drop it onto your STM32 Nucleo board.

Double-clicking the firmware icon will download the appropriate firmware to the STM32 Nucleo board.



Figure 9. Firmware Management tab

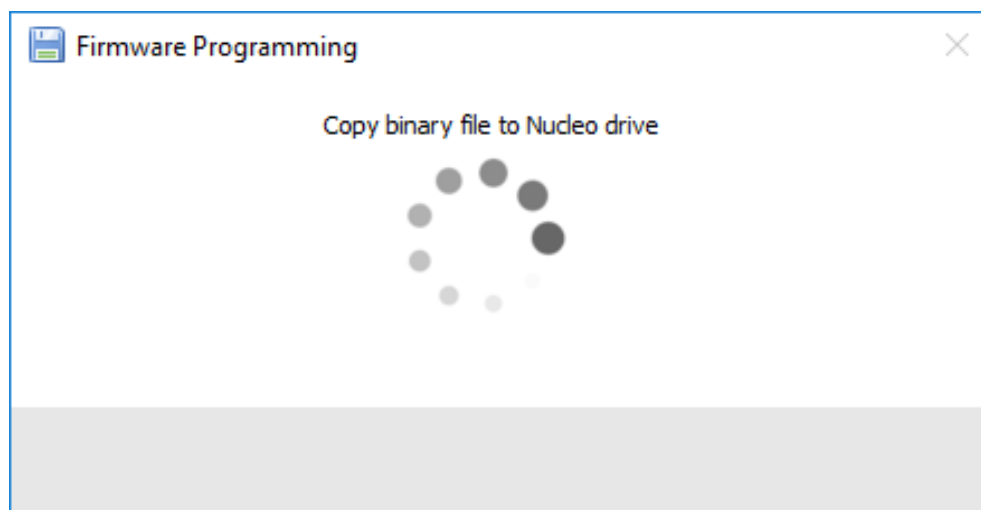


Information about the selected firmware is read from the binary file.

The STM32 Nucleo drive indicates the embedded drive of the STM32 Nucleo board where the binary file will be copied. The application automatically detects the STM32 Nucleo drive that corresponds with the communication port selected in horizontal tool bar.

While the firmware binary file is being copied to the STM32 Nucleo drive, the dialog box below indicates the progress. If programming is unsuccessful, hints are displayed inside dialog box.

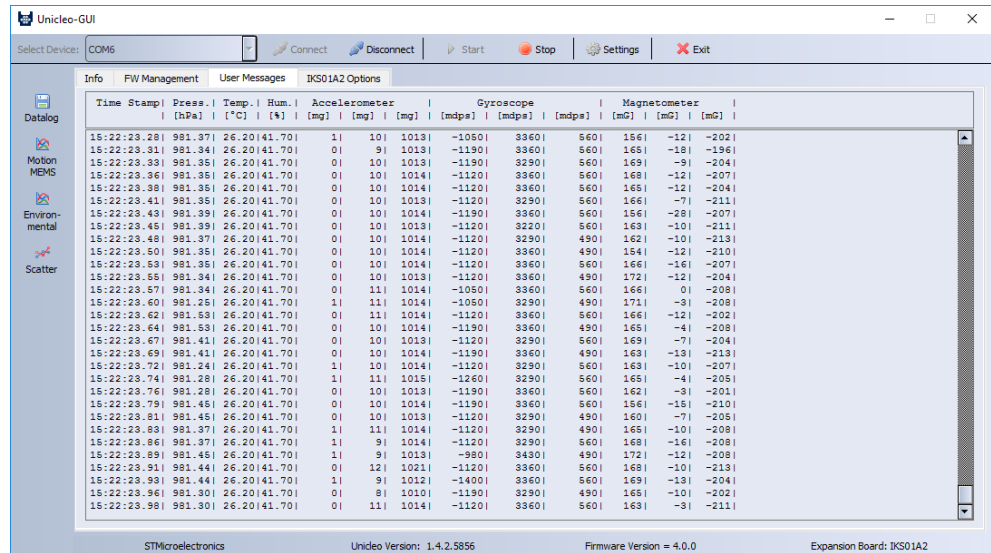
Figure 10. FW programming dialog box



## 3.4 User Messages tab

- Step 1.** Select this tab to view debug information like initialization messages and text readouts of received sensor data.

Figure 11. User Messages tab



- Step 2.** Right-click inside the window to open the menu.  
The menu lets you clear all the content, select the content and copy to clipboard or save the content to a file.
- Step 3.** Select Save whole content.  
The Save File dialog box offers an automatically generated file name, but you can change it along with the file location.

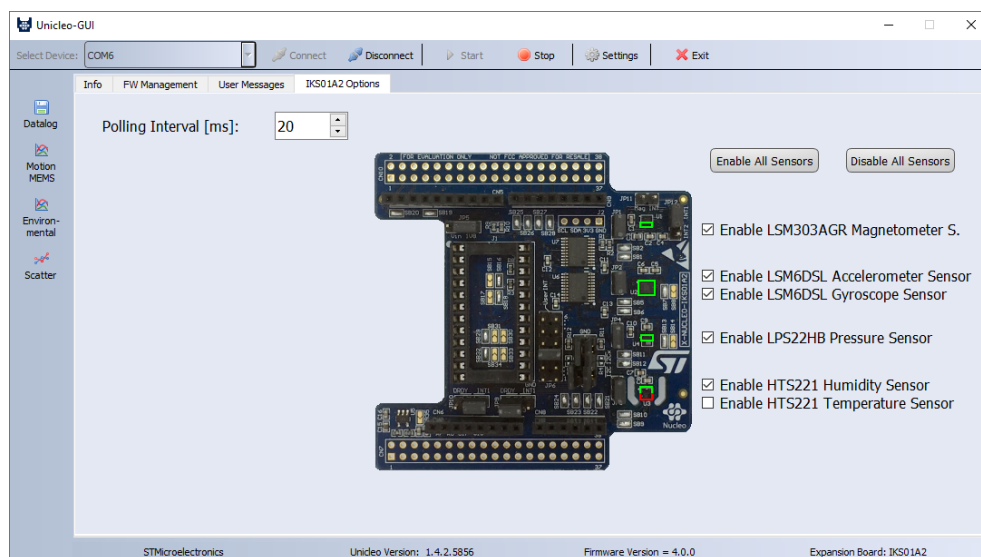
## 3.5 Options tab

The Options tab lets you configure certain sensor parameters, depending on the loaded firmware.

