1. RoKiX IoT Platform

1.1. Overview

The *RoKiX IoT Platform* provides a powerful and easy to use environment to begin the evaluation of ROHM and Kionix products. Multiple hardware options are supported (*RoKiX IoT Platform HW*), as well as common, hardware independent SW tools (*RoKiX IoT Platform SW*). *RoKiX Windows GUI* consists of an easy to use graphical user interface for displaying and recording data, and a register map editor which allows the user to see and change the content of control registers. *RoKiX Python CLI,* in turn, provides reference implementation for driver SW and also a convenient way to access device low level features and versatile data logging functionality.

For a quick set up with:

- *RoKiX Windows GUI*, refer to section 5.3
- *RoKiX Python CLI*, refer to section 6.1

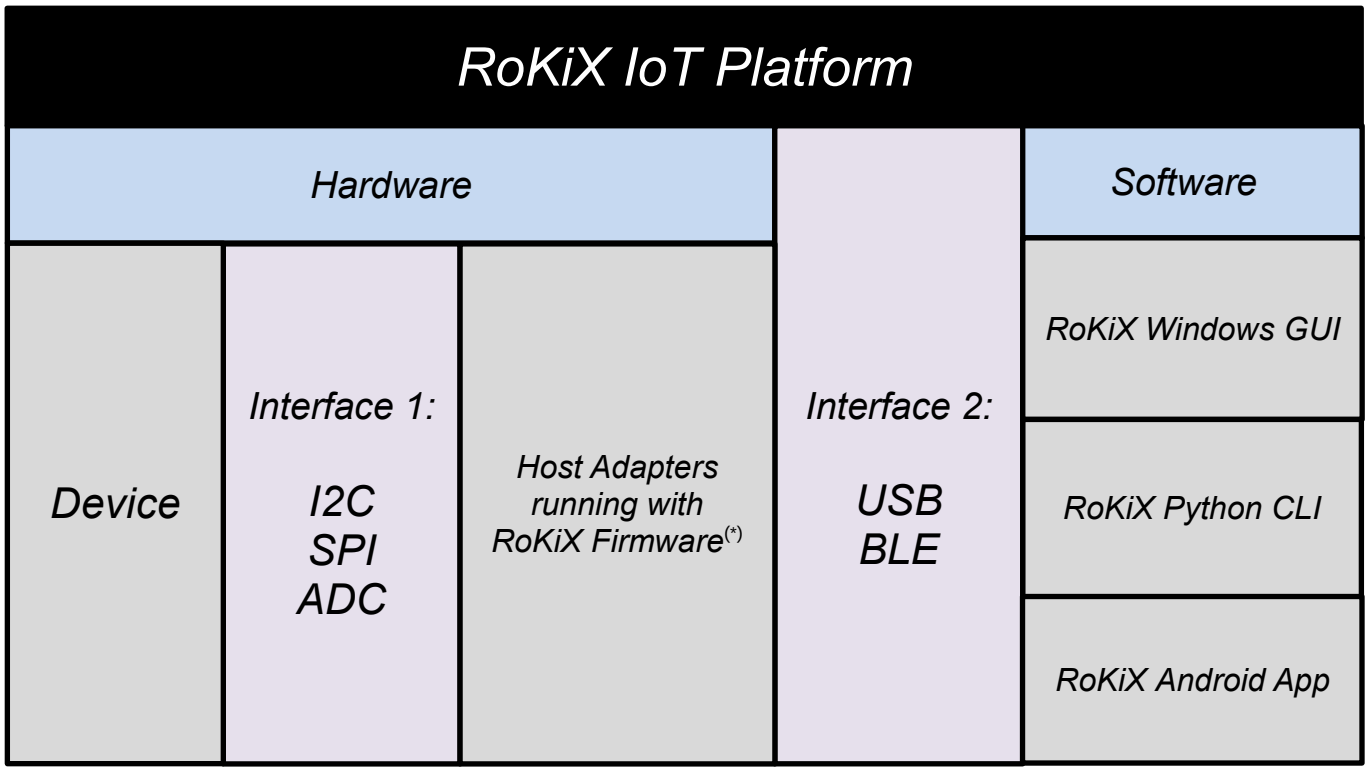

Figure 1. Structure of *RoKiX IoT Platform.*
(*) Additionally also Aardvark is supported in the RoKiX Python CLI.

1.2. Definitions

RoKiX IoT Platform	Complete offering of HW and SW for device evaluation purposes
RoKiX Hardware	PWB containing device and/or bus connection between device and host adapter
RoKiX Sensor Node	MCU + BLE + sensors + battery running *RoKiX Firmware*
RoKiX Sensor Node Mounting Accessory	Wrist band for *RoKiX Sensor Node*
RoKiX Adapter Board A3	Board specifically designed to easily interface with RoKiX devices and numerous development platforms
Kionix Evaluation Board	RoKiX sensor evaluation board with 14 pin header http://www.kionix.com/developer-tools
RoKiX Windows GUI	RoKiX device evaluation software with graphical user interface (GUI) running in Windows OS
RoKiX Python CLI	RoKiX device evaluation software with Python based command line interface for quickly testing device low level features
RoKiX Android App	RoKiX Android App is used to access and collect device data from Bluetooth enabled *RoKiX Hardware*
RoKiX Firmware	Proprietary firmware running on microcontroller based host adapters

1.3. Acronyms

ADB	Android Debug Bridge
ASIC	Application-Specific Integrated Circuit
BLE	Bluetooth Low Energy
DFU	Device Firmware Update
DLL	Dynamic Link Library
DRDY	Data Ready
FFT	Fast Fourier Transform
FTDI	Future Technology Devices International
GPIO	General-Purpose Input/Output
GUI	Graphical User Interface
I2C	Inter-Integrated Circuit
IC	Integrated Circuit
IoT	Internet of Things
LDO	Low-Dropout (regulator)
LED	Light-Emitting Diode
MAC	Media Access Control
MCU	Microcontroller Unit
ODR	Output Data Rate
OS	Operating System
OTA	Over The Air
PWB	Printed Wiring Board
QR	Quick Response (code)
SAD	Slave Address
SoC	System-on-Chip
SPI	Serial Peripheral Interface
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
USB	Universal Serial Bus
WLAN	Wireless Local Area Network

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2. Hardware

RoKiX IoT Platform is designed to support multiple host adapters for accessing devices from the *RoKiX IoT Platform SW*.

2.1. Hardware architecture

Usually platform software runs on a client machine where there is no direct connectivity to the device. Because of this, a separate host adapter which transfers messages from the client machine to the device is needed. For the connectivity, two separate connection interfaces are needed.

- Interface 1 between the device and the host adapter. Currently I2C, SPI and ADC connectivity options are supported with dedicated adapter boards.
- Interface 2 between the host adapter and the client machine. Currently USB and BLE connections are supported.

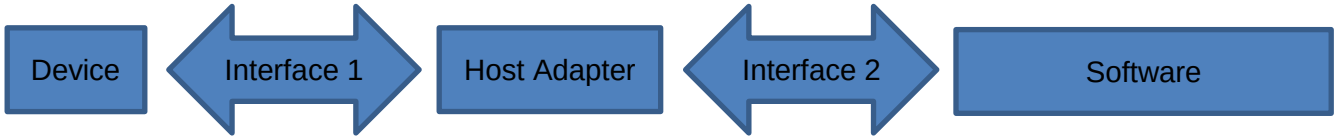


Figure 2: Hardware architecture of *RoKiX IoT Platform*

2.1.1. Supported hardware configurations

Both "off-the-shelf" adapters (e.g. Cypress, Aardvark, Arduino Uno, nRF51-DK) and microcontroller based adapters (e.g. *RoKiX Sensor Node*) are supported. Microcontroller based adapters use proprietary *RoKiX Firmware* for communication.

Adapter boards are offered for "Interface 1" connection between the host adapter and device (sections 2.4 and 2.5). For "Interface 2" connection both wired USB and wireless BLE connections are supported.

Currently supported main hardware configurations are listed in the following tables (Table 1 and Table 2) and output data rates for connection interface options are shown in Table 3, respectively. Appendix 1 introduces other supported HW configurations (Table 10 - Table 13).

<table>
<tr><th>Sensor</th><th>Interface to sensor HW</th><th>Host adapter</th><th>Interface to client SW</th><th>Client</th></tr>
<tr><td></td><td colspan="2">I2C SPI ADC
RoKiX Sensor Node</td><td rowspan="2">USB
or
BLE</td><td rowspan="5">RoKiX Windows GUI
or
RoKiX Python CLI</td></tr>
<tr><td>RoKiX Evaluation Board,
Rohm sensor module or
IoT node add-on board</td><td colspan="2">I2C SPI ADC
RoKiX Sensor Node</td></tr>
<tr><td>RoKiX Evaluation Board,
Rohm sensor module or
IoT node add-on board</td><td>I2C SPI ADC
RoKiX Adapter Board A3</td><td>Cypress CY8CKIT-059</td><td>USB</td></tr>
<tr><td></td><td colspan="2">I2C
Kionix IoT Sensor Node</td><td rowspan="2">USB
or
BLE</td></tr>
<tr><td>RoKiX Evaluation Board,
Rohm sensor module or
IoT node add-on board</td><td colspan="2">I2C
Kionix IoT Sensor Node</td></tr>
</table>

Table 1: Supported main HW configurations for the Windows and Python CLI environments

<table>
<tr><th>Sensor</th><th>Interface to sensor HW</th><th>Host adapter</th><th>Interface to client SW</th><th>Client</th></tr>
<tr><td></td><td colspan="2">I2C SPI ADC RoKiX Sensor Node</td><td rowspan="2">Bluetooth 4.1, 4.2, 5.0</td><td rowspan="6">RoKiX Android App</td></tr>
<tr><td>IoT Node add-on board</td><td colspan="2">I2C SPI ADC RoKiX Sensor Node</td></tr>
<tr><td>RoKiX Evalua-tion board</td><td>I2C RoKiX Adapter Board A3</td><td rowspan="2">nRF51-DK</td><td rowspan="4">Bluetooth 4.1</td></tr>
<tr><td>Rohm sensor module</td><td>Rohm Sensor Evaluation Kit 001/002/003</td></tr>
<tr><td></td><td colspan="2">I2C Kionix IoT Sensor Node</td></tr>
<tr><td>IoT Node add-on board</td><td colspan="2">I2C Kionix IoT Sensor Node</td></tr>
</table>

Table 2: Supported HW configurations for the Android environment

Development board with interface to device HW		Interface to client SW		
		USB	**BT4**	**BT5**
RoKiX Sensor Node	I2C	3200 Hz	≤ 800 Hz	≤ 1600 Hz
	SPI	12.8 kHz	≤ 800 Hz	≤ 3200 Hz
	ADC	X	X	X
Cypress CY8CKIT-059	I2C	3200 Hz	X	X
	SPI	25.6 kHz	X	X
	ADC	10 kHz	X	X
Kionix IoT Sensor Node	I2C	800 Hz	≤ 200 Hz	X
Arduino	I2C	1600 Hz	X	X
nRF51-DK	I2C	400 Hz	≤ 200 Hz	X

Table 3: Output data rates for different development boards and interface options

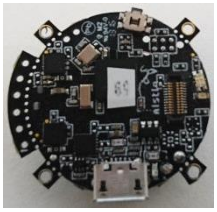
RoKiX Sensor Node Board	
Kionix IoT Sensor Node Board	
RoKiX Adapter Board A3	
IoT Node Add on Board	
Kionix Evaluation Board	
Rohm Sensor Module	

Table 4: HW glossary, part 1.

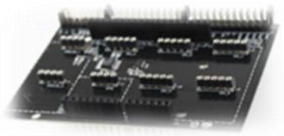
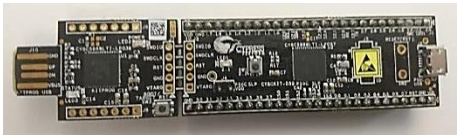
Rohm Sensor Evaluation Kit	
Cypress CY8CKIT-059	
nRF51-DK	
Raspberry Pi3	
Arduino Uno R3	
Aardvark I2C/SPI host adapter and a level shifter board	

Table 5: HW glossary, part 2.

2.2. RoKiX Sensor Node

Figure 3: *RoKiX Sensor Node*

The *RoKiX Sensor Node* is a small sensor node based on the Nordic Semiconductor nRF52840 Series system-on-chip (SoC), and it supports both Bluetooth Low Energy (BLE 4.1, 4.2, 5.0) and USB interfaces. It consists of several sensors: gyroscope, accelerometers, magnetometers and barometer.

The *RoKiX Sensor Node* has the *RoKiX Firmware* preinstalled. Firmware update instructions are described in section 4.3.1.

The hardware configuration of the *RoKiX Sensor Node* is as below (Table 6). The serial number of the *RoKiX Sensor Node* is given in the form "AA – 12345". The Media Access Control address (MAC address) of the device is shown as "AA:BB:CC:DD:EE:FF", respectively.

NOTE: Initially with the *RoKiX Sensor Node*, the Bluetooth signal is connected to the internal chip antenna (Figure 4). However, if the BLE connector is used for external antenna connection, please follow these instructions:

- Jumper pins 2 and 3 should be routed together,
- a connector for the external antenna is Murata MM4829-2702,
- example: antenna's side connector is IPEX MHF1 (u.fl compatible):

Pin	Name	Description
1	ANT	Antenna RF transmit/receive
2	GND	Ground
3	GND	Ground

Product feature	Notes
Enclosure and mounting bracket	
nRF52840 SoC	
External antenna connector	See a guidance below this table
Charger for LiPo battery	
LiPo battery	With wire connector; Joy Battery Technology, type: 652025
On/Off switch	
Battery level measurement	
Power on indicator	
USB connector	
External SPI memory	Size: 8 Mbit
System top connector	
System bottom connector	
Rohm 5+ connector	Combines the Rohm 5-pin and Kionix 14-pin connectors
RGY LED indicators	
On-board sensors: KX122 KMX62 KXG08 BM1383 BM1422	

Table 6: Product description for *RoKiX Sensor Node*

2.2.1. RoKiX Sensor Node Layout

The main parts of layout and component placement are as follows (Figure 3, Figure 4 and Figure 7):

A. Power switch
B. Red power-on LED
C. Red battery charging indication LED. When the battery is charging this LED is lit
D. USB connector for communication (yellow LED)
E. Blinking green status LED indicates BLE advertisement
F. Green LED is lit when BLE is connected
G. Red LED for indicating the bootloading mode

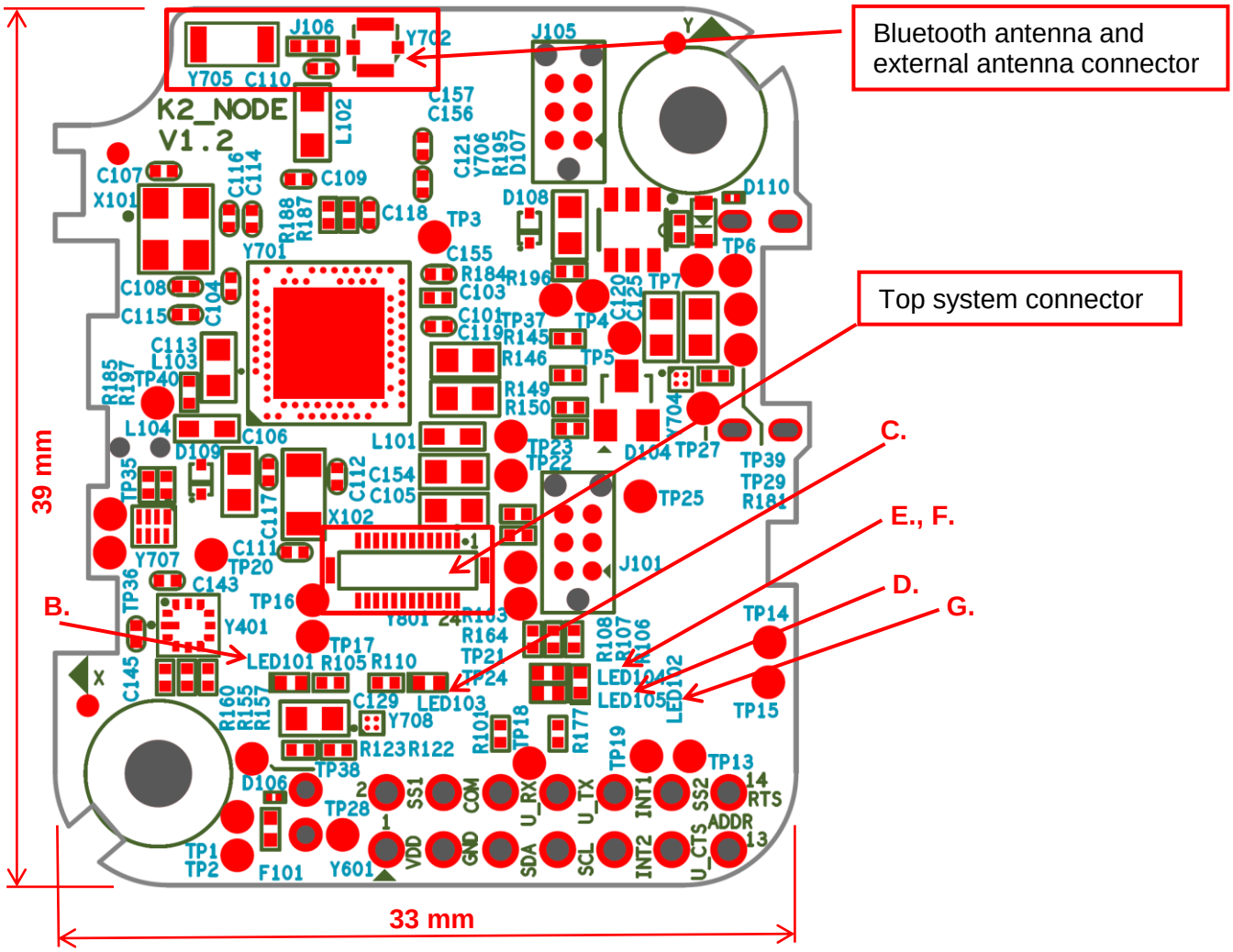


Figure 4: *RoKiX Sensor Node* top component placement

2.2.2. Adding new I2C/SPI slave devices

More devices can be connected to the *RoKiX Sensor Node* in two ways (Figure 4 and Figure 7):

- *RoKiX IoT Node* add-on board on the Top system connector, see Figure 5.
  For assembling/disassembling the add-on board, please follow instructions given by the connector manufacturer.
- Rohm 5+ connector that is a combination of the Rohm 5-pin and Kionix 14-pin connectors. With suitable SW and HW controls, the evaluation boards of Rohm and Kionix can be plugged-in directly to the connector. Connector specifications are presented in Table 7, and the correct placement of the sensor board on the bottom side of the board is shown in Figure 6. Pins marked with yellow color in Table 7 are for the Rohm sensor module, see Figure 6.

NOTE: the Top system connector on the *RoKiX Sensor Node Board* is intended for connecting legacy (sensor) add-on boards (Figure 4). On the contrary, the Bottom system connector is intended only for "other use case" add-on boards (Figure 7).

SoC pin	SPI	I2C	Silk text	CONNECTOR		Silk text	I2C	SPI	SoC pin
			VDD	1	2	SS1		Chip select 1	P0.12
			GND	3	4	COM			AIN5
P0.19	MOSI	SDA	SDA	5	6	U_RX			P0.21
P0.24	SCLK	SCL	SCL	7	8	U_TX			P0.20
P1.01	Interrupt 2	Interrupt 2	INT2	9	10	INT1	Interrupt 1	Interrupt 1	P1.12
P0.22			U_CTS	11	12	SS2		Chip select 2	P0.14
P0.15	MISO	Slave address	ADDR	13	14	RTS			P0.23

Table 7: Specifications for the Rohm 5+ connector

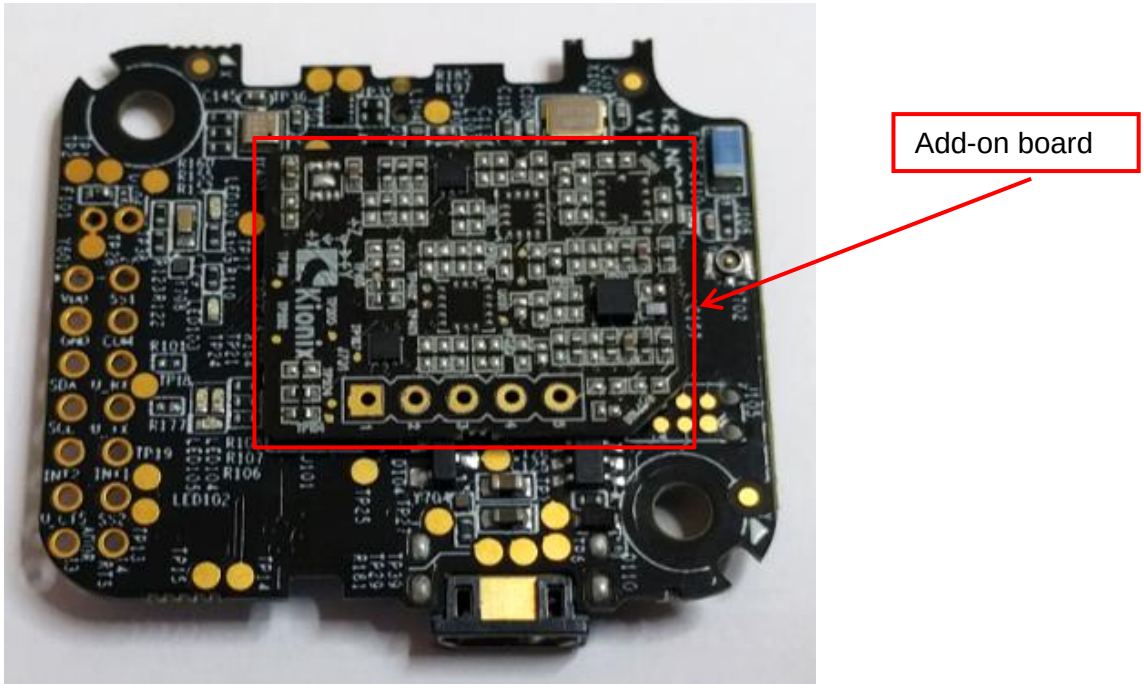


Figure 5: Correct placement of the *RoKiX IoT Node* add-on board on the Top system connector

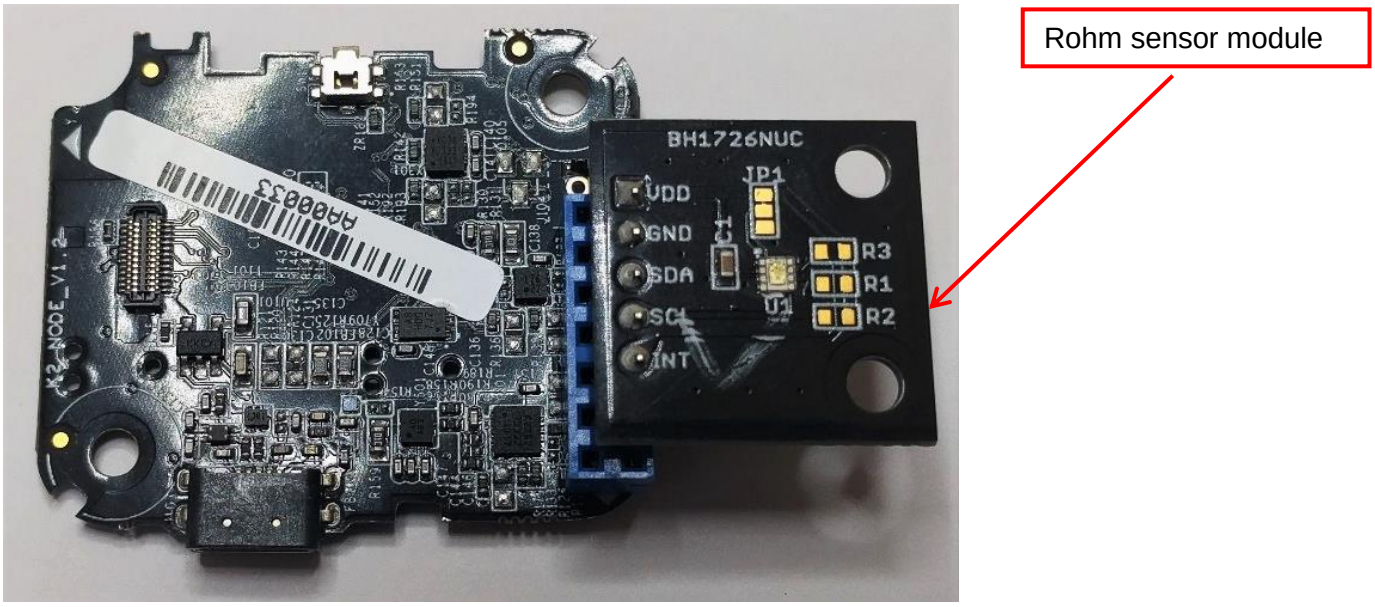


Figure 6: Correct placement of the Rohm sensor module on the bottom side of the *RoKiX Sensor Node Board* using the Rohm 5+ connector.

