AlgoBuilder

Rapid Prototyping with MEMS Sensors and Microcontrollers – Introduction to the ST AlgoBuilder

Thiago Reis & Mauro Scandiuzzo

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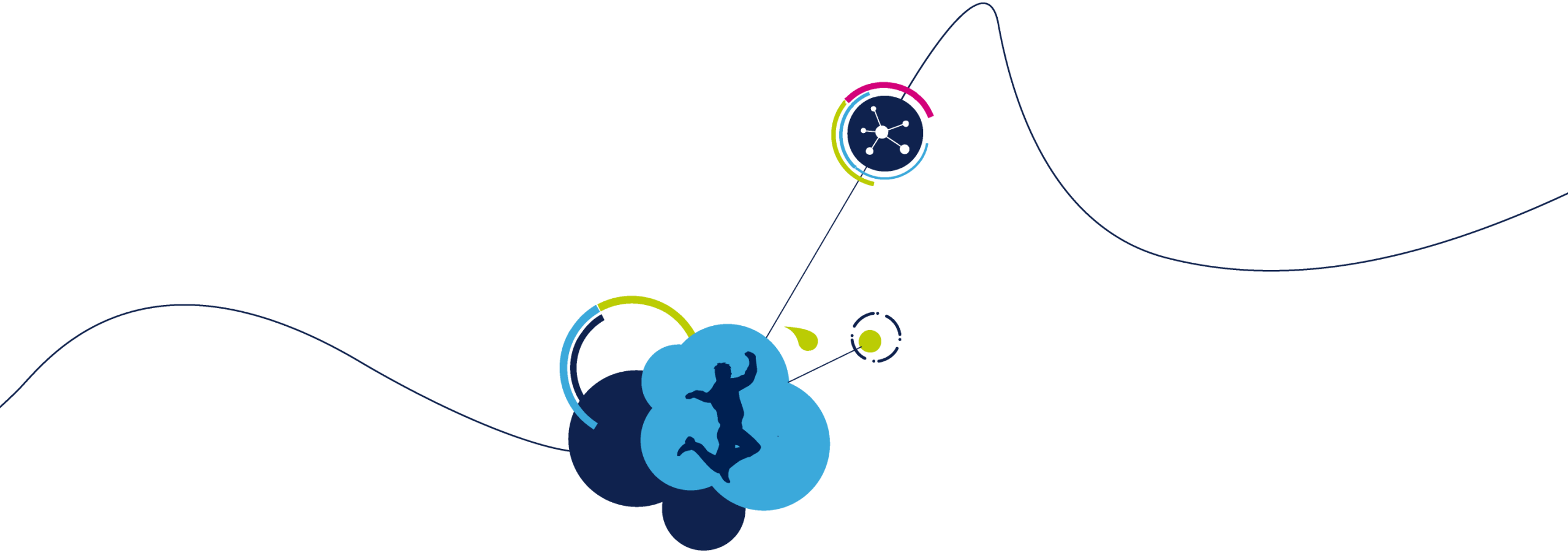
Technology Tour 2019

Dallas-Richardson, TX | March 7

Content



Introduction

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Who Is ST

- A global semiconductor leader
- 2017 revenues of **$8.35B** with year-on-year growth of **19.7%**
- Listed: NYSE, Euronext Paris and Borsa Italiana, Milan

- Approximately **45,500** employees worldwide
- Approximately **7,400** people working in R&D
- **11** manufacturing sites
- Over **80** sales & marketing offices

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As of December 31, 2017

ST: Products & Ecosystem

to Match IoT Market Trends

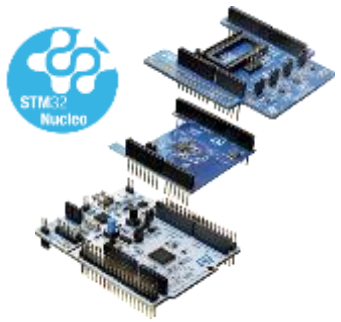
Market Trends

Smart Things	Smart Home	Smart City	Smart Industry
			
Ultra-low power, Form Factor, Sensors Performance…	Wifi, BTLE, sub-GHz, Sensors, Audio, Touch, Graphics…	LTE, Sub-GHz, Motion Sensors	Longevity, Certification, motion sensors…

ST Offering

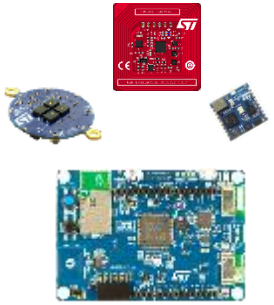
Broad Technology Offer

Ecosystem for application development



STM32 Nucleo development kits

STM32 Nucleo expansion boards for connectivity, sensing, actuating



Starter Kits and Form Factor Boards

STM32 Cube

STM32 Open Development Environment

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Partner Program

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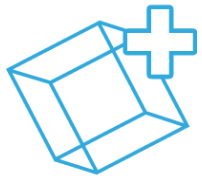
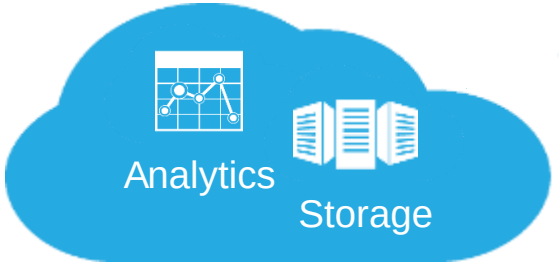
The IoT Trend

Any system able to leverage the Internet and its ecosystem



Nodes
(Billions)

Gateways
(Millions)



Cloud

Smart Things
Applications

20km

10cm

Gateway

Smartphone

Servers
(Big data & cloud)

Network infrastructure
(Switch / Router)

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IoT Devices Come in Many Form Factors

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…but Their Needs are the Same

	Sensing & Actuating	Processing & Security	Connectivity	Signal Conditioning & Protection	Power & Energy Management
Smart Things Smart Home Smart City Smart Industry	Full range of sensors and actuators	Ultra-Low Power to High Performance Scalable Security solutions	10 cm to 10 km	Nano Amps to Kilo Amps	Nano Watt to Mega Watt

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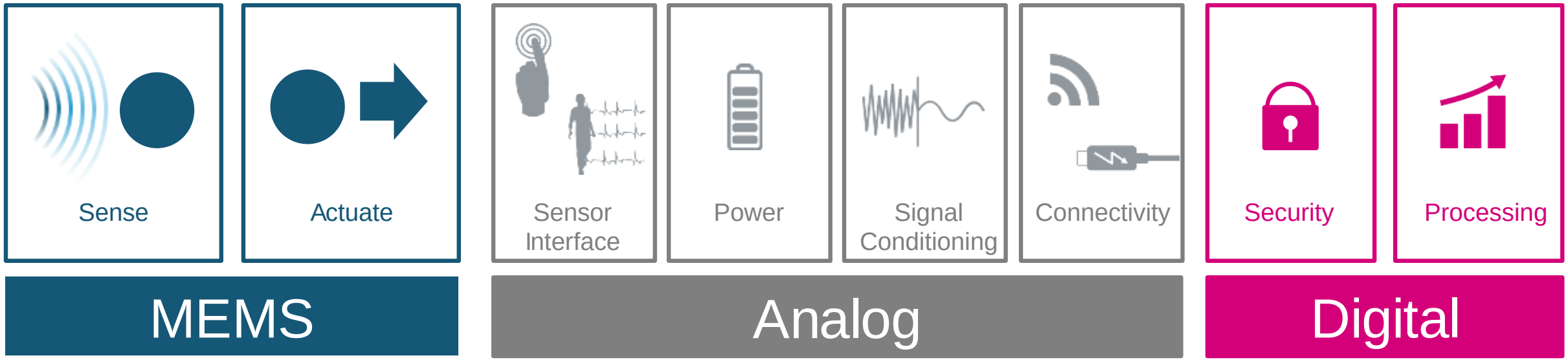
MEMS and Analog Empower the IoT



Today only a tiny portion of the sensory data that would be useful is captured, stored and analyzed

…and even smaller part of that is used to carry out actions through actuators

Supporting the IoT Movement

Connect

Translate

Move
Actuate

Power

Secure

Process

Sense

SensorTile

BlueCoin

SmarTAG

Discovery Kit IoT Node

STM32 Nucleo Development
& Expansion boards

Pre-integrated SW for vertical applications

Smart Things

Smart Home

Smart City

Smart Industry

Development Ecosystem

Code generators

Prototyping software

IDE

Development environments

Debug solutions

Simulation and analysis tools

On-line design tools

ST Community

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Partner Program

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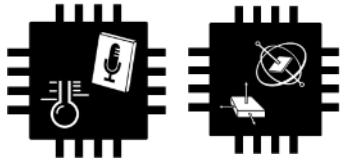
ST as Sensors & Actuators Supplier

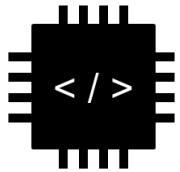
Market-proven Manufacturing Technologies

Front-End / Back-End/ Testing & Calibration

High Volume Manufacturing



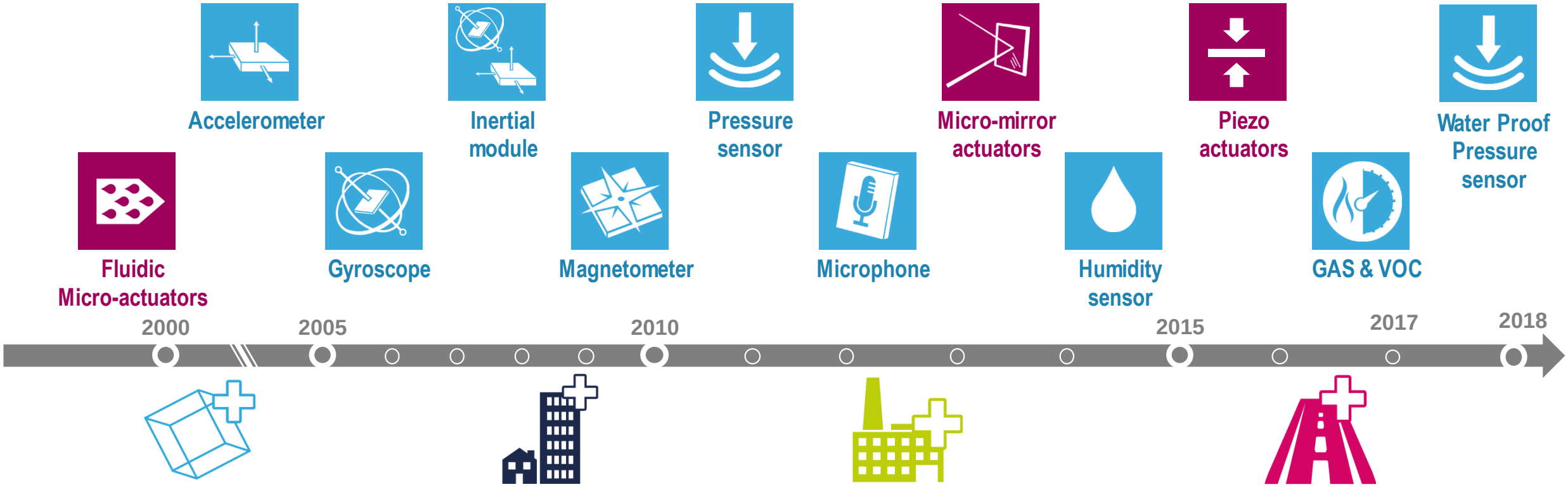
Expertise in multi-sensor Integration



Leading Smart Functions Integration

Key Partnerships in product development

20 Years of MEMS at ST



Smart Industry

Advanced Industrial Sensors

10-Year Product Longevity


Industrial


Appliances


Building automation


Medical


Defense


Navigation

ST Longevity Program Benefits

- 10-YEAR LONGEVITY FROM PRODUCT INTRODUCTION DATE
- DESIGN AND MANUFACTURING FOR HIGHER ROBUSTNESS & PERFORMANCES
- CALIBRATION & TESTING FOR HIGHER ACCURACY & QUALITY
- EXTENDED TEMPERATURE RANGE AND ENDURANCE TO SHOCK AND VIBRATION

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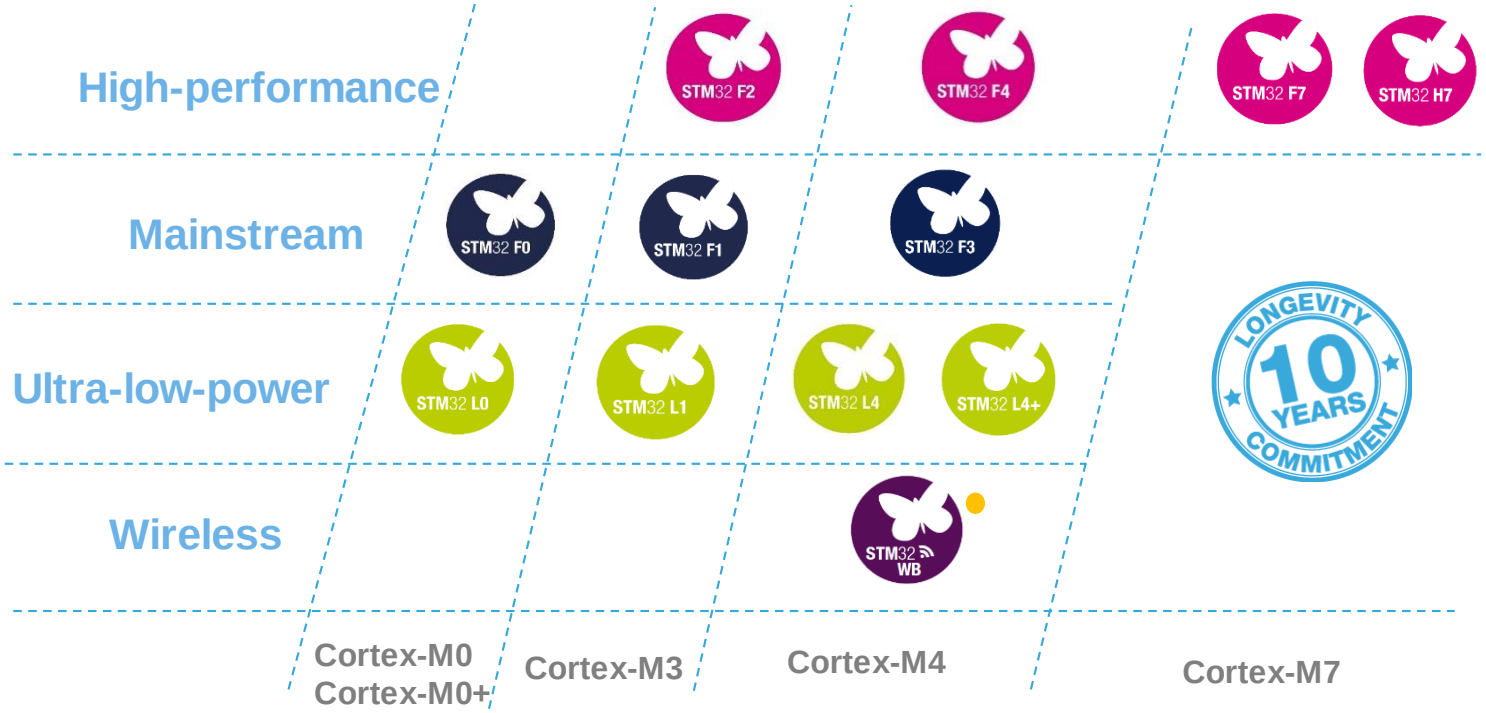
STM32 portfolio positioning

12 product series / More than 800 Parts



More than
40,000 customers

Note ●: Cortex-M0+ Radio Co-processor

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Supporting the IoT Movement

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Translate

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Actuate

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Secure

Process

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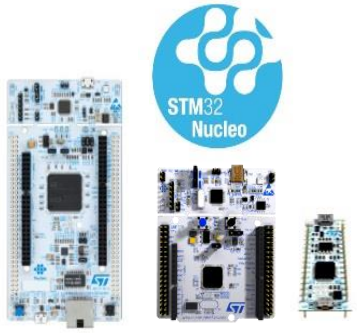
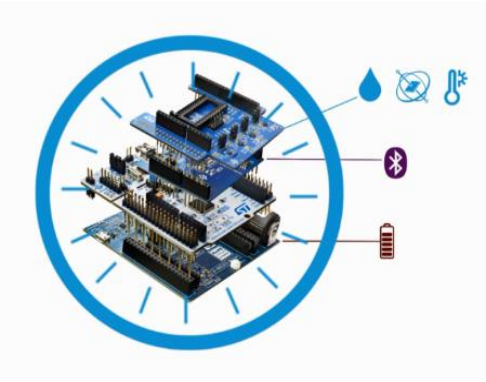
HW Development Tools

Development Tools adapted to your needs





STM32 Nucleo	Discovery kits	Evaluation boards	STM32 Nucleo expansion	Third-party boards
Flexible prototyping	Key feature prototyping	Full feature evaluation	Functionality add-on	From full evaluation to open hardware
www.st.com/stm32nucleo	www.st.com/stm32discovery	www.st.com/stm32evaltools	www.st.com/x-nucleo	

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An Application-Oriented Approach

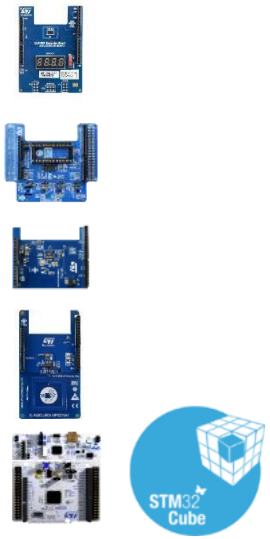
Your need

- Sensors
- Connectivity
- Translate
- Motor drivers
- Power
- Processing

The building blocks

Processor boards (Nucleo 64)
Expansion boards (X-NUCLEO)

- Motion
- Environmental
- Bluetooth LE
- Sub-1GHz
- NFC
- Op Amp
- Motor controller
- Power manager
- Microcontroller



STM32 Cube

Our answer

Function Packs (FP)

Application software and development tools

Integrated Development Environment and middleware

Ready-to-use application-oriented package

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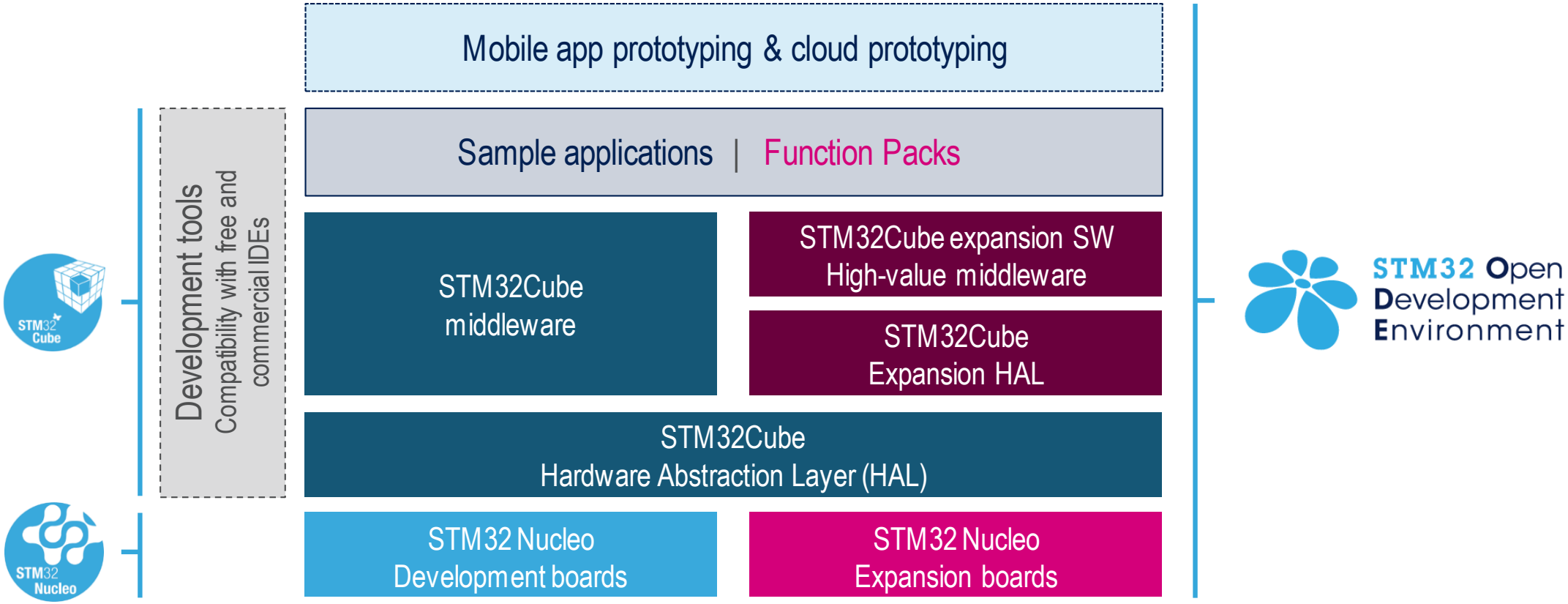
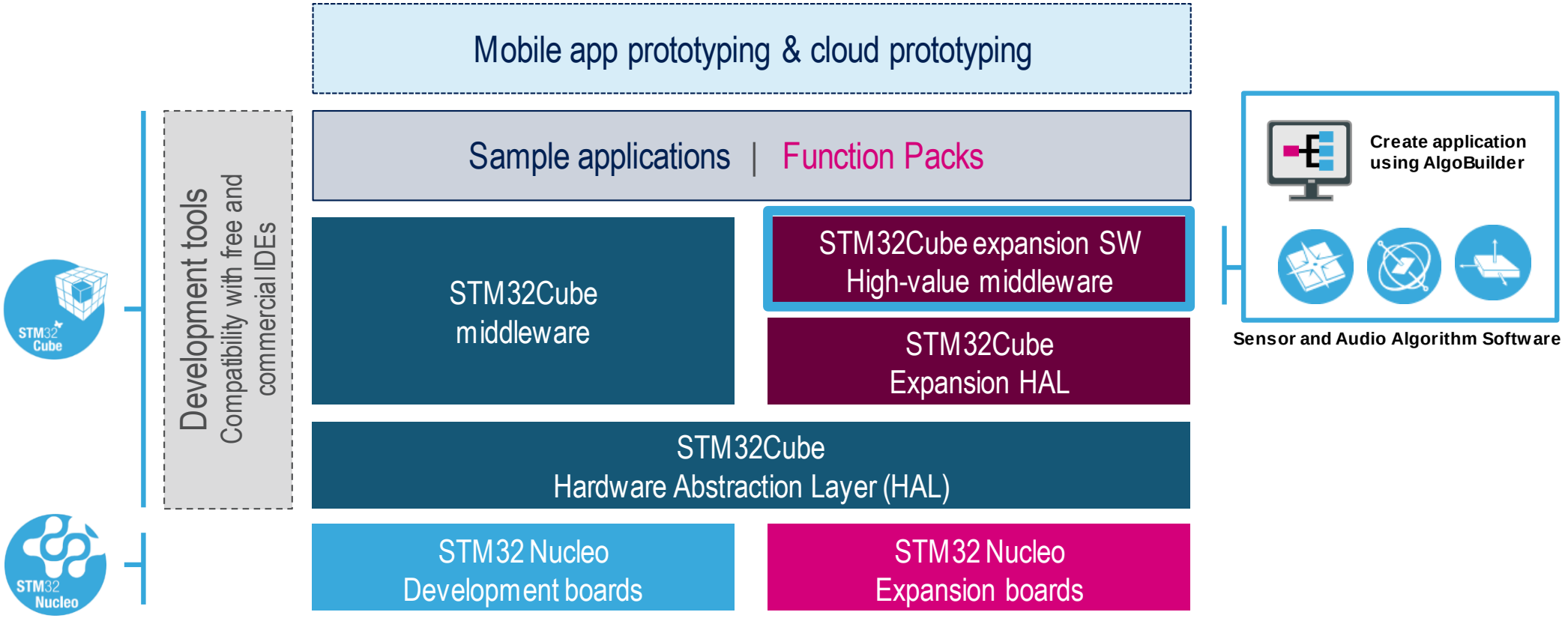
Development Software Architecture