### 3.5.1 Standard datalog

All firmware except Extended datalog uses the same Options tab as the standard datalog.

The window shows an image of the connected expansion board and supplementary boards like the DIL24 expansion connector.

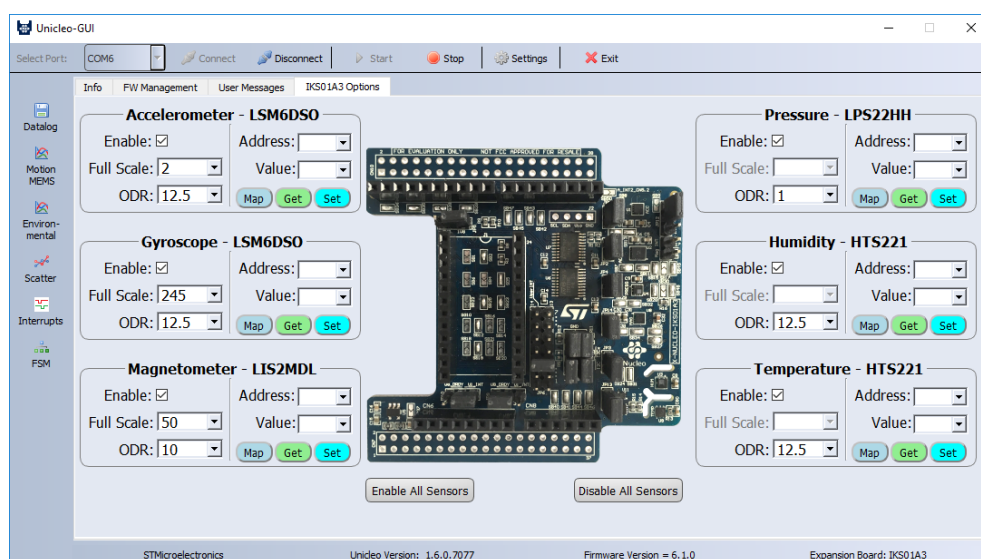
**Figure 12. Options tab for standard datalog**


- Step 1.** Use the checkboxes to enable and disable corresponding sensors.
- Step 2.** Configure the polling interval (if available) for the data streamed from the [STM32 Nucleo](#) board. The true output data rate of the sensors is fixed by the firmware and cannot be changed by the application.
- Step 3.** Use the checkboxes to enable and disable corresponding sensors.
- a green rectangle around a sensor indicates that it is enabled
  - a red rectangle indicates that it is disabled
- Note:* if a sensor is required for actual algorithm operation, it cannot be disabled
- a blinking rectangle indicates that the enabled sensor is currently streaming data

### 3.5.2

#### Extended datalog

The Extended datalog is a separate tab which allows more control of sensor parameters.

**Figure 13. Options tab for extended datalog**


- Step 1.** Use the checkboxes to enable and disable corresponding sensors.

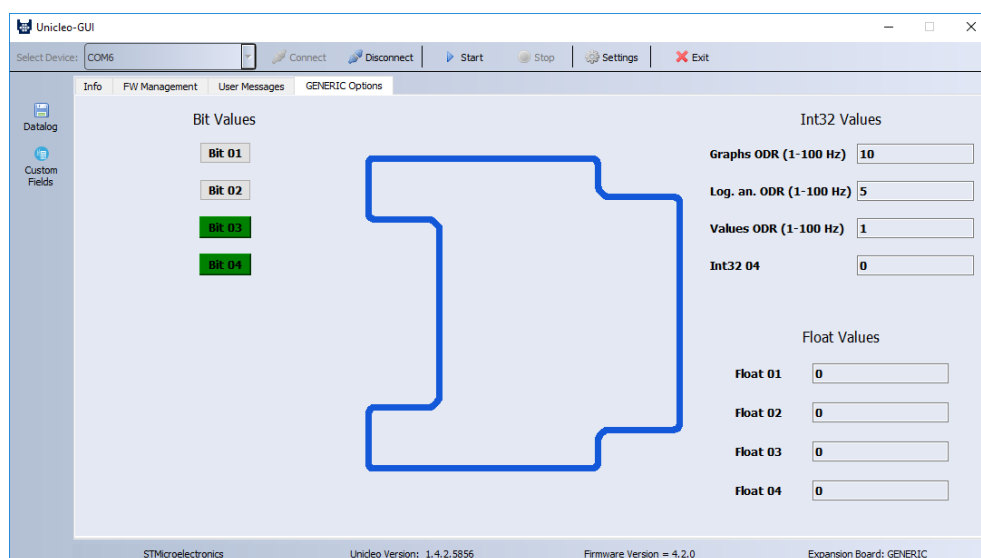
- Step 2.** Set the full scale and output data rate of each sensor.  
The serial line used for communication has limited bandwidth, so higher ODR values (above 500 Hz) may not be respected.
- Step 3.** Read and write sensor registers by interacting with the Address and Value boxes and the Get and Set buttons.
- Step 4.** Click on the **[Map]** button to display the complete sensor register map, where it is possible to read/write to the registers and display register description.

### 3.5.3

#### Custom lite datalog

Custom lite datalog is for expansion boards other than the [X-NUCLEO-IKS01A1](#) and [X-NUCLEO-IKS01A2](#). Free space under the option tab is used for displaying custom values, which can be used to send information from the application to the firmware. Up to four values of each type is supported.

**Figure 14. Options tab for custom lite datalog**

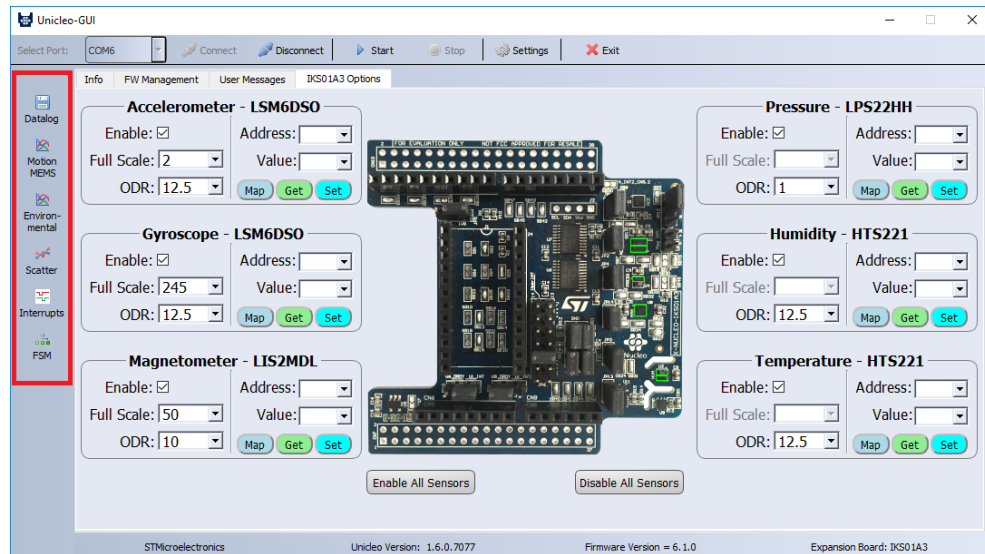


### 3.6

#### Vertical tool bar

The vertical tool bar contains all the tools available for the firmware in use.