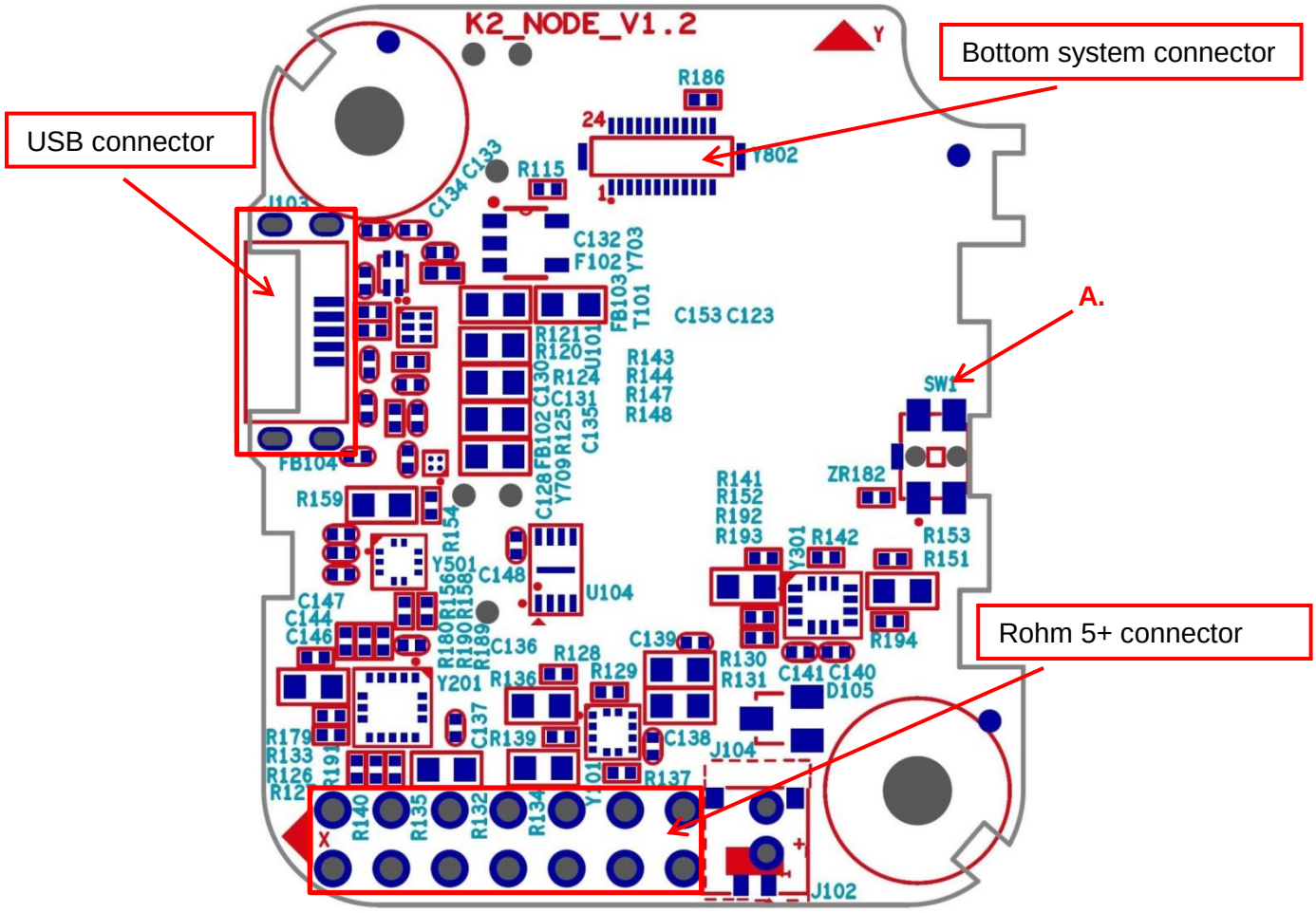


Figure 7: *RoKiX Sensor Node* bottom component placement

2.3. Kionix IoT Sensor Node

Serial number	**#100-899** **White sticker**	**#900-** **Green sticker**	**#1111-** **Yellow sticker**
Board name in *RoKiX Windows GUI*	kionix_iot_node_ k1_build2	kionix_iot_node _k1_build3	kionix_iot_node _k1_build4
Gyroscope	KXG03	KXG03	KXG08
Accelerometer	KX122	KX126	KX122
Magnetometer	KMX62	KMX62	KMX62
Barometer	BM1383AGLV	BM1383AGLV	BM1383AGLV

Table 8: Sensors in *Kionix IoT Sensor Node*

The serial number can be found on the label located on the sticker of the *Kionix IoT Sensor Node*.

Figure 8: *Kionix IoT Sensor Node* serial number

Detailed information about the *Kionix IoT board* can be found in the directory `\Documents\Rohm\RoKiX-HW-Docs\Kionix-IoT-Sensor-Node` and at the Kionix website.

Notes:

- Before using the *Kionix IoT Sensor Node* with a battery, please make sure the battery is fully charged. The battery is charged via the USB connector. The battery is fully charged when the battery charging LED turns off.
- If a battery is connected, the *Kionix IoT Sensor Node* does not automatically turn on the power when the USB is connected to the PC. The power switch must be pressed to power on the device before connecting the USB cable.

2.4. RoKiX Adapter Board A3

The *RoKiX Adapter Board A3* is a tool specifically designed to easily interface with ROHM/Kionix devices and numerous development platforms. It is a great platform for someone who needs an easy way to interface with Kionix's standard evaluation boards featuring a 14-pin male header, RoKiX 24-pin add-on boards, or ROHM Sensor Shield Modules 5-pin digital or 4-pin analog boards, with ready-to-use development platforms such as Cypress, Arduino, and Raspberry Pi.

The adapter board utilizes 3.3V/5V power from the host platform and converts to rotary switch selectable (1.7V/1.8V/2.5V/2.8V/3.0V/3.3V/3.6V) VDD voltage using a dedicated ROHM adjustable LDO. There is also an option to bypass the voltage regulator and provide the power from the host directly to devices that meet the voltage requirements. Furthermore, the IO_VDD voltage can be supplied from an independent adjustable LDO set to 3.3V or be tied to the selected VDD voltage using an onboard switch. The adapter board also features a pair of level shifters that can be used in I2C and SPI communication to interface 5V host systems with devices supporting lower VDD voltages. Current measurement is possible via removable jumpers on VDD rail and via in circuit removable zero-ohm jumper on IO_VDD rail. An LED is provided on the power rail to indicate the board is powered by the host.

2.5. Rohm Sensor Evaluation Kit

Rohm's SensorShield-EVK-001/002/003 sensor evaluation kit is compatible with open platforms such as Arduino Uno and mbed. The sensor shield enables easy evaluation of the 8 onboard high-performance sensors, making it ideal for verifying sensor operation, initial set development, and as a learning and training tool.

SensorShield-EVK-001/002/003 can be used with the *RoKiX IoT Platform* by using Nordic Semiconductor's nRF51-DK and Arduino Uno development boards through the *RoKiX Firmware* ref. section 3.1.

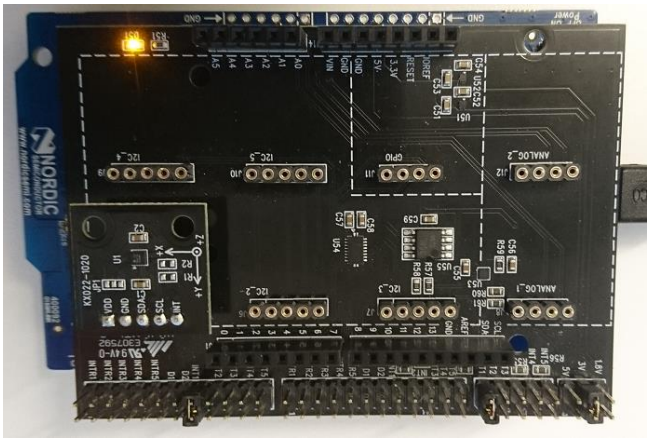


Figure 9: Rohm EVK-001 with proper jumper configuration

2.6. Aardvark I2C/SPI Host Adapter

Aardvark is a product of Total Phase Inc. *RoKiX Python CLI* running on a Windows PC supports both I2C and SPI connections on Aardvark. Since Aardvark uses 5 volts for logic voltage, level shifting may be required.

2.7. Embedded Linux

RoKiX Python CLI can be run on an embedded Linux system. The recommended configuration setup is to use Raspberry Pi3 with the *RoKiX Adapter Board A3* (ref. section 2.4) and *Kionix Evaluation Board*.

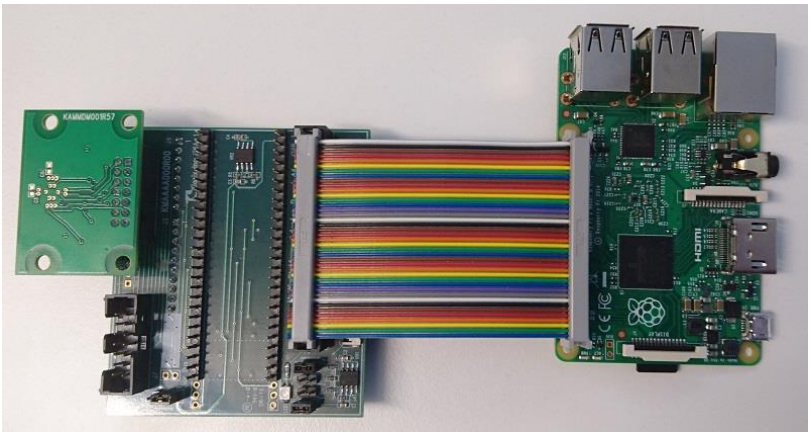


Figure 10: *Kionix Evaluation Board* with Raspberry Pi3

Other Linux boards may require jump wires for device connection. Please note the possible need of a level shifter.

3. Software

RoKiX IoT Platform SW consists of both *RoKiX Firmware* for supported evaluation kit hardware, as well as, *RoKiX IoT Platform Client SW* for evaluating the array of devices ROHM/Kionix has to offer.

3.1. RoKiX Firmware

Firmware for supported microcontroller based *RoKiX IoT Platforms* is provided by ROHM. Programming instructions and updating instructions are described in section 4.3. *RoKiX Firmware* supports communication with *RoKiX IoT Platform Client SW*. ROHM currently offers firmware for:

- RoKiX Sensor Node
- Cypress CY8CKIT-059
- Kionix IoT Sensor Node
- Arduino Uno R3
- Nordic Semiconductor nRF51-DK

3.2. RoKiX IoT Platform Client SW

The provided *RoKiX IoT Platform Client SW* is divided into three parts: *RoKiX Windows GUI, RoKiX Python CLI and RoKiX Android App*.

3.2.1. RoKiX Windows GUI

RoKiX Windows GUI provides an intuitive graphical user interface demonstrating high level device offerings and features. Some of the features included are:

- Visual display of real-time device data
- Ability to record device data to a file
- Device registry editor
- Demonstration of RoKiX Software offerings such as
    - Sensor Fusion Algorithm
    - Air mouse

Please see chapter 5 for usage instructions for the *RoKiX Windows GUI.*

3.2.2. RoKiX Python CLI

RoKiX Python CLI provides an advanced interface for demonstrating low level device features. Some of the features included are:

- Independent of Operating System
- Reference implementation for creating device driver software
- Flexible tool for recording device data
- Reference implementation for usage of device ASIC level features
- Framework for quick modification and testing of device functionality

The usage instructions for *RoKiX Python CLI* are in chapter 6. Section **Error! Reference source not found.** describes the installation processes of the necessary 3rd party software.

3.2.3. RoKiX Android App

RoKiX Android App's purpose is to collect device data over Bluetooth low energy connection. Currently this application is available for Android devices in the Play store or GitHub. The application is also bundled with the *RoKiX IoT Platform* and located in the folder `\Documents\Rohm\RoKiX-Android-App` .

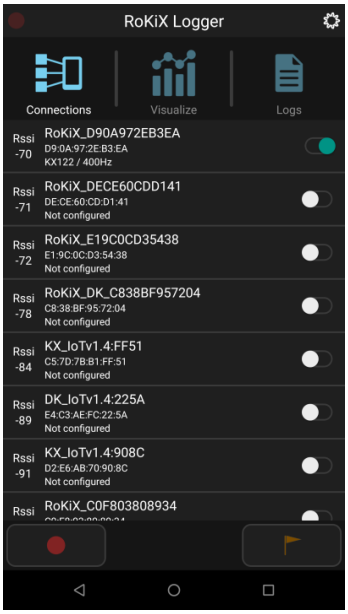


Figure 11: *RoKiX Android App*

3.2.3.1. QR code

4. Dependencies

This chapter lists dependencies needed by *RoKiX IoT Platform SW*.

4.1. USB driver installations

4.1.1. RoKiX Sensor Node USB driver

With Windows 10, the operating system should automatically use the correct USB driver. Earlier Windows versions are not able to automatically find the CDC ACM driver and the user will need to install the signed release `inf` file from the USB drivers (`\Documents\Rohm\RoKiX-Firmware\Windows-dependencies\RoKiX-Sensor-Node\cdc_acm_driver`).

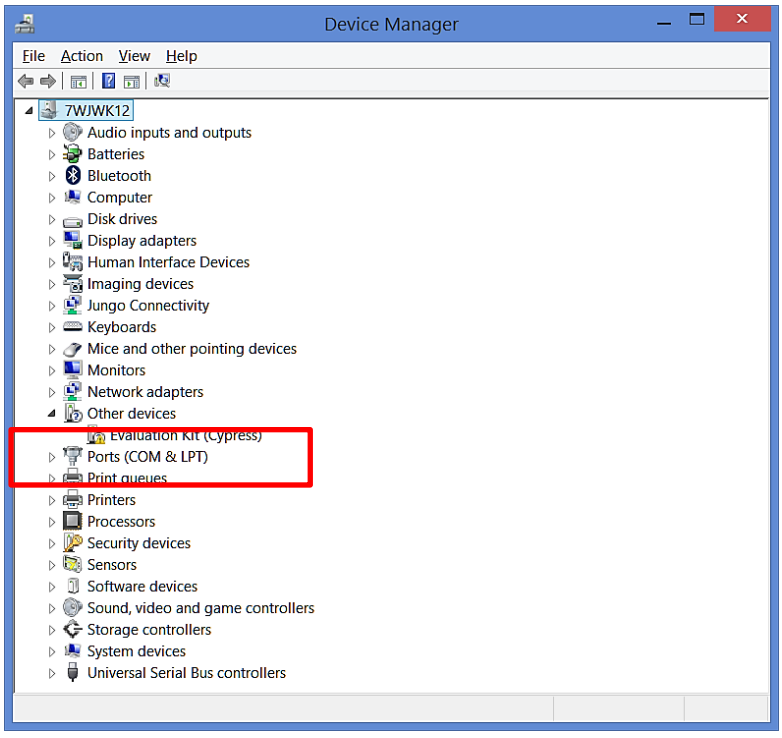
NOTE: For CDC ACM USB driver installation, please follow the instructions in the next section "*Cypress USB driver*", but select the `inf` file from `\Documents\Rohm\RoKiX-Firmware\Windows-dependencies\RoKiX-Sensor-Node\cdc_acm_driver` .

4.1.2. Cypress CY8CKIT-059 USB driver

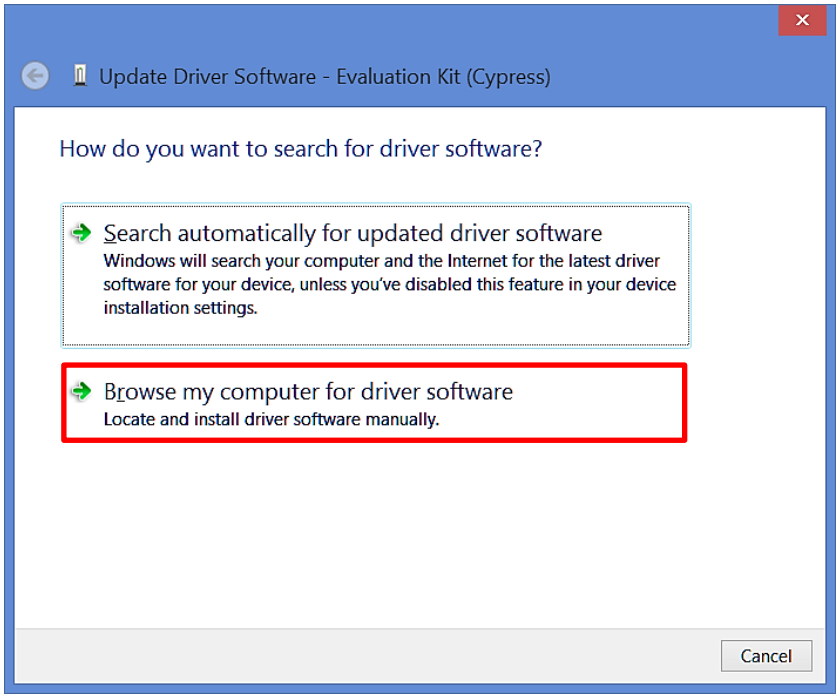
On Windows 10, the operating system should automatically use the correct driver. Earlier versions of Windows cannot automatically find the CDC driver and the user will need to install the signed driver.

For USB driver installation, please follow the steps below.

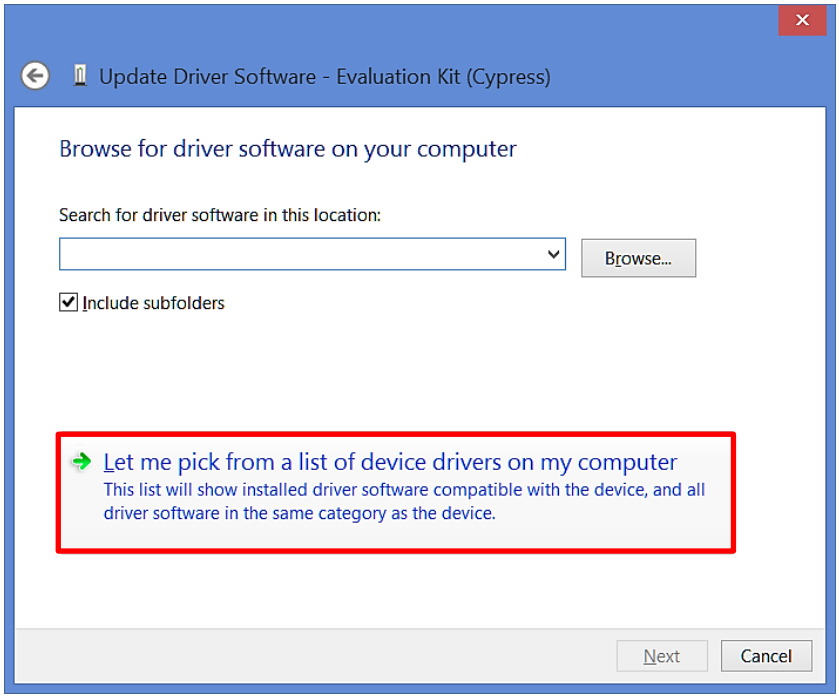
1. Acquire the `inf` and `cat` driver files:
   `\Documents\Rohm\RoKiX-Firmware\Windows-dependencies\Cypress-PSoC\USBFS_cdc_130418`
2. Connect the Cypress board to a computer using the Cypress kit's Micro-USB connector.
3. Open the Device Manager where you should find the "Evaluation Kit (Cypress)" as shown in the figure below.