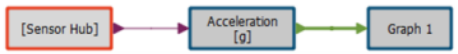


Development Software Architecture

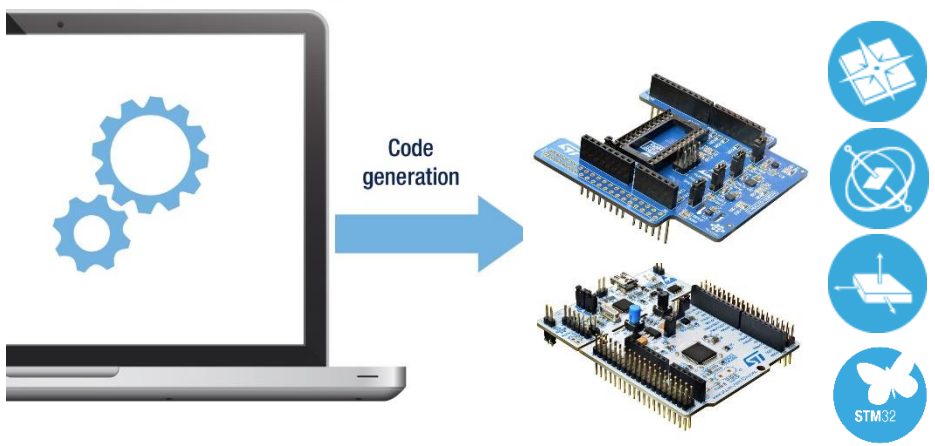


AlgoBuilder

An application for the graphical design and testing of algorithms



Existing algorithms
User-defined data processing blocks
Additional functionalities



GUI quickly elaborates proto applications
for
MEMS sensors
and
STM32 microcontrollers

AlgoBuilder
eases the process of
implementing
proof of concept
without writing the code

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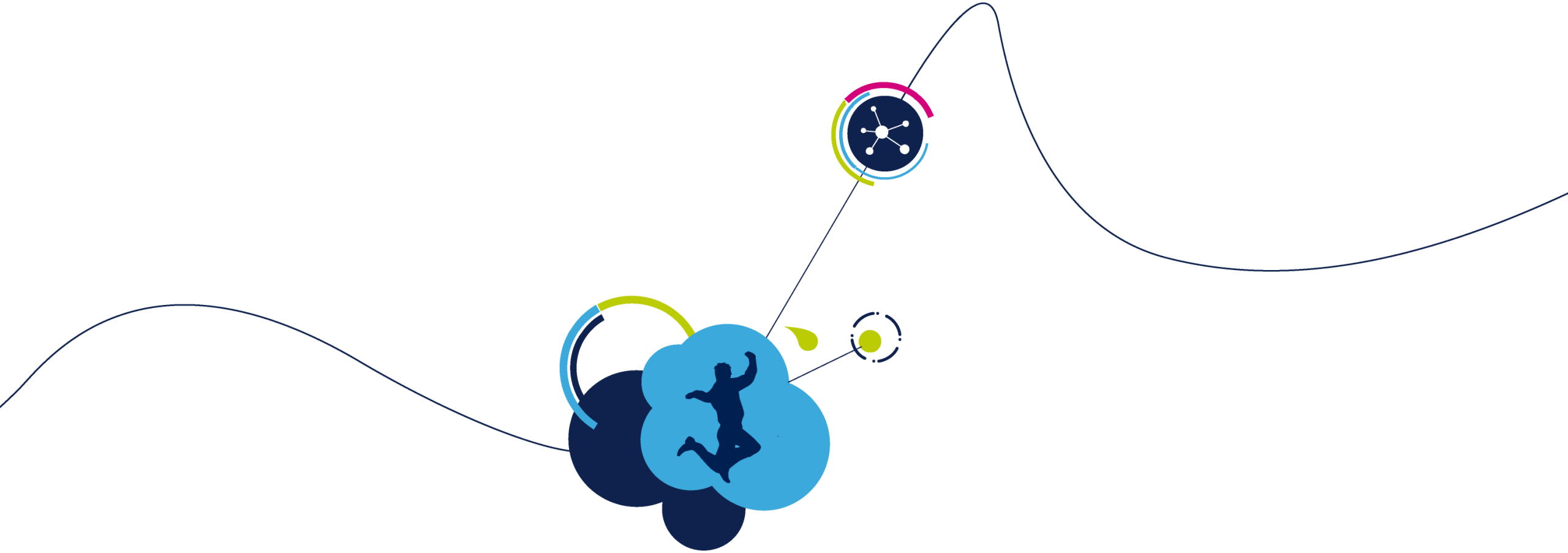

AlgoBuilder Overview

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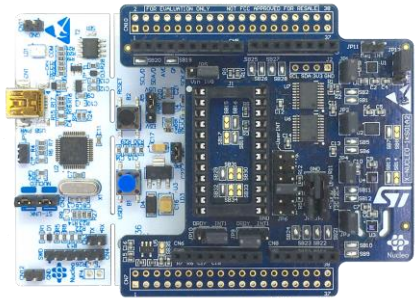
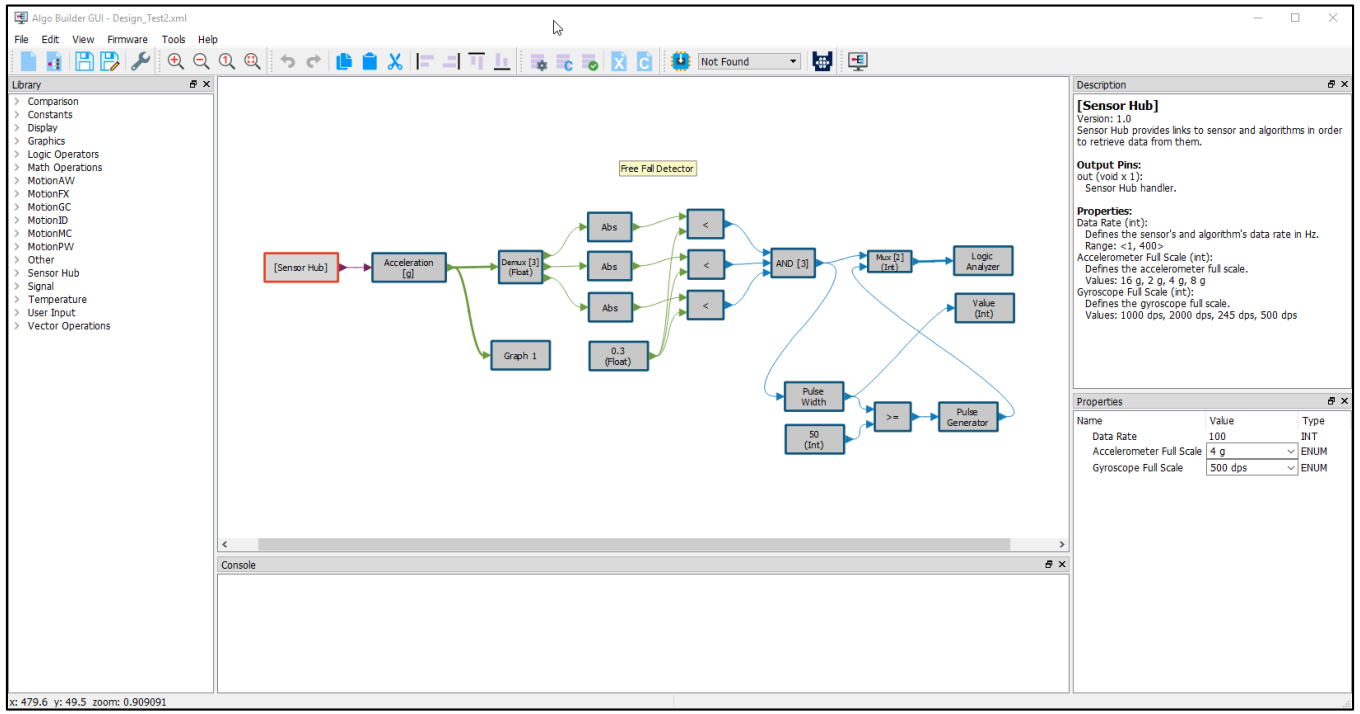
AlgoBuilder

Overview

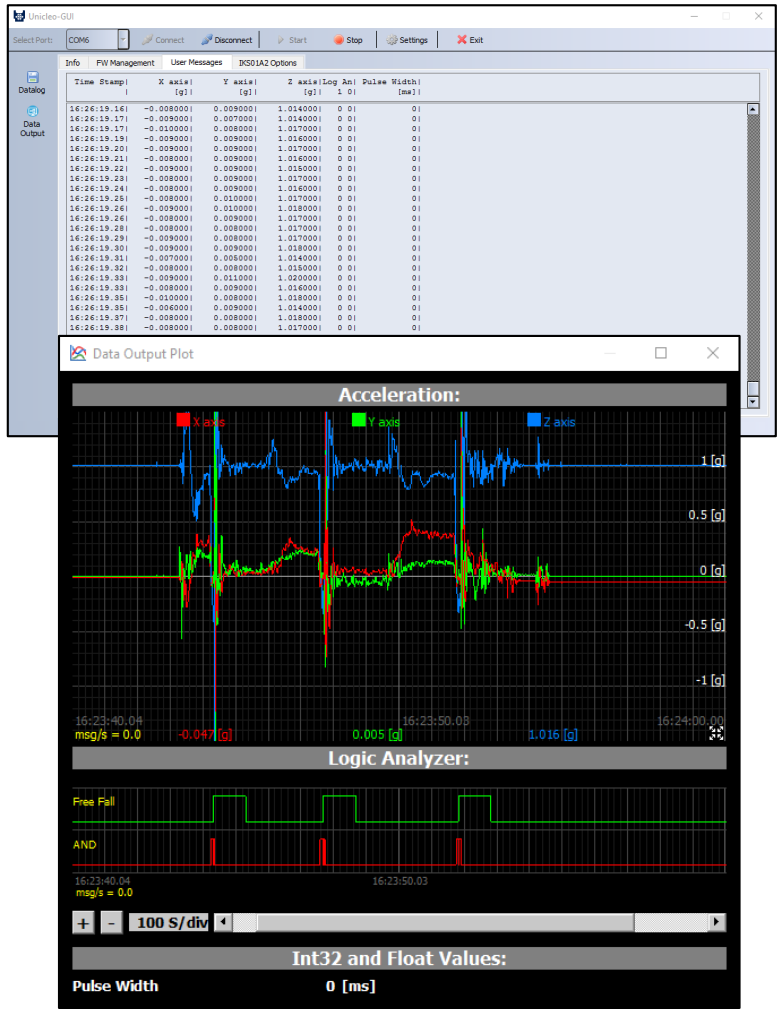


DEVELOPMENT BOARD

IDEA



GRAPHIC DESIGN



RESULT

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AlgoBuilder

Overview

AlgoBuilder is an application for the graphical design of algorithms.

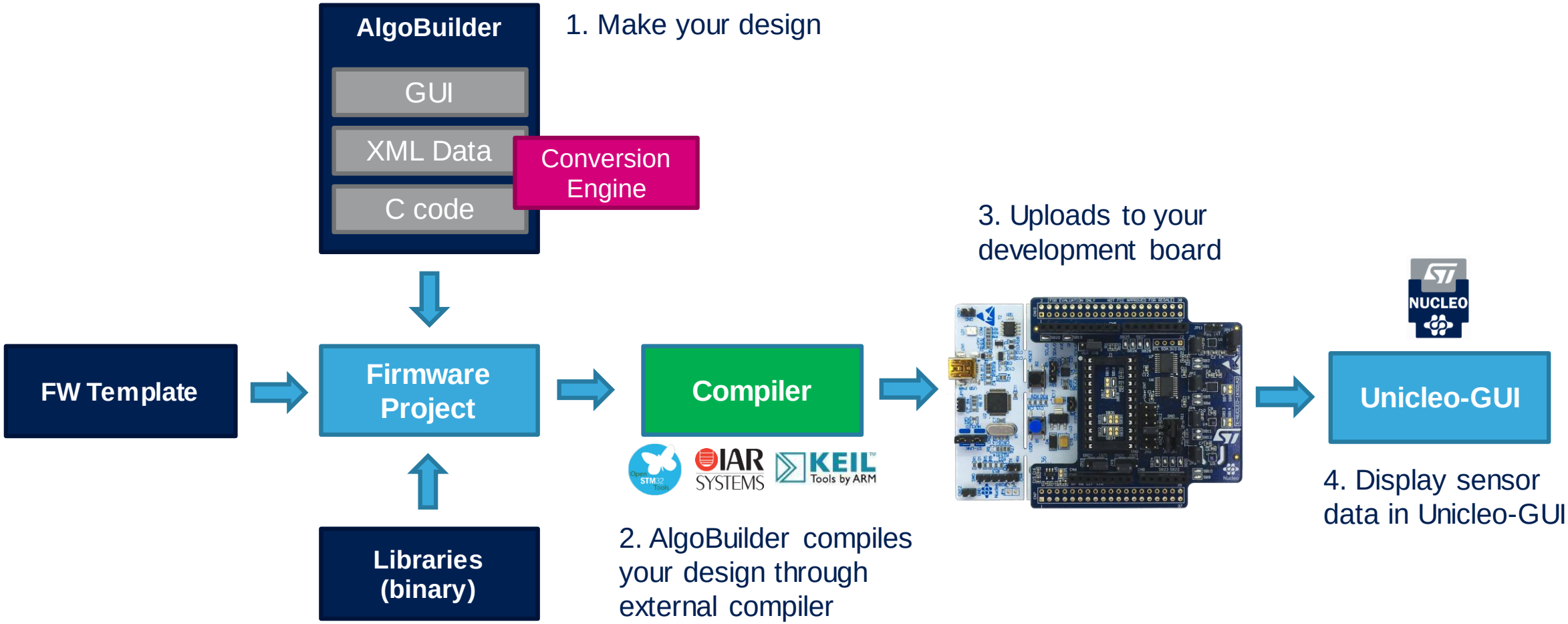
The main objectives of this application are:

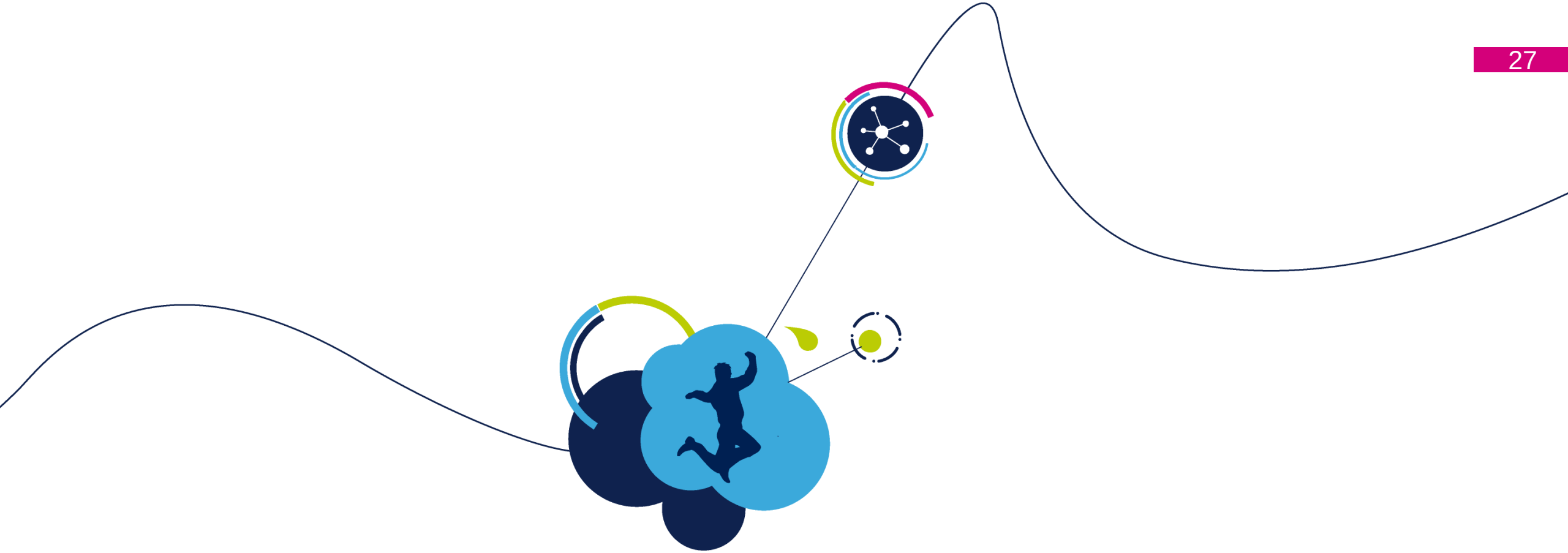
- Quick prototyping of applications for STM32 microcontrollers and MEMS sensors which include already existing algorithms (i.e. sensor fusion or pedometer), user-defined data processing blocks and additional functionalities.
- Ease the process of implementing proof of concept using graphical interface without writing the code.
- Visualize the data on Unicleo-GUI in real time using plot and display.

- **The main feature of this application:**
  - Simple graphical design (drag and drop, connect, set properties)
  - A wide range of function blocks are available in libraries including motion sensor algorithms.
  - Customize function blocks. Open XML for function blocks and design storage.
  - C code generated from the graphical design.
  - Support for various compilers: SW4STM32 (GCC), IAR EWARM, Keil uVision.
  - Outputs from generated firmware can be displayed in Unicleo-GUI application.

AlgoBuilder

Principle





Environment Setup

Prerequisites: Software

- AlgoBuilder: Application for the graphical design of algorithms
- Unicleo-GUI

  The Unicleo-GUI is used to display outputs from the running FW generated by the AlgoBuilder
- STM32 ST-LINK utility
- STM32 Virtual COM Port Driver

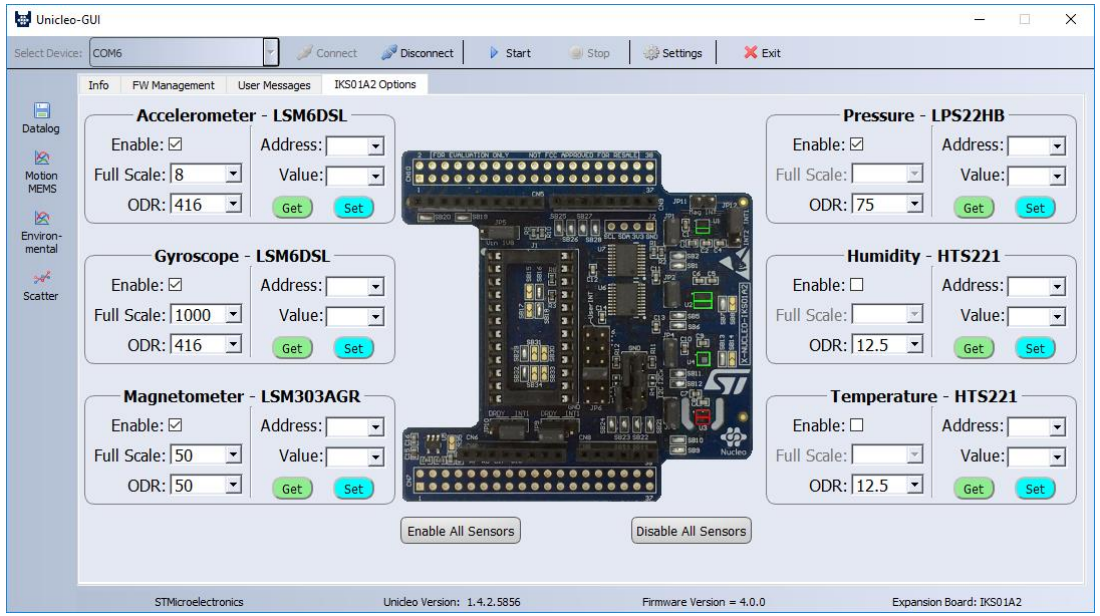
- AlgoBuilder uses external compiler to build the FW.

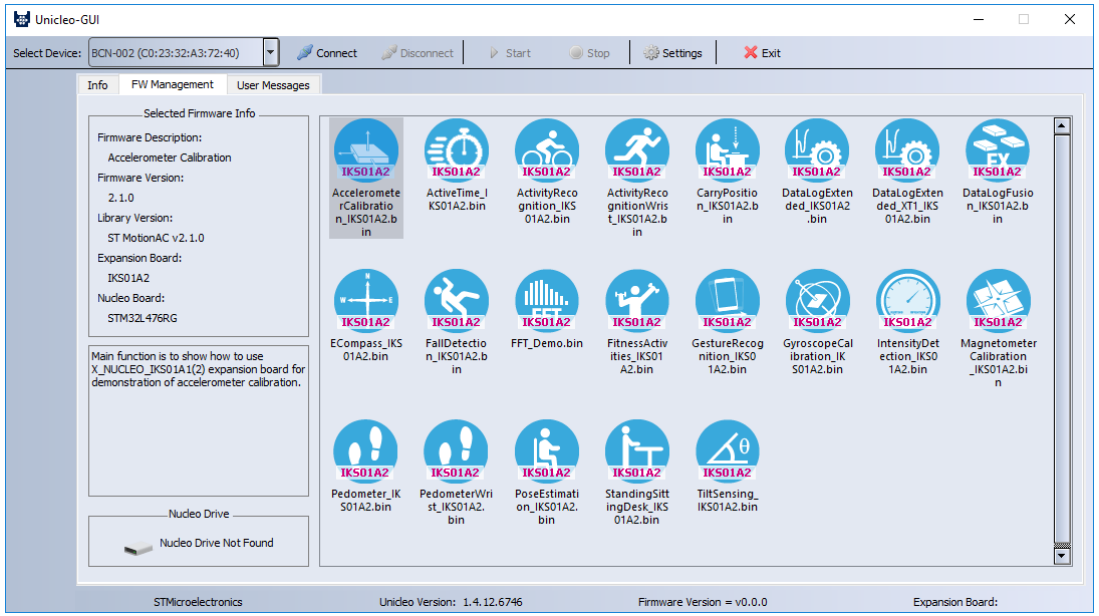
  It is mandatory to have available at least one of the IDE if you want to compile a project.
- Supported IDEs
  - System Workbench for STM32 v1.13.1 or newer
  - IAR EWARM 7.80.4 or newer
  - Keil uVision 5.22 or never

Unicleo-GUI
X-CUBE-MEMS1

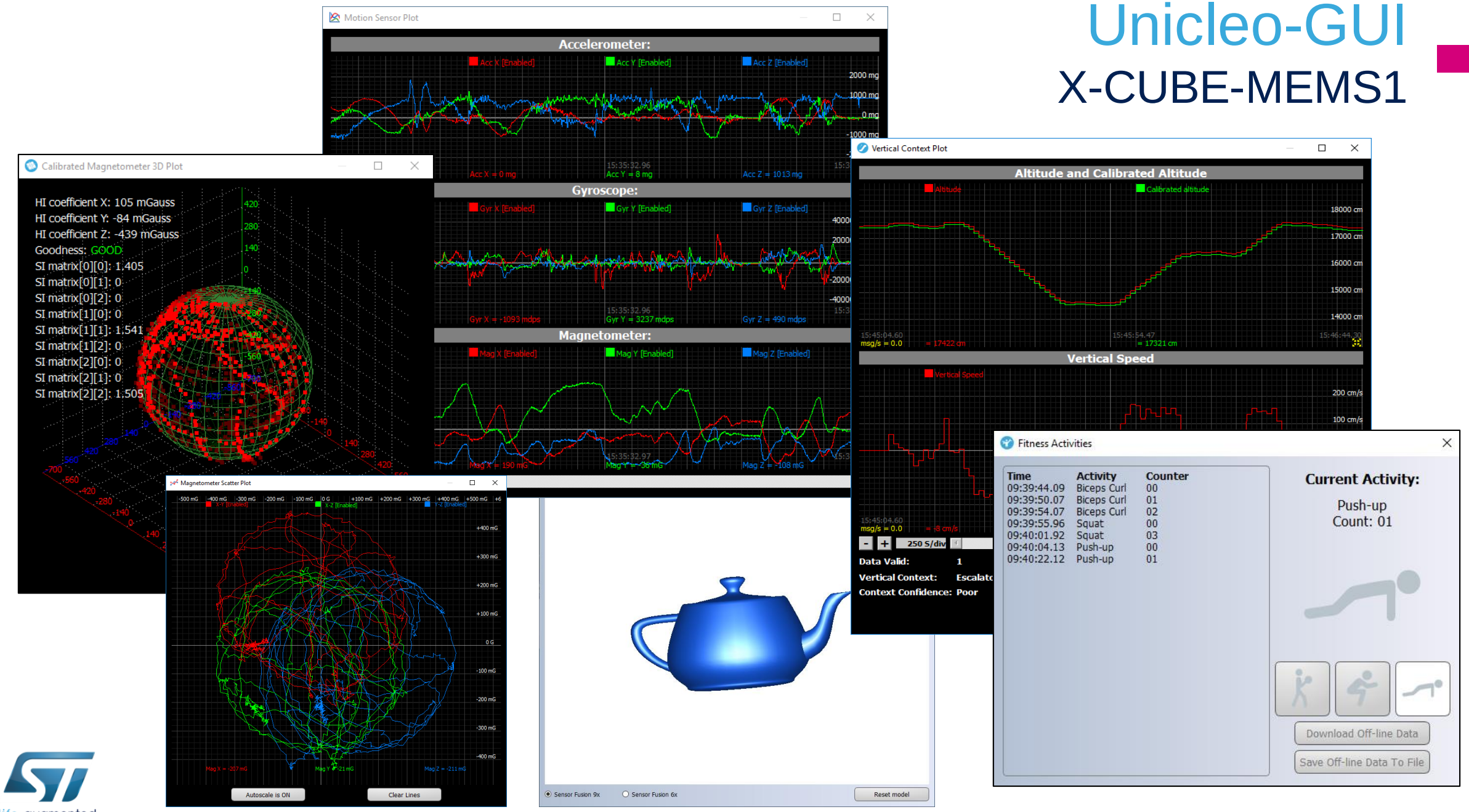
Key features:

- Display output data from connected sensors in various views (**X-NUCLEO-IKS01A1**, **X-NUCLEO-IKS01A2**)
- Display outputs from algorithms
- Save data to comma separated (CSV) or tab separated (TSV) files
- Configure sensor output data rate and full scale
- Direct read from and writes to sensor registers
- Program NUCLEO board with selected FW





Unicleo-GUI
X-CUBE-MEMS1



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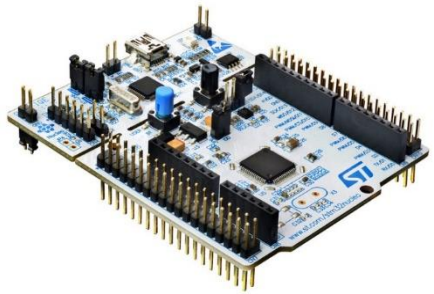
Prerequisites: Hardware

Nucleo Development & Expansion Boards

- NUCLEO-F401RE or NUCLEO-L476RG
- X-NUCLEO-IKS01A2: Motion MEMS and environmental sensor expansion board for STM32 Nucleo



Sensor Tile

- The development kit simplifies prototyping, evaluation and development of innovative solutions.