Figure 15. Vertical menu bar

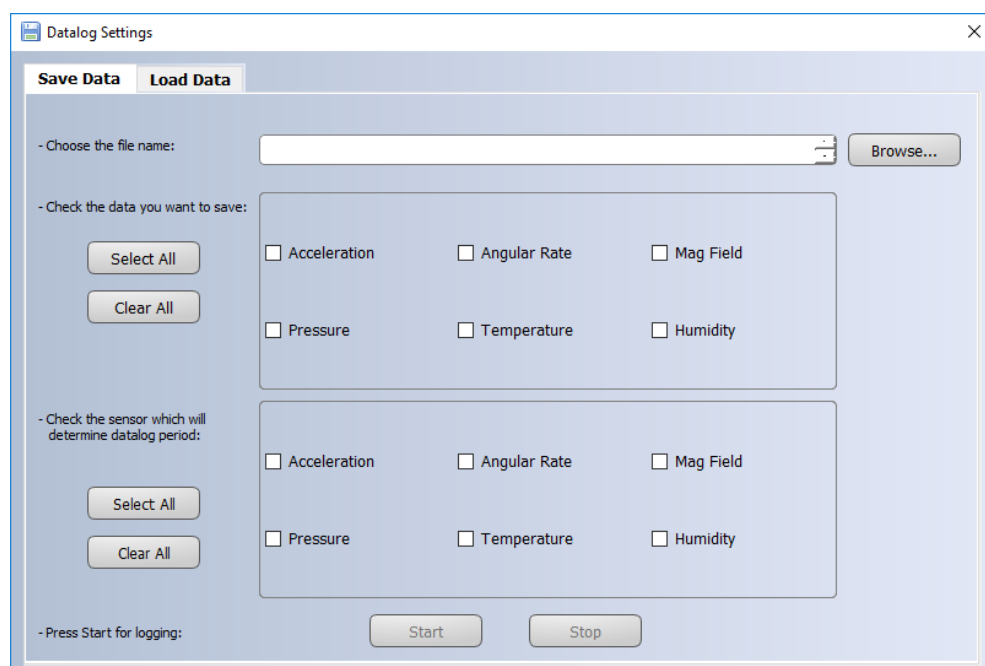


- Step 1.** Scroll the vertical tool bar using the mouse wheel.  
The tool bar does not contain a vertical scroll bar.
- Step 2.** Click each tool button inside the bar to open the corresponding widget.
- Step 3.** Right-click the widget to center it on the screen.
- Step 4.** Single-click the widget to move it to the top of the screen.
- Step 5.** Double-click the widget to hide it.

### 3.6.1 Datalog tool

This window lets you stream sensor data to a text file for subsequent post-processing.

Figure 16. Datalog widget



- Step 1.** Check the data you want to store and sensor which will determine logging period.
- Step 2.** Click the Browse button.  
The Save File dialog box opens with an automatically generated file name.
- Step 3.** Confirm or modify the proposed file format, name and location.  
The available output file formats are comma separated file (CSV) and tab separated file (TSV).
- Step 4.** Use Start and Stop buttons to begin and end the acquisition period, respectively.

### 3.6.2

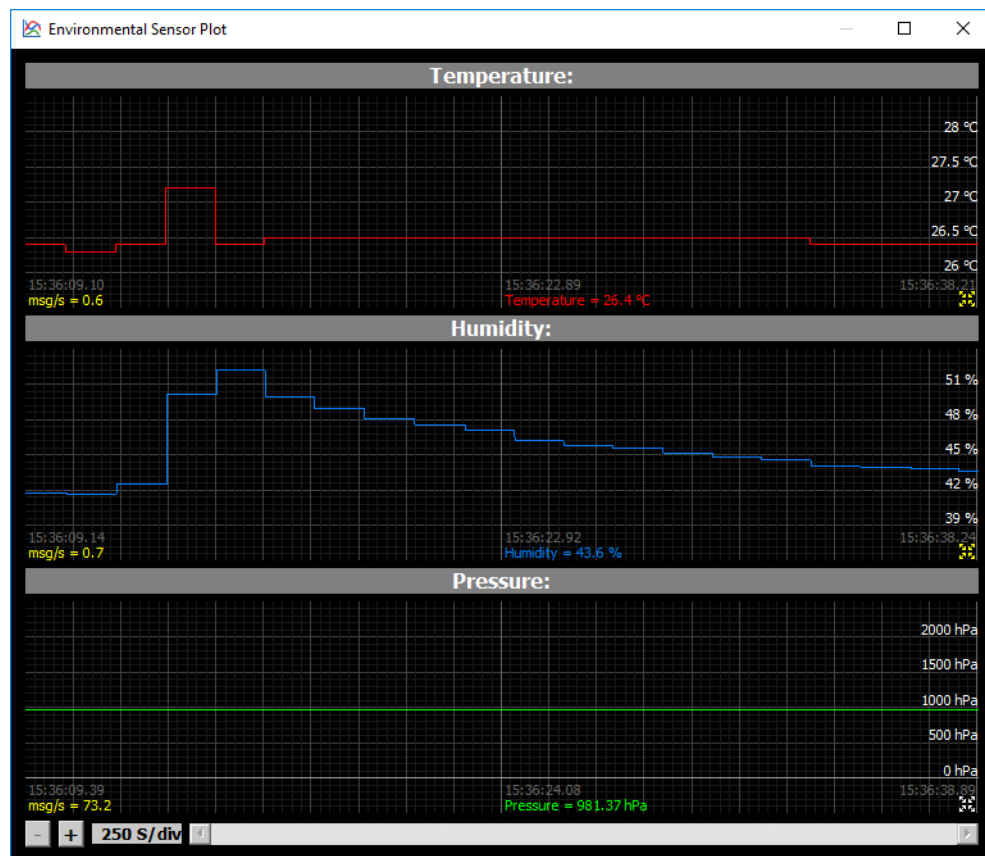
#### Plot tool

This tool generates a time graph of data samples from connected expansion board sensors.