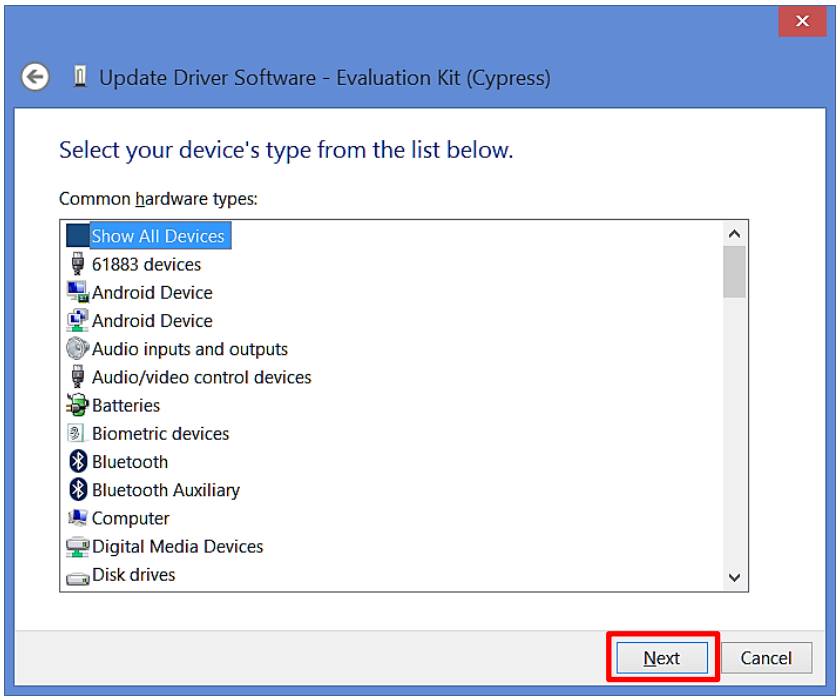
Right-click the "Evaluation Kit (Cypress)" item, and choose "Update Driver Software …". A new window should open. Select "Browse my computer for driver software" as shown below.



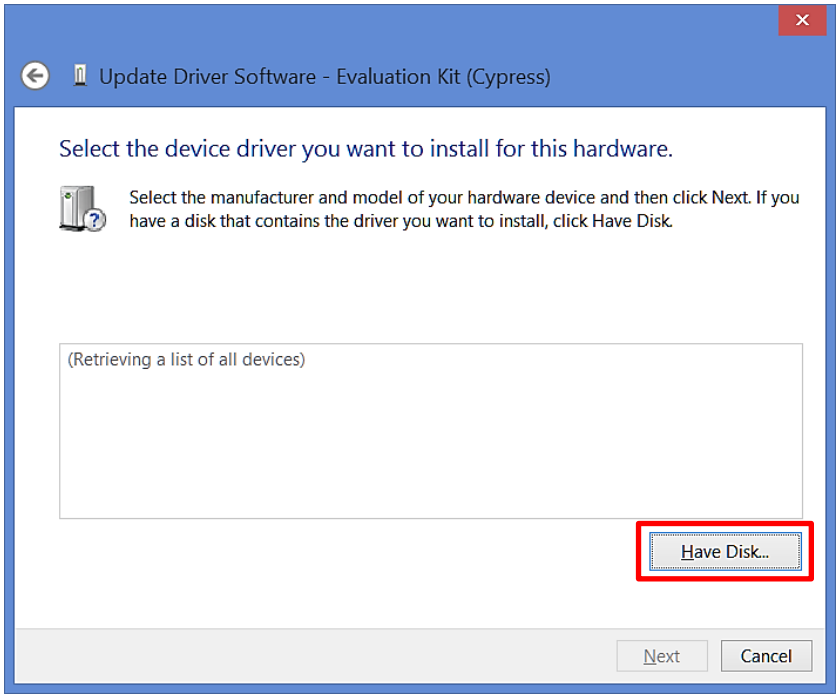
4. Select "Let me pick from a list of drivers on my computer":



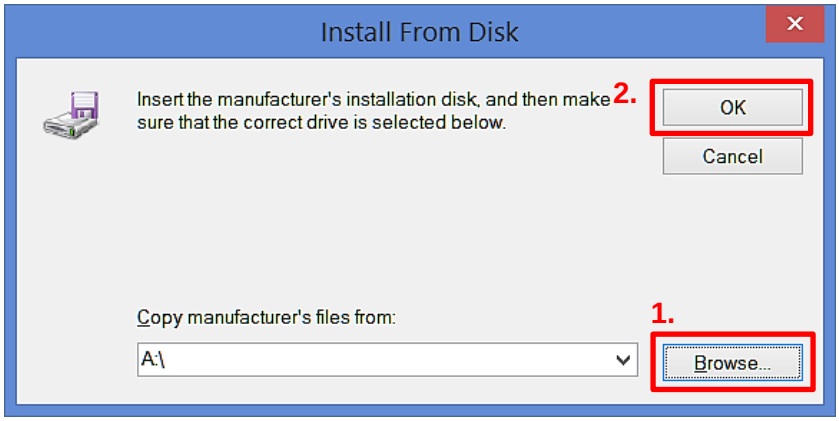
5. Choose “Next”, the selection in the list does not matter:

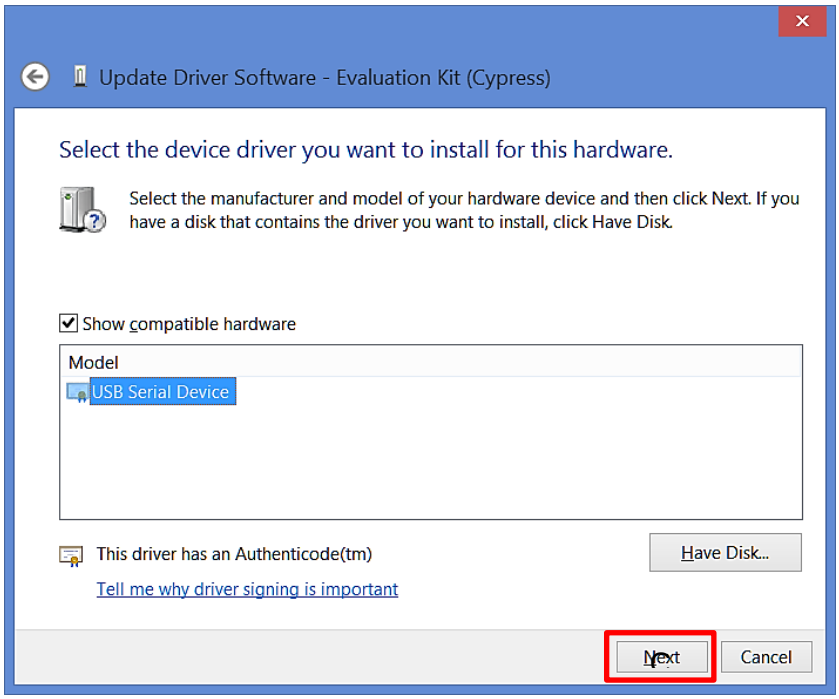


6. Choose “Have Disk” as shown below:



7. Then choose "Browse" and find the downloaded `inf` file and then select "OK". You will be returned to an older pop-up window where you should select "Next".





8. Windows will prompt you to install the driver, please select "Install".

9. Finally, please wait until the driver installation is complete.

4.1.3. Aardvark USB driver

The Aardvark I2C/SPI host adapter is supported by *RoKiX Python CLI*.

The Total Phase USB driver for Aardvark is bundled with the *RoKiX IoT Platform* and located in the folder `\Documents\Rohm\RoKiX-Firmware\Windows-dependencies\Aardvark` . The latest drivers are also available at http://www.totalphase.com/products/usb-drivers-windows

4.1.4. Arduino USB driver

For installation of the Arduino board driver, download the Arduino software package from Github. This download includes the driver file named `arduino.inf`, which is located in the `\Arduino\build\windows\dist\drivers` folder of the Arduino software package, and it may be installed by following the step-by-step guide shown in here.

4.1.5. Kionix IoT Sensor Node USB driver

Kionix IoT Sensor Node uses FTDI for USB serial communications. If Windows does not install the needed drivers automatically, they can be loaded from: http://www.ftdichip.com/Drivers/VCP.htm

Interoperability is tested with the following driver version
http://www.ftdichip.com/Drivers/CDM/CDM21216_Setup.exe

If drivers are not installed correctly, the *Kionix IoT Sensor Node* will be shown in the Device Manager in the following way:

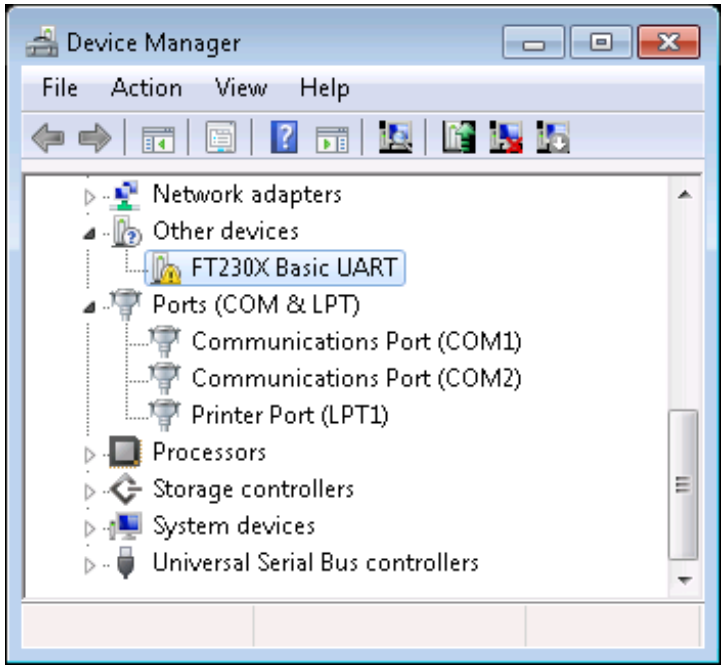


Figure 12: *Kionix IoT Sensor Node* USB driver not properly installed

After drivers are installed, *Kionix IoT Sensor Node* is listed as "USB Serial Port (COMx)" where 'x' is the COM port allocated for the *Kionix IoT Sensor Node*.

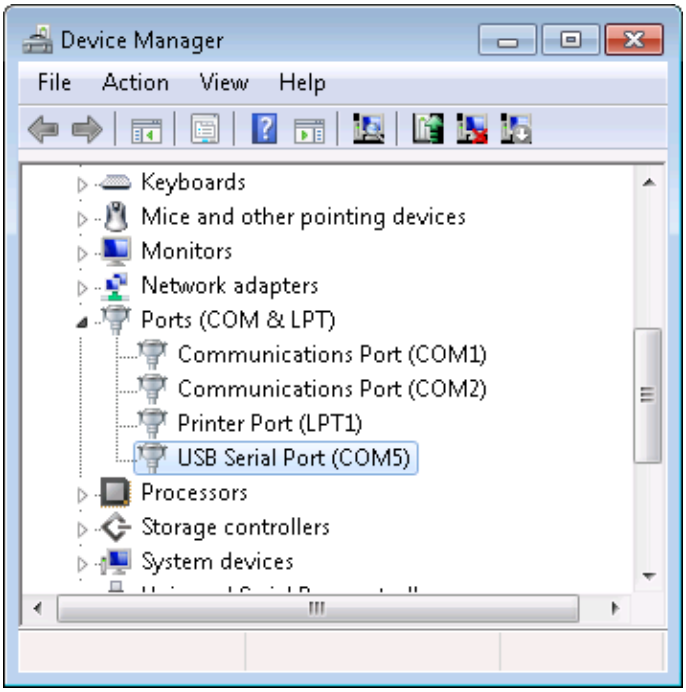


Figure 13: *Kionix IoT Sensor Node* USB driver properly installed

When using FTDI USB Serial connections with high ODR speeds (≥ 400 Hz), the COM port setting should be updated to ensure data is transferred as soon as it is available. Otherwise the data may come in bursts and time stamping values may not be correct.

The following configuration of a COM port was found to be suitable:

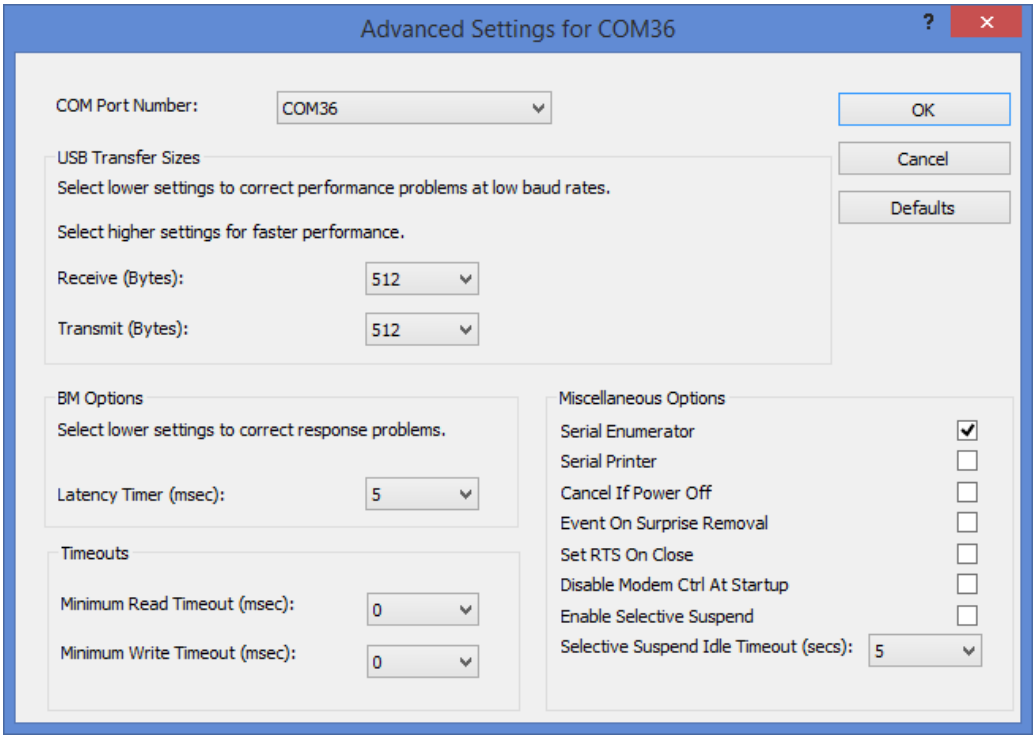


Figure 14: *Kionix IoT Sensor Node* USB settings

4.1.6. Apple OS X and FT232RL device

This section gives some notes on using the *RoKiX Sensor Node* or some versions of the Arduino Uno with an FTDI FT232RL device.

Apple OS X version 10.9 and later versions contain driver software for FTDI which is implemented by Apple. Usage scenarios with Apple FTDI driver(s) are limited; only `drdy_operation = INTERVAL_READ` is working reliably.

For higher ODRs, the user needs to install the FTDI VCP driver. The installation instructions are available at:

http://www.ftdichip.com/Support/Documents/AppNotes/AN_134_FTDI_Drivers_Installation_Guide_for_MAC_OSX.pdf

After an installation reboot of your machine, connect the evaluation board and check the driver installation using the terminal command

```
kextstat | grep FTDI
```

The output should contain only one line containing the text `"com.FTDI.driver.FTDIUSBSerialDriver"`. If there are several lines, then the Apple FTDI driver is still loaded and may cause communication problems. In this case, follow the instructions in AN134 chapter 7 on disabling the Apple provided VCP driver for OS X.

4.1.6.1. Finding a proper serial port if auto-detect fails

If the com-port is not automatically found/located the proper com-port can be found (to be set) in `rokix_settings.cfg` with the terminal command

```
ls -l /dev/tty.*
```

FTDI based com-ports are seen in the listing as `"/dev/tty.usbserial-*"`, com-ports using a generic USB CDC-device are seen as `"/dev/tty.usbmodem*"` .

4.2. Pairing Bluetooth enabled RoKiX IoT Platform HW with Windows

If the established *RoKiX IoT Platform HW* supports Bluetooth connectivity, the pairing with Windows is done with the following steps:

1. Go to Control Panel\All Control Panel Items\Devices and Printers
2. Add a device
3. Choose `"RoKiX_<MAC address>"`
4. Next
   ≫ *RoKiX Sensor Node* led light should turn green during the device installation

If the pairing succeeded, the **"**`RoKiX_<MAC address>`**"** device is visible in the `"Unspecified"` - section of "Devices and Printers". Note that the device name **"**`RoKiX_<MAC address>`**"** is shown as an example, however, many other names exist as diverse HW and firmware versions are supported. For example, with the nRF51-DK development board the device name will appear as **"**`DK_IoTv1.4:90BC`**"**.

During Bluetooth pairing with Windows 10, the status LED in the node will change from red to green for a few seconds, but turn to red again until the *RoKiX Windows* GUI is started and an active connection is maintained.

When the connection is changed back to USB, the *RoKiX Sensor Node* will also start to use USB automatically. The color of the *RoKiX Sensor Node* status LEDs will change from green to red.

4.3. RoKiX Firmware programming and updating

This section describes the programming process of *RoKiX Firmware* to the supported *RoKiX IoT Platform HW*. These instructions are also suitable for programming the *Kionix IoT Node Firmware.*

4.3.1. RoKiX Sensor Node firmware

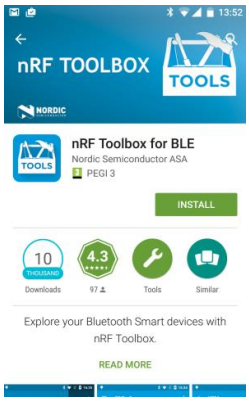
This section provides instructions on how to use the DFU (Device Firmware Update) to update the bootloader and *RoKiX Firmware* to the *RoKiX Sensor Node* with OTA (Over The Air) using an Android or IOS phone.

The *RoKiX Sensor Node* is shipped with a pre-installed bootloader and *RoKiX Firmware*. Both can be updated with an iPhone or Android using the "DFU" functionality of the "nRF Toolbox", which is available in the application store (for example in Google Play). The *RoKiX Firmware* is also bundled with the *RoKiX IoT Platform* and located in the folder `\Documents\Rohm\RoKiX-Firmware\RoKiX-Sensor-Node`.

4.3.1.1. QR code for the firmware

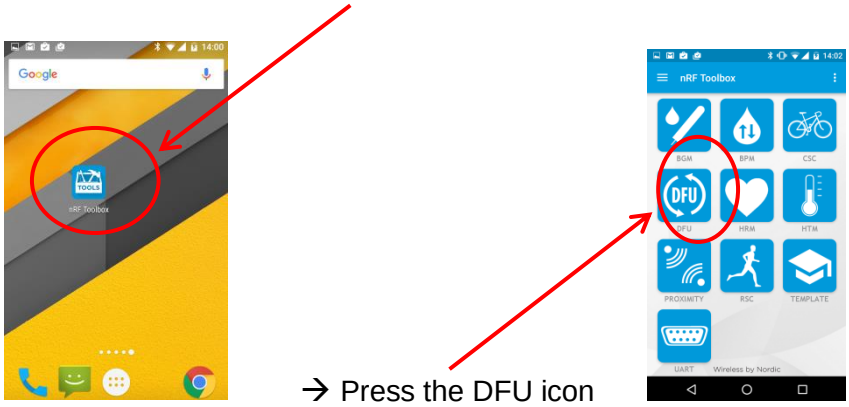
Update the *RoKiX Firmware* to the *RoKiX Sensor Node* with the following procedure:

1) Load the Nordic Toolbox App (nRF Toolbox App) for your Android –phone (Google Play store) or Apple Store for IPhone. Here is an example of the Android phone installation via the Google Play store;



Press the Install button

2) Start the application from the main icon

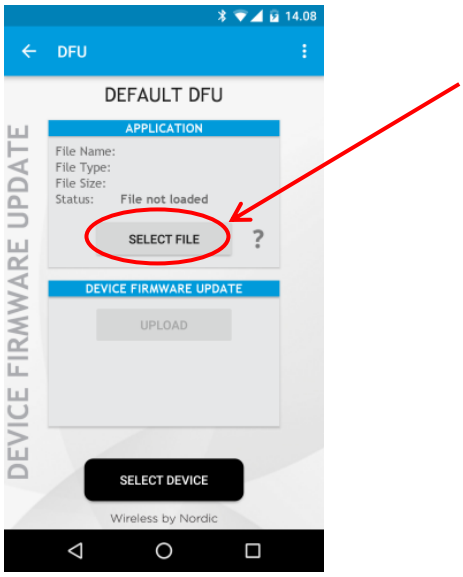


3) The DFU menu will open

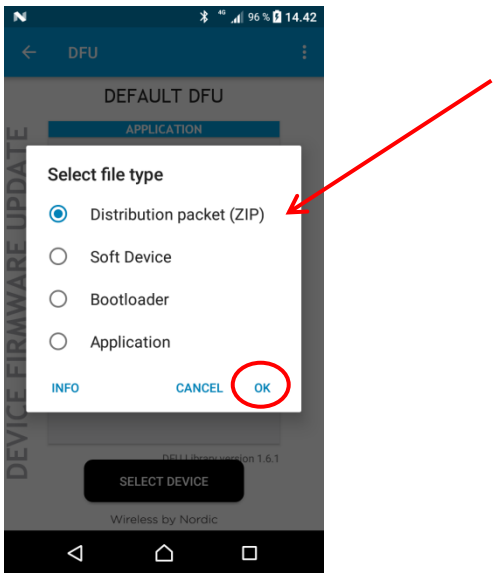
4) The *RoKiX Firmware* is bundled with the *RoKiX IoT Platform* and located in the directory `\Documents\Rohm\RoKiX-Firmware\RoKiX-Sensor-Node .`

   1. Load the firmware update file to the Android phone into the directory of your choice. For example `RoKiX-IoT-firmware.zip` to `/sdcard` –directory.
   2. The *RoKiX Evaluation Kit Firmware* can be downloaded to the device from GitHub:
      RoKiX Firmware

5) Press the "Select File"-button



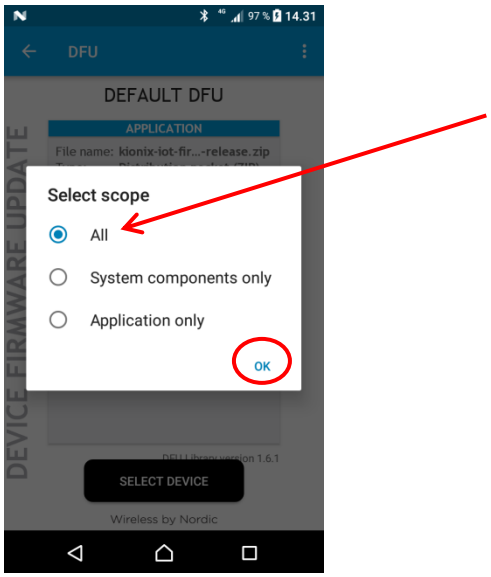
Select "Distribution packet (ZIP)"