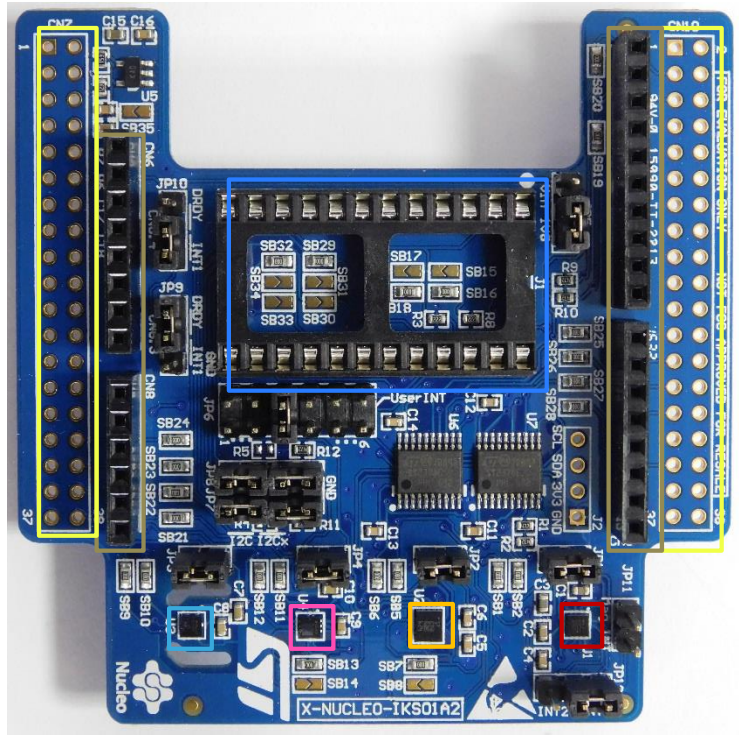
Motion MEMS and environmental sensor expansion board

X-NUCLEO-IKS01A2 Hardware Description

- The X-NUCLEO-IKS01A2 is a motion MEMS and environmental sensor evaluation board system.
- It is compatible with the Arduino UNO R3 connector layout, and is designed around ST's latest sensors.

Key Product on board

LSM6DSL
MEMS 3D accelerometer (±2/±4/±8/±16 g) + 3D gyroscope (±125/±245/±500/±1000/±2000 dps)
LSM303AGR
MEMS 3D magnetometer (±50 gauss) + MEMS 3D accelerometer (±2/±4/±8/±16 g)
LPS22HB
MEMS pressure sensor, 260-1260 hPa absolute digital output barometer
HTS221
Capacitive digital relative humidity and temperature DIL 24-pin
Socket available for additional MEMS adapters and other sensors (UV index)



Latest info available at www.st.com
X-NUCLEO-IKS01A2

** Connector for the STM32 Nucleo Board

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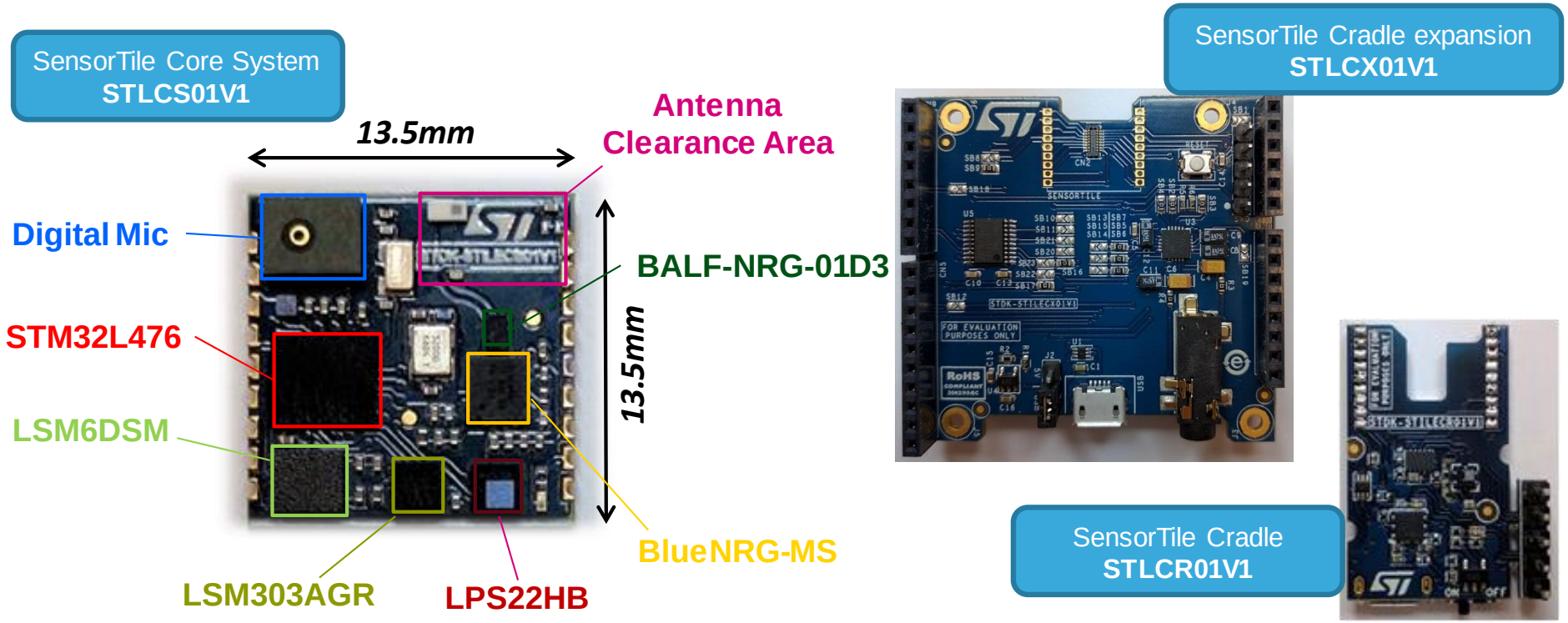
SensorTile Platform

STEVAL-STLKT01V1 Hardware Description

- STEVAL-STLKT01V1 is the development kit for the SensorTile board (STLCS01V1), a highly Integrated Development Platform with a broad range of functionalities aiming to improve system design cycle and accelerate delivery of results



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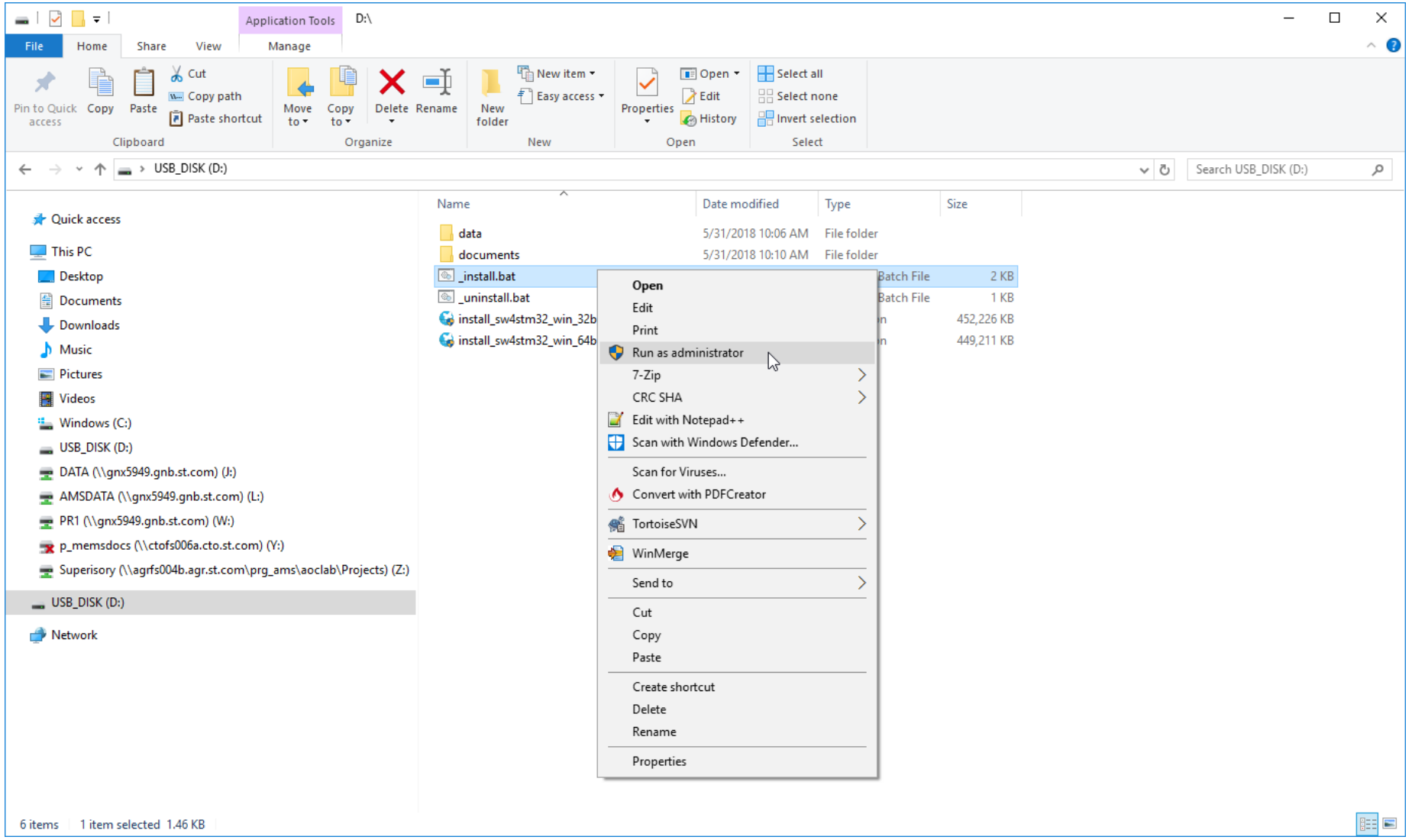
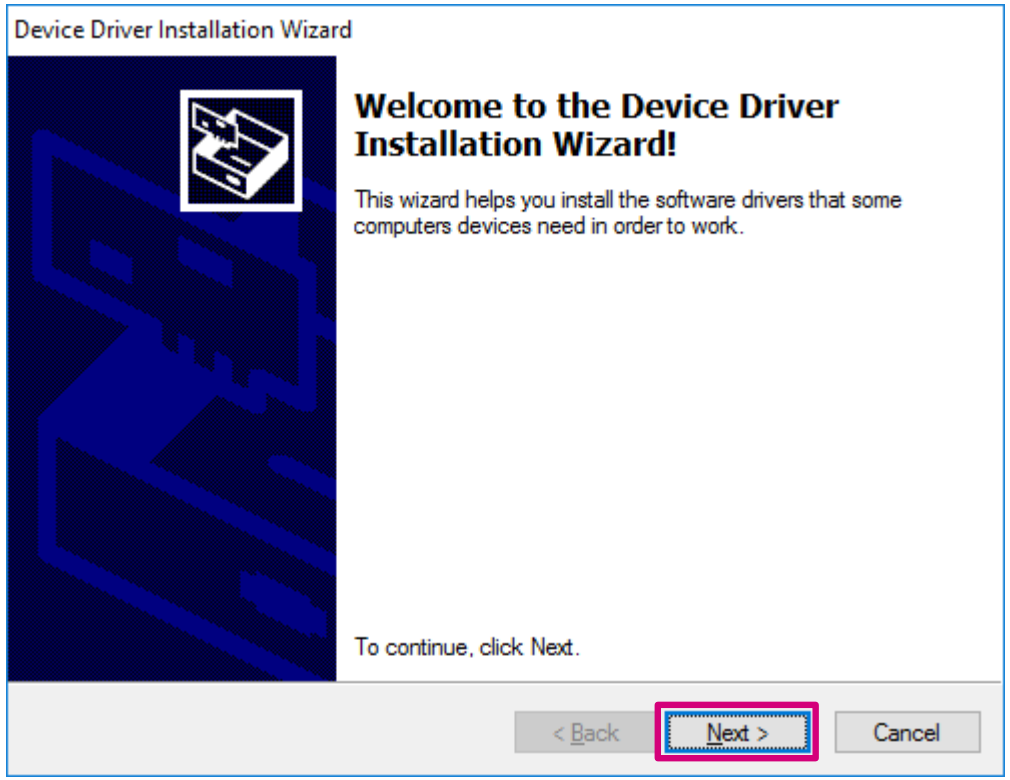
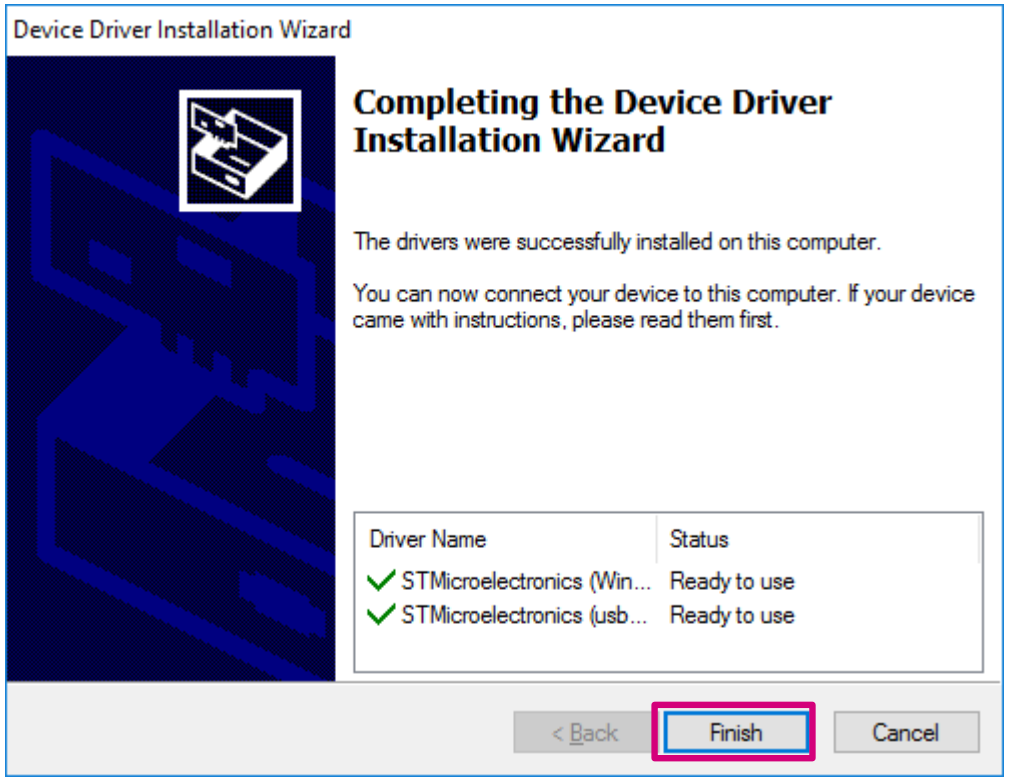
1. Run _install.bat as administrator.



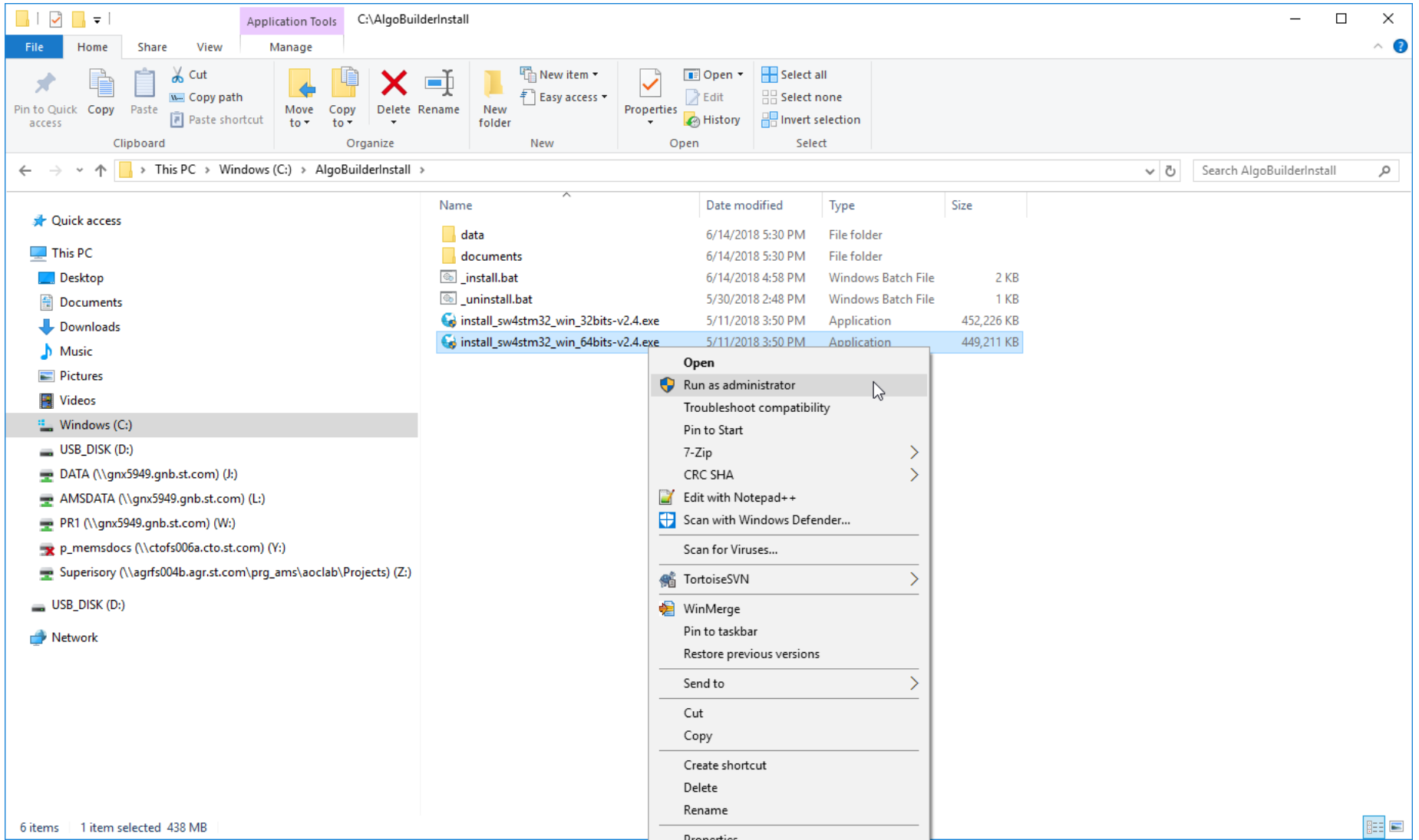
2. Confirm Device Drivers installation.





This will install ST-Link and Virtual Com Port Drivers.