**Figure 17. Motion sensor plot widget**



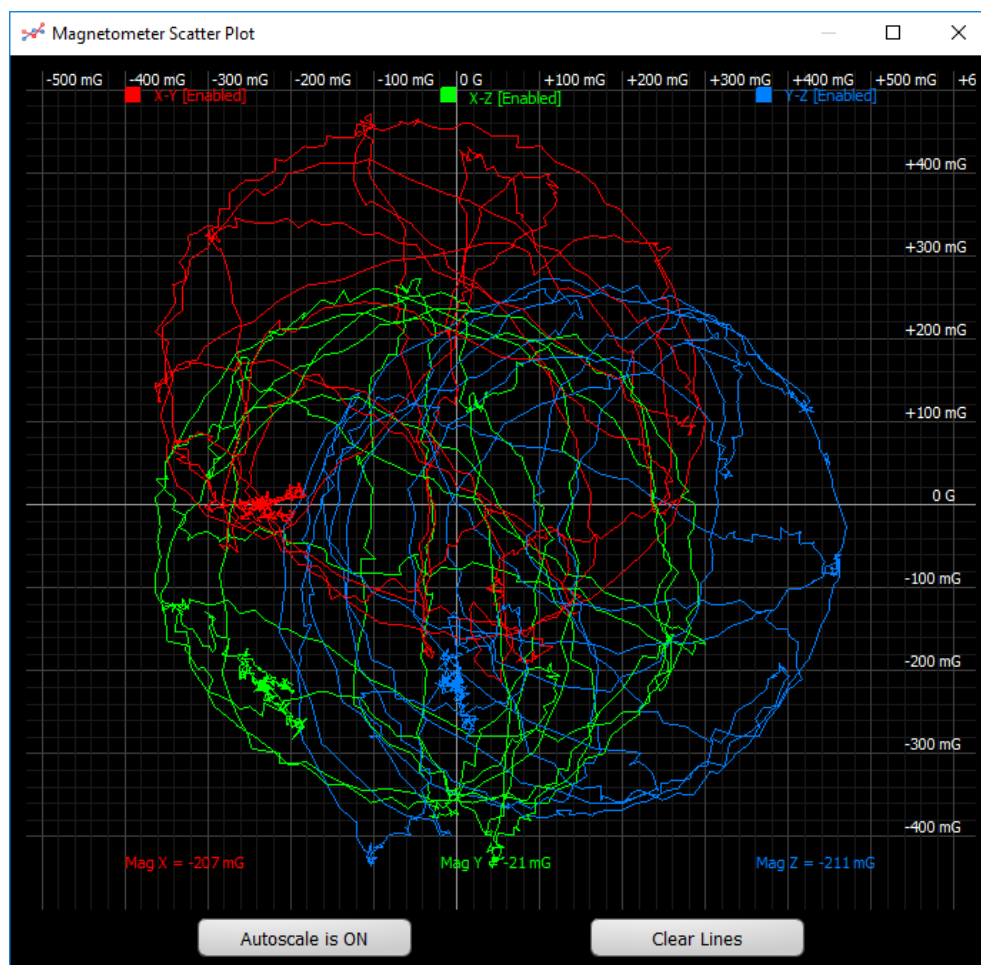
Figure 18. Environmental sensor plot widget



- Step 1.** For motion sensor plots, enable and disable the X, Y and Z axes lines by clicking on the corresponding text at the top of the window.
- Step 2.** Move the mouse in plot areas showing data samples.
  - The time and measured values are displayed below the enable/disable labels.
  - The last measured values are displayed at the bottom of the window.
  - The yellow text in bottom left corner displays how many messages (i.e., samples) were received during last second for a certain sensor.
- Step 3.** Toggle the plot scale between auto scale and fixed scale by clicking on the yellow icon in bottom right corner of each plot window.
- Step 4.** Click on the minus and plus at the bottom of the window to manually scale the plot horizontally. The rate can be modified to any value between 250 to 5 samples per section.
- Step 5.** Use the scroll bar to scroll through last 5000 samples.

### 3.6.3 Scatter plot tool

The scatter plot tool shows the graphical representation of the magnetometer data, used to evaluate the quality of the magnetometer calibration.

**Figure 19. Scatter plot widget**


- the red line represents the magnetometer X data on the X-axis, and the magnetometer Y-data on the Y-axis;
- the green line represents the magnetometer X data on the X-axis, and the magnetometer Z-data on the Y-axis;
- the blue line represents the magnetometer Y data on the X-axis, and the magnetometer Z-data on the Y-axis.

**Step 1.** Enable and disable any colored plot by clicking on the corresponding text at the top of the window.

**Step 2.** Click on CLEAR LINES to reset all the data in the plot.  
 The window contents can be moved with the left mouse button.