Press the OK button

6) Select your favorite file manager program

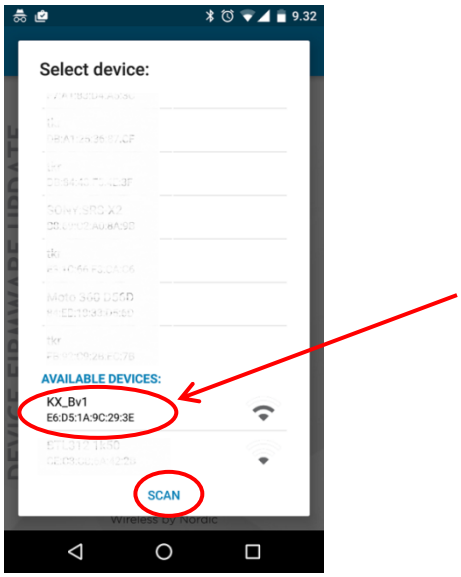
1. Select the file
2. Select scope (All)



3. Press OK button

7) Press the "Select Device"-button

1. Scan to update MAC number info and choose your device



2. Select your *RoKiX Sensor Node*'s MAC number from the list

8) Press the "Upload"-button

1. Wait until the uploading starts (may take up to 2 minutes)
    i. The upload status bar informs the percentage level of the current upload
    ii. If uploading does not start, please check "Troubleshooting hints" below.
2. The DFU application should notify the user that the update was successful

Troubleshooting hints:

a. Make sure that the battery of the *RoKiX Sensor Node* is fully charged or plug the USB cable to the *RoKiX Sensor Node* during the DFU operation.
b. Reboot the device in which the nRF toolbox is running
c. Disable WLAN from the device in which the nRF toolbox is running
d. Check the package size setting parameters in the DFU Settings

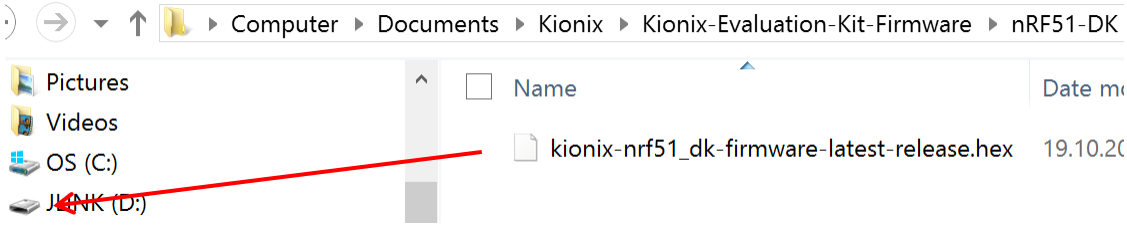
References:

- nRF Toolbox manual
- Nordic Semiconductor Infocenter
- Nordic Semiconductor Developer Forum

4.3.2. Nordic Semiconductor nRF51-DK firmware

The nRF51-DK development kit has a pre-installed mbed boot loader. The *RoKiX Firmware* can be programmed to the development board with the following steps:

- Connect the nRF51-DK to the PC with a USB cable. The nRF51-DK is listed as a hard drive in the Windows File Explorer
- Copy & Paste the firmware to nRF51-DK. The firmware is located in `\Documents\Rohm\RoKiX-Firmware\nRF51-DK` or it can be loaded from Github.



4.3.2.1. QR code

4.3.3. Arduino firmware

Since the Arduino has a pre-installed bootloader, the *RoKiX Firmware* can be programmed through USB connection. If the Arduino board is shipped with the *RoKiX IoT Platform* then the *RoKiX Firmware* has already been pre-installed.

The Arduino USB driver must be installed as a prerequisite for installing the *RoKiX Firmware*, see section 4.1.4.

The *RoKiX Firmware* for the Arduino is bundled with the *RoKiX IoT Platform* and it is located in the folder `\Documents\Rohm\RoKiX-Firmware\Arduino` :

- `flash.bat`
- `RoKiX-arduino-firmware-latest-release.hex`

If the Arduino IDE is already installed then the *RoKiX Firmware* programming can be done from the Windows command line using `flash.bat`. Otherwise, please use the `XLoader` tool.

The `XLoader` tool can be downloaded from

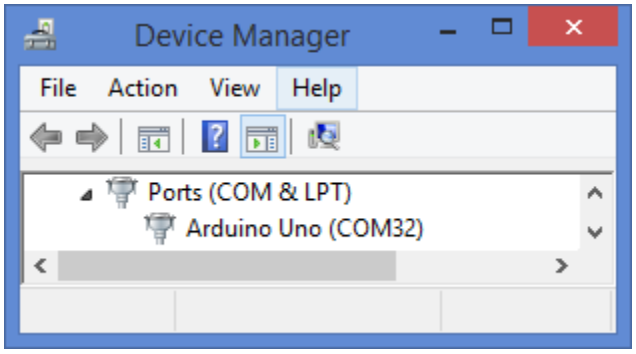
http://xloader.russemotto.com/,

Place this software package in a separate directory (see also Github):

`\Documents\Rohm\RoKiX-Firmware\Arduino`

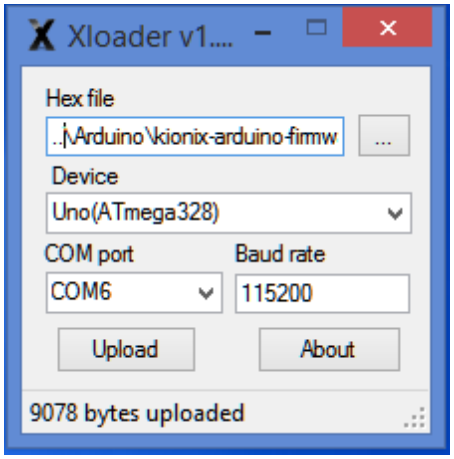
Update the *RoKiX Firmware* to the Arduino with the following procedure:

1) Open the Device Manager from Control Panel.
2) Look under ports (COM & LPT). You should see "Arduino Uno",
3) Check the port number.



4) Navigate to the tools folder and open `XLoader`.
5) With the `XLoader` interface, select:
   - `RoKiX-arduino-firmware-latest-release.hex` image as hexfile
   - Device as Uno (ATmega328)
   - COM port as the comport Arduino is connected
   - Baud rate as 115200
6) Press Upload

   After a successful update, the console printout should look like this:

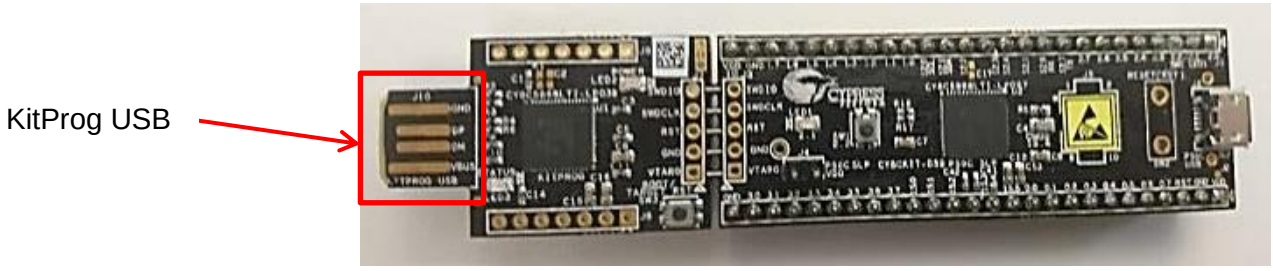


4.3.3.1. QR code

4.3.4. Cypress firmware

The Cypress device can be programmed with the stand-alone PSoC Programmer, please follow the steps below.

1. Install and launch the PSoC Programmer.
2. Connect the KitProg USB to the PC:



3. If the indicator at the lower-right corner of the programmer is red and displays "Not Connected", select the KitProg from the Port Selection box.
4. Use "File -> File Load" to select the Cypress firmware `hex` file. The firmware is located in `\Documents\Rohm\RoKiX-Firmware\Cypress-PsoC`. See also Github.
5. Use "File -> Program" to program the device.

4.3.4.1. QR code

5. RoKiX Windows GUI

5.1. Introduction

The *RoKiX Windows GUI* provides an easy to use graphical user interface demonstrating high level device offerings and features. Some of the features include:

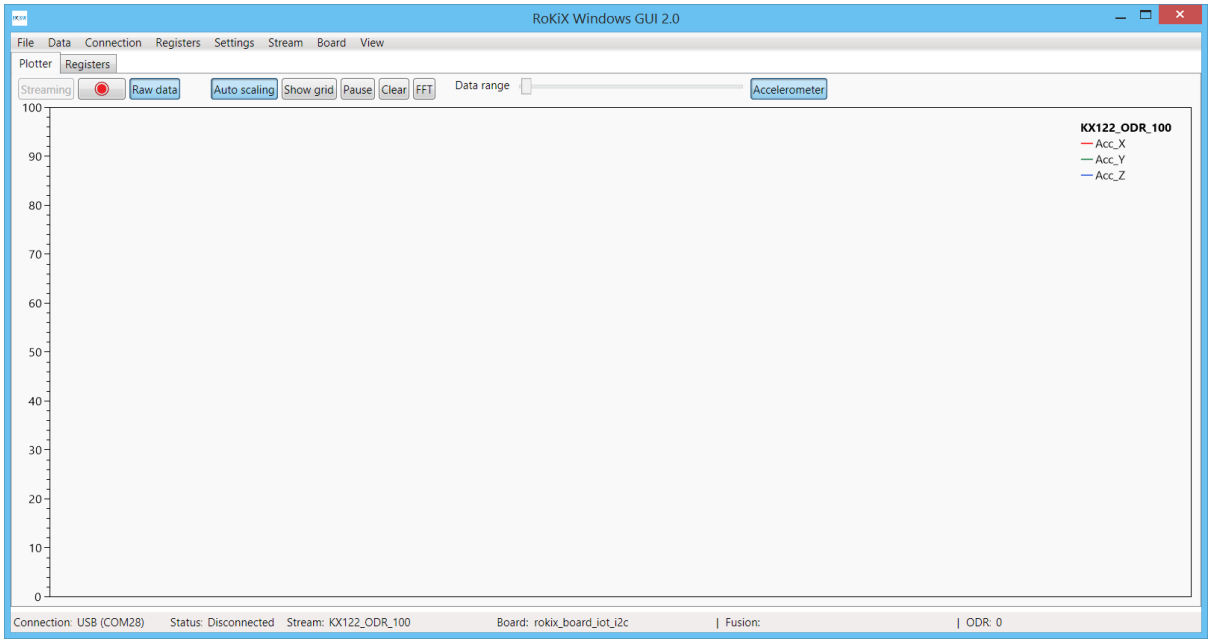
- A visual display of real-time device data
- Ability to record device data onto a file
- Device registry editor
- A demonstration of Rohm and Kionix software offering which includes the Sensor Fusion Algorithm

RoKiX Windows GUI is compatible with Windows OS versions 7, 8 and 10.

5.2. Setup

5.2.1. Installation

The *RoKiX Windows GUI* is located in `\Documents\Rohm\RoKiX-Windows-GUI\RoKiX.exe`



Before running the software, the following installation steps may be necessary:

1. When using the *RoKiX Sensor Node* with a USB connection, necessary USB serial drivers (4.1.5) must be installed (if Windows does not install these drivers automatically)
2. When using the *RoKiX Sensor Node* with a Windows Bluetooth connection, pairing is needed (4.2)

The download link to latest the release of *RoKiX Windows GUI*: Latest release

5.2.2. Configuration

5.2.2.1. Board configuration and connection type

The following settings must be done from the application menu to get the device connected:

- Board configuration from Board-menu 5.4.6
- Connection type from Connection-menu 5.4.3

If these settings are not done properly, the "No data received" pop-up will appear (see section 5.7.1).

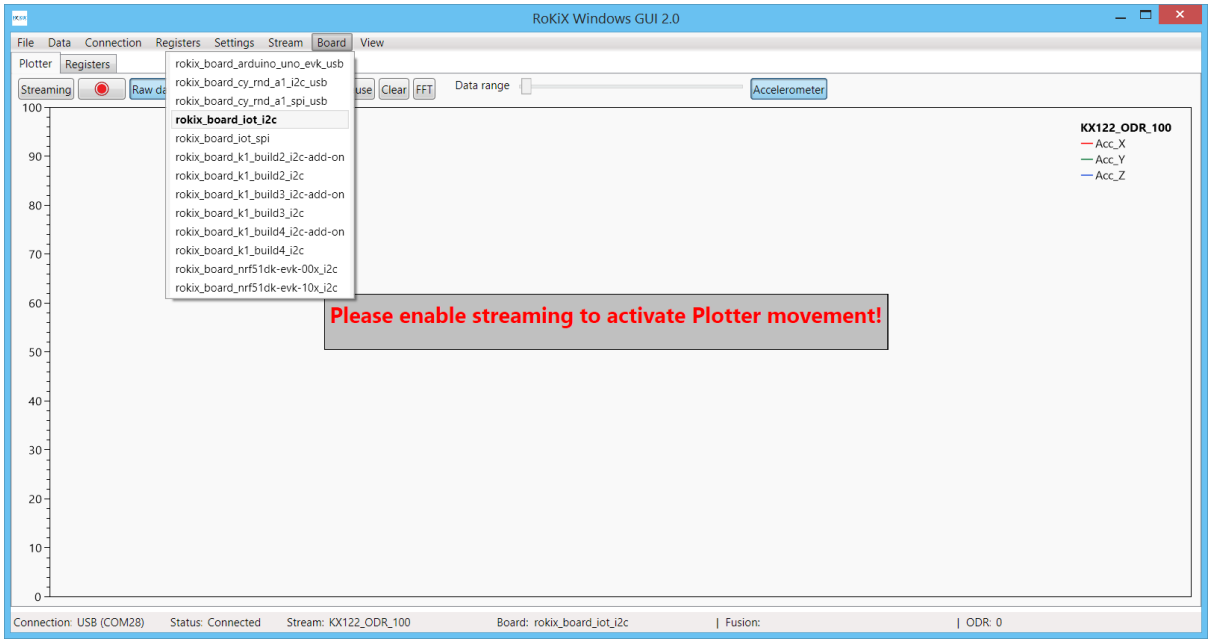
5.3. Getting Started

Follow these steps to get started with the *RoKiX Windows GUI* using USB connection and the *RoKiX Sensor Node*:

1. Plug in a USB cable between the PC and the *RoKiX Sensor Node*
2. Power on the *RoKiX Sensor Node* by pressing the blue button located on the left side of the node

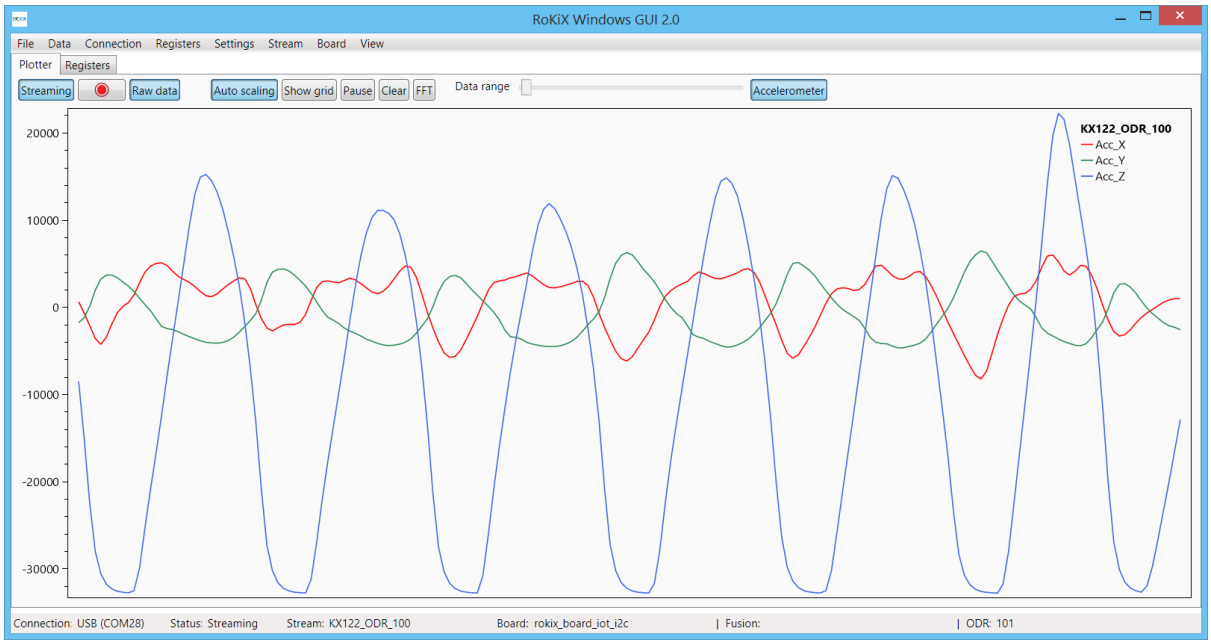
3. Start RoKiX Windows GUI

4. Check that either "rokix_board_iot_i2c" or "rokix_board_iot_spi" board configuration is selected



5. When the "Please enable streaming to activate Plotter movement!" – Pop-up window appears on the screen, enable data streaming with "Streaming" button.

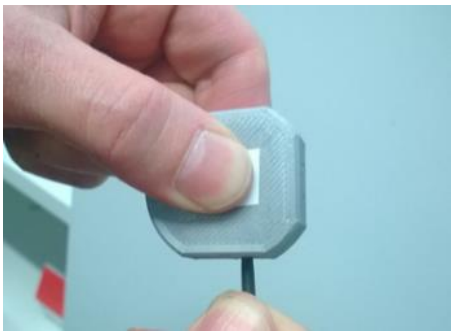
6. The Plotter now shows graphs according to your *RoKiX Sensor Node* movements



5.3.1. Getting Started with Kionix IoT Sensor Node

Follow these simple steps to get started with the *RoKiX Windows GUI* using USB connection and the *Kionix IoT Sensor Node*:

If a battery powered board is used, power on the *Kionix IoT Sensor Node* by pressing the power switch.



Plug in a USB cable between the PC and the *Kionix IoT Sensor Node*

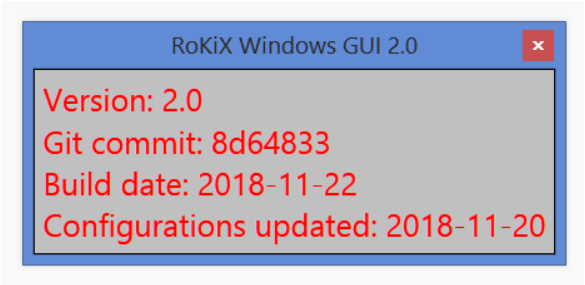
NOTE: When using the *Kionix IoT Sensor Node* on your PC for the first time, Windows will install a USB serial driver for it. It may take a while, please be patient. If the installation does not occur automatically, please refer to section 4.1.5 for installation instructions.

5.4. User Interface – Menu bar

5.4.1. File – Menu

5.4.1.1. About

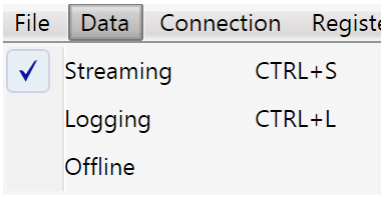
The menu shows the *RokiX Windows GUI's* version and which Git commit it is from and when it has been built.



5.4.1.2. Exit

Selecting "Exit" will exit from the application.

5.4.2. Data – Menu



The data menu contains all main options for the device data usage.

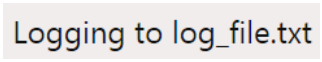
5.4.2.1. Streaming

The streaming menu is used for enabling / disabling device data streaming. Shortcut: CTRL + S

NOTE: Data stream enabling / disabling may take a while, please be patient.

5.4.2.2. Logging

The logging menu is used for enabling / disabling device data logging. The status bar will show the log file name.



More logging settings are defined in 5.4.4.5.

Shortcut: CTRL + L

NOTE: Offline data is not supported in logging.

5.4.2.3. Offline

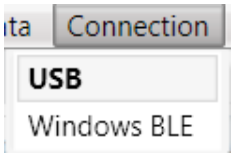
When "Offline" is selected a file dialog will open for choosing the offline device data file to be used. Offline data is mainly used in sensor fusion development and demo purposes. The selected offline data file must have accelerometer + magnetometer + gyro data to be used by the sensor fusion algorithm.

NOTE: Offline mode is not supported in Plotter and logging.

5.4.3. Connection – Menu

The *RoKiX Windows GUI* connects to the *RoKiX Sensor Node* either via USB COM port or via Bluetooth LE.

The connection menu is used to select the desired connection type. *RoKiX Windows GUI* uses USB COM connection by default. When auto-connect is enabled, the USB connection is established automatically when the *RoKiX IoT Platform HW* is connected.



NOTE: "`Windows BLE`" can be used when the system is running on Windows OS version 8.1 or later.

NOTE: Changing connection may take a while, please be patient.

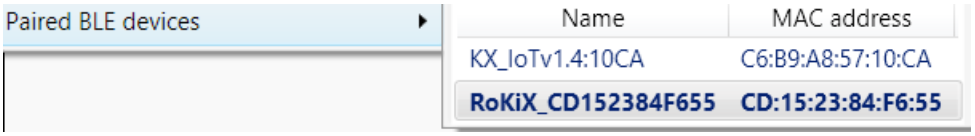
NOTE: If you are having connection problems, "CTRL + R" can be used to refresh current connection.

5.4.3.1. Windows BLE connection

The Windows BLE connection works only with Windows 8.1 or later versions. Please note that when selecting Windows BLE, the ODR can sometimes be a bit slow. The FAQ section has information about this (section 7.3).

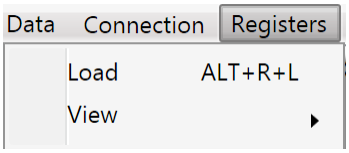
The *RoKiX Sensor Node* must be paired with Windows before BLE connection can be created. This procedure is described in section 4.2.

NOTE: When multiple Bluetooth devices are paired with Windows, you can select the used device in the "Paired BLE devices" – list in the Settings menu



NOTE: In order to disconnect the Windows BLE connection manually, the *RoKiX Sensor Node* device must be turned off.