3. Remove USB and open C:/AlgoBuilderInstall/ folder.
Run install_sw4stm32_win_64bits-v2.4.exe as administrator.



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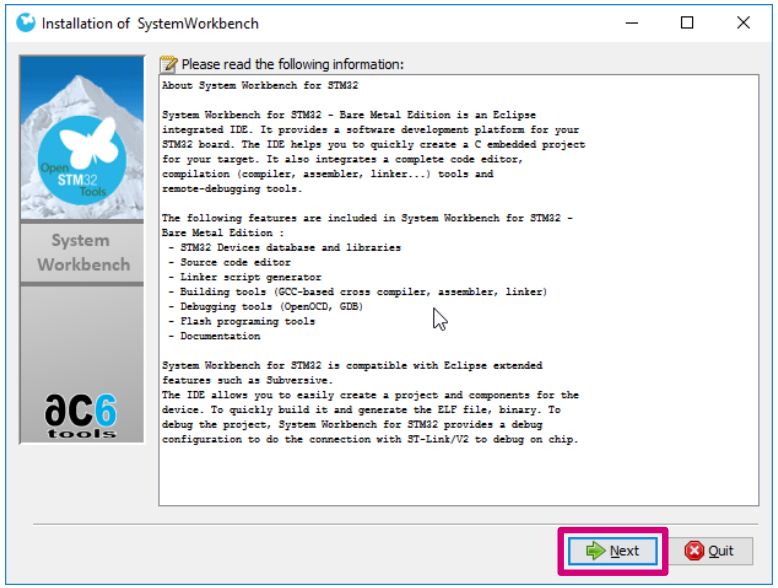
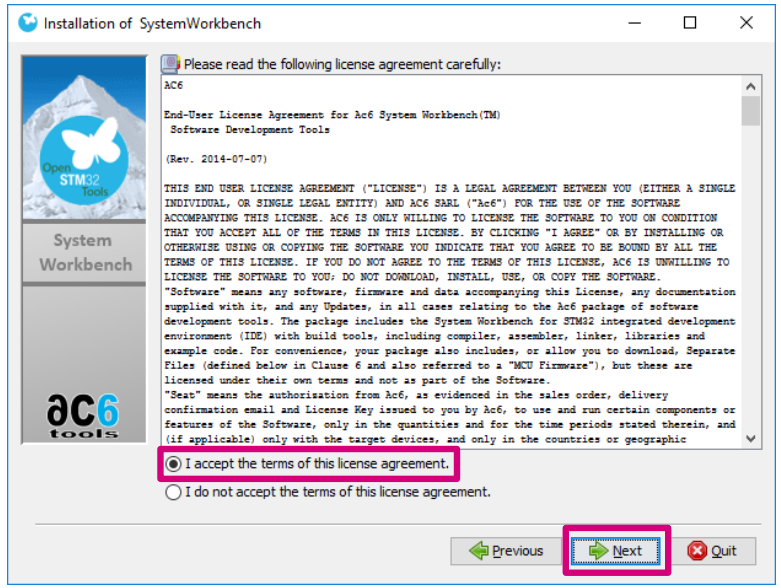
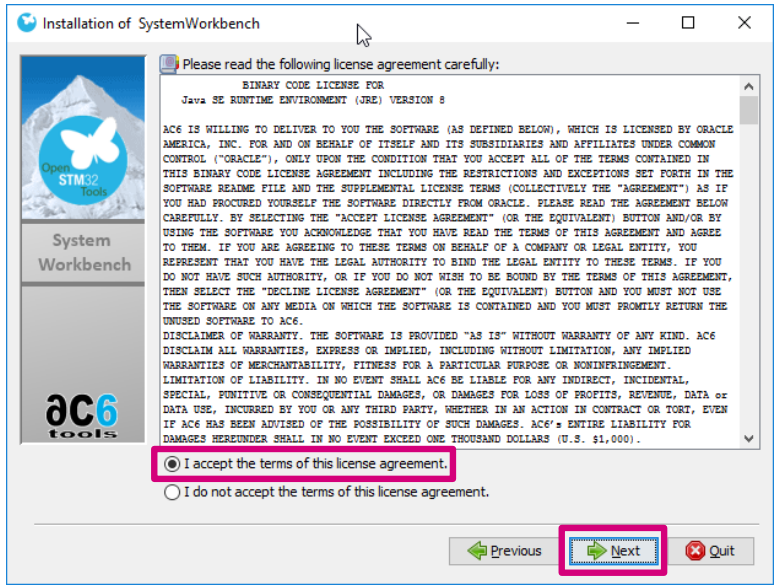
Installation

4. Execute the install_sw4stm32_win_64bits-v2.4.exe as administrator and confirm default settings.

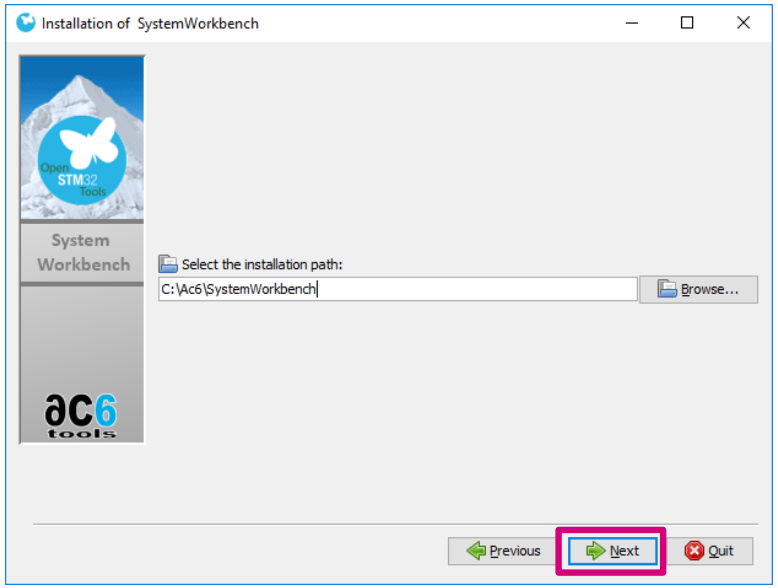


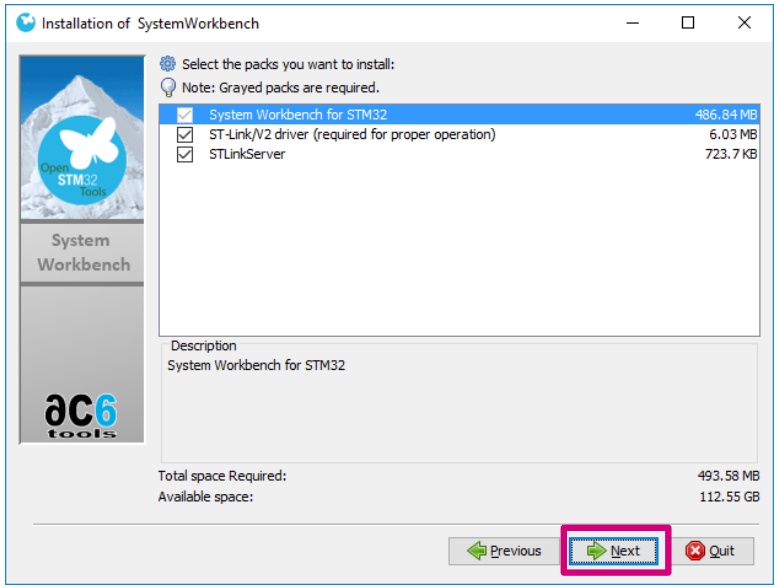


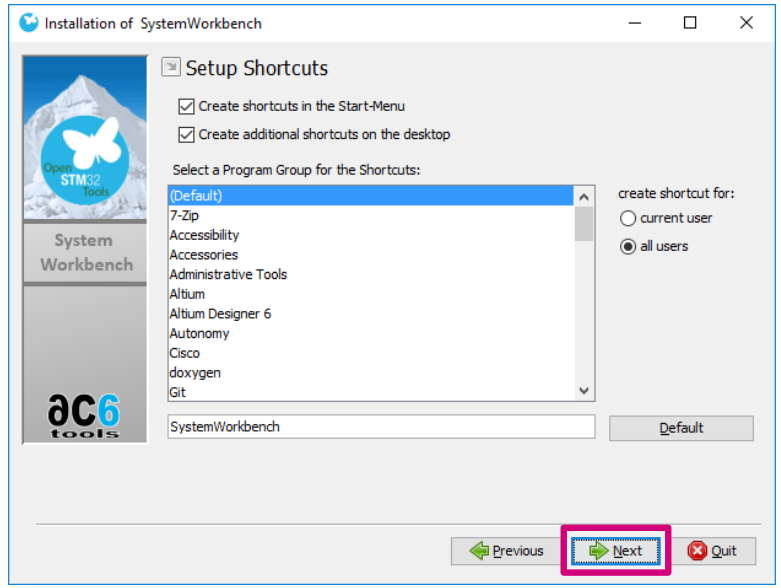


AlgoBuilder

Installation







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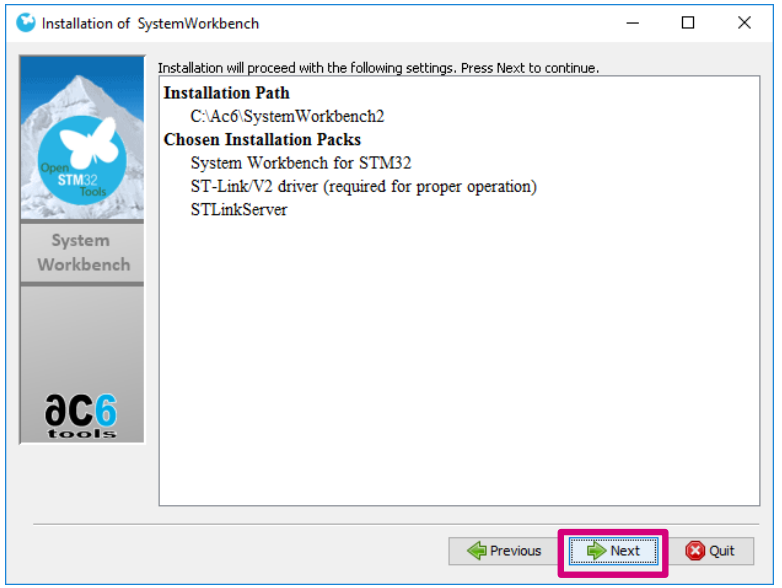
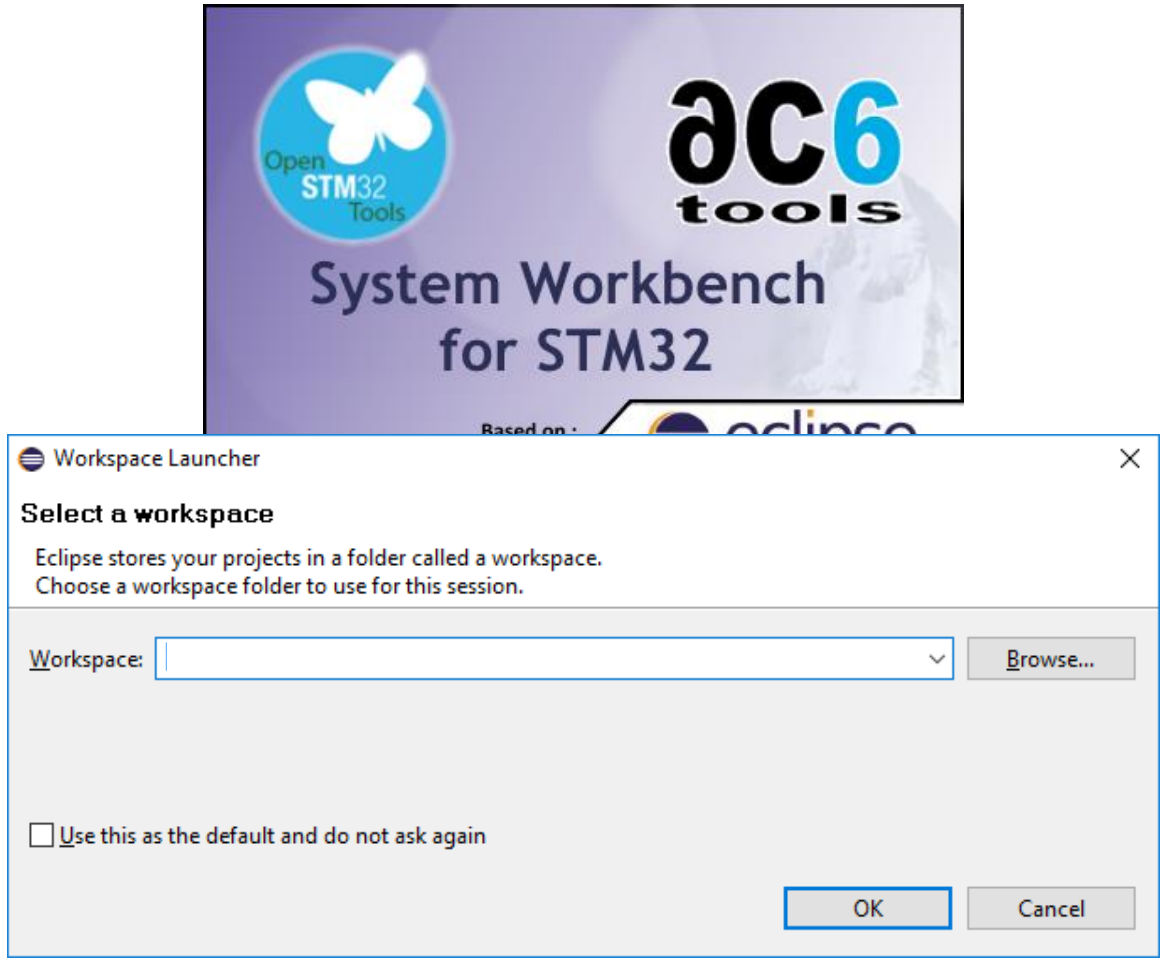
Installation

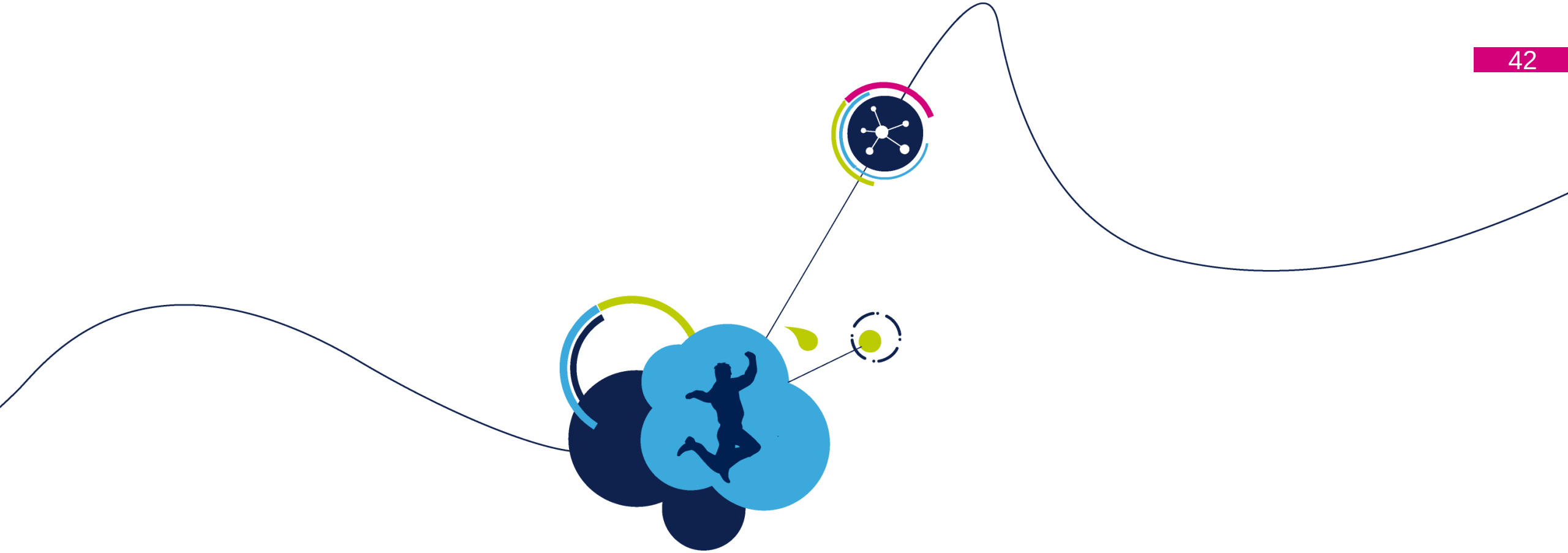


5. **Execute SW4STM32, set the Workspace directory to the default options, then close the application.**



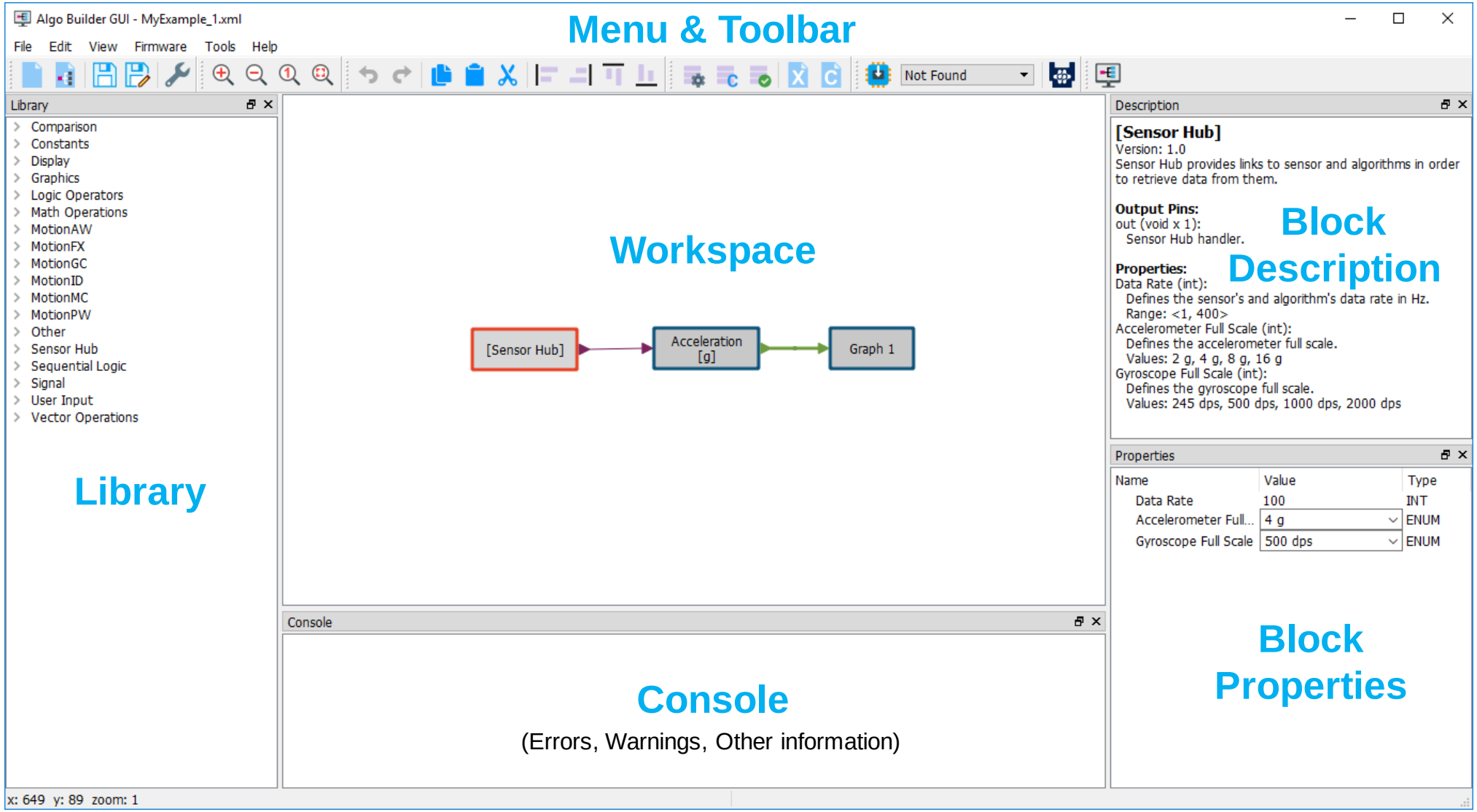
6. Check that following applications were installed on your PC:

- ✓ **AlgoBuilder v2.0.0**
- ✓ **Unicleo-GUI v1.5.0**
- ✓ **STM32 ST-LINK Utility**
- ✓ **System Workbench for STM32 (AC6)**



AlgoBuilder GUI walkthrough

AlgoBuilder



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Display:

Several options can be used to display output data.

Properties

Name	Value	Type
Number of Curves	4	INT
Graph Name	Arbitrary Float ...	STRING
Waveform 1 Name	Float 1	STRING
Waveform 2 Name	Float 2	STRING
Waveform 3 Name	Float 3	STRING
Waveform 4 Name	Float 4	STRING
Waveform 5 Name		STRING
Waveform 6 Name		STRING
Unit Name		STRING

Properties

Name	Value	Type
Number of Values	4	INT
Value 1 Name	Float 1	STRING
Value 2 Name	Float 2	STRING
Value 3 Name	Float 3	STRING
Value 4 Name	Float 4	STRING
Value 5 Name		STRING
Value 6 Name		STRING
Value 7 Name		STRING
Value 8 Name		STRING
Unit 1 Name	Unit 1	STRING
Unit 2 Name	Unit 2	STRING
Unit 3 Name	Unit 3	STRING
Unit 4 Name	Unit 4	STRING
Unit 5 Name		STRING
Unit 6 Name		STRING
Unit 7 Name		STRING
Unit 8 Name		STRING

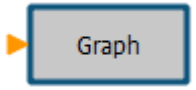
Properties

Name	Value	Type
Number of Channels	4	INT
Channel 1 Name	Sw 1	STRING
Channel 2 Name	Sw 2	STRING
Channel 3 Name	Sw 3	STRING
Channel 4 Name	Sw 4	STRING
Channel 5 Name		STRING
Channel 6 Name		STRING
Channel 7 Name		STRING
Channel 8 Name		STRING

Properties

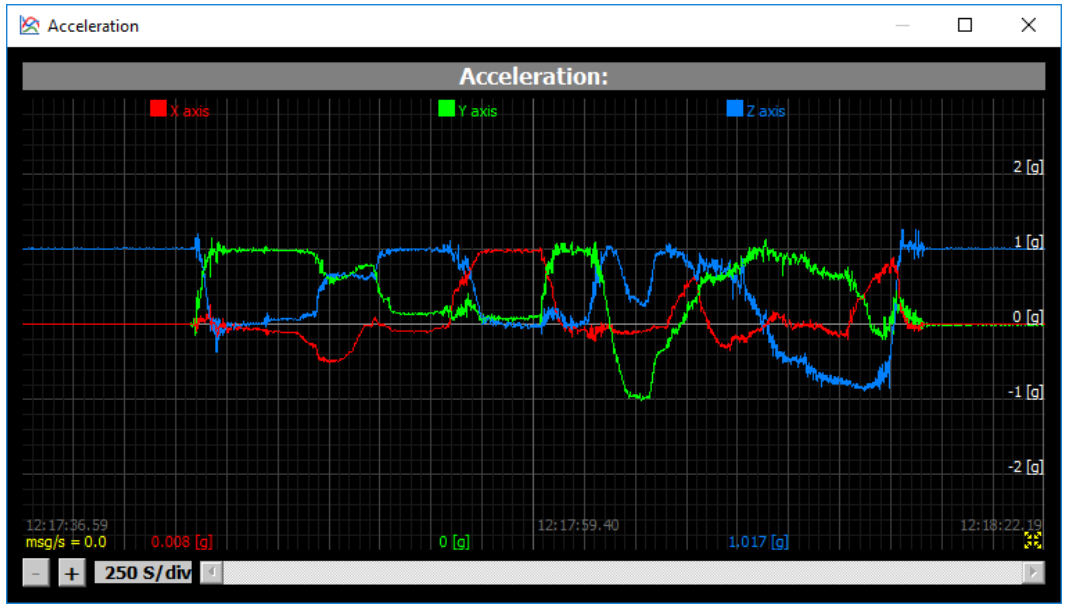
Name	Value	Type
Number of Values	4	INT
Value 1 Name	Int 1	STRING
Value 2 Name	Int 2	STRING
Value 3 Name	Int 3	STRING
Value 4 Name	Int 4	STRING
Value 5 Name		STRING
Value 6 Name		STRING
Value 7 Name		STRING
Value 8 Name		STRING
Unit 1 Name	Unit 1	STRING
Unit 2 Name	Unit 2	STRING
Unit 3 Name	Unit 3	STRING
Unit 4 Name	Unit 4	STRING
Unit 5 Name		STRING
Unit 6 Name		STRING
Unit 7 Name		STRING
Unit 8 Name		STRING

Graph - Displays data as a time graph

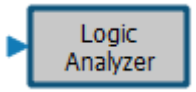


Properties

Name	Value	Type
Number of Curves	6	INT
Graph Name	Graph	STRING
Waveform 1 Name	Waveform 1	STRING
Waveform 2 Name	Waveform 2	STRING
Waveform 3 Name	Waveform 3	STRING
Waveform 4 Name	Waveform 4	STRING
Waveform 5 Name	Waveform 5	STRING
Waveform 6 Name	Waveform 6	STRING
Unit Name		STRING
Zero axis position	Middle	ENUM
Auto-scale	OFF	ENUM
Full Scale	1	STRING