**Step 3.** Use the mouse wheel to zoom in or out.  
 This action causes the AUTOSCALE option to toggle OFF.

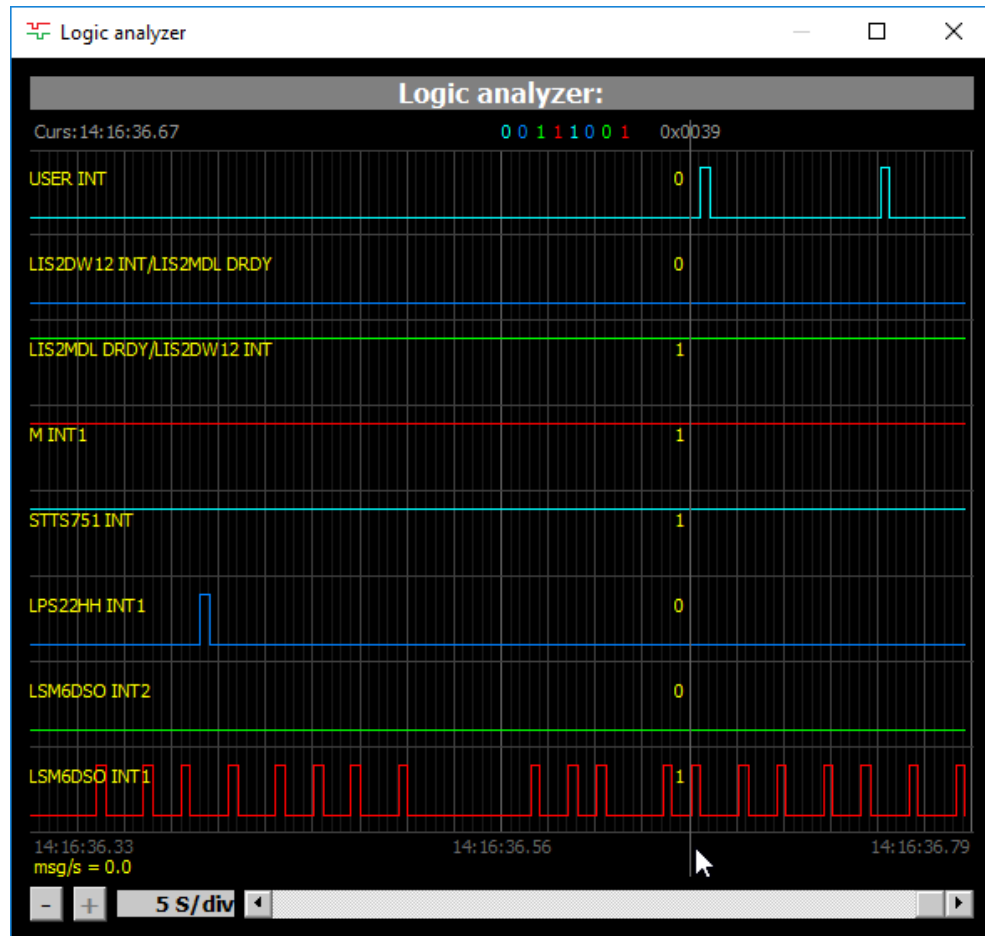
**Step 4.** Click on AUTOSCALE any time to re-enable the default automatic zoom.  
 Default scatter plot behavior is automatic zooming to fit all data into window.

### 3.6.4 Interrupts Tool

The Interrupts tool allows monitoring logic state of sensor interrupt pins.



Figure 20. Interrupt Logic Analyzer



- Step 1.** Move the mouse in plot areas to show logic state at certain time.  
The status of each interrupt pin is displayed close to each signal.
- Step 2.** Click on the minus and plus at the bottom of the window to manually scale the plot horizontally.  
The rate can be modified to any value between 250 to 5 samples per section.
- Step 3.** Use the scroll bar to scroll through the last 5000 samples.

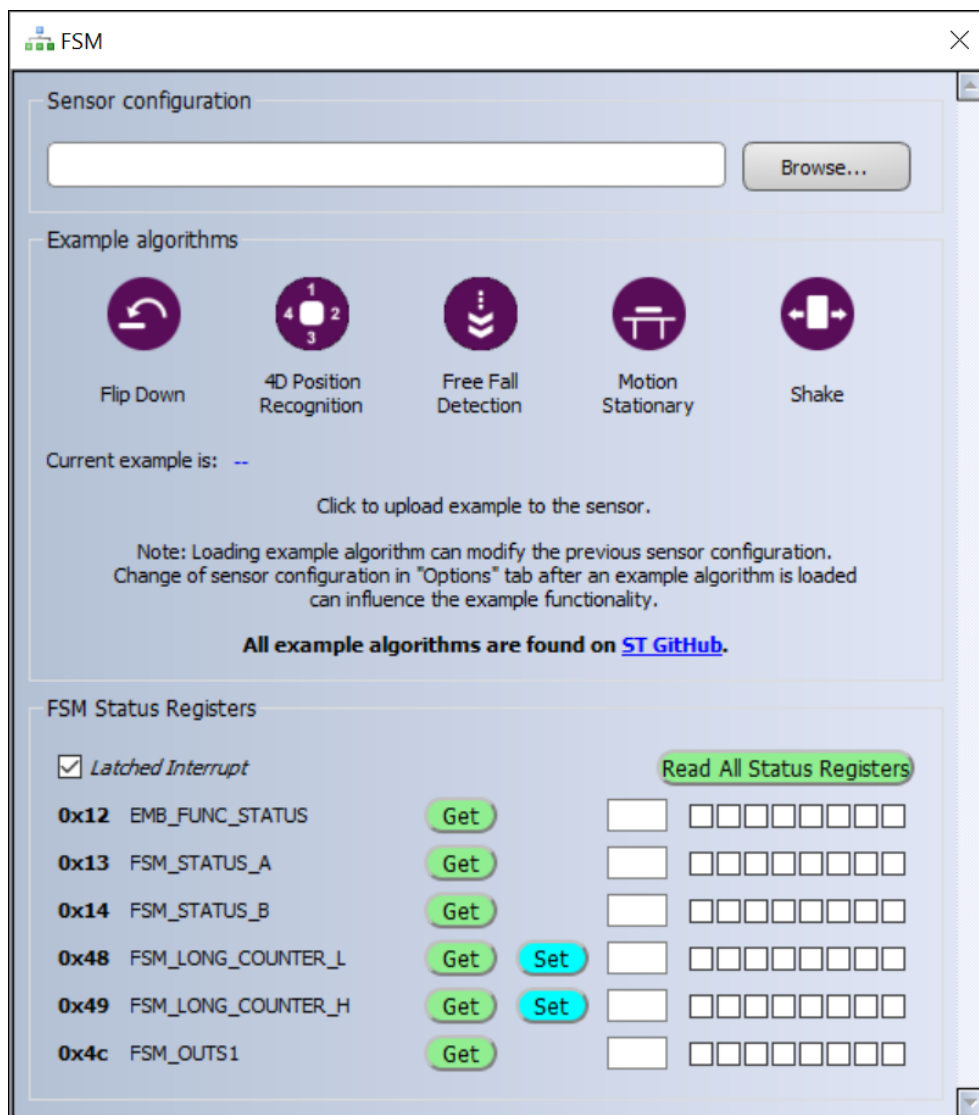
### 3.6.5 Finite State Machine Tool

FSM tool is available if a selected sensors in equipped with FSM feature (e.g. [LSM6DSO](#)). It allows to configure FSM with example algorithms or with custom sensor configuration saved in .ucf file and monitors its functionality.

- Step 1.** Click on one of the example algorithms, which you want to try or select custom .ucf file with sensor configuration. Appropriate sensor's configuration will be send to the sensor.
- Step 2.** Monitor sensor's interrupt state using Interrupt Logic analyzer when moving with the device.
- Step 3.** Read the value of particular register related to FSM using **Get** button next to register name.