5.4.3.2. Registers - Menu



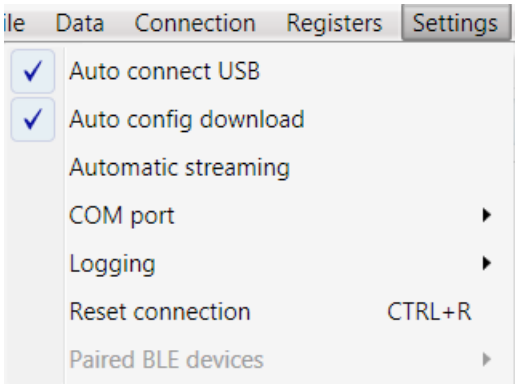
5.4.3.3. Load

Selecting "Load" will allow the user to load the device's register definition file from the "Registers" – tab. Please refer to section 5.5.4.

5.4.3.4. View

Selecting "View" will allow the user to change the "Registers" – tab view type. "Simple" is a descriptive register view and "Advanced" is a line per register type of an approach.
The "Advanced" – view is used by default.

5.4.4. Settings – Menu



5.4.4.1. Auto Connect

When "Auto connect" is enabled, the *RoKiX Windows GUI* will automatically select the USB COM port for the connected device and connect to it.

5.4.4.2. Auto config download

When "Auto config download" is enabled, the *RoKiX Windows GUI* will automatically check and download the latest board and stream configurations. The user will be notified when there are new configurations available for download.

5.4.4.3. Automatic streaming

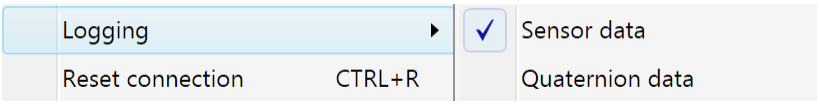
When "Automatic streaming" is enabled, the *RoKiX Windows GUI* will automatically start data streaming when the device stream is changed.

5.4.4.4. COM port

When there are multiple devices connected or there is some problem with the USB COM port selection, the COM port can be selected from the dropdown list. Before doing this the "Auto-connect" feature must be disabled.

5.4.4.5. Logging

Under the logging menu you can define what data is stored to file during device data logging.



NOTE: Logging will always use raw device data instead of SI units.

5.4.4.6. Reset connection

If you are having connection problems, "Reset connection" can be used for refreshing the current connection. It also initializes the current data stream again.

Shortcut: CTRL + R

5.4.4.7. Paired BLE devices

This menu will be enabled automatically when "Windows BLE" – connection is taken into use. All paired devices and their MAC addresses are on this list. When multiple devices are paired with Windows, you can select the used device here.

NOTE: When you pair a new device while *RoKiX Windows GUI* is on, please reset the connection in order to refresh the paired devices list.

The *RoKiX Windows GUI* will store the selected settings to the user settings on the computer and will restore them the next time the application is started.

5.4.5. Stream - Menu

The stream menu is used for selecting the device data stream which the application uses to receive data. The list of streams is dynamic and will change according to the chosen board configurations (section 5.4.6).

NOTE: KX122/KX126 have the same I2C slave addresses if the corresponding part is assembled on the *Kionix IoT Sensor Node*.
For example: this means that the application allows the use of KX122 stream even if KX126 is present in the device. Please make sure that the correct board configuration (ref. section 2.2) and stream are selected to avoid misleading device data.

NOTE: The *RoKiX Windows GUI* will store the last used stream configuration and it will be loaded in the next application startup.

5.4.5.1. Sensor Fusion

The Sensor Fusion algorithm to be used is selected automatically according to the used sensor data stream:

- Stream contains accelerometer and gyroscope data, but is missing the magnetometer data
  - Accelerometer + Gyro fusion is selected
- Stream contains accelerometer, magnetometer and gyroscope data
  - Accelerometer + Magnetometer + Gyro fusion is selected
- Stream contains accelerometer and magnetometer data, but is missing the gyroscope data
  - Accelerometer + Magnetometer fusion is selected

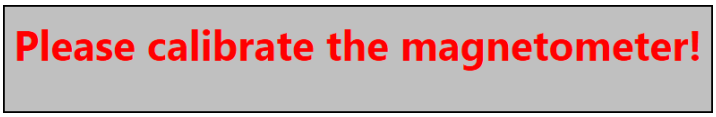
This selection affects the operation of Cube 5.5.2, Air mouse 5.5.3, and logging 5.4.4.5.

You can also use key shortcuts to override the sensor fusion mode:

CTRL + F1:	Accelerometer + Gyro
CTRL + F2:	Accelerometer + Magnetometer + Gyro
CTRL + F3:	Accelerometer + Magnetometer

5.4.5.2. Streams with magnetometer

When the magnetometer is in use and the dialog box shown below appears, it is time to calibrate the magnetometer:



Calibration is done by performing "8" – like movement with the sensor.

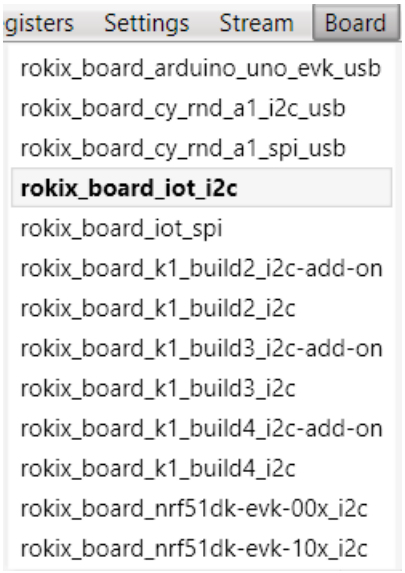
The following levels of the calibration quality are defined:

- Level 0: Not OK, calibration is requested
- Level 1: Satisfactory
- Level 2: Good
- Level 3: Ideal

NOTE: The need for the magnetometer calibration and the stability of the calibration level may vary a lot according to the prevailing magnetic conditions around the sensor.

5.4.6. Board – Menu

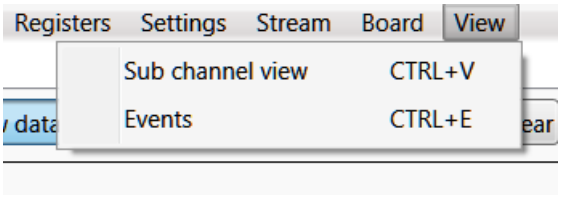
The *RoKiX Windows GUI* supports multiple board configurations:



The type of board that is used can be selected from this menu. The default board configuration is "rokix_board_iot_i2c".

When the board is changed, the connection will be changed to USB automatically.

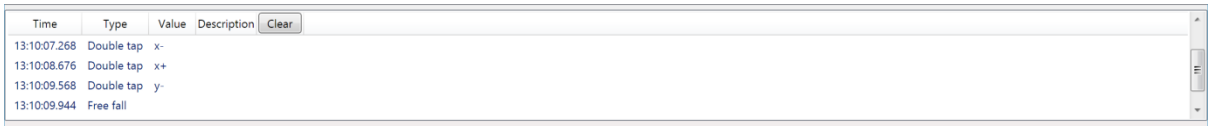
5.4.7. View – Menu



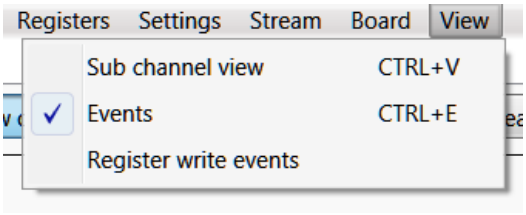
From View – Menu the "Events" – view can be enabled. It will appear on the bottom of the *RoKiX Windows GUI* window.

The "Events" – view will show "Double tap" and "Free fall" events.

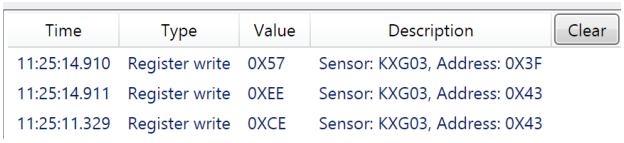
NOTE: This functionality currently supports only "KXG03_KX122_DT_FF", "KXG03_KX126_DT_FF" and "KXG08_KX122_DT_FF" – sensor streams.



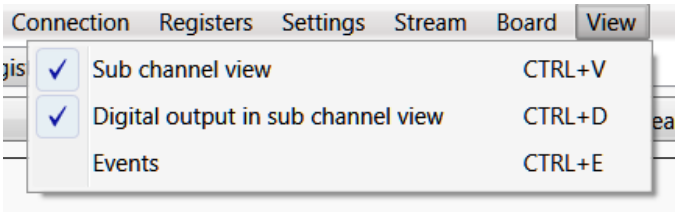
From View – Menu you can enable "Register write events" if "Events" has also been enabled.



When the "Register write events" is enabled, you will see all register write actions which the *RoKiX Windows GUI* is executing in the background.



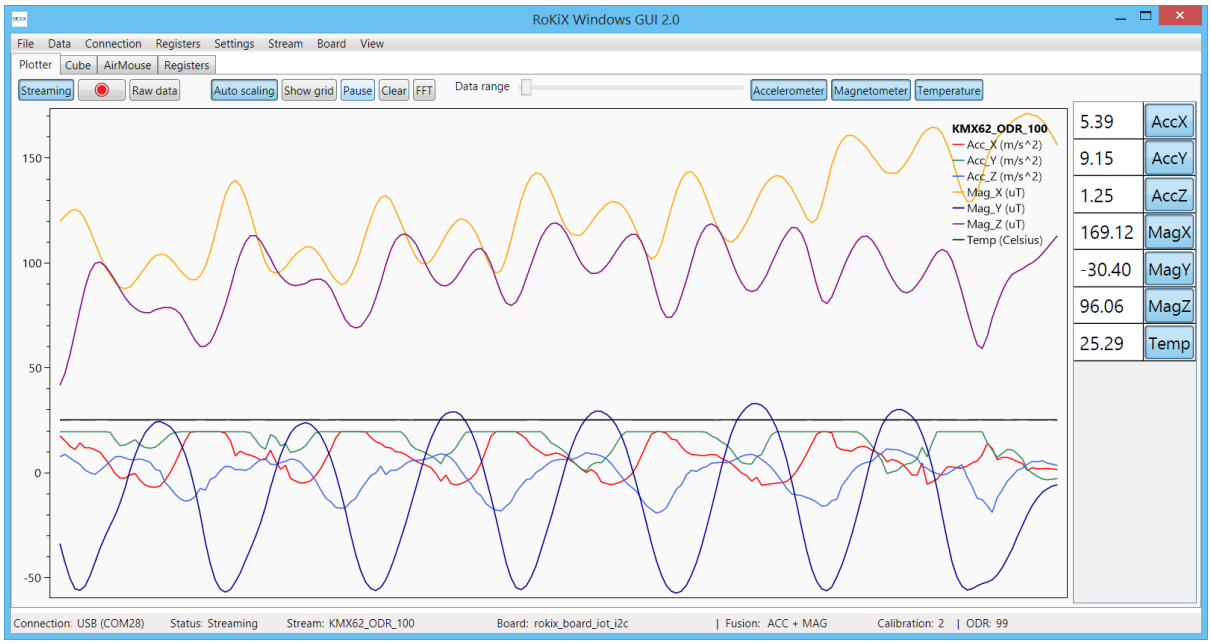
5.4.7.1. Sub-channel view



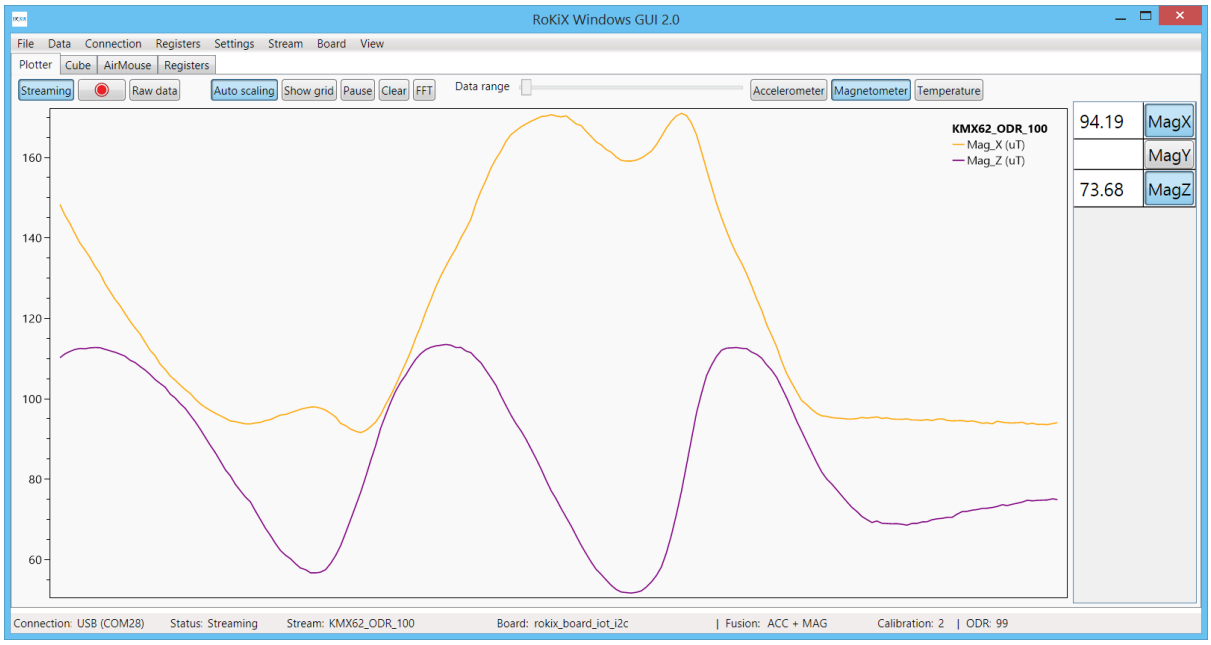
When the "Sub channel view" is enabled, the plotter shows an additional side panel on the right which can be used to show/hide the sub channel view. It also has a column for the digital output of each sub channel which can be enabled with "Digital output in sub channel view".

NOTE: Available sub channel views are always related to the used device stream and the data channels inside of it.

NOTE: When you have a very high ODR (12.8 kHz or 25.6 kHz), the digital output can slow down the plotter's performance.



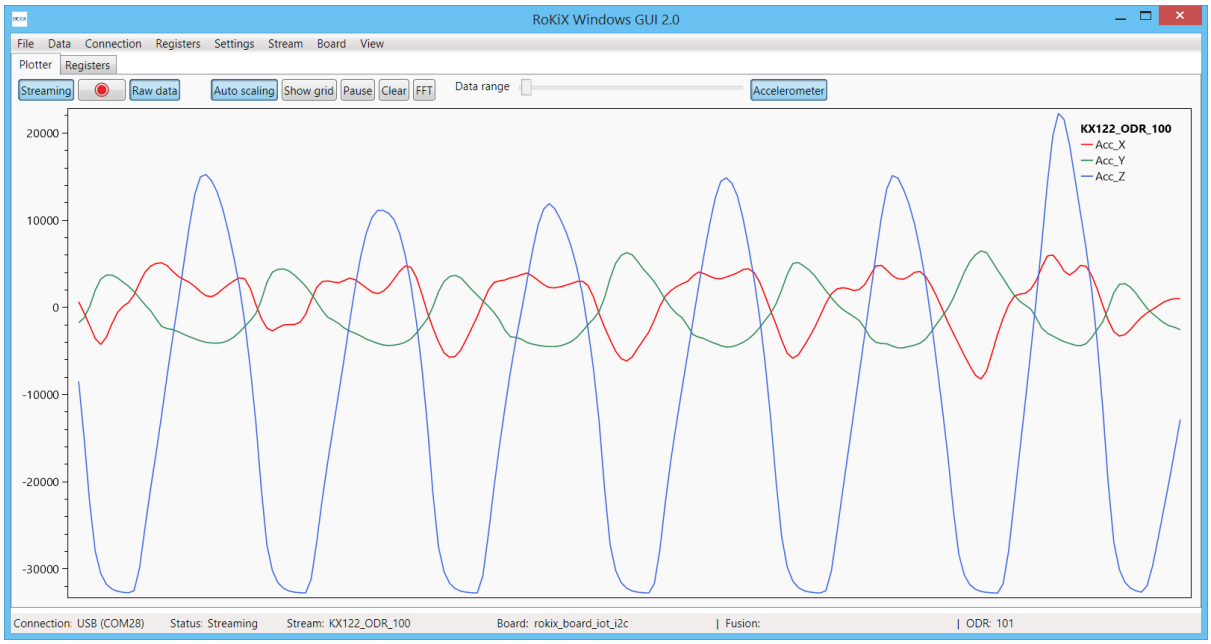
For example in this picture only "MagX" and "MagZ" sub-channels are shown:



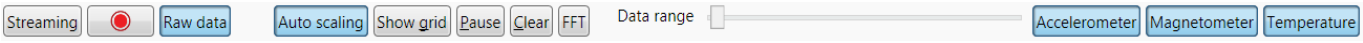
5.5. User Interface - Tabs

The functionalities of the *RoKiX Windows GUI* are divided between separate tabs.

5.5.1. Plotter – Tab



The Plotter shows device data from the current stream. The Plotter has its own `Streaming` and `Raw data` buttons in order to change them quickly.



Data logging can be enabled/disabled easily with the button with the red circle icon.
NOTE: When logging is enabled the red circle icon starts to blink.

When `Auto scaling` is enabled, plotter will auto scale the minimum and maximum values in the y-axis according to the device data.

`Show grid` – enables data grid lines. The shortcut "G" can also be used for this.
NOTE: This may slow down the plotter's performance.

`Pause` – pauses the plotter. The shortcut "P" can also be used for this.

`Clear` – clears all data points from the plotter. The shortcut "C" can also be used for this.

`FFT` – turns on the "FFT" functionality of the plotter. More information can be found in section 5.5.1.6.

`Data range` – adjusts the amount of data points shown in the plotter.

The Plotter has dynamic buttons in order to show/hide data channels within the used device stream. For example in the KMX62_ODR_100 stream there are "Accelerometer", "Magnetometer" and "Temperature" buttons that can be toggled.

5.5.1.1. Raw data

When `Raw data` is disabled, SI units for data streams are visible:

5.5.1.2. Zooming

You can zoom in and out using the mouse scroll button or right mouse button+CTRL.

NOTE: When zooming and "Auto scaling" is enabled, the Plotter will no longer perform auto scaling. In order to re-enable "Auto scaling" after zooming, it must be disabled and enabled again.

5.5.1.3. Pausing

You can pause with the "Pause" – button or with the shortcut "P". The Plotter can also be paused to a certain a position using the left mouse button.

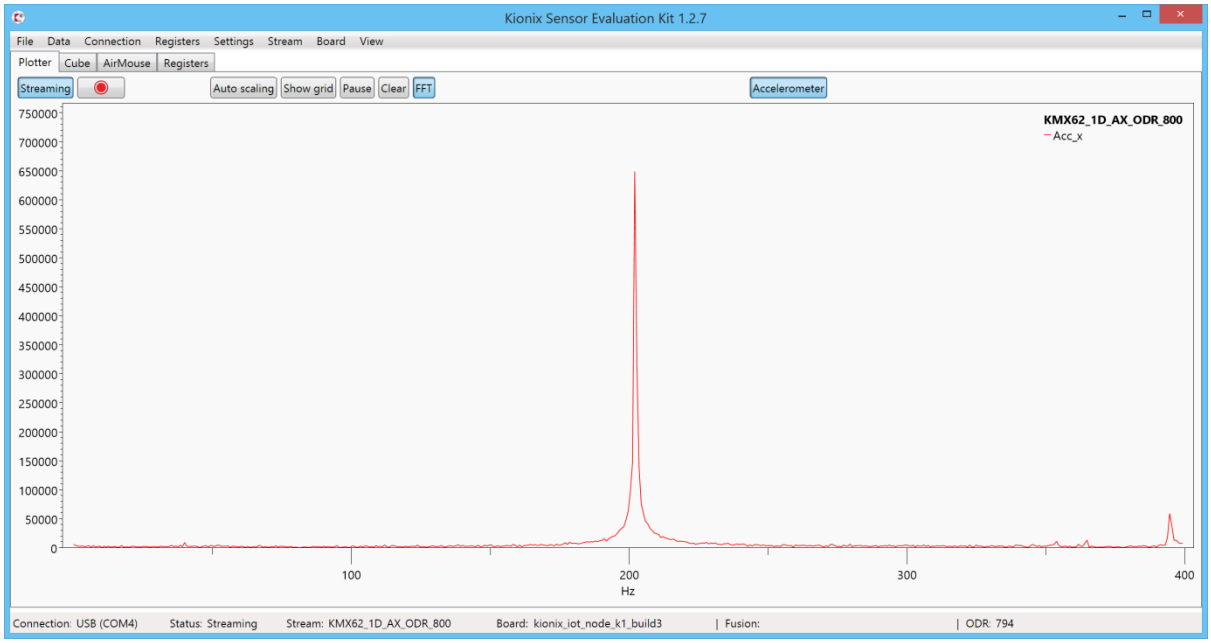
5.5.1.4. Moving

The position of the Data axis (y-axis) can be moved up and down using the right mouse button.