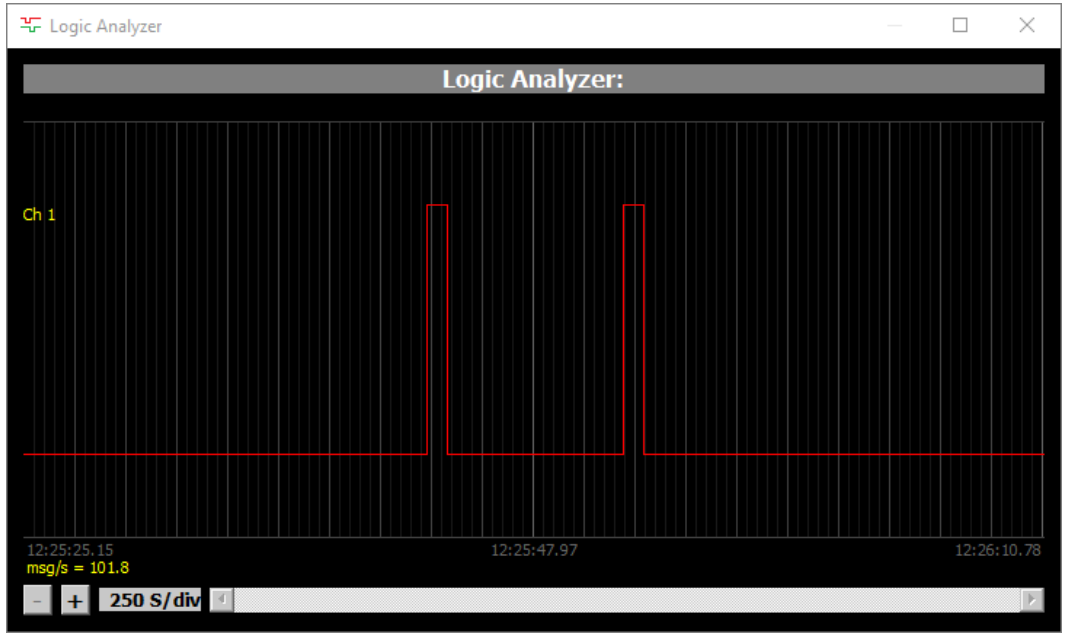


Logic Analyzer - Displays logic signals which can have values only 0 or 1



Properties

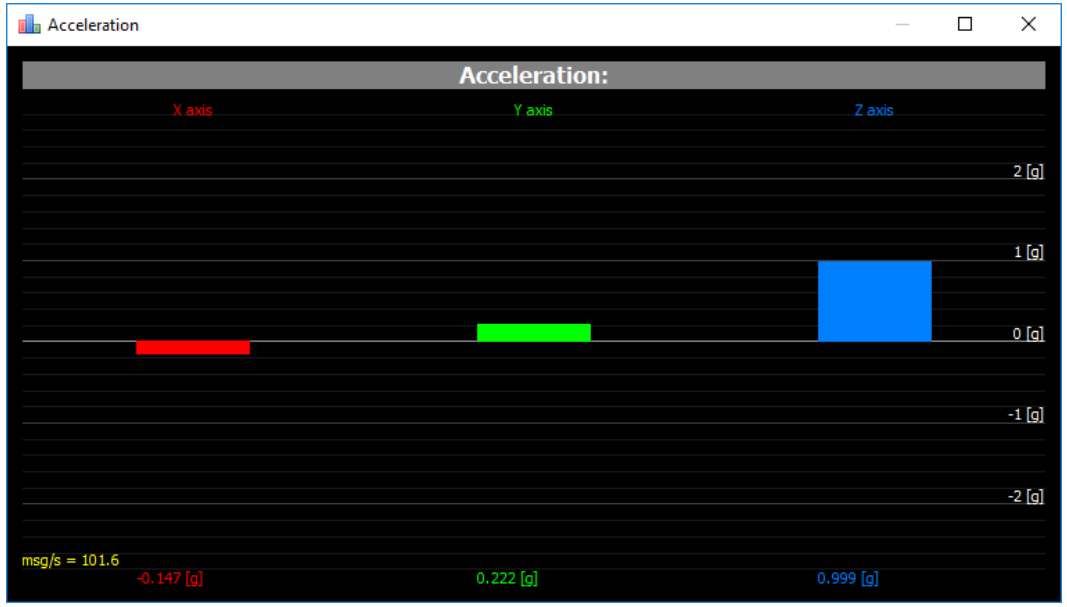
Name	Value	Type
Number of Channels	8	INT
Logic Analyzer Name	Logic##Analyzer	STRING
Channel 1 Name	Ch 1	STRING
Channel 2 Name	Ch 2	STRING
Channel 3 Name	Ch 3	STRING
Channel 4 Name	Ch 4	STRING
Channel 5 Name	Ch 5	STRING
Channel 6 Name	Ch 6	STRING
Channel 7 Name	Ch 7	STRING
Channel 8 Name	Ch 8	STRING



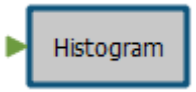
Bar Graph - Displays actual value as bar

Properties

Name	Value	Type
Number of Bars	6	INT
BarGraph Name	BarGraph	STRING
Bar 1 Name	Bar 1	STRING
Bar 2 Name	Bar 2	STRING
Bar 3 Name	Bar 3	STRING
Bar 4 Name	Bar 4	STRING
Bar 5 Name	Bar 5	STRING
Bar 6 Name	Bar 6	STRING
Unit Name		STRING
Zero axis position	Middle	ENUM
Auto-scale	OFF	ENUM
Full Scale	1	STRING

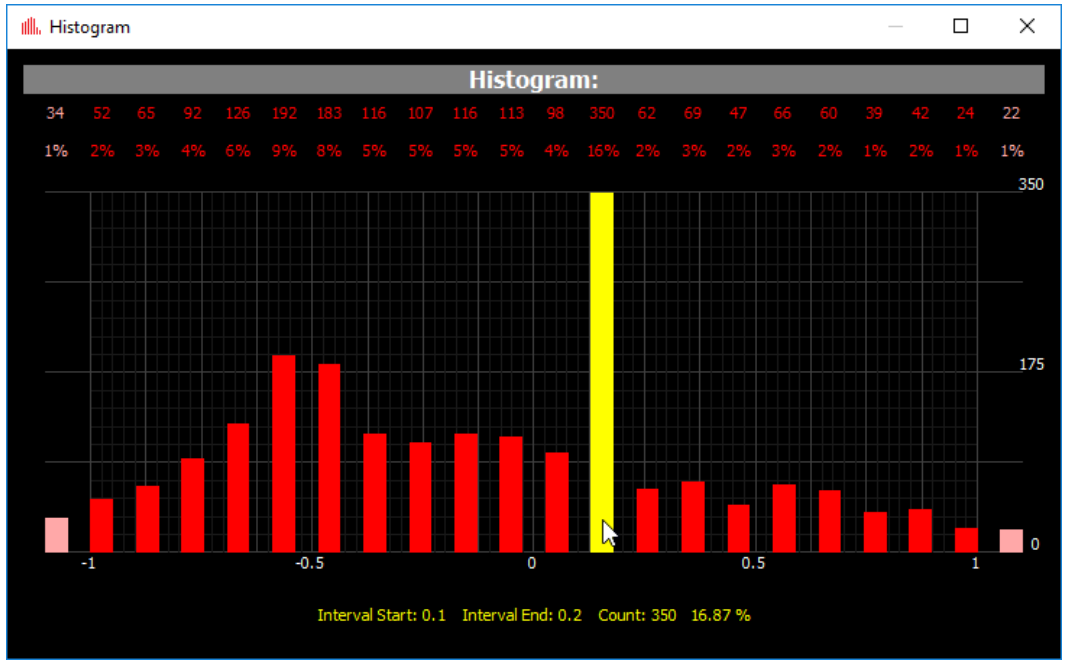


Histogram - Displays values distribution



Properties

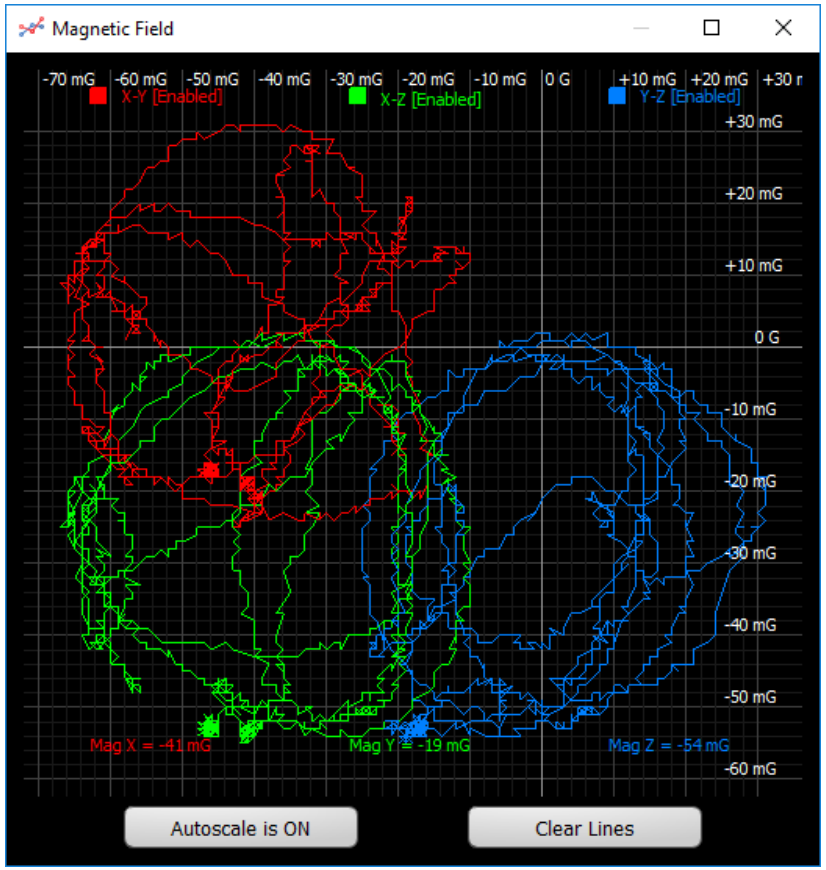
Name	Value	Type
Histogram Name	Histogram	STRING
Unit Name		STRING
Number of Intervals	10	INT
Zero axis position	Middle	ENUM
Auto-scale	OFF	ENUM
Full Scale	1	STRING



Scatter - Displays X,Y,Z data in 2D X-Y, X-Z, Y-Z chart

Properties

Name	Value	Type
Size of Input	3	INT
Scatter Name	Scatter	STRING
Value 1 Name	Value 1	STRING
Value 2 Name	Value 2	STRING
Value 3 Name	Value 3	STRING
Unit Name		STRING
Auto-scale	OFF	ENUM
Full Scale	1	STRING



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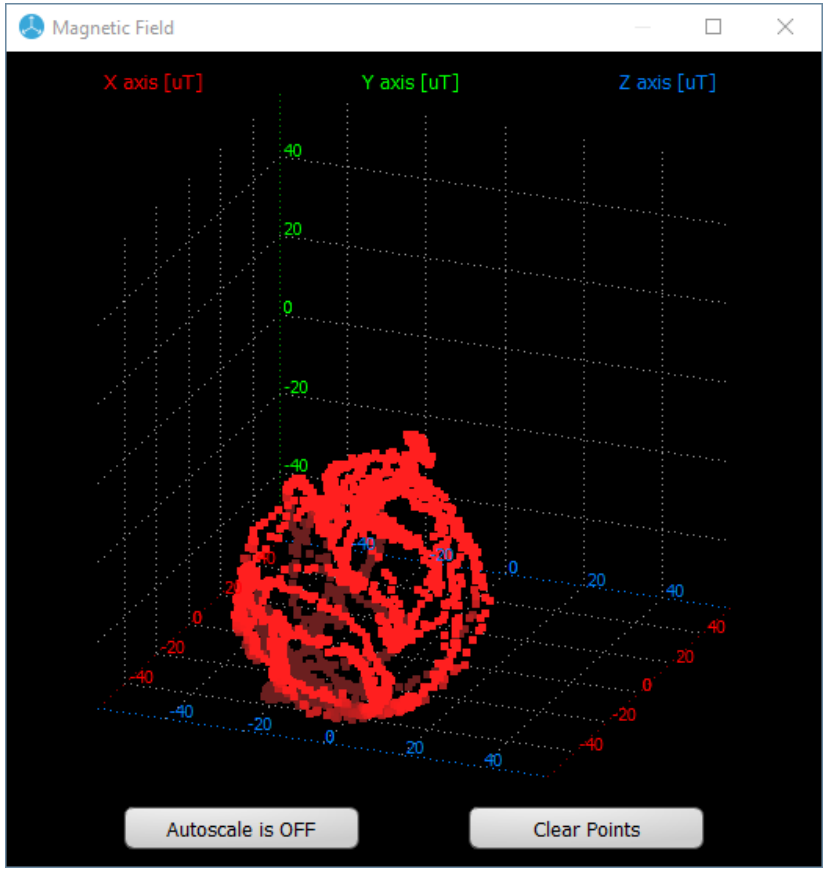
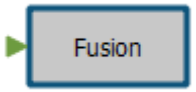
3D Plot - Displays X,Y,Z data in 3D chart

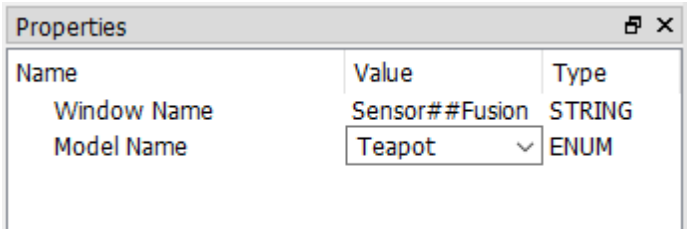
Properties

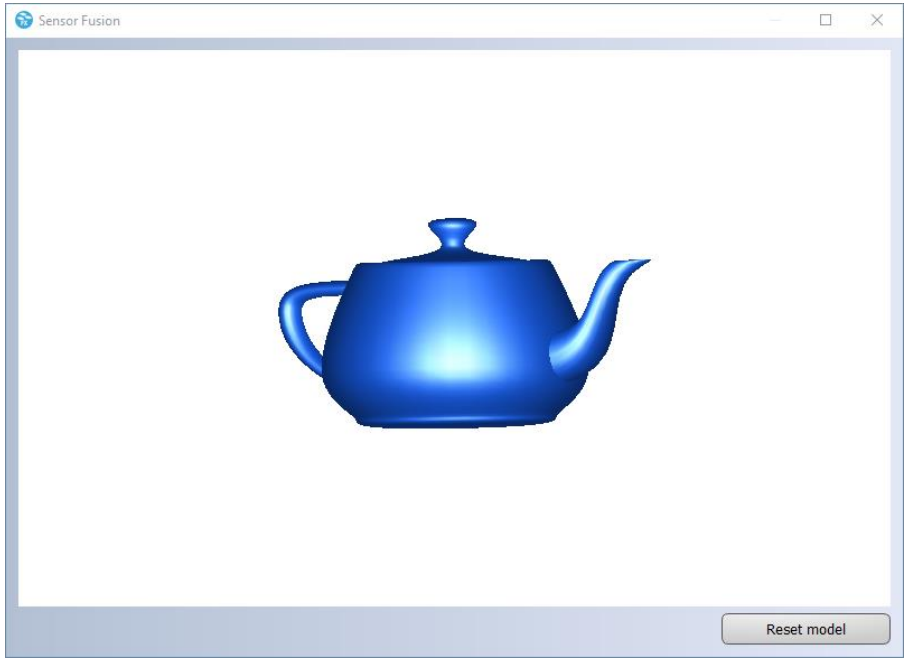
Name	Value	Type
Plot Name	3D Plot	STRING
Value 1 Name	Value 1	STRING
Value 2 Name	Value 2	STRING
Value 3 Name	Value 3	STRING
Unit Name		STRING
Auto-scale	OFF	ENUM
Full Scale	1	STRING



Fusion - Displays quaternion data as teapot 3D model.



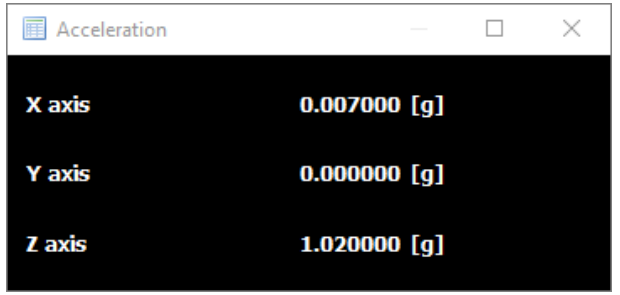




Value - Displays the exact float or integer value

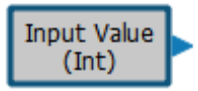
Properties

Name	Value	Type
Number of Values	8	INT
Window Name	Values	STRING
Value 1 Name	Value 1	STRING
Value 2 Name	Value 2	STRING
Value 3 Name	Value 3	STRING
Value 4 Name	Value 4	STRING
Value 5 Name	Value 5	STRING
Value 6 Name	Value 6	STRING
Value 7 Name	Value 7	STRING
Value 8 Name	Value 8	STRING
Unit 1 Name	Unit 1	STRING
Unit 2 Name	Unit 2	STRING
Unit 3 Name	Unit 3	STRING
Unit 4 Name	Unit 4	STRING
Unit 5 Name	Unit 5	STRING
Unit 6 Name	Unit 6	STRING
Unit 7 Name	Unit 7	STRING
Unit 8 Name	Unit 8	STRING



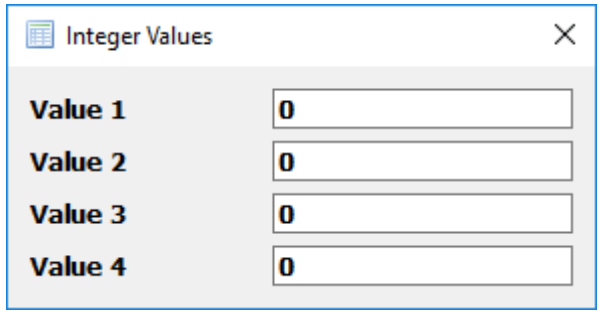
User Input:

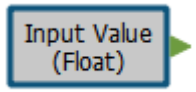
Three types of data can be sent from Unicleo-GUI to running firmware: Binary, Integer and Float.
Input blocks can be used in the design to allow user interaction with the running firmware.



Properties

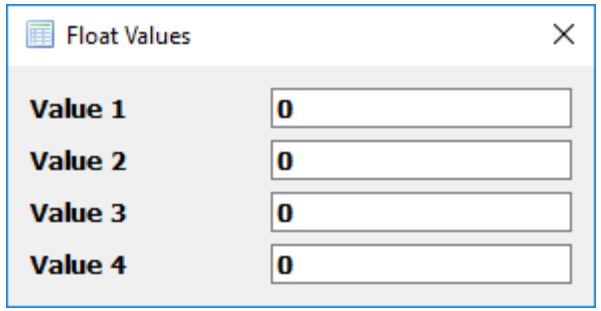
Name	Value	Type
Window Name	Integer Values	STRING
Number of Values	4	INT
Default Value 1	0	INT
Default Value 2	0	INT
Default Value 3	0	INT
Default Value 4	0	INT
Value 1 Name	Value 1	STRING
Value 2 Name	Value 2	STRING
Value 3 Name	Value 3	STRING
Value 4 Name	Value 4	STRING

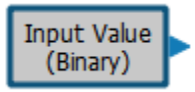




Properties

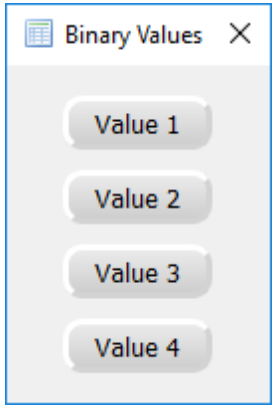
Name	Value	Type
Window Name	Float Values	STRING
Number of Values	4	INT
Default Value 1	0	FLOAT
Default Value 2	0	FLOAT
Default Value 3	0	FLOAT
Default Value 4	0	FLOAT
Value 1 Name	Value 1	STRING
Value 2 Name	Value 2	STRING
Value 3 Name	Value 3	STRING
Value 4 Name	Value 4	STRING





Properties

Name	Value	Type
Window Name	Binary Values	STRING
Number of Values	4	INT
Default Value 1	0	INT
Default Value 2	0	INT
Default Value 3	0	INT
Default Value 4	0	INT
Value 1 Name	Value 1	STRING
Value 2 Name	Value 2	STRING
Value 3 Name	Value 3	STRING
Value 4 Name	Value 4	STRING



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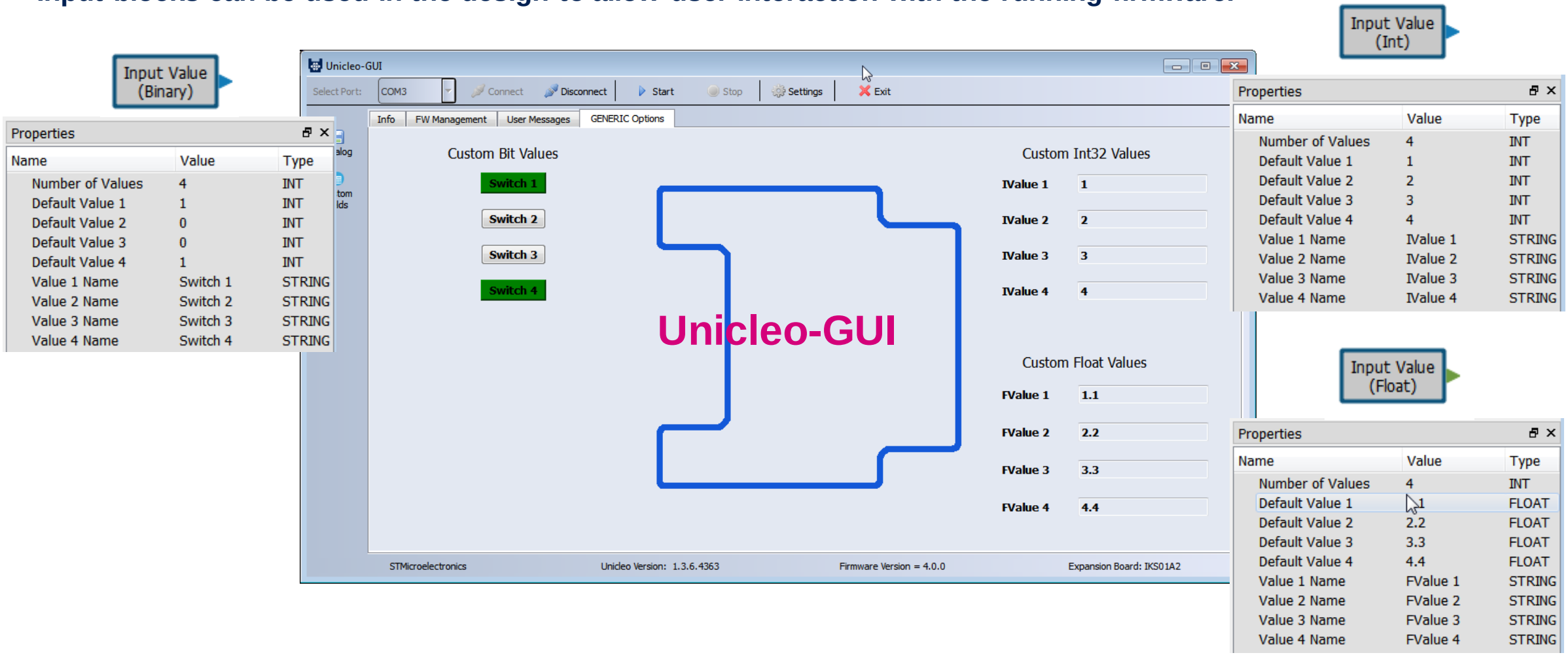
User Input:

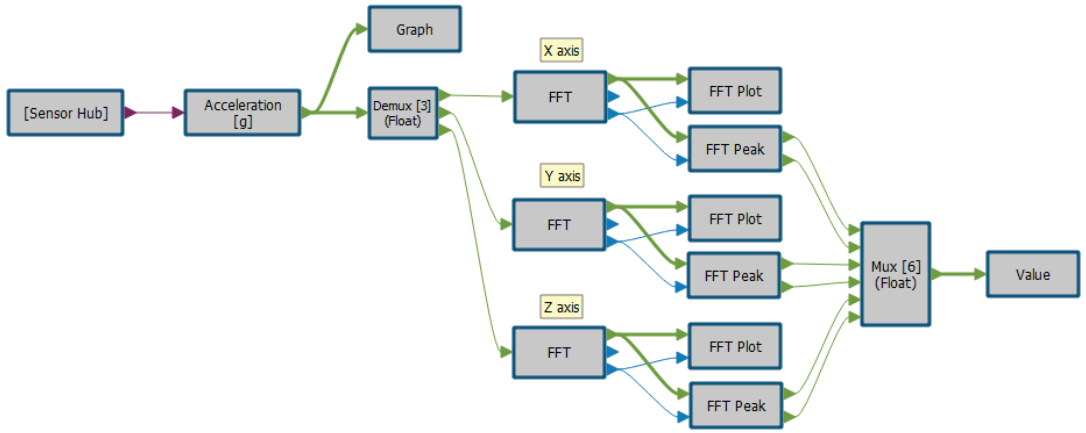
Input blocks can be used in the design to allow user interaction with the running firmware.