**Step 4.** Latched or non-latched interrupt mode can be change using corresponding check box.

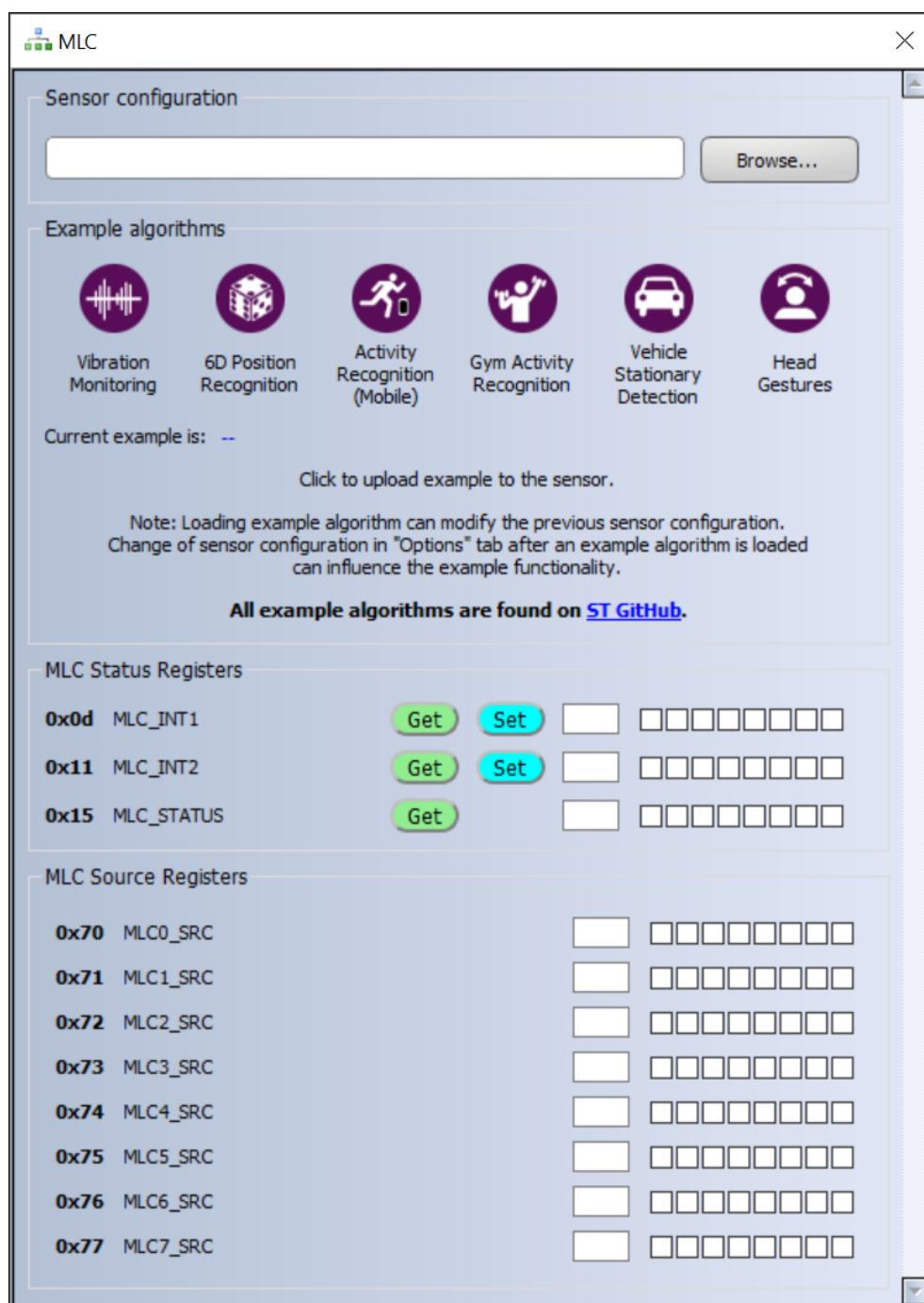
Figure 21. FSM Tool



### 3.6.6 Machine Learning Core (MLC) Tool

The MLC Tool is available if a selected sensor is equipped with the MLC feature (e.g. [LSM6DSOX](#)). It allows configuring MLC with example algorithms or custom sensor configuration saved in .ucf file and monitors its functionality.

Figure 22. MLC Tool



- Step 1.** Click on one of the example algorithms you want to try or select custom .ucf file with sensor configuration.  
Appropriate sensor configuration will be sent to the sensor.
- Step 2.** Monitor MLC output in MLC source register section.
- Step 3.** Read the value of the particular register related to MLC using [Get] button next to the register name.

### 3.6.7 FFT tool

The FFT tool displays a window for FFT (Fast Fourier Transform) analysis of the accelerometer data.

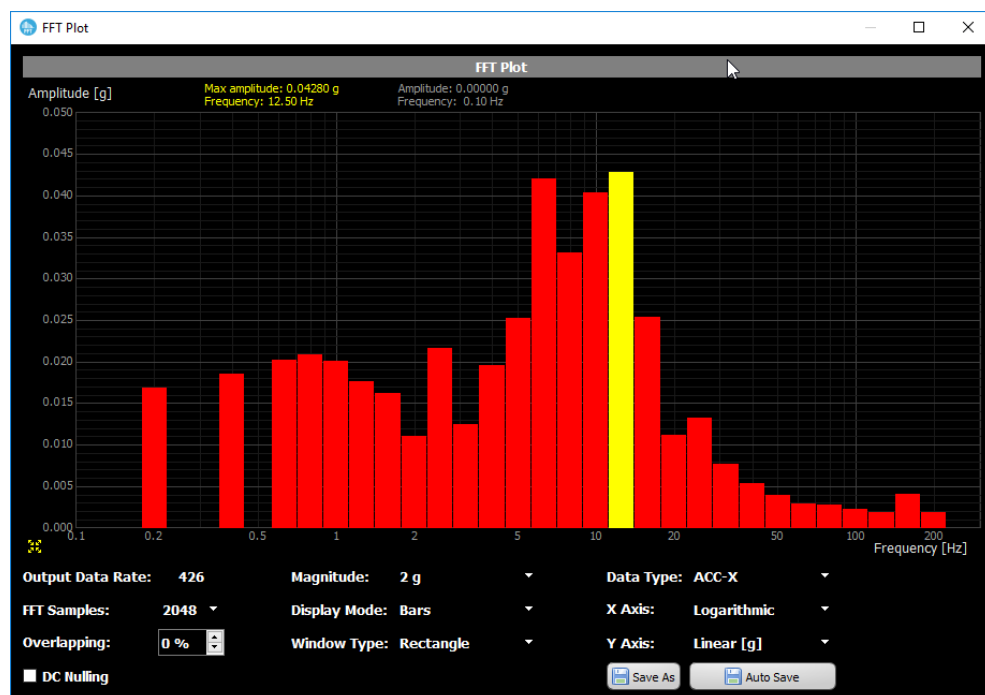
It measures the actual output data rate and automatically adjusts the X (frequency) axis.