5.5.1.5. Clearing

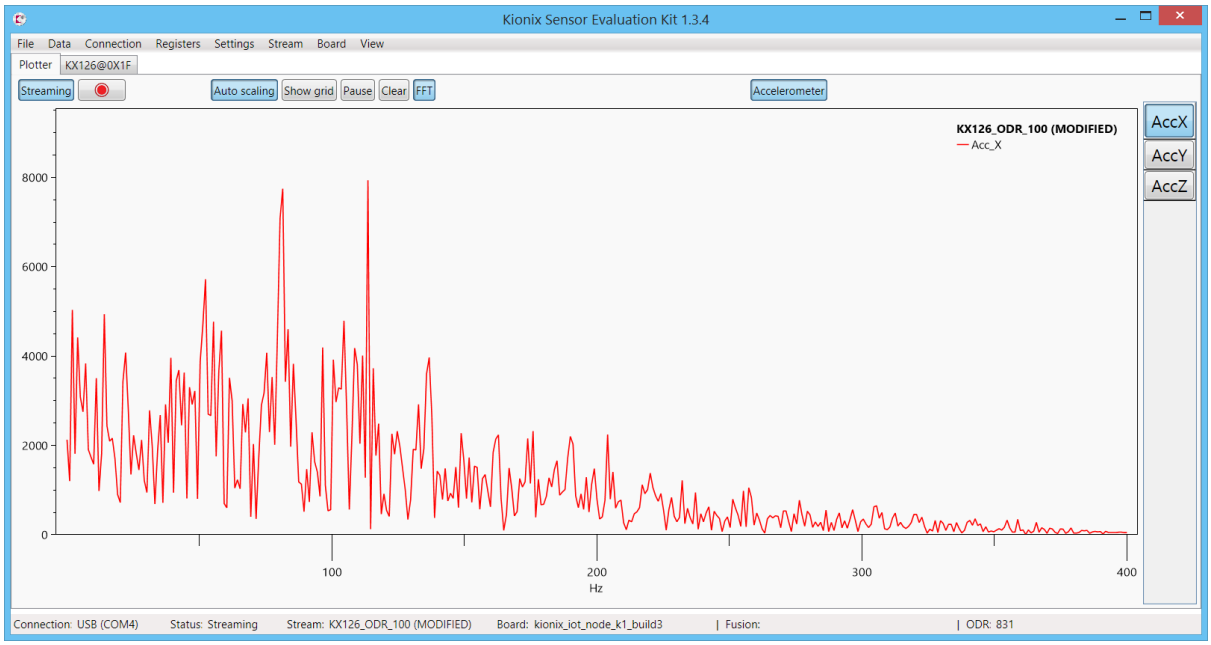
You can clear all visible data points from the plotter with the "Clear" – button.

5.5.1.6. Frequency analysis



The Plotter also has an FFT (Fast Fourier Transform) functionality to show frequency data. The "FFT" – functionality can be used with all device streams.

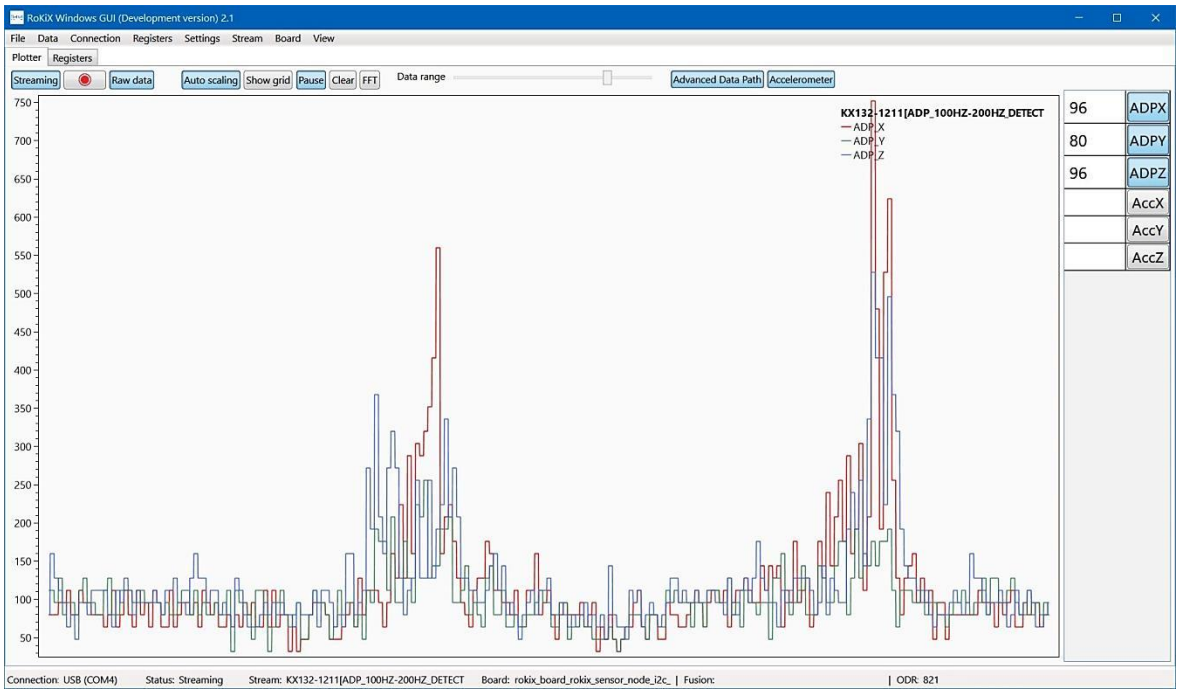
The sub-channel view can be used to show only the wanted sub-channel frequency graph(s).



NOTE: The x-axis range starts from 0 and ends in ODR/2. It will be automatically adjusted if the ODR is modified.

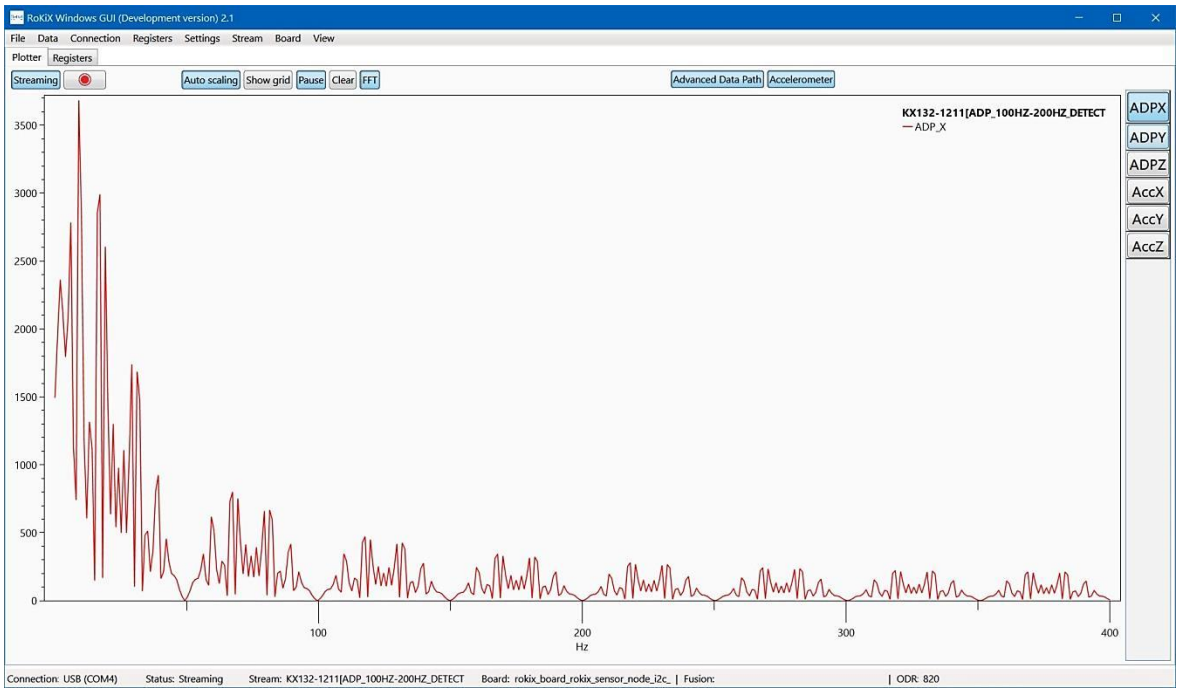
NOTE: KMX62 1-axis streams with 1600 ODR require a USB connection.

5.5.1.7. Advanced Data Path (ADP)



Advanced Data Path (ADP) is a special ASIC level functionality only for KX13x products, which consists of three blocks including a low-pass filter, low-pass/high-pass filter, and RMS calculation engine. A user can configure each stage of the ADP individually or they can be bypassed with the corresponding register settings using the register editor.

Output of the ADP engine can be monitored with the Plotter by showing device stream data (above) or applying the frequency analysis (FFT) function (below).



5.5.2. Cube – Tab

The 3D rotating cube is used for demonstrating the sensor fusion algorithm's performance. Sensor fusion is performed automatically in the background when the data streaming is started by pressing the "`Streaming`" button.

The Cube tab is visible only when the used data stream supports sensor fusion. It must include one of these channel combinations:

- Accelerometer + Gyroscope
- Accelerometer + Magnetometer + Gyroscope
- Accelerometer + Magnetometer

Please refer to section 5.8.1 to get the rotation operating correctly.

5.5.2.1. Double Tap and Free Fall demo

NOTE: This functionality can be used only with the *Kionix IoT Sensor Node.*

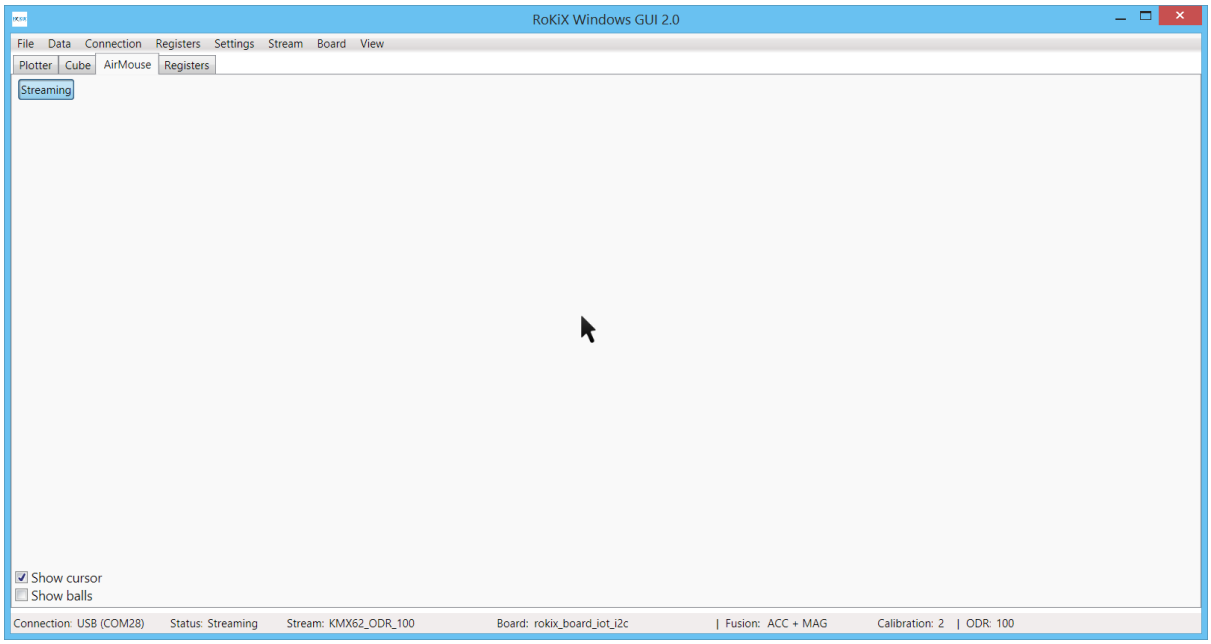
When "KXG03_KX122_DT_FF", "KXG03_KX126_DT_FF" or "KXG08_KX122_DT_FF" is selected as the used device stream and "Streaming" is enabled the Kionix sensor's Double Tap and Free Fall functionalities can be tested with the Cube. "KXG03_KX122_DT_FF" and "KXG08_KX122_DT_FF" – streams use the KX122 sensor for receiving Double Tap and Free Fall interrupts. "KXG03_KX126_DT_FF" is a similar kind of stream for the KX126 sensor.

When double tapping the *Kionix IoT Sensor Node* the corresponding side of the Cube will be shortly high-lighted with a red color.

When performing free fall (e.g. drop *Kionix IoT Sensor Node* to your hand), the Cube will also drop.

NOTE: This functionality is currently tied to the "KXG03_KX122_DT_FF", "KXG03_KX126_DT_FF" and "KXG08_KX122_DT_FF" – device streams.

5.5.3. Air Mouse – Tab



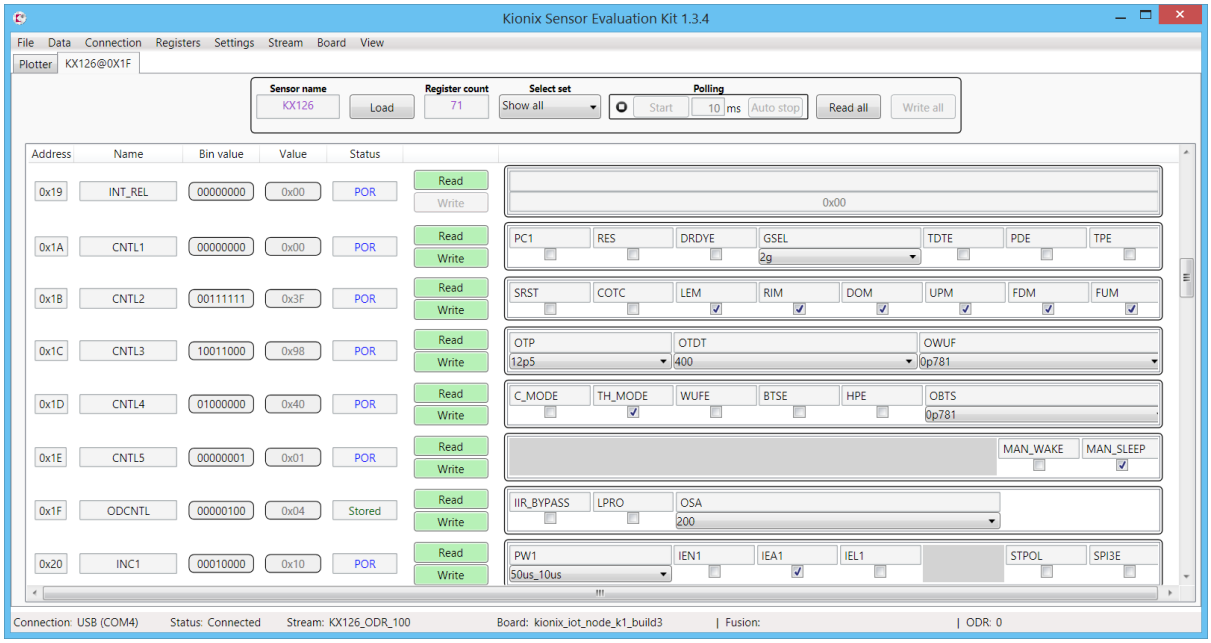
The Air mouse uses sensor fusion for moving the cursor. "Show balls" can be activated to show movement of the x, y and z axis. The Air Mouse can be started by pressing the "`Streaming`" button.

The Air mouse tab is visible only when the used data stream supports sensor fusion. It must include one of these channel combinations:

- Accelerometer + Gyroscope
- Accelerometer + Magnetometer + Gyroscope
- Accelerometer + Magnetometer

Please refer to section 5.8.2 to get the movement operating correctly.

5.5.4. Registers – Tab



The register editor tab can be used for reading and writing device register values. When you have loaded the device register XML file, the tab name will change to <device name>@<SAD>. If the selected device is not supported in the currently connected board, then "NOT FOUND" – text will be displayed instead of the SAD hex address.

When a new device in the register tab is opened, the register's content is **not updated automatically**. Instead, register values can be updated with the "Read All" button or "Read" of individual register.

NOTE: Streaming and logging is automatically paused once the Register editor tab is selected.

NOTE: When register values are changed and you return back to the Cube or Air Mouse, it is possible that changes have been made to the register values that had an effect on data streaming. Please change the data channel to any other channel and then change back to the original channel from the Stream-menu (5.4.5) in order to reset the data streaming register values.

5.5.4.1. Register sets

It is also possible to create application specific register sets. The Register set will view only a subset of sensor registers. This helps in using a particular feature of the sensor. These are example settings related to:

- Changing data streaming related parameters: g-range, ODR, etc.
- The testing of ASIC level functionality: Motion wake-up, double tap detection, etc.

5.5.4.2. Register polling function

Register polling is a simple way to monitor register values when the register editor-tab is active. Polling can be activated with a specific interval (the default interval is 10ms). The polling feature has an "auto stop" – checkbox, which stops the polling to the first register value change. The below example shows how to monitor double tap detection:

- Select sensor KX122 by pressing the "Load" button.
- Select set "Double Tap" from the pull down menu

- Check Double Tap Detection Enabled (TDTE) and Power Control (PC1) from register CNTL1 (0x18) and press write.
- Activate "Auto stop" from "Polling"
- Press the "Start" button from "polling" (optionally change polling interval to 0)

Once double tap has been detected, the updated values are highlighted in red.

NOTE: Streaming and logging are automatically paused when register polling is started.

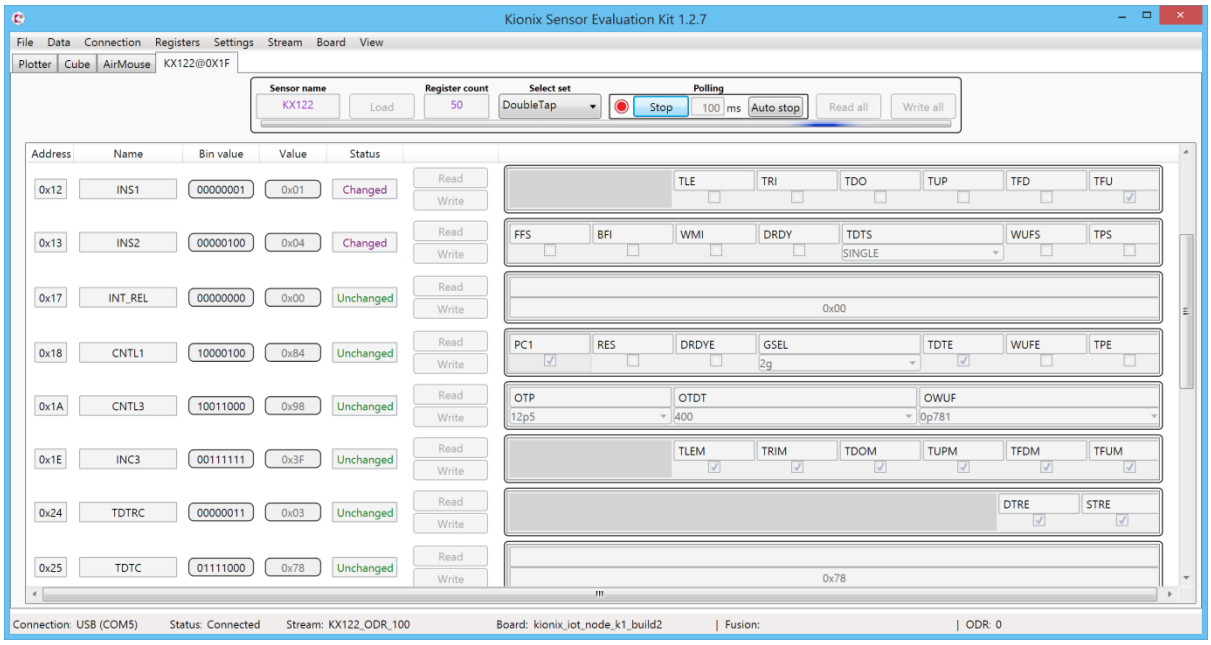


Figure 15: Double tap detection register set.

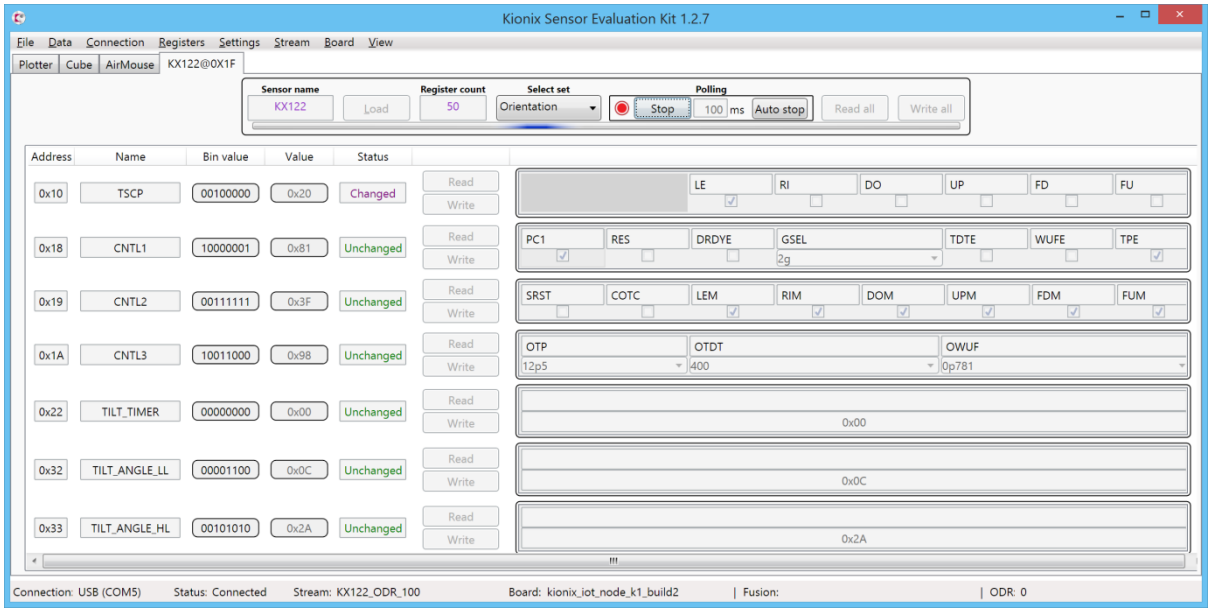


Figure 16: Orientation detection register set.

5.5.4.3. Stream modify mode

When the Register editor tab is selected while Streaming is enabled, the register editor will enter into a data stream modify mode. This mode offers the user a way to change the registers which will have an effect on the data stream itself. When wanted register changes have been made and the user selects the Plotter, Cube or Air Mouse tab, Streaming will be re-enabled with the changed register values. For example this makes it easy to change the ODR or data range.

NOTE:

- Some devices require that the power control bit (PC) is set to 0 before changing the register values. Otherwise register value changes are not applied. After registers are edited, the PC bit must be set back to 1 to enable the device again.
- In order to restore default register values of the data stream, "Streaming" must be disabled and enabled again.
- Many data streams have their own register sets called "Data stream". They contain only registers which are directly linked to the used data stream. Thus, this makes it easier to modify data registers related to data reading.