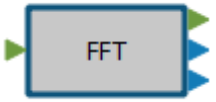


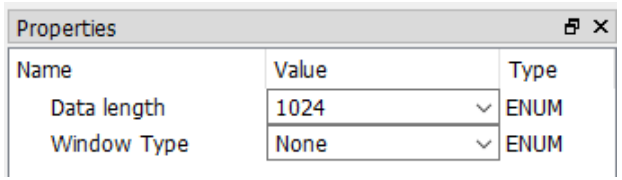
FFT analysis, FFT plot, Window, Peak detection in frequency spectrum

Real ODR measurement for accurate FFT analysis

New example for FFT analysis

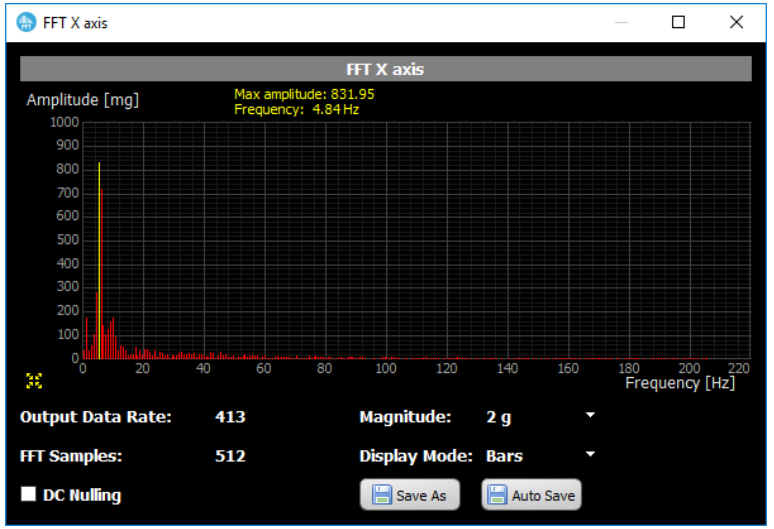






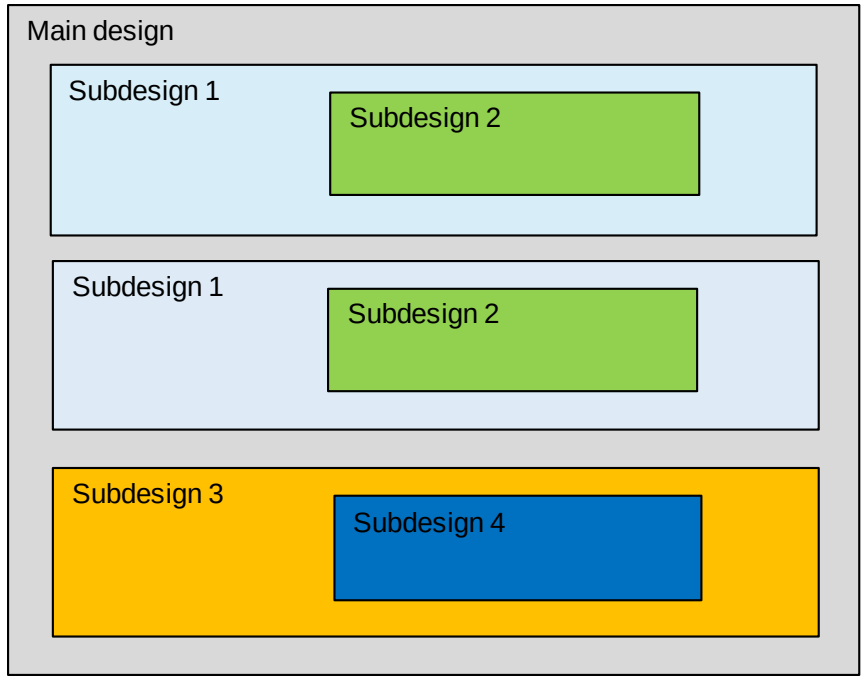
Data length: 32, 64, 128, 256, 512, 1024

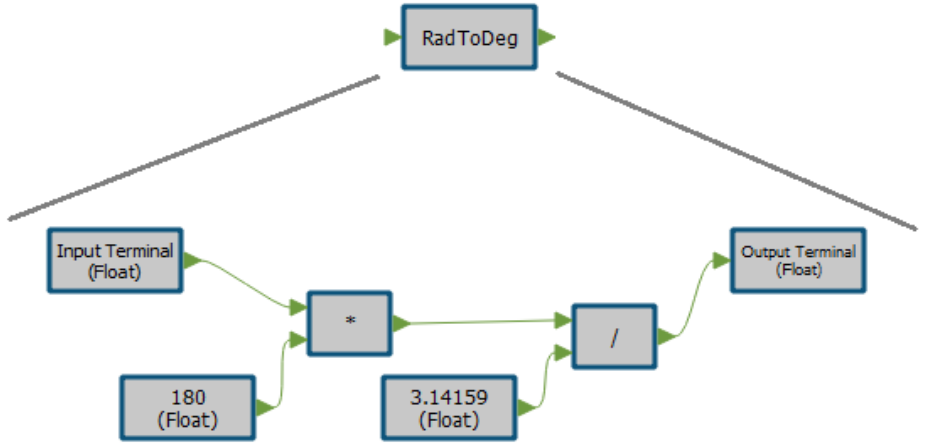
Window: Hanning, Hamming, Flat Top



Multi level design

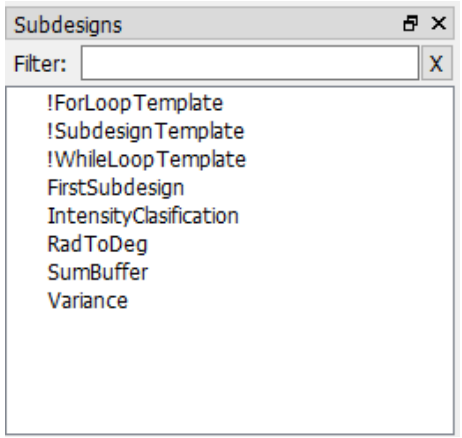
Possibility encapsulate part of the design into one function block, which can be saved into a library to be reused many times

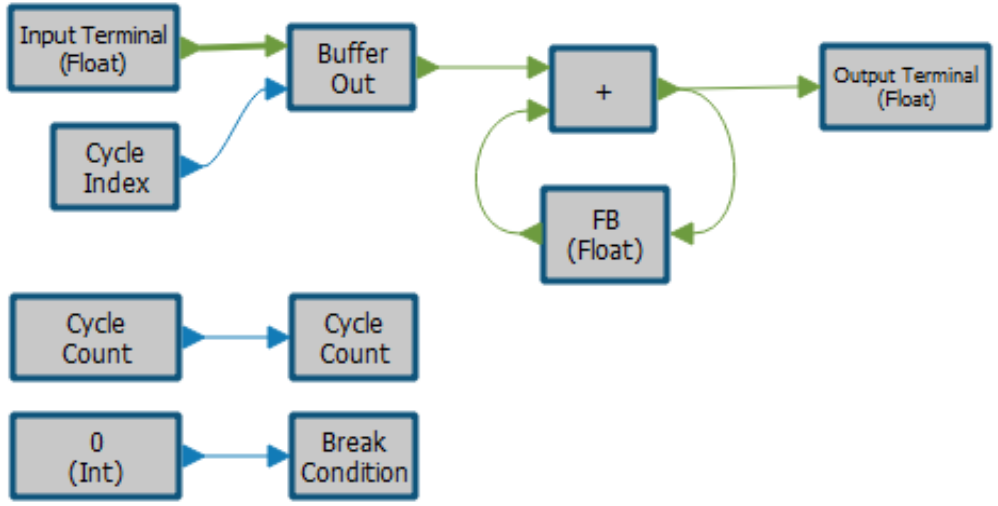




Loops (for, while)

For Loop - is subdesign intended for loop, which is used if number of iteration is known before entering the loop
While Loop - is subdesign intended for loop, which is executed until a defined condition is valid

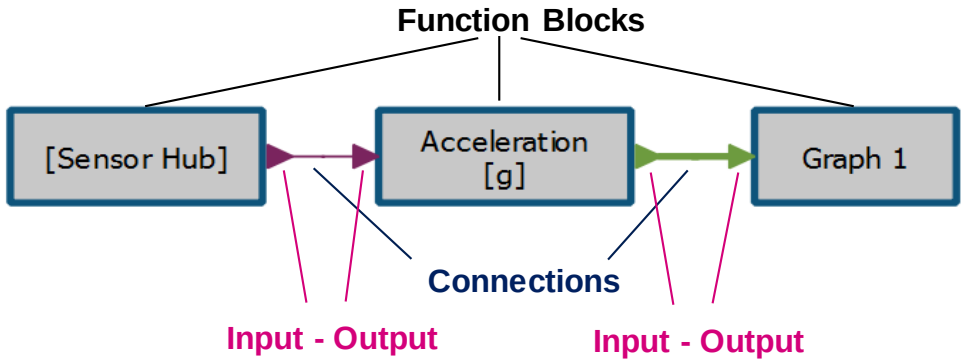


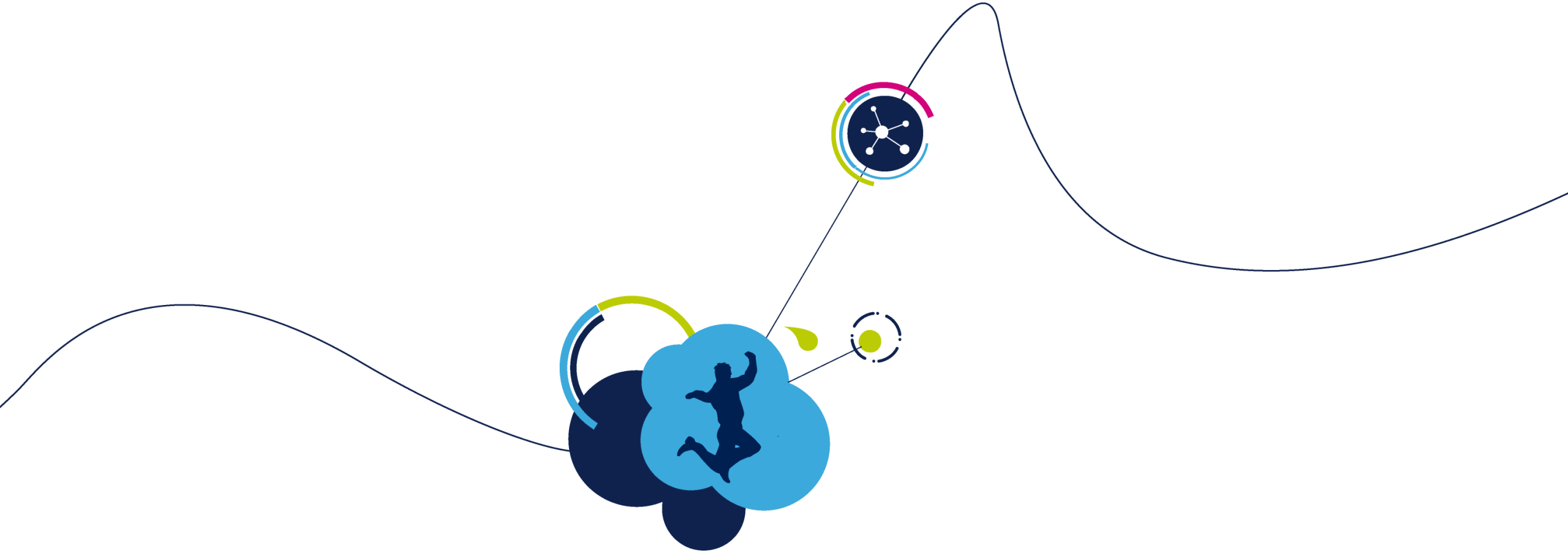


Design Rules:

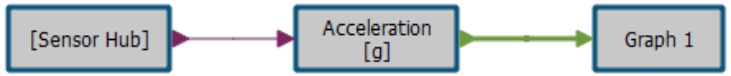
Several rules must be kept during project design to create project which could be validated and compiled.

- Connection can be made between input and output of different function blocks
- It is impossible to connect two inputs or two outputs together
- Only input and output of the same type can be connected, exception is variant input which will get the type of connected output
- Only input and output of the same size can be connected together. Some inputs and outputs can have variable size. Size value can be changed inside properties window. The size of input or output can be seen in the description window when the block is selected.
- For clarity the thickness of the connection line indicates the size of input and output and color of the connection line indicated the type (default: green – float, blue – integer, violet – other).
- All inputs must be connected





Demo 1
Reading Data From Sensors



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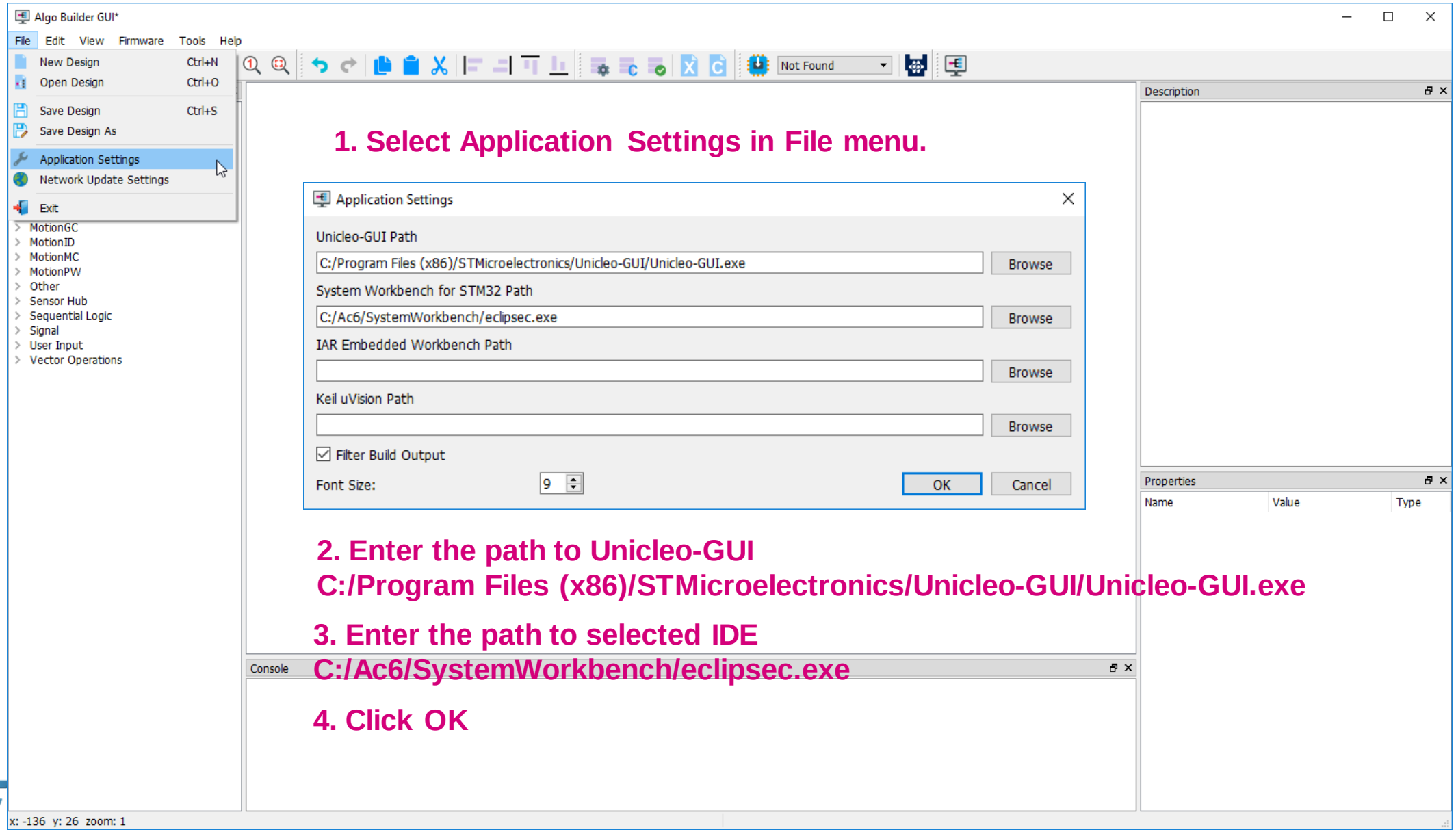
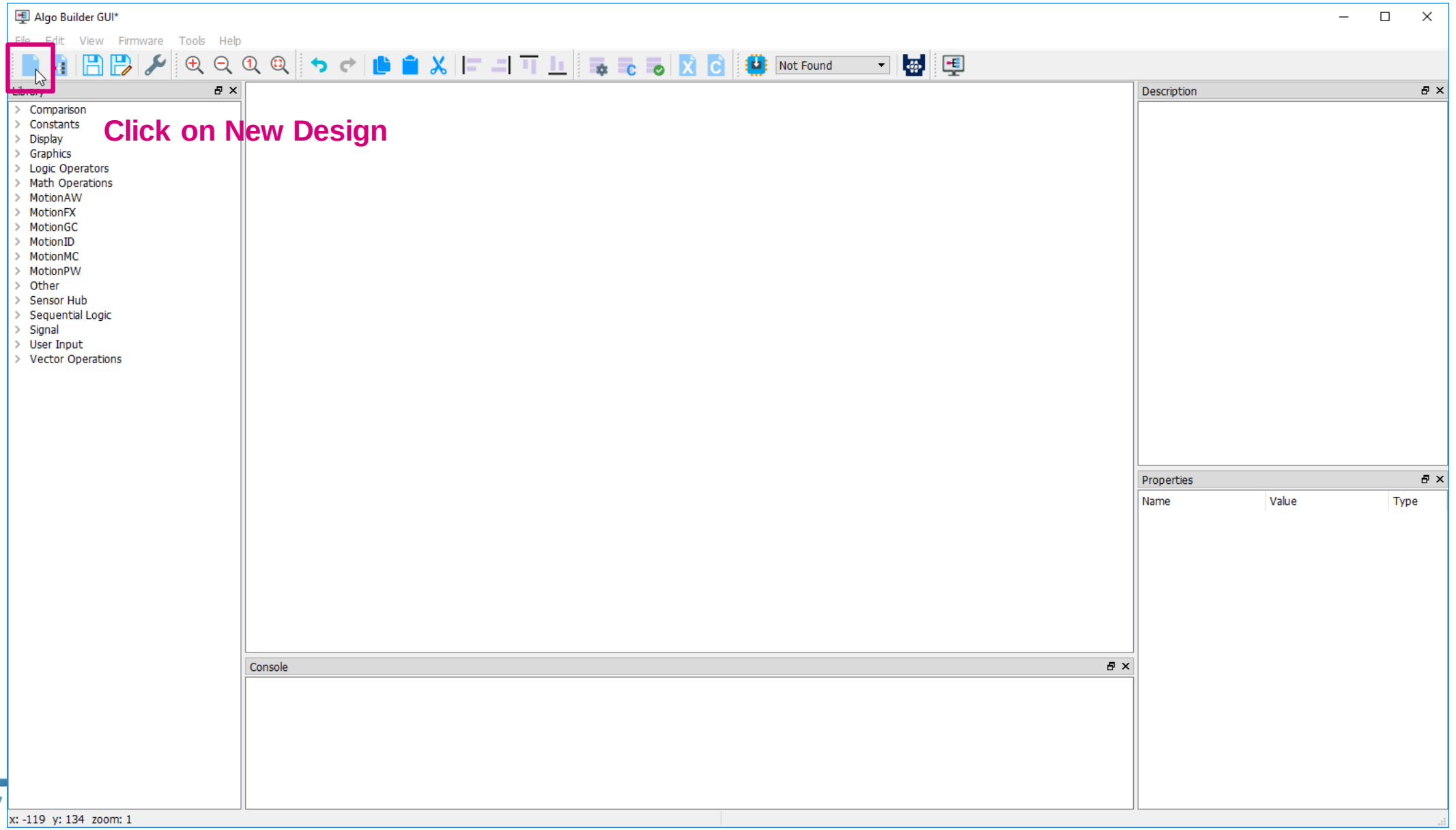
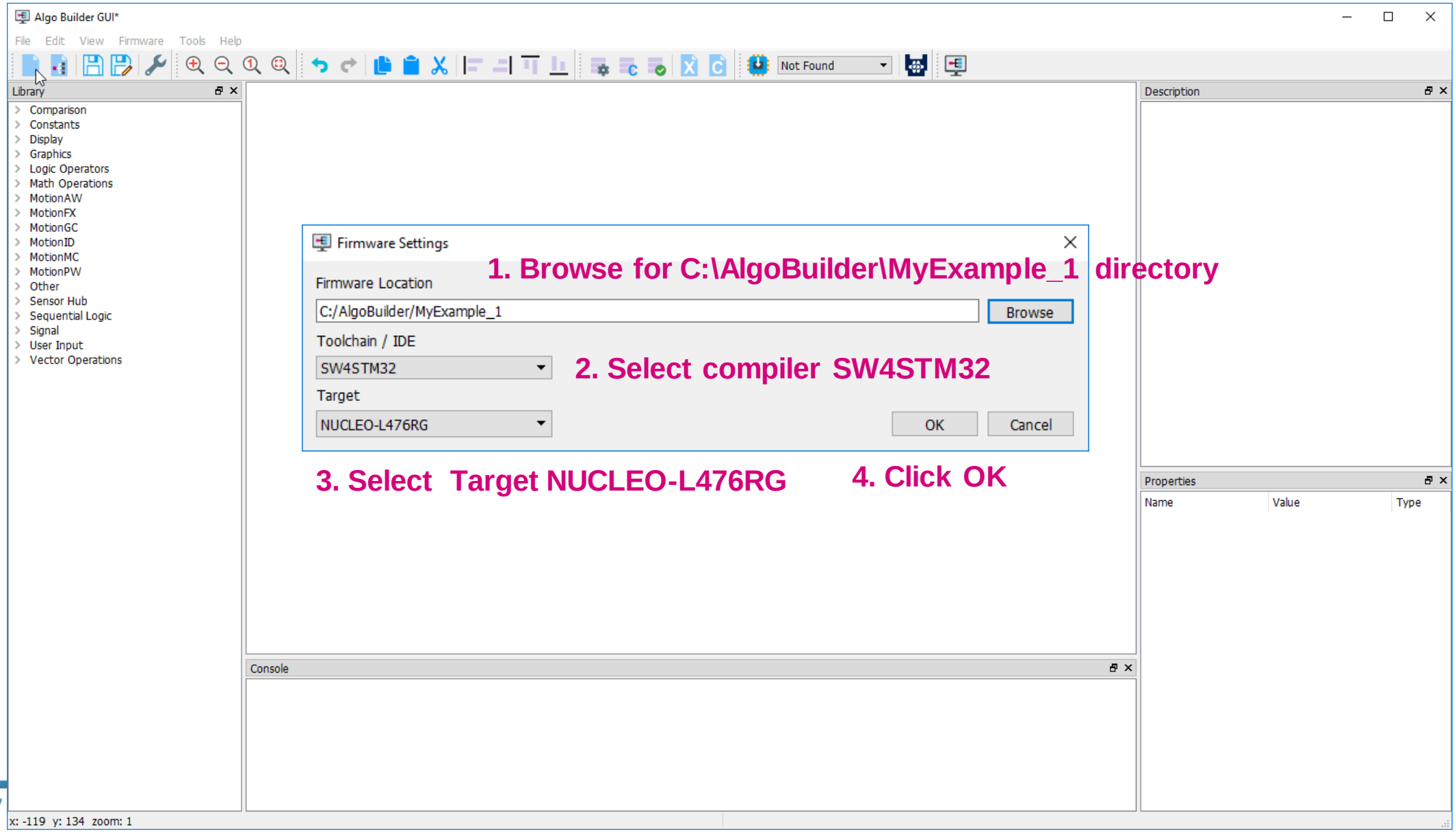
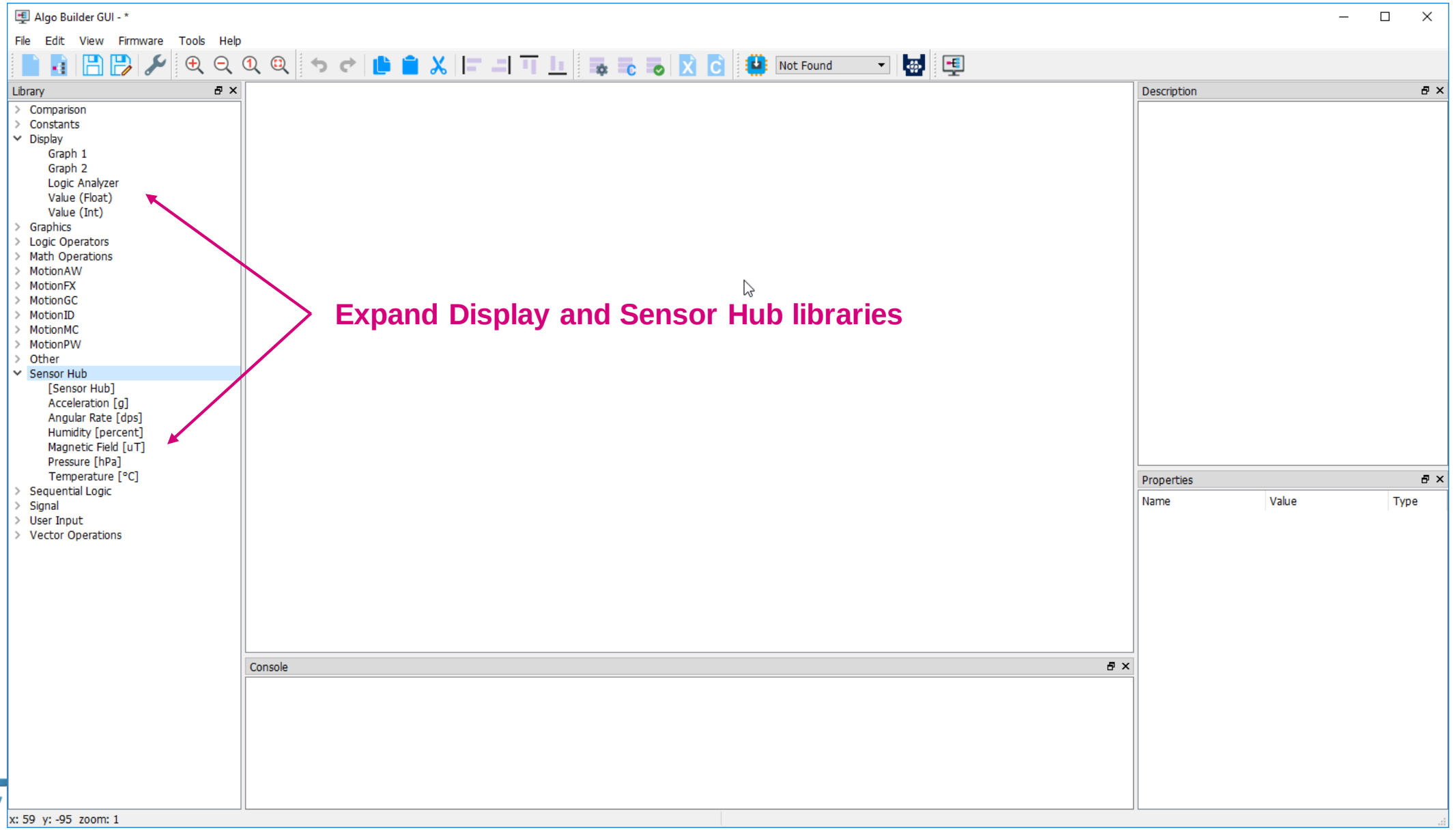
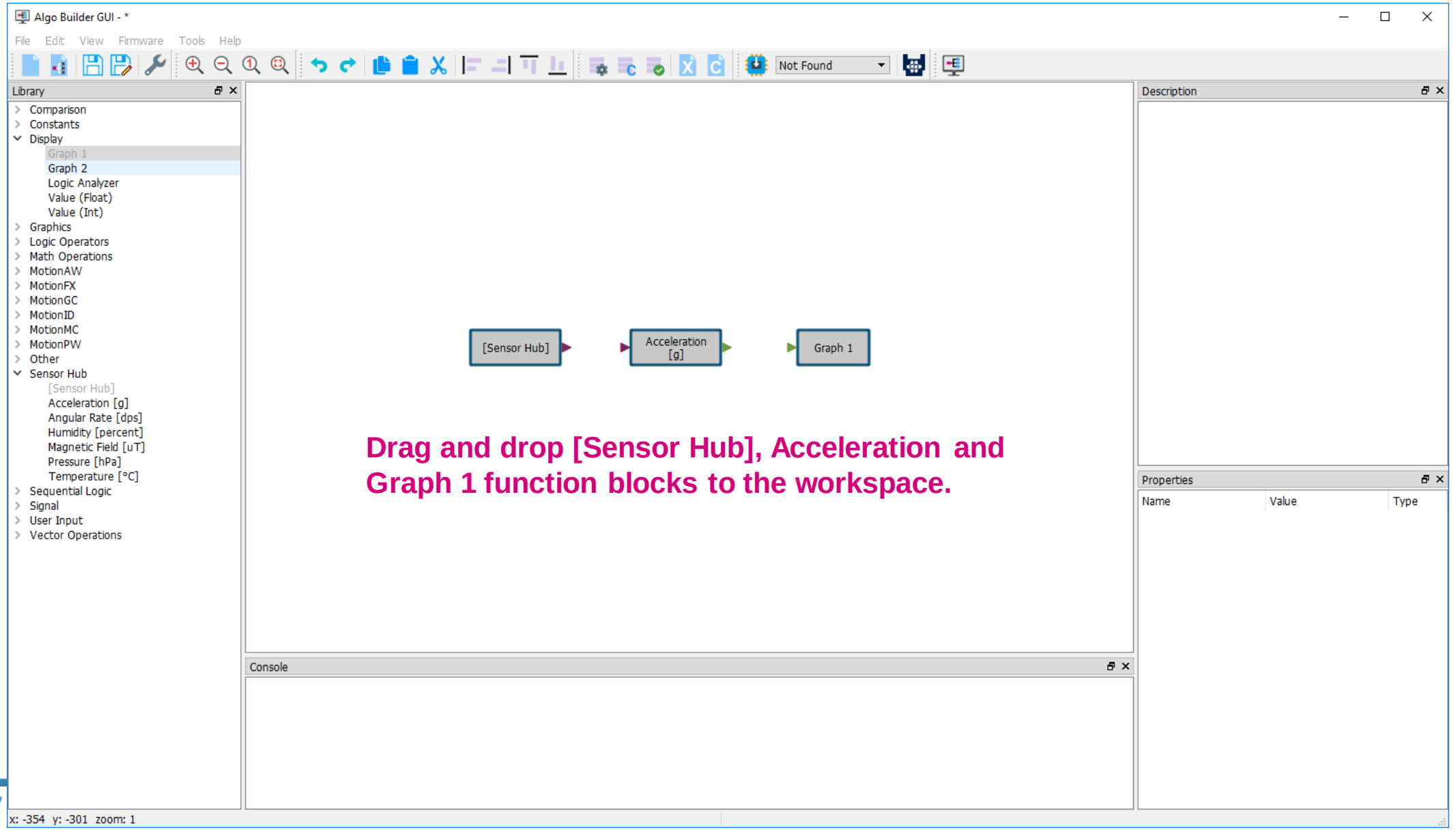
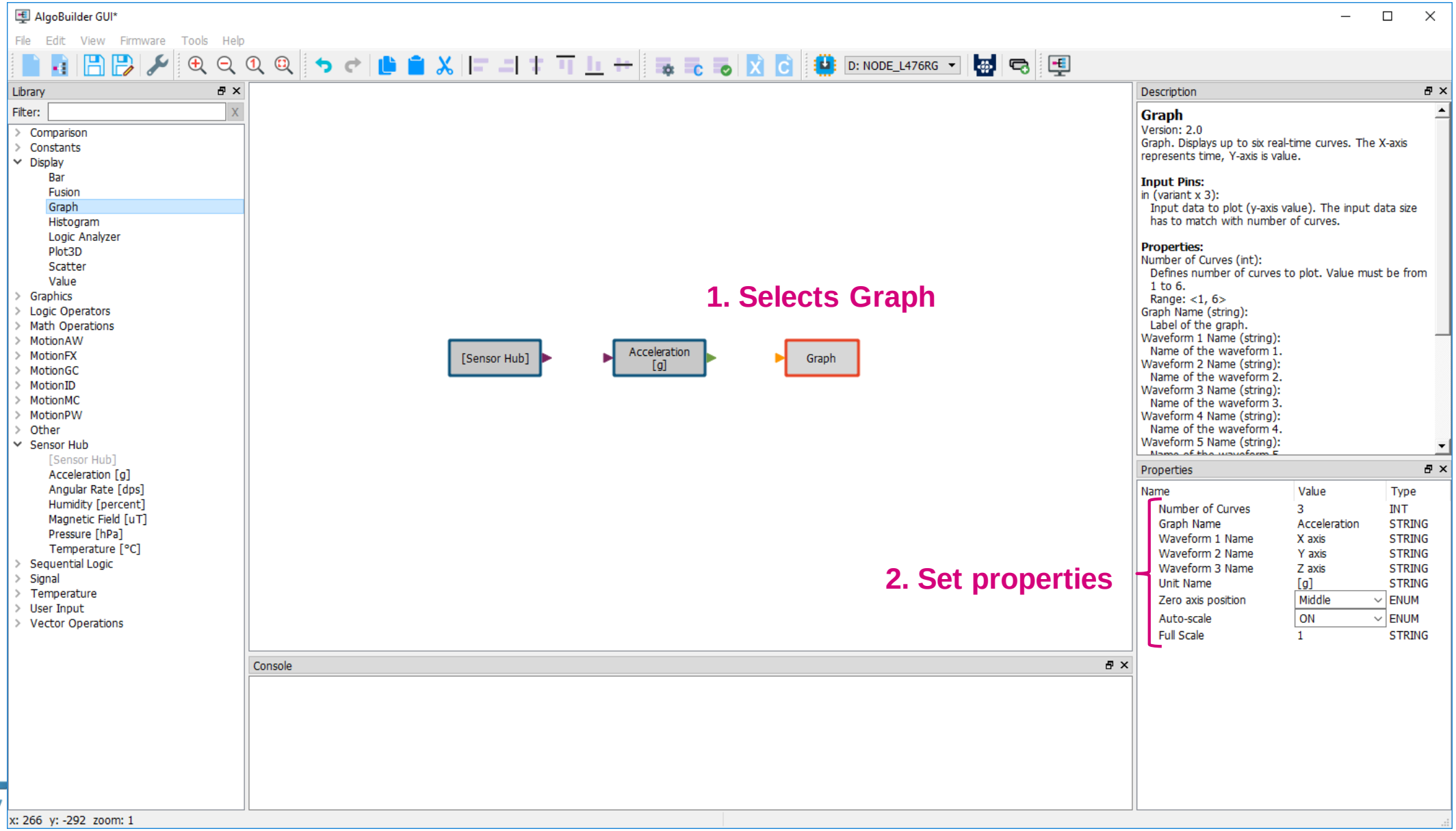