The user can set following parameters:

- number of samples from which FFT is computed
- overlapping = percentage of samples saved for the next FFT computation
- magnitude of graph when autoscale mode is not chosen
- display mode – bars or waveform
- window type – one of following window functions:
  - Rectangle
  - Bartlett
  - Blackman-Harris
  - Flat top
  - Hamming
  - Hann
  - Kaiser-Bessel
  - Exponential
- data type – X, Y or Z axis of accelerometer
- axis type – both X and Y axis of graph can be displayed as linear or logarithmic

As shown in the image below, the maximal amplitude is colored in yellow. When hovered on bar or waveform, the frequency and amplitude are shown in the headline. It is possible to save the result of FFT into a Comma Separated (CSV) file by clicking on **[Save As]** or **[Auto Save]** button.

Figure 23. FFT Tool



**Step 1.** Set all parameters needed for FFT, such as number of samples, overlapping etc.

**Step 2.** Click on the **[Start]** icon in the main window.

The application will start to collect samples from which the FFT is computed. The graph is displayed and updated after the FFT computation.

### 3.6.8

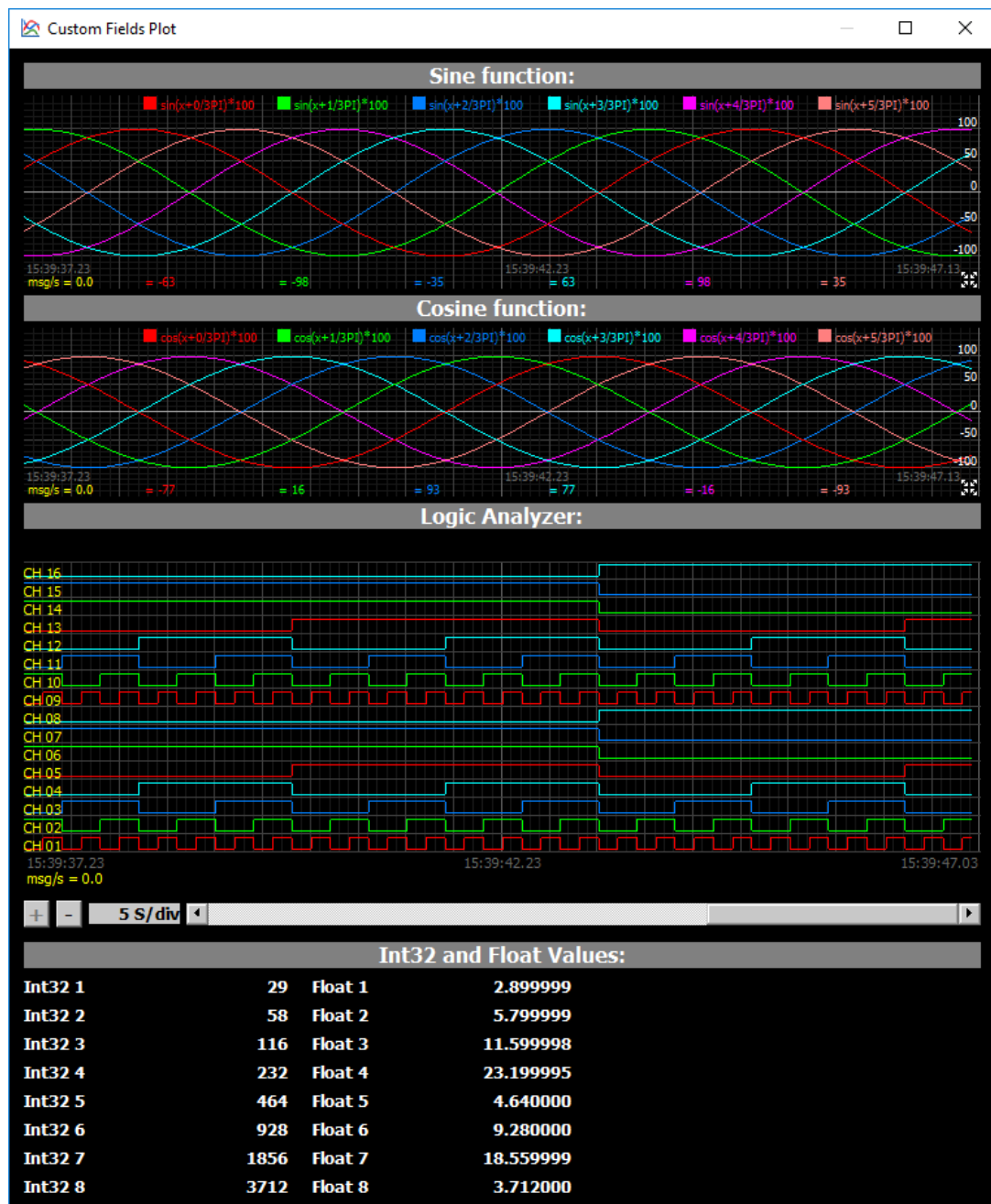
#### Custom field tool

The custom field tool displays a window for custom user data visualization, featuring:

- two graph plots with up to six axes for each graph
- a logic analyzer with up to sixteen channels
- up to eight custom integer 32 and custom float values

The window content is fully configurable from the firmware.