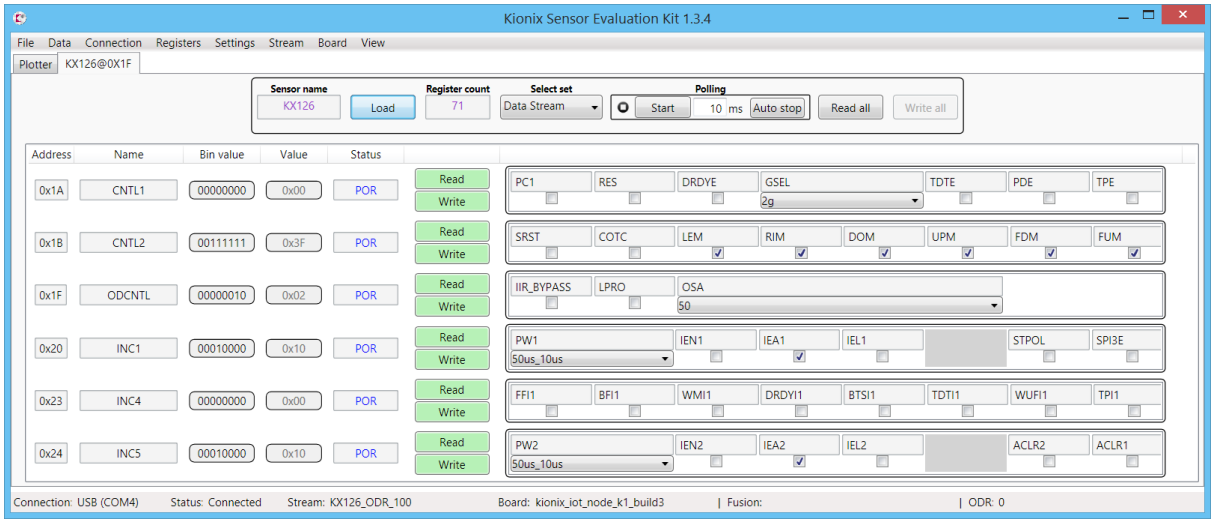


Figure 17: Register editor view.

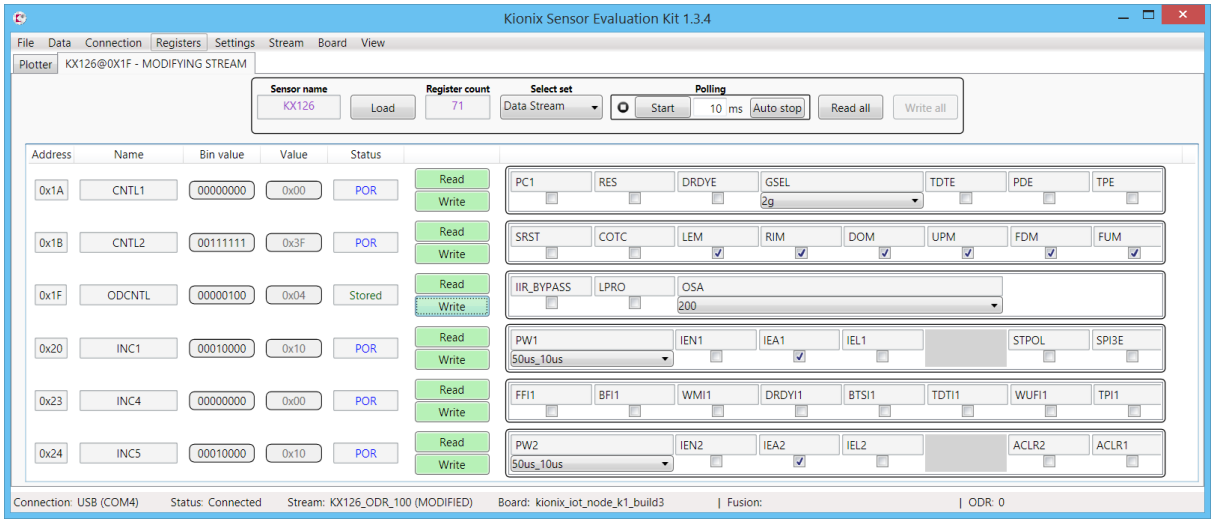


Figure 18: Stream modify mode in the register editor.

When registers have been changed, (MODIFIED) text will be shown after the stream name (Figure 19).

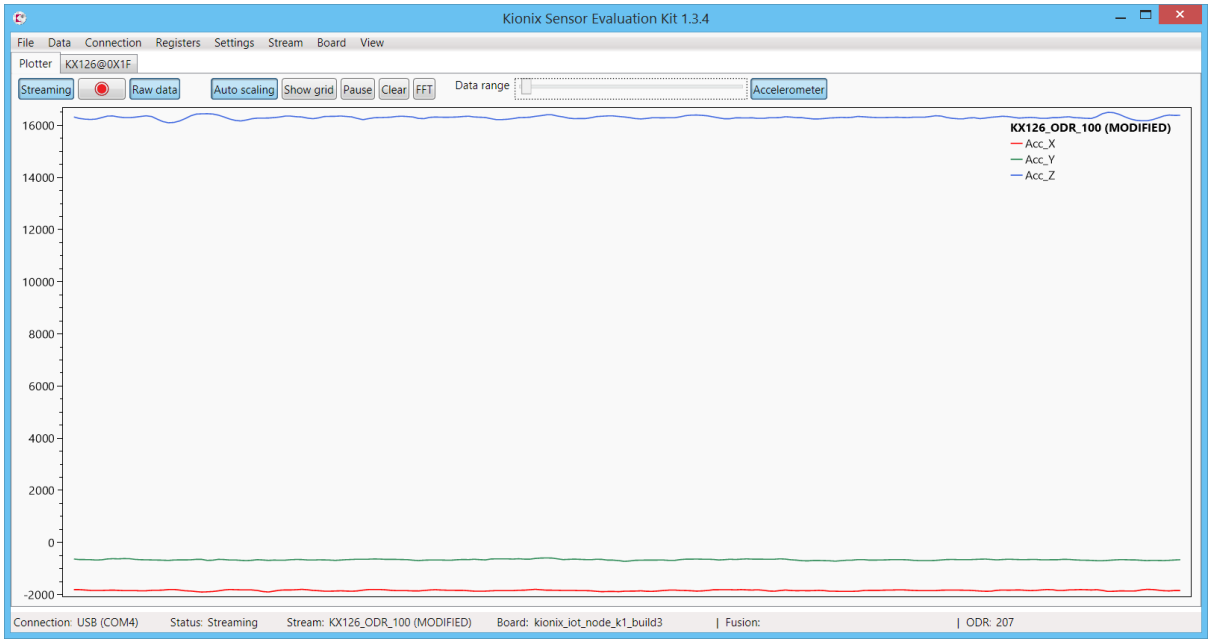


Figure 19: The plotter view after modifying the register values.

5.6. User Interface - Status bar

The status bar shows the current connection and its status. It also keeps the user updated on the selected stream and board configuration, sensor fusion and magnetometer calibration status.

ODR is visible in the right corner. It can be hidden with the "O" – key shortcut if needed.

NOTE: It is normal to see a slight variation in the ODR value. Data is received at varying intervals and the ODR is calculated when *RoKiX Windows GUI* receives the data from the used connection layer.

5.7. User Interface - Pop-up windows

The application makes use of pop-up windows to notify the user about important actions. This section provides detailed information about pop-up windows.

5.7.1. No data pop-up window

"No data received" pop-up is showed when streaming has been started, but no data is received. The problem could be invalid board configuration selection or some connection problem.

5.7.2. Streaming pop-up window

Streaming pop-up window is showed in Cube, Plotter, and Air Mouse to notify the user about data stream enabling. Streaming can be enabled with specific "Streaming" – button, from Data/Streaming – menu or with the shortcut "CTRL + S".

5.7.3. Orientation reset pop-up window

Orientation reset pop-up is showed once per created device connection. It reminds the user to perform device orientation reset in Cube and Air Mouse.

5.7.4. Magnetometer calibration pop-up window

Magnetometer calibration pop-up is showed in Cube and Air Mouse when a channel including magnetometer is used and the calibration status is 0, see section 5.4.5.2 for more details. The calibration is done by performing "8" – like movement with the sensor.

5.8. Orientation reset

5.8.1. Cube reset

5.8.1.1. RokiX Sensor Node

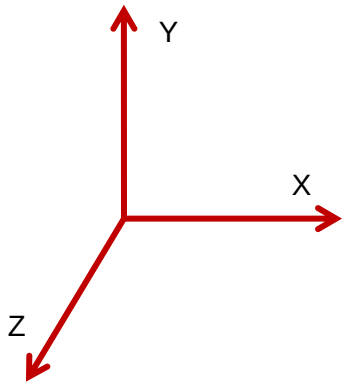
In order to reset the rotating cube position and calibrate it with the position of the *RoKiX Sensor Node*, please follow these steps:

1. Place the *RoKiX Sensor Node* in the position where the USB cable connector is pointing upward and the *RoKiX Sensor Nodes* front side is pointing towards the Cube
2. Press the "Space" – button on your keyboard
3. The Cube is now reset to the *RoKiX Sensor Nodes* position and the *RoKiX Windows GUI* logo is on the front side

5.8.1.2. Kionix IoT Sensor Node

In order to reset the rotating cube position and calibrate it with the position of the *Kionix IoT Sensor Node*, please follow these steps:

1. Place the *Kionix IoT Sensor Node* in the position where USB cable connector is pointing downward and status LEDs points to the right
2. Press the "Space" – button on your keyboard
3. The Cube is now reset to the *Kionix IoT Sensor Nodes* position and the Kionix logo is on the front side

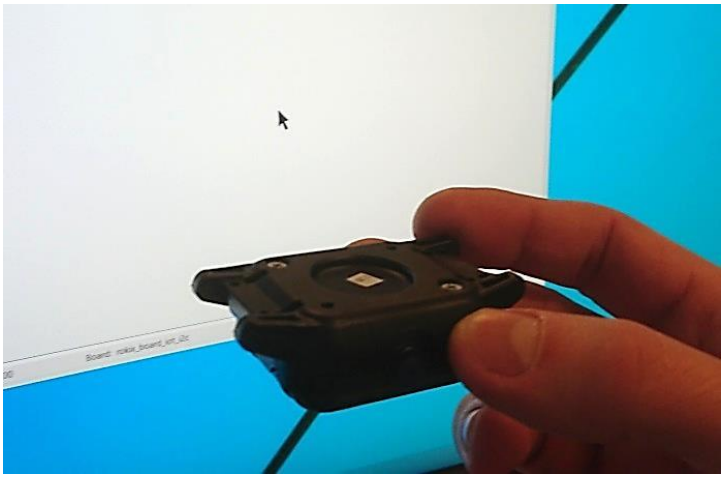


5.8.2. Air Mouse reset

5.8.2.1. RoKiX Sensor Node

In order to reset the Air Mouse position and calibrate it with the position of the *RoKiX Sensor Node*, please follow these steps:

1. Place the *RoKiX Sensor Node* in a position where the USB cable connector points towards the screen, the power button points away from the screen, and the *RoKiX Sensor Nodes* front side is pointed downwards.
2. Press the "Space" – button on your keyboard
3. The Air Mouse is now reset to the *RoKiX Sensor Node*'s position



5.8.2.2. Kionix IoT Sensor Node

In order to reset the Air Mouse position and calibrate it with the position of the *Kionix IoT Sensor Node*, please follow these steps:

1. Place the *Kionix IoT Sensor Node* in a position where the USB cable connector points away from the screen, the power button points towards the screen, and status LEDs point to the right
2. Press the "Space" – button on your keyboard
3. The Air Mouse is now reset to the *Kionix IoT Sensor Nodes* position

5.9. Shortcuts

The *RoKiX Windows GUI* has many keyboard shortcuts:

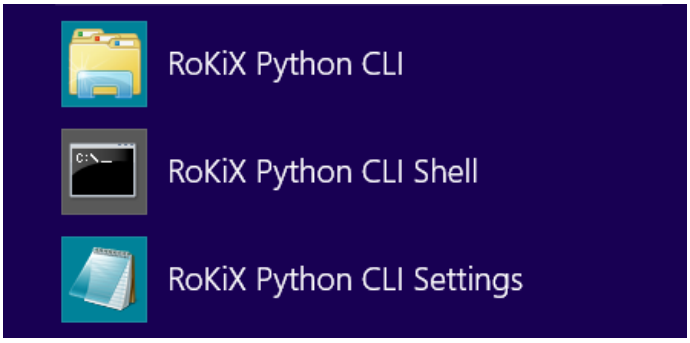
CTRL + F1:	Activate Accelerometer + Gyro sensor fusion mode
CTRL + F2:	Activate Accelerometer + Magnetometer + Gyro sensor fusion mode
CTRL + F3:	Activate Accelerometer + Magnetometer sensor fusion mode
CTRL + L:	Enable/disable logging
CTRL + S:	Enable/disable streaming
ALT + R + L:	Load sensor register XML file
CTRL + R:	Reset used connection and data streaming (disconnect and connect when having connection problem)
CTRL + E:	Show events view
CTRL + V:	Show sub channel view
CTRL + D:	Show digital output in sub channel view
+ C:	Clears the current points in plotter view
+ G:	Shows the grid in the plotter
+ P:	Pause plotter
+ O:	Hide/show ODR in status bar

6. RoKiX Python CLI

The *RoKiX Python CLI* offers versatile access to the device register level functionality. Simple and minimalistic demonstrator applications are provided for testing a variety of device features. These will help to test and evaluate device functionality and provide needed information on how to implement device driver SW.

6.1. Installation for Windows OS

The *RoKiX IoT Platform SW* Windows installer includes the *RoKiX Python CLI* and it will be installed to the following directory: `\Documents\Rohm\RoKiX-Python-CLI.` Additionally, the installer creates start menu items for the *RoKiX Python CLI*:



Section 6.3 describes the installation processes of the necessary Python environment. The following URL will always point to the latest version of the *RoKiX Python CLI*:

https://github.com/RohmSemiconductor/RoKiX-IoT-Platform/releases/latest

6.2. Installation for Linux and OS X

On the Linux system, the latest version of the *RoKiX Python CLI* can be downloaded with the following command:

```
wget https://github.com/RohmSemiconductor/RoKiX-IoT-Platform/releases/latest
```

Currently, Bluetooth usage with the *RoKiX Python CLI* is not supported when running on Apple OS X. Connecting via USB is the default.

See section 6.3 below for installation of the Python environment.

6.3. Python Set Up

A Python interpreter is needed to run the *RoKiX Python CLI*. Currently, Python versions above 3.0 are recommended for use (e.g., 3.7.1). As usual, a separate Python environment is recommended to bring into use, the instructions below will guide you through the required installation procedure.

Windows installation

For your Windows installation, please download the Anaconda distribution of Python:

https://www.anaconda.com/download/

and follow the instructions:

http://docs.anaconda.com/anaconda/install/windows/

After the installation is complete, please create a new virtual environment:

```
conda create –n rokix_env python
```

Take the `rokix_env` environment into use,

```
activate rokix_env
```

With Windows OS; if automatic USB serial port detection is used in the *RoKiX Python CLI* (by default this feature is active in `rokix_settings.cfg`, refer to section 6.4.1), the following modules (dependencies) are also needed:

```
python –m pip install –r requirements_windows.txt
```

To start using the virtual environment do the following:

```
activate rokix_env
cd kx022
python kx022_data_logger.py
```

If the *RoKiX Sensor Node* is used with a USB connection and CDC ACM USB drivers are not already installed, refer to section 4.1.1.

Linux installation

The Python virtual environment is installed as follows:

```
sudo apt-get install python-virtualenv
```

Next, create a virtual environment,

```
virtualenv rokix_env
```

A new virtual environment is activated with the command

```
source rokix_env/bin/activate
```

and the required Python dependencies are installed with

```
python –m pip install –r requirements_linux.txt
```

To start using the virtual environment do the following:

```
source rokix_env/bin/activate
cd kx022
python kx022_data_logger.py
```

On some Linux system's (e.g. Ubuntu 18.04) serial ports may not be accessible for the user by default. If you encounter the problem "`Permission denied: '/dev/ttyACM0'`" while running data loggers, please refer to section 7.4 for details.

If automatic USB serial port detection is not used, the port settings to the `rokix_settings.cfg` file are used as an example:

```
serial_port = /dev/ttyUSB0
```

Ports of the connected devices can be obtained with the following command

```
ls –la /dev/serial/by-id
```

OS X installation

By default Apple OS X is missing the Python package manager "`pip`". It is necessary to install the required python packages. The easiest way to install `pip` is by opening the terminal and using the command

```
sudo easy install pip
```

After `pip` is installed, please follow the instructions on the previous section for Linux install.

6.4. Configuration

The *RoKiX Python CLI* settings are in the `rokix_settings.cfg` file located in the root directory of *RoKiX Python CLI*. The settings file uses windows `.ini` file syntax. Semicolon "`;`" at the beginning of the line indicates a comment.

There are settings for both:

- *RoKiX Python CLI* framework and
- Test applications included in the *RoKiX Python CLI*

6.4.1. Connection to RoKiX IoT Platform HW

The most important framework level setting is configuration. It defines the board configuration which is used. The definition can be found in the section `[board]`.

```
[board]
; Board selection

; RoKiX IoT Board, main board only
;board=rokix_board_rokix_sensor_node_i2c.json
;board=rokix_board_rokix_sensor_node_spi.json

; RoKiX IoT Board, with addon board
board=rokix_board_rokix_sensor_node_i2c_addon.json
;board=rokix_board_rokix_sensor_node_rohm5.json
;board=rokix_board_rokix_sensor_node_spi_addon.json

.
.
.
```

```
; Cypress CY8KIT059 development board with a RoKiX Adapter Board A3.
;board=rokix_board_cy8ckit059_analog_a3.json
;board=rokix_board_cy8ckit059_i2c_a3.json
;board=rokix_board_cy8ckit059_i2c_a3_rohm5.json
;board=rokix_board_cy8ckit059_spi_a3.json

.
.
.
; Other
; 8MHz spi example config
;board=rokix_board_nrf52840dk_example_spi.json

;board=linux

.
.
.
```

Key `bus2` settings defines the connection type for the interface 2. Default is USB.

```
[bus2]
; bus2 selection for board
; NOTE: bus2=USB setting works for both USB_SERIAL and USB_AARDVARK if only one of
those is connected
bus2=USB
;bus2=BLE_PYGATT

;bus2=USB_SERIAL
;bus2=USB_AARDVARK

;bus2=BLE
```

The corresponding COM port can be written in the `rokix_settings.cfg` file:

```
[bus2]
; USB serial COM port number or 'auto' for autodetection
serial_port = COM10
```

The default connection is set to automatic port search:

```
[bus2]
serial_port = auto
```

On Linux the latest connected USB device can also be seen with the command `dmesg`.

When using BLE connection with Windows 8/10 please apply the pairing instructions given in section 4.2.

6.4.2. Generic settings

The [generic] section contains connection independent settings. These include debug logging settings and interrupt related settings.

The debug logging level is defined with the logging_level and the default level is INFO:

```
logging_level = INFO
```

Other alternatives are: DEBUG, INFO, WARNING, ERROR and CRITICAL. Interrupt related configurations are explained in the following sections.

6.4.3. Data Ready operation settings

There are four options for data ready operations.

```
drdy_operation          = ADAPTER_GPIO1_INT
;drdy_operation         = ADAPTER_GPIO2_INT
;drdy_operation         = REG_POLL
;drdy_operation         = TIMER_POLL
```

The default setting used for drdy_operation is ADAPTER_GPIO1_INT. The interval time is defined in drdy_timer_interval and the default value is set to 0.04 s.

When the REG_POLL option is used the data ready bit is monitored from the status register to trigger device data reading. This will introduce more traffic on the bus and thus reduce ODR. This will also verify that all data is read from the device. Physical interrupt lines are not used in this option. Table 9 summarizes the available modes to acquire data with the *RoKiX Python CLI*.

Data ready operations for ASIC level feature events are defined by the following setting:

```
; This setting defines how asic feature event works in applications where the features
is enabled
; REG_POLL / TIMER_POLL / ADAPTER_GPIO1_INT / ADAPTER_GPIO2_INT
other_function_mode = ADAPTER_GPIO2_INT

; if other_function_mode is TIMER_POLL or polling_mode is TRUE, use this value as in-
terval to poll
other_timer_interval = 0.04
```

Mode	**Setting for** `drdy_operation`	**Physical interrupt lines**	**Measurement mode with data ready operation**	**Notes**
Interval read	`INTERVAL_READ`	Connections are not used.	Asynchronous reading	Default mode
Polling	`DRDY_REG_POLL`	Connections are not used.	Synchronous reading	Monitoring the DRDY bit increases traffic in the bus. The slowest mode, checks the DRDY bit.
Interrupt read	`ADAPTER_GPIO1_INT`, `ADAPTER_GPIO2_INT`	Use device's interrupt lines.	Synchronous reading	Needs to configure GPIO numbers. Polls the GPIO line.
Streaming	`ADAPTER_GPIO1_INT`, `ADAPTER_GPIO2_INT`	Use device's interrupt lines, see section **Error! Reference source not found.**.	Synchronous reading	The fastest option and suitable for logging with higher ODRs.

Table 9: Data acquisition modes within the *RoKiX Python CLI*.

6.5. Getting Started

The default configuration is `rokix_board_iot_i2c` with USB connection, e.g. the *RoKiX Sensor Node* is connected to the PC with a USB cable (USB driver installation described in section 4.1.1).

6.6. File structure of the evaluation kit

The overall structure of the *RoKiX Python CLI* is the following:

```
RoKiX-Python-CLI/
LICENSE.txt
plot.py
requirements_linux.txt
requirements_plot.txt
```

```
requirements_windows.txt
rokix_settings.cfg
├───bm1383aglv
├───bm1422gmv
├───cfg
├───kmx62
├───kx_lib
├───kx022
├───kx224
└───license
```

Each device has its own directory containing:

- Register definitions (for example `kx022_registers.py`)
- Reference driver implementation (for example `kx022_driver.py`)
- Test application for reading device data (for example `kx022_data_logger.py`)

`kx_lib` directory contains *RoKiX Python CLI* middleware.

6.7. Running test applications

Test applications are device specific and located in their corresponding folders. For example: data logging application for KX022 is located in `\Documents\Rohm\RoKiX-Python-CLI\kx022` and it is executed with the command:

```
cd kx022
python kx022_data_logger.py --help
```

A command line argument `--help` will show the available options. The output of the application is the following (CTRL+C will stop the application):

```
2018-11-22 15:28:43,665 INFO :  kx_util.py (42) :       <module> :      Configurations read from from ../rokix_settings.cfg.
2018-11-22 15:28:43,729 INFO :  kx_board.py (37) :      __init__ :      Opening board configuration ../cfg/rokix_board_iot_i2c.json
2018-11-22 15:28:43,729 INFO :  kx_board.py (77) :      __init__ :      USB_SERIAL bus2 selected
2018-11-22 15:28:43,743 INFO :  kx_adapter_evk.py (291) :       adapter_connect :       Firmware protocol version 2.0
2018-11-22 15:28:43,759 INFO :  kx_adapter_evk.py (309) :       adapter_connect :       Board hw id 7
2018-11-22 15:28:43,776 INFO :  kx_adapter_evk.py (311) :       adapter_connect :       Device UID F5:EC:F4:3B:53:5E
2018-11-22 15:28:43,790 INFO :  kx_adapter_evk.py (313) :       adapter_connect :       Firmware version 15789979
2018-11-22 15:28:43,822 INFO :  kx022_driver.py (85) :  probe : KX112/KX122/KX123/KX124 found
2018-11-22 15:28:43,822 INFO :  kx_board.py (464) :     add_sensor :    Sensor KX122 found. I2C address 0x1f
2018-11-22 15:28:43,822 INFO :  kx022_data_logger.py (90) :     enable_data_logging :   enable_data_logging start
2018-11-22 15:28:44,338 INFO :  kx022_data_logger.py (200) :    enable_data_logging :   enable_data_logging done
# Log File Format Version = 1.0
# Stream Configuration File = kx022_data_logger.py
# Start time = 2018-11-22 15:28:44:000
# timestamp;    48;     ax;     ay;     az
0.008717;       48;     -159;   6;      -16622
0.010696;       48;     -165;   4;      -16622
0.046531;       48;     -167;   3;      -16622
0.086079;       48;     -168;   0;      -16622
0.125537;       48;     -167;   1;      -16623
0.165081;       48;     -161;   2;      -16623
0.204677;       48;     -162;   -3;     -16625
0.243629;       48;     -167;   -4;     -16624
0.283271;       48;     -163;   -1;     -16621
0.322848;       48;     -159;   -2;     -16613
0.362389;       48;     -157;   -1;     -16612
0.402370;       48;     -155;   4;      -16614
0.441524;       48;     -157;   4;      -16610
0.481299;       48;     -158;   2;      -16610
# End time = 2018-11-22 15:28:44:000
```

Device data can also be directed to a file:

```
python kx022_data_logger.py > kx022.csv
```

6.7.1. Other provided tools

It is possible to view the recorded log with the plot.py application (Figure 20):

```
kx022_kx122>python ..\plot.py kx022.csv
```

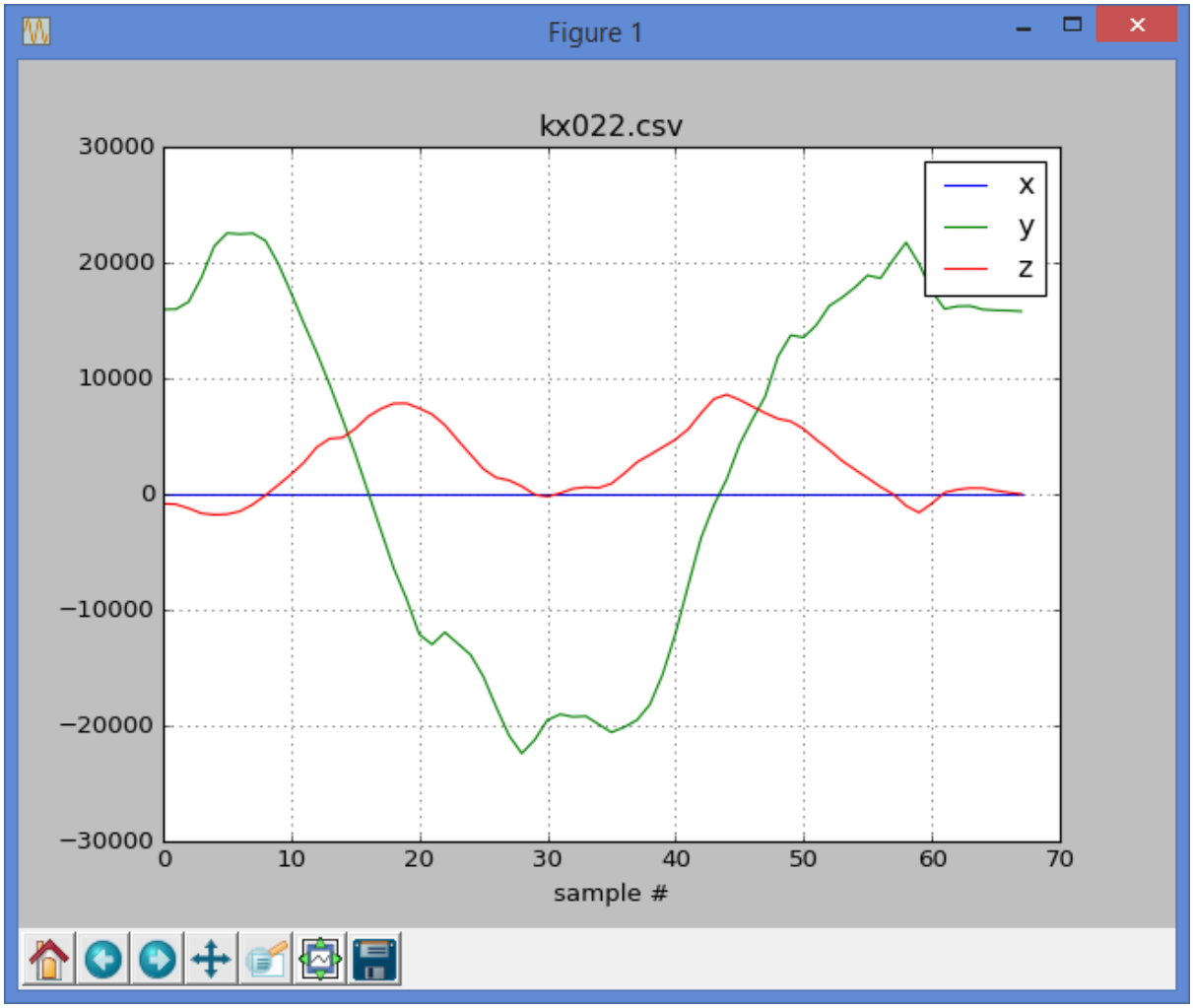


Figure 20: Recorded signals shown by the `plot.py` application.

6.8. Changing test application configuration

Test applications allow the user to modify the most common device configuration alternatives, for example, g-range, filtering and ODR settings (see Figure 21 below). It is recommended that the new configurations are given by the main program calling the test application and then overriding the default settings as required.

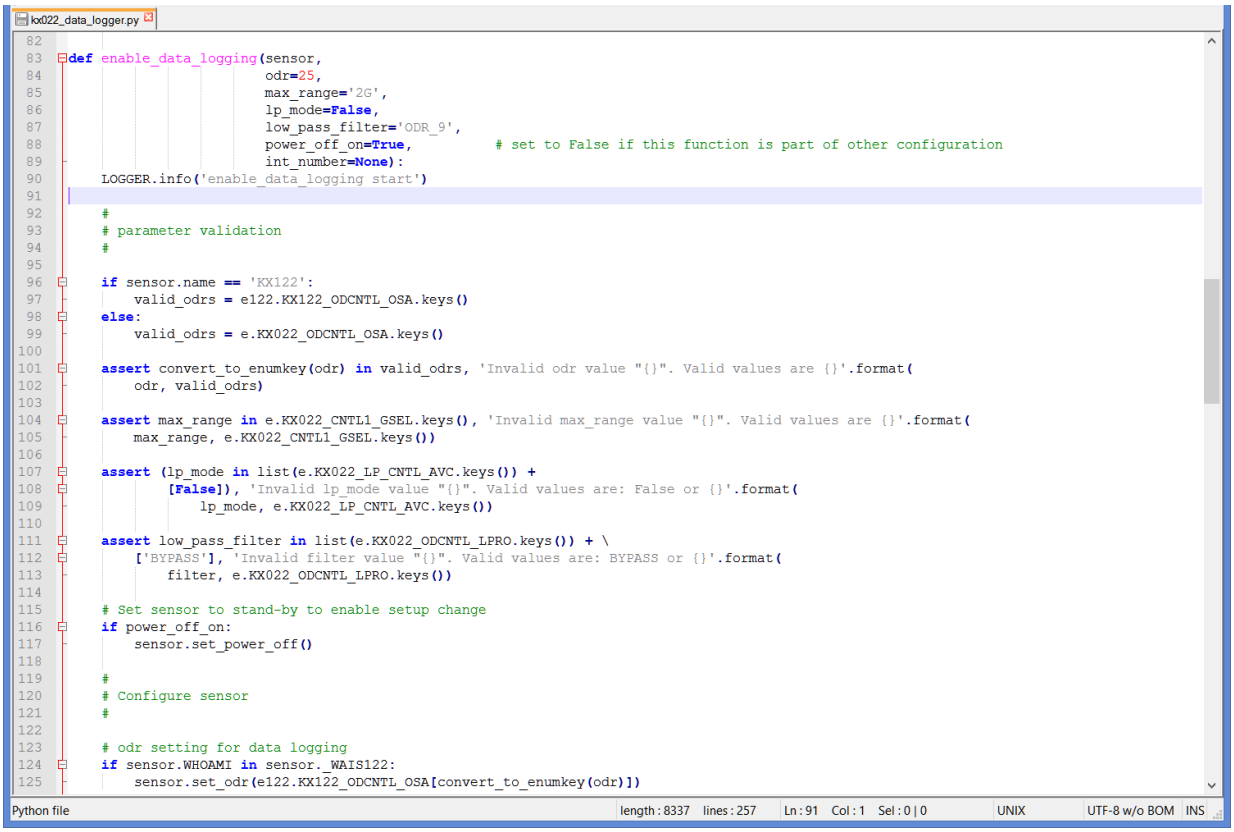


Figure 21: Python code of an example test application.

6.9. Reference driver implementation

The *RoKiX Python CLI* offers platform independent reference device driver software implemented by Python. Since only the device related configurations are in the driver, and the platform specific dependencies are not visible, it gives a good starting point for porting the driver software to a desired target platform (Figure 22).

All drivers follow the same interface defined in `kx_lib\sensor_base.py`

kx022_driver.py

```
22  import struct
23  from . import imports  # pylint: disable=unused-import
24  from kx_lib.kx_configuration_enum import BUS1_I2C, BUS1_SPI
25  from kx_lib.kx_sensor_base import SensorDriver, AxisMapper
26  from kx_lib import kx_logger
27  from kx_lib.kx_util import delay_seconds, bin2uint16, bin2uint8
28  from kx_lib.kx_configuration_enum import CH_ACC, ACTIVE_LOW, ACTIVE_HIGH
29  from kx022 import kx022_registers
30  from kx022 import kx122_registers
31
32  LOGGER = kx_logger.get_logger(__name__)
33  # LOGGER.setLevel(kx_logger.DEBUG)
34
35  r = kx022_registers.registers()
36  b = kx022_registers.bits()
37  m = kx022_registers.masks()
38  e = kx022_registers.enums()
39
40  r122 = kx122_registers.registers()
41  b122 = kx122_registers.bits()
42  m122 = kx122_registers.masks()
43  e122 = kx122_registers.enums()
44
45  # for PC1 start delay (acc) calculation
46  hz = [12.5, 25.0, 50.0, 100.0,
47        200.0, 400.0, 800.0, 1600.0,
48        0.781, 1.563, 3.125, 6.25,
49        3200.0, 6400.0, 12800.0, 25600.0]
50
51
52  class KX022Driver(SensorDriver):
53      _WAIS022 = [b.KX012_WHO_AM_I_WIA_ID,
54                  b.KX022_WHO_AM_I_WIA_ID,
55                  b.KX023_WHO_AM_I_WIA_ID]
56
57      _WAIS122 = [0x2C,  # for KX222
58                  b122.KX112_WHO_AM_I_WIA_ID,
59                  b122.KX122_WHO_AM_I_WIA_ID,
60                  b122.KX123_WHO_AM_I_WIA_ID,
61                  b122.KX124_WHO_AM_I_WIA_ID]
62
63      def __init__(self):
64          SensorDriver.__init__(self)
65          self.i2c_sad_list = [0x1E, 0x1F, 0x1C, 0x1D]
```

Python file | length : 12515 | lines : 299 | Ln : 1 | Col : 1 | Sel : 0 | 0 | UNIX | UTF-8 w/o BOM | INS

Figure 22: Screen capture of an example driver software.

7. Troubleshooting and known issues

7.1. General

- Both with *RoKiX Windows GUI* and *RoKiX Python CLI*, timestamping is done on a PC and it is not accurate with high ODRs. This influences the delta time statistics.

7.2. Communications

- USB communication may miss device data samples or the USB connection is lost randomly: Use good quality USB cables which are USB certified.

- The *RoKiX IoT Platform SW* may not connect to the *Kionix IoT Sensor Node* when USB connection is used and the battery is connected to the *Kionix IoT Sensor Node*: the *Kionix IoT Sensor Node* must be powered on before connecting it to the PC with a USB cable. Otherwise the FTDI IC may get powered on slightly before nRF51822 SoC and thus may not detect nRF51822 SoC properly.

7.3. RoKiX Windows GUI

- When running the application for the first time Windows may inform the user that it is a security risk to run an unknown application. This can be solved by selecting *more info / run anyway*.

- When using Windows BLE, ODR can occasionally be slow. Turning off WLAN usually helps to improve the speed. Windows BLE connection speed is highly dependent on your PC load.

- When using Windows BLE, especially on Windows 10, there can be a pairing problem with the *RoKiX IoT Sensor Node*. As the pairing problem can be seen by the LEDs flashing green and red colors. This problem can be solved just by releasing the pairing and doing it again.

- If an error message shown in Linux installation (section **Error! Reference source not found.**) appears, the Windows .NET installation is not up-to-date. Please run Windows update in order to solve this.

- Sometimes after installation the desktop shortcuts will not work. To overcome this, please uninstall and reinstall the application again to a different destination directory.

- Bluetooth streaming speed (bandwidth) varies widely over many HW/SW configurations. If you encounter issues, please try:
    1. Closing all other programs
    2. Setting the Power profile to High Performance
    3. Plugging the laptop into AC power
    4. Turning Wi-Fi off
    5. Changing the RoKiX Windows GUI window size
    6. Turning off grid lines

- In case of connection problems or application crash, please check the error log file of the *RoKiX Windows GUI*. The default path of this file is: `\Documents\RoKiX\RoKiX-Windows-GUI\errorlog.txt`.

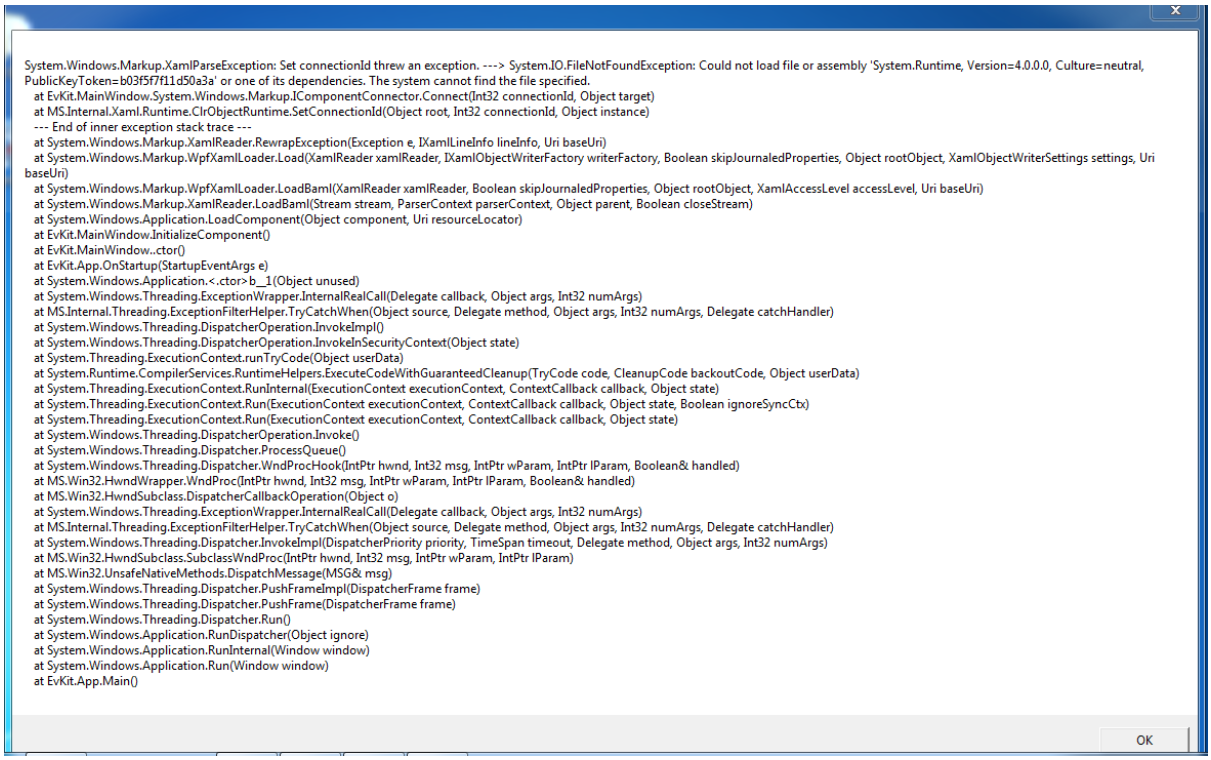


Figure 23: A Windows error message which indicates that Windows .NET installation is out-of-date.

7.4. RoKiX Python CLI

- In case there are issues with the *RoKiX Python CLI* operations, it is possible to change the logging level from default INFO to DEBUG for example.
  `logging_level = ERROR ; DEBUG / INFO / WARNING / ERROR / CRITICAL`

- Additionally, logs can be saved to file by defining a file name for the key `log_file`, which is empty (e.g. no logging to file) by default.

- The *RoKiX Python CLI* verifies that it can capture all interrupts (before starting to monitor interrupt lines it is first verified that interrupt is not yet triggered). If the `logging_level` is set to `WARNING` or higher and interrupt speed (for example ODR) is too high a warning message will be displayed.

- If the driver or lib code have been modified and execution fails to import error, delete all `*.pyc` files.

- When having issues with accessing the serial ports on some Linux systems (e.g. Ubuntu 18.04) do the following: Create a file `/etc/udev/rules.d/50-rohm.rules` with the following content (as an administrator or use '`sudo`'):

```
# Kionix IoT Sensor Node:

ACTION=="add", SUBSYSTEM=="usb", ENV{DEVTYPE}=="usb_device",
ATTRS{idVendor}=="0403", ATTRS{idProduct}=="6015"
ACTION=="add", KERNEL=="ttyUSB[0-9]*", ATTRS{idVendor}=="0403",
ATTRS{idProduct}=="6015", MODE="0666"

# RoKiX Sensor Node:

ACTION=="add", SUBSYSTEM=="usb", ENV{DEVTYPE}=="usb_device",
ATTRS{idVendor}=="04b5", ATTRS{idProduct}=="0602", ENV{ID_MM_DEVICE_IGNORE}="1"
ACTION=="add", KERNEL=="ttyACM[0-9]*", ATTRS{idVendor}=="04b5",
ATTRS{idProduct}=="0602", MODE="0666"

# nRF51-DK:

ACTION=="add", SUBSYSTEM=="usb", ENV{DEVTYPE}=="usb_device",
ATTRS{idVendor}=="1366", ATTRS{idProduct}=="1015", ENV{ID_MM_DEVICE_IGNORE}="1"
ACTION=="add", KERNEL=="ttyACM[0-9]*", ATTRS{idVendor}=="1366",
ATTRS{idProduct}=="1015", MODE="0666"

# CY8CKIT-059:

ACTION=="add", SUBSYSTEM=="usb", ENV{DEVTYPE}=="usb_device",
ATTRS{idVendor}=="04b5", ATTRS{idProduct}=="0601", ENV{ID_MM_DEVICE_IGNORE}="1"
ACTION=="add", KERNEL=="ttyACM[0-9]*", ATTRS{idVendor}=="04b5",
ATTRS{idProduct}=="0601", MODE="0666"
```

  Reload newly created rules:

```
sudo udevadm control --reload-rules
```

8. Appendix 1

Sensor	Interface to sensor HW	Host adapter	Interface to client SW	Client
RoKiX Evaluation board	I2C RoKiX Adapter Board A3	nRF51-DK or Arduino Uno	USB	RoKiX Windows GUI
Rohm sensor module	Rohm Sensor Evaluation Kit 001/002/003			

Table 10: Additional HW configurations with USB interface for the Windows environment

Sensor	Interface to sensor HW	Host adapter	Interface to client SW	Client
RoKiX Evalua-tion board	I2C RoKiX Adapter Board A3	nRF51-DK	BLE	RoKiX Windows GUI
Rohm sensor module	Rohm Sensor Evaluation Kit 001/002/003			

Table 11: Additional HW configurations with BLE interface for the Windows environment

<table>
<tr><th>Sensor</th><th>Interface to sensor HW</th><th>Host adapter</th><th>Interface to client SW</th><th>Client</th></tr>
<tr><td>RoKiX Evaluation Board, Rohm sensor module
or
IoT node add-on board</td><td>I2C SPI

Level shifter board</td><td>Aardvark I2C/SPI host adapter</td><td rowspan="3">USB</td><td rowspan="4">RoKiX Python CLI</td></tr>
<tr><td>RoKiX Evaluation board</td><td>I2C
RoKiX Adapter Board A3</td><td rowspan="2">nRF51-DK

or

Arduino Uno</td></tr>
<tr><td>Rohm sensor module</td><td>Rohm Sensor Evaluation Kit 001/002/003</td></tr>
<tr><td>RoKiX Evaluation Board</td><td>I2C

RoKiX Adapter Board A3</td><td>Raspberry Pi3</td><td>Flat cable</td></tr>
</table>

Table 12: Additional HW configurations with USB or flat cable interface for the Python environment

<table>
<tr><th>Sensor</th><th>Interface to sensor HW</th><th>Host adapter</th><th>Interface to client SW</th><th>Client</th></tr>
<tr><td>RoKiX Evaluation board</td><td>I2C
RoKiX Adapter Board A3</td><td rowspan="2">nRF51-DK</td><td rowspan="2">BLE</td><td rowspan="2">RoKiX Python CLI</td></tr>
<tr><td>Rohm sensor module</td><td>Rohm Sensor Evaluation Kit 001/002/003</td></tr>
</table>

Table 13: Additional HW configurations with BLE interface for the Python environment