Algo Builder GUI*
File Edit View Firmware Tools Help
New Design Ctrl+N
Open Design Ctrl+O
Save Design Ctrl+S
Save Design As
Application Settings
Network Update Settings
Exit
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
Not Found
Description
Properties
Name
Value
Type
Console
x: -136 y: 26 zoom: 1
1. Select Application Settings in File menu.
Application Settings
Unicleo-GUI Path
C:/Program Files (x86)/STMicroelectronics/Unicleo-GUI/Unicleo-GUI.exe
Browse
System Workbench for STM32 Path
C:/Ac6/SystemWorkbench/eclipsec.exe
Browse
IAR Embedded Workbench Path
Browse
Keil uVision Path
Browse
Filter Build Output
Font Size:
9
OK
Cancel
2. Enter the path to Unicleo-GUI
C:/Program Files (x86)/STMicroelectronics/Unicleo-GUI/Unicleo-GUI.exe
3. Enter the path to selected IDE
C:/Ac6/SystemWorkbench/eclipsec.exe
4. Click OK

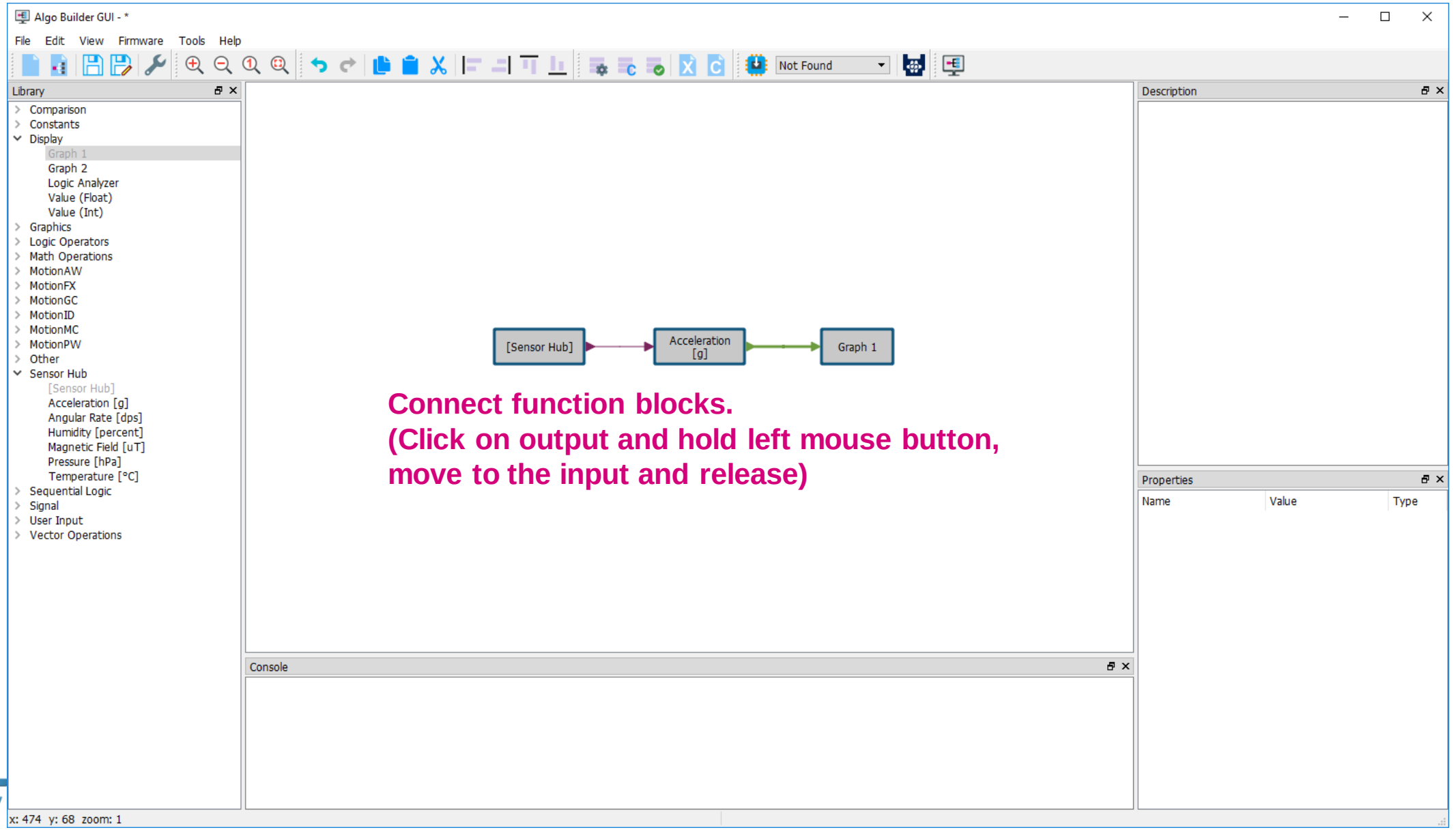

Algo Builder GUI*
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
Click on New Design
Description
Properties
Name
Value
Type
Console
x: -119 y: 134 zoom: 1

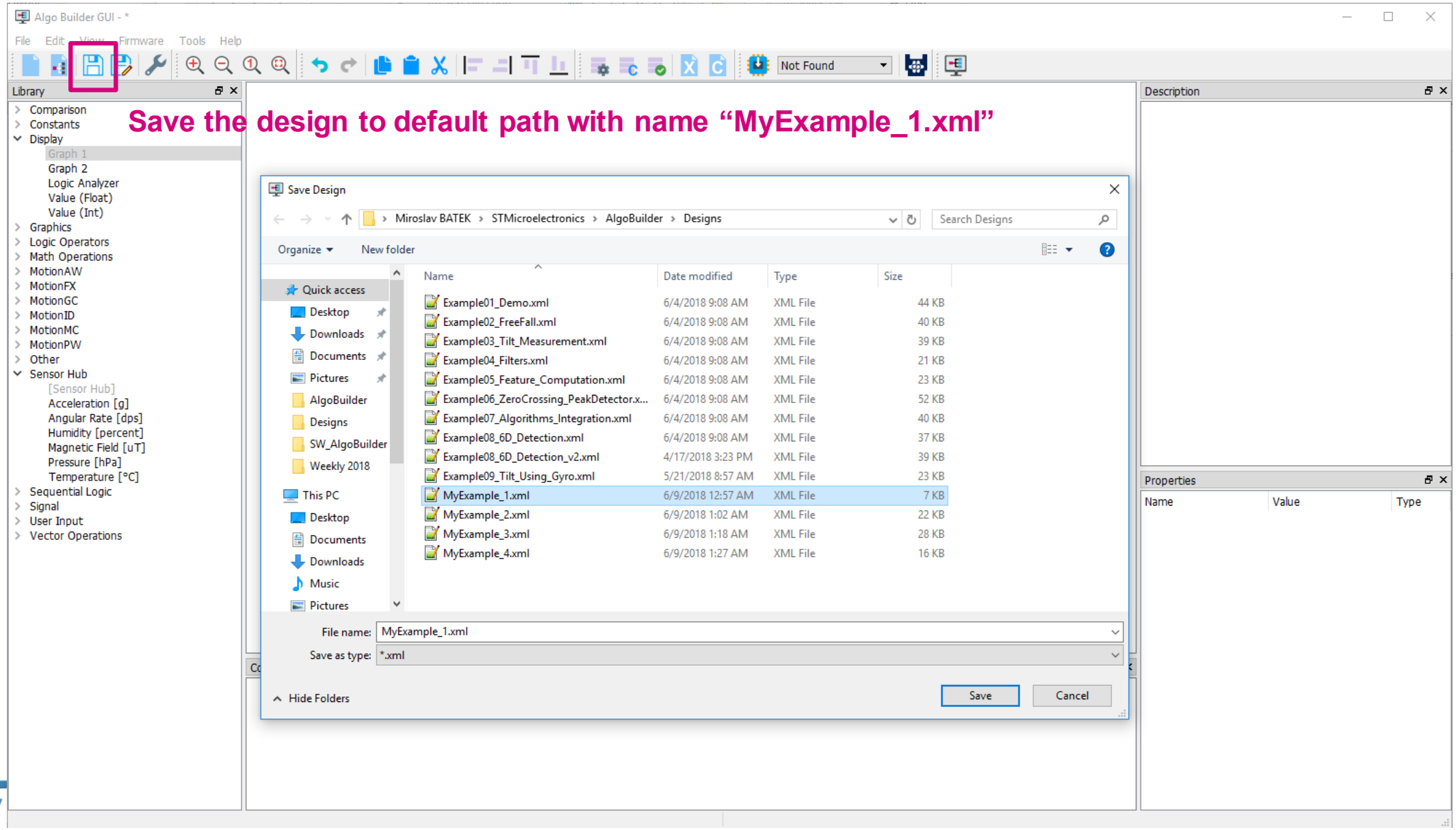

Algo Builder GUI*
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
Description
Properties
Name
Value
Type
Console
x: -119 y: 134 zoom: 1
Firmware Settings
Firmware Location
C:/AlgoBuilder/MyExample_1
Browse
Toolchain / IDE
SW4STM32
Target
NUCLEO-L476RG
OK
Cancel
1. Browse for C:\AlgoBuilder\MyExample_1 directory
2. Select compiler SW4STM32
3. Select Target NUCLEO-L476RG
4. Click OK

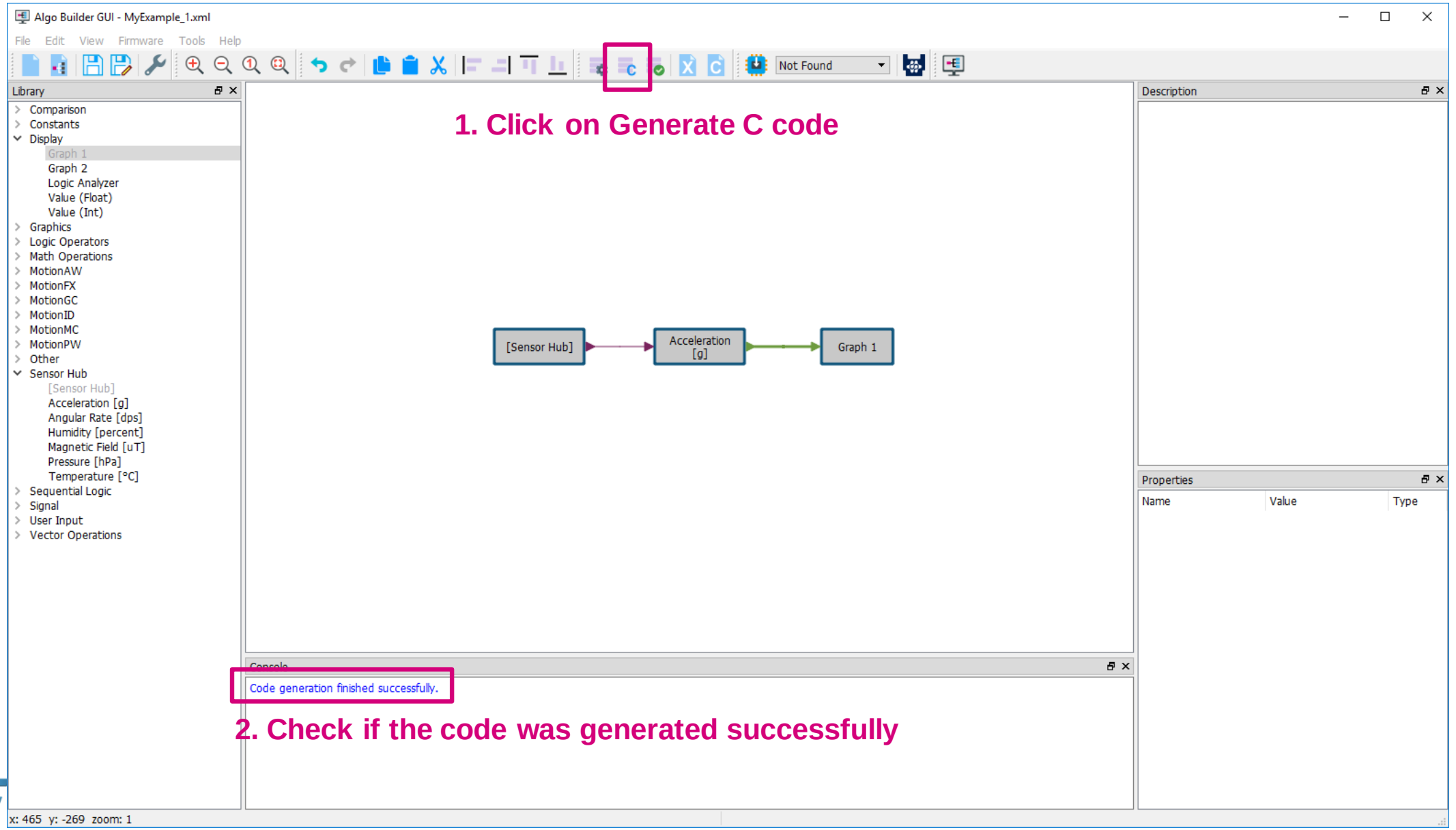

Algo Builder GUI - *
File
Edit
View
Firmware
Tools
Help
Not Found
Library
Comparison
Constants
Display
Graph 1
Graph 2
Logic Analyzer
Value (Float)
Value (Int)
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
Expand Display and Sensor Hub libraries
Description
Properties
Name
Value
Type
Console
x: 59 y: -95 zoom: 1

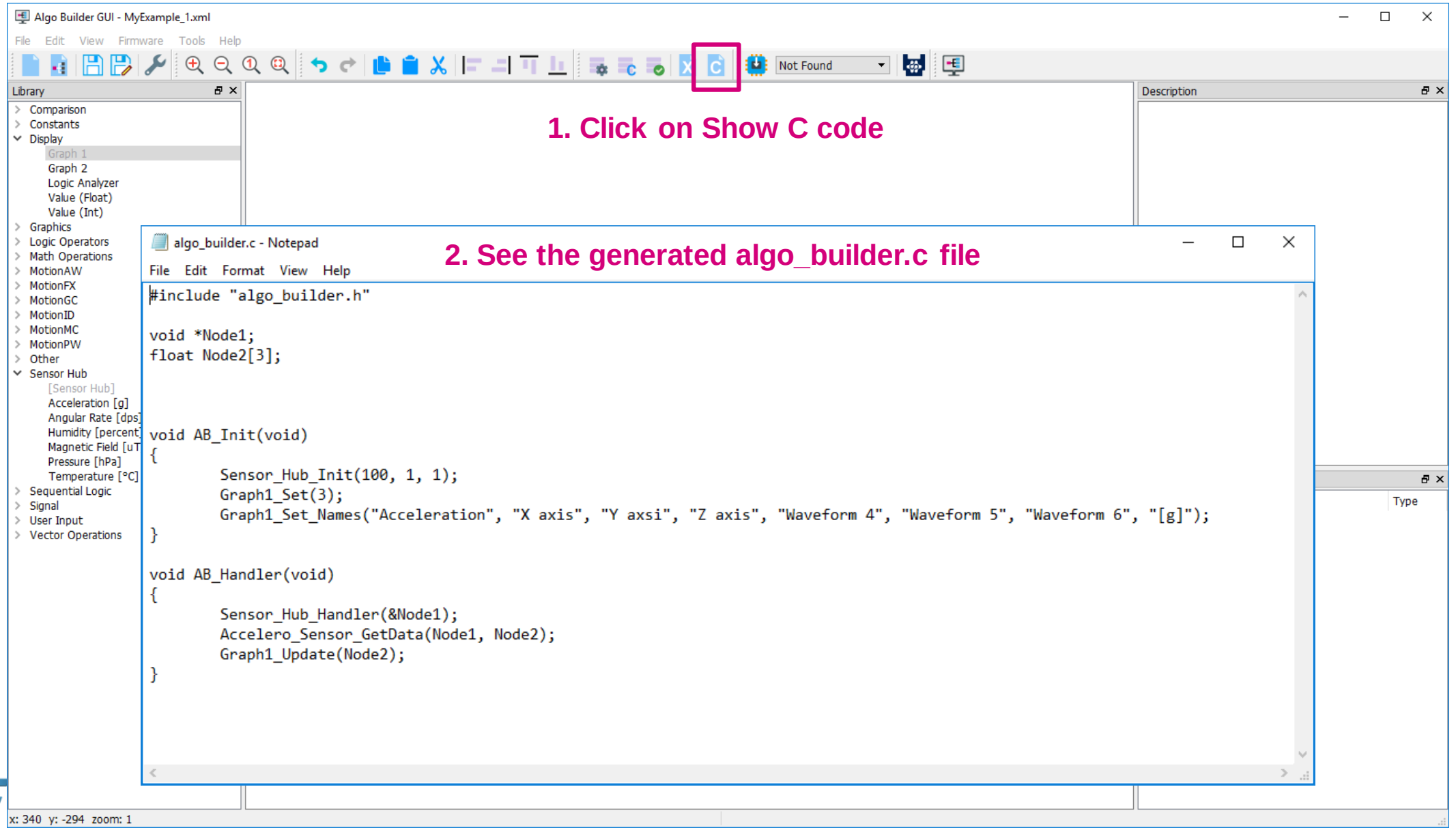

Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graph 1
Graph 2
Logic Analyzer
Value (Float)
Value (Int)
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
[Sensor Hub]
Acceleration [g]
Graph 1
Drag and drop [Sensor Hub], Acceleration and Graph 1 function blocks to the workspace.
Description
Properties
Name
Value
Type
Console
x: -354 y: -301 zoom: 1

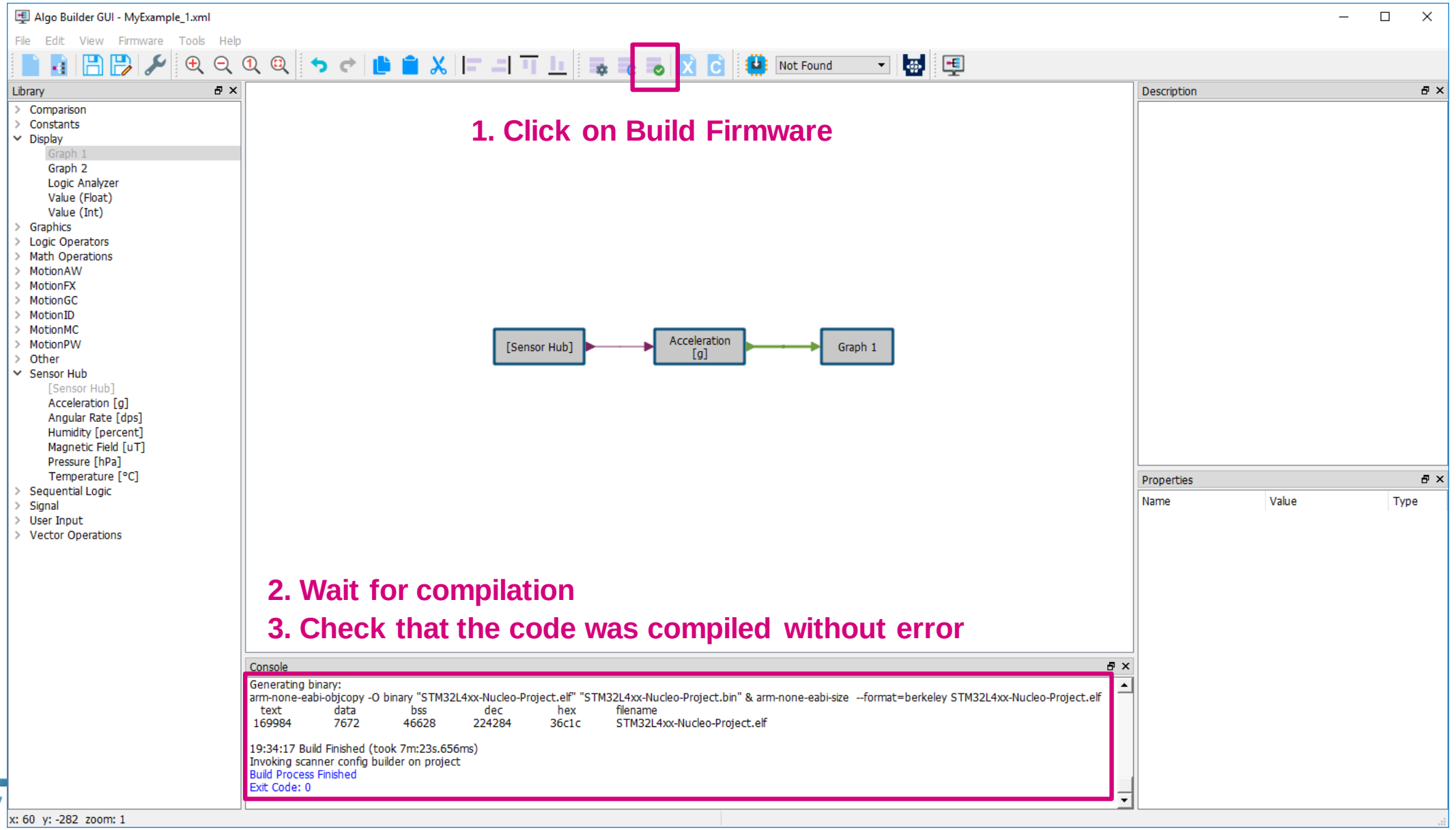

AlgoBuilder GUI*
File Edit View Firmware Tools Help
D: NODE_L476RG
Library
Filter:
Comparison
Constants
Display
Bar
Fusion
Graph
Histogram
Logic Analyzer
Plot3D
Scatter
Value
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
Temperature
User Input
Vector Operations
1. Selects Graph
[Sensor Hub]
Acceleration [g]
Graph
2. Set properties
Console
Description
Graph
Version: 2.0
Graph. Displays up to six real-time curves. The X-axis represents time, Y-axis is value.
Input Pins:
in (variant x 3):
Input data to plot (y-axis value). The input data size has to match with number of curves.
Properties:
Number of Curves (int):
Defines number of curves to plot. Value must be from 1 to 6.
Range: <1, 6>
Graph Name (string):
Label of the graph.
Waveform 1 Name (string):
Name of the waveform 1.
Waveform 2 Name (string):
Name of the waveform 2.
Waveform 3 Name (string):
Name of the waveform 3.
Waveform 4 Name (string):
Name of the waveform 4.
Waveform 5 Name (string):
Properties
Name
Value
Type
Number of Curves 3 INT
Graph Name Acceleration STRING
Waveform 1 Name X axis STRING
Waveform 2 Name Y axis STRING
Waveform 3 Name Z axis STRING
Unit Name [g] STRING
Zero axis position Middle ENUM
Auto-scale ON ENUM
Full Scale 1 STRING
x: 266 y: -292 zoom: 1

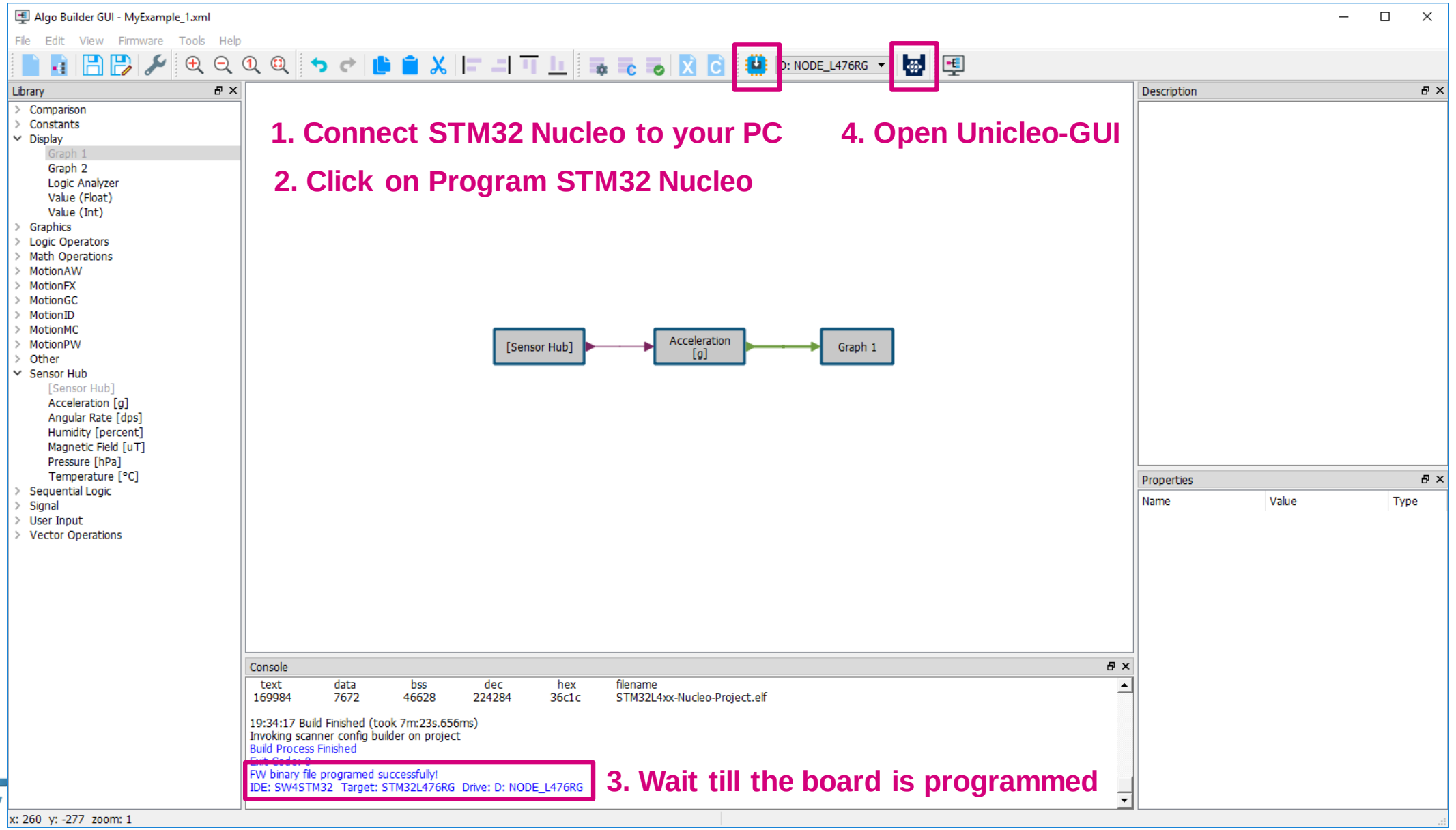

Algo Builder GUI - *
File
Edit
View
Firmware
Tools
Help
Not Found
Library
Comparison
Constants
Display
Graph 1
Graph 2
Logic Analyzer
Value (Float)
Value (Int)
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
[Sensor Hub]
Acceleration [g]
Graph 1
Connect function blocks.
(Click on output and hold left mouse button,
move to the input and release)
Description
Properties
Name
Value
Type
Console
x: 474 y: 68 zoom: 1


Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graph 1
Graph 2
Logic Analyzer
Value (Float)
Value (Int)
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
Save the design to default path with name "MyExample_1.xml"
Description
Properties
Name
Value
Type
Save Design
Miroslav BATEK › STMicroelectronics › AlgoBuilder › Designs
Search Designs
Organize
New folder
Quick access
Desktop
Downloads
Documents
Pictures
AlgoBuilder
Designs
SW_AlgoBuilder
Weekly 2018
This PC
Desktop
Documents
Downloads
Music
Pictures
Name
Date modified
Type
Size
Example01_Demo.xml 6/4/2018 9:08 AM XML File 44 KB
Example02_FreeFall.xml 6/4/2018 9:08 AM XML File 40 KB
Example03_Tilt_Measurement.xml 6/4/2018 9:08 AM XML File 39 KB
Example04_Filters.xml 6/4/2018 9:08 AM XML File 21 KB
Example05_Feature_Computation.xml 6/4/2018 9:08 AM XML File 23 KB
Example06_ZeroCrossing_PeakDetector.x... 6/4/2018 9:08 AM XML File 52 KB
Example07_Algorithms_Integration.xml 6/4/2018 9:08 AM XML File 40 KB
Example08_6D_Detection.xml 6/4/2018 9:08 AM XML File 37 KB
Example08_6D_Detection_v2.xml 4/17/2018 3:23 PM XML File 39 KB
Example09_Tilt_Using_Gyro.xml 5/21/2018 8:57 AM XML File 23 KB
MyExample_1.xml 6/9/2018 12:57 AM XML File 7 KB
MyExample_2.xml 6/9/2018 1:02 AM XML File 22 KB
MyExample_3.xml 6/9/2018 1:18 AM XML File 28 KB
MyExample_4.xml 6/9/2018 1:27 AM XML File 16 KB
File name: MyExample_1.xml
Save as type: *.xml
Hide Folders
Save
Cancel

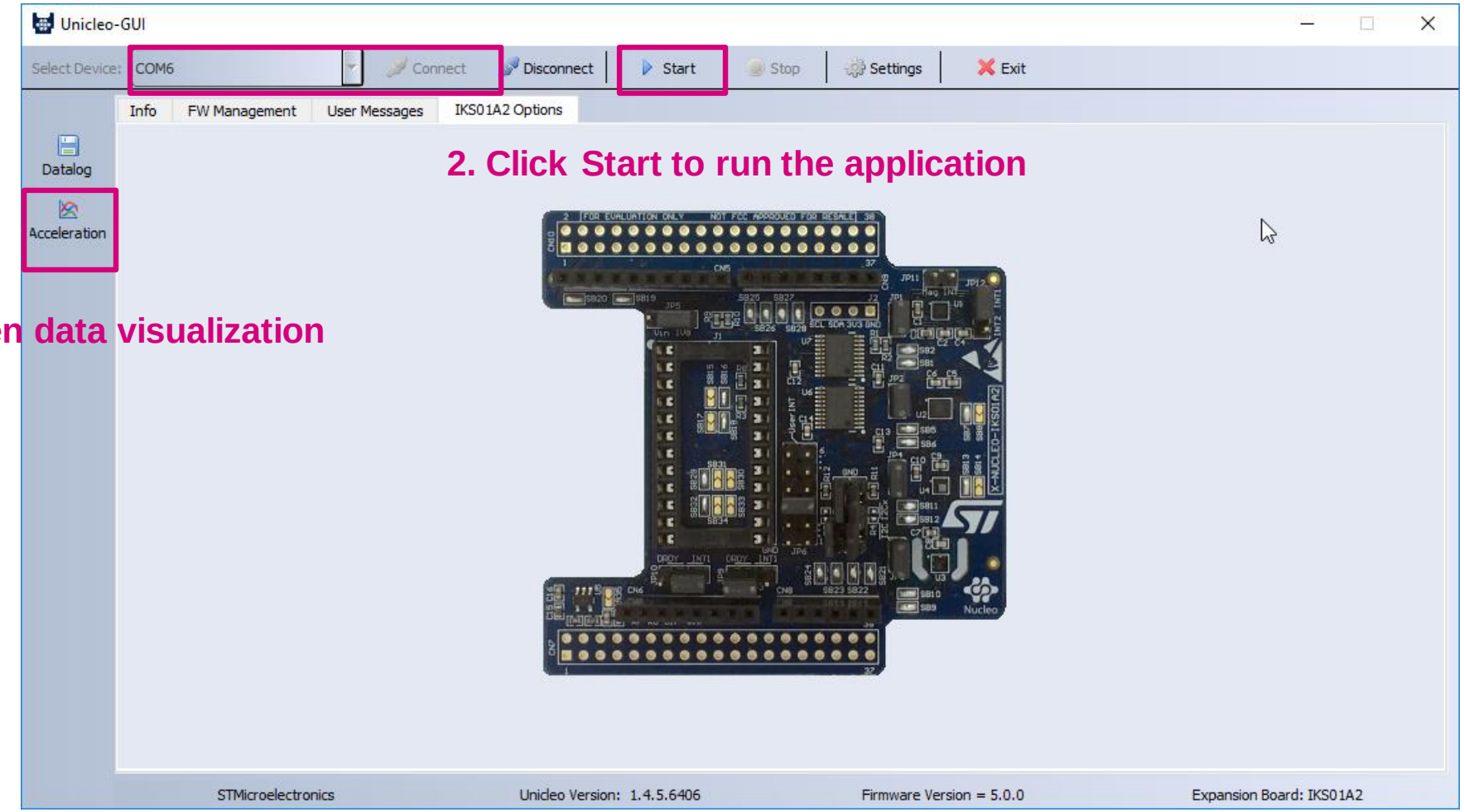

Algo Builder GUI - MyExample_1.xml
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graph 1
Graph 2
Logic Analyzer
Value (Float)
Value (Int)
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
1. Click on Generate C code
[Sensor Hub]
Acceleration [g]
Graph 1
Description
Properties
Name
Value
Type
Console
Code generation finished successfully.
2. Check if the code was generated successfully
x: 465 y: -269 zoom: 1


Algo Builder GUI - MyExample_1.xml
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graph 1
Graph 2
Logic Analyzer
Value (Float)
Value (Int)
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
Description
Type
1. Click on Show C code
2. See the generated algo_builder.c file
algo_builder.c - Notepad
File Edit Format View Help
#include "algo_builder.h"
void *Node1;
float Node2[3];
void AB_Init(void)
{
Sensor_Hub_Init(100, 1, 1);
Graph1_Set(3);
Graph1_Set_Names("Acceleration", "X axis", "Y axsi", "Z axis", "Waveform 4", "Waveform 5", "Waveform 6", "[g]");
}
void AB_Handler(void)
{
Sensor_Hub_Handler(&Node1);
Accelero_Sensor_GetData(Node1, Node2);
Graph1_Update(Node2);
}
x: 340 y: -294 zoom: 1


Algo Builder GUI - MyExample_1.xml
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graph 1
Graph 2
Logic Analyzer
Value (Float)
Value (Int)
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
1. Click on Build Firmware
[Sensor Hub]
Acceleration [g]
Graph 1
2. Wait for compilation
3. Check that the code was compiled without error
Description
Properties
Name
Value
Type
Console
Generating binary:
arm-none-eabi-objcopy -O binary "STM32L4xx-Nucleo-Project.elf" "STM32L4xx-Nucleo-Project.bin" & arm-none-eabi-size --format=berkeley STM32L4xx-Nucleo-Project.elf
text data bss dec hex filename
169984 7672 46628 224284 36c1c STM32L4xx-Nucleo-Project.elf
19:34:17 Build Finished (took 7m:23s.656ms)
Invoking scanner config builder on project
Build Process Finished
Exit Code: 0
x: 60 y: -282 zoom: 1

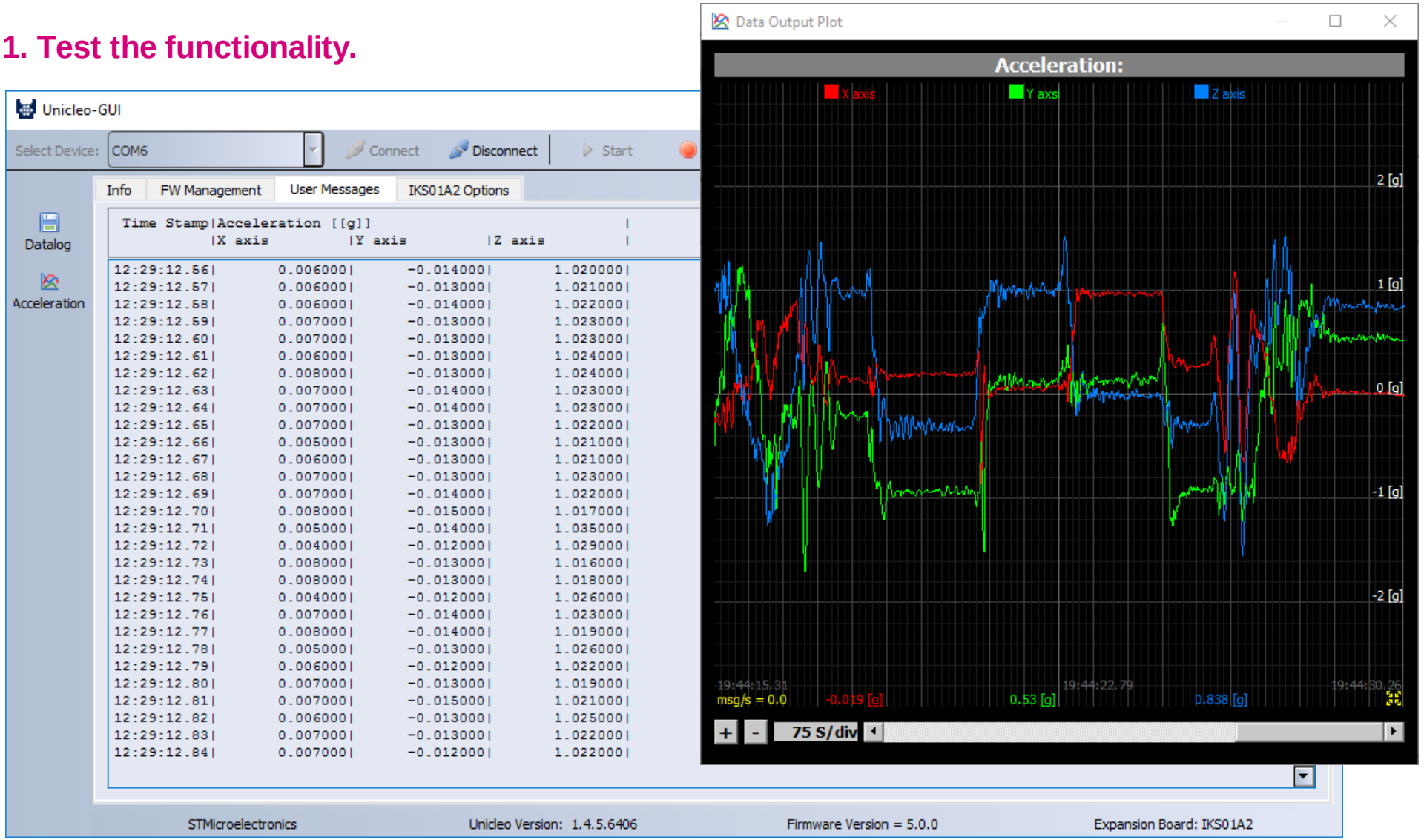

Algo Builder GUI - MyExample_1.xml
File Edit View Firmware Tools Help
D: NODE_L476RG
Library
Comparison
Constants
Display
Graph 1
Graph 2
Logic Analyzer
Value (Float)
Value (Int)
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
1. Connect STM32 Nucleo to your PC
2. Click on Program STM32 Nucleo
4. Open Unicleo-GUI
[Sensor Hub]
Acceleration [g]
Graph 1
Description
Properties
Name
Value
Type
Console
text data bss dec hex filename
169984 7672 46628 224284 36c1c STM32L4xx-Nucleo-Project.elf
19:34:17 Build Finished (took 7m:23s.656ms)
Invoking scanner config builder on project
Build Process Finished
FW binary file programed successfully!
IDE: SW4STM32 Target: STM32L476RG Drive: D: NODE_L476RG
3. Wait till the board is programmed
x: 260 y: -277 zoom: 1

1. Check the boards is connected to Unicleo GUI



life.augmented