Figure 24. Custom fields plot



### 3.6.9

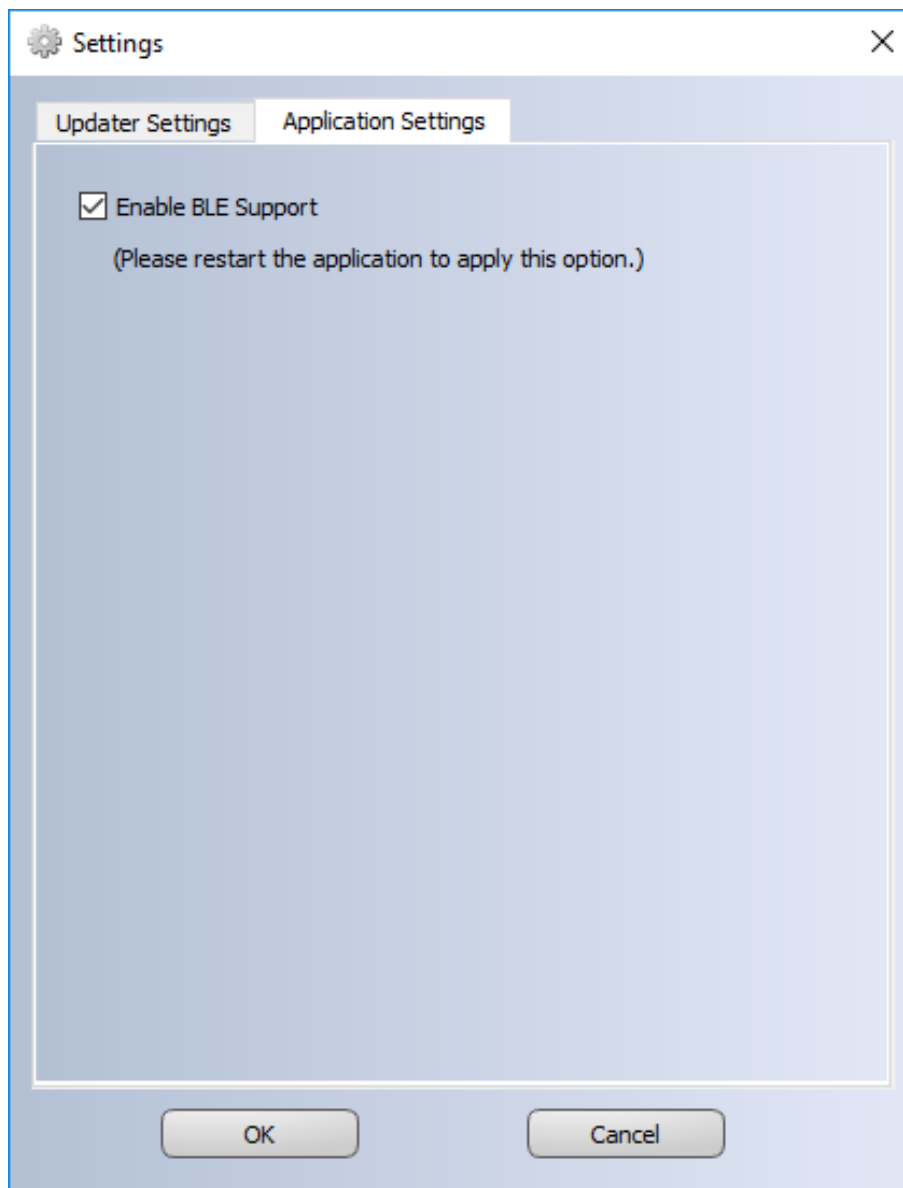
#### Tools related to algorithms

If sample algorithm demonstration application is loaded on the [STM32 Nucleo](#), the set of tools automatically changes to reflect the specific functionality. Dedicated tools for algorithms are explained in specific user manuals.

### 3.7 BLE support

The communication with Bluetooth Low energy devices is supported only in Windows 10 and above. To enable this functionality, you have to tick the **Enable BLE support** checkbox in the application Settings and restart it.

Figure 25. BLE support settings



When the BLE support is enabled, the [Unicleo-GUI](#) features not only a COM port with connected Nucleo boards but also Bluetooth devices paired with Windows operating system and has a dedicated sensor service with UUID "00000000-0001-11E1-9AB4-0002A5D5C51B".

If the application connects to a BLE device, a dedicated tab is created, displaying a picture of the connected device and the list of Bluetooth characteristics, which are supported by the firmware and the Unicleo-GUI. The characteristics can be enabled or disabled by clicking on particular icon.

If a characteristic is enabled, the data can be seen in an appropriate window opened using the related icon in the vertical toolbar.

Figure 26. BLE device tab



### 3.8 Command line arguments

The **Unicleo-GUI** application can be executed with following parameters:

- **-list\_all**: the application shows all available system communication ports. Verification of whether a COM port belongs to a Nucleo board with supported firmware is disabled.
- **-COMx**: this parameter forces the application to connect to the selected communication port number. Usage: -COM3. It can be used together with -list\_all parameter.

## 4 Data acquisition quick start

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To acquire the data from the demonstration board:

- Step 1.** Plug one of the supported device (e.g. [STM32 Nucleo](#) board with [X-NUCLEO-IKS01A2](#)) expansion board into the USB port.
- Step 2.** Start the [Unicleo-GUI](#).
- Step 3.** Check that the relevant sensors are enabled in the Options tab.
- Step 4.** Click Start to commence a sensor data collection session.
- Step 5.** Click the Stop to terminate a sensor data collection session.
- Step 6.** Use the buttons in the vertical menu bar to display the desired tool.
- Step 7.** Click Exit or simply close the main window to close the application.



## Revision history

**Table 2. Document revision history**

Date	Version	Changes
25-Oct-2016	1	Initial release.
27-Apr-2017	2	Updated Section 3.1 Updater settings, Section 3.2 The Info tab, Section 3.3 FW Management tab, Section 3.6.5 Tools related to algorithms.
02-May-2018	3	Updated Introduction, Section 1 Unicleo-GUI overview and all the document figures. Added Section 3.7 BLE support.
20-May-2019	4	Updated Introduction, Section 1 Unicleo-GUI overview, Figure 3. Installation guide, Section 3 Running the graphical user interface, Figure 5. Unicleo-GUI main window, Figure 6. Unicleo-GUI Sensor List window, Section 3.5.2 Extended datalog, Figure 15. Vertical menu bar. Added Section 3.6.4 Interrupts Tool, Section 3.6.5 Finite State Machine Tool and Section 3.6.6 Machine Learning Core (MLC) Tool.
29-Oct-2019	5	Updated Introduction, <a href="#">Section 1 Unicleo-GUI overview</a> , <a href="#">Figure 3. Installation guide</a> , <a href="#">Figure 16. Datalog widget</a> , <a href="#">Figure 21. FSM Tool</a> and <a href="#">Figure 22. MLC Tool</a> . Added <a href="#">Section 3.6.7 FFT tool</a> .

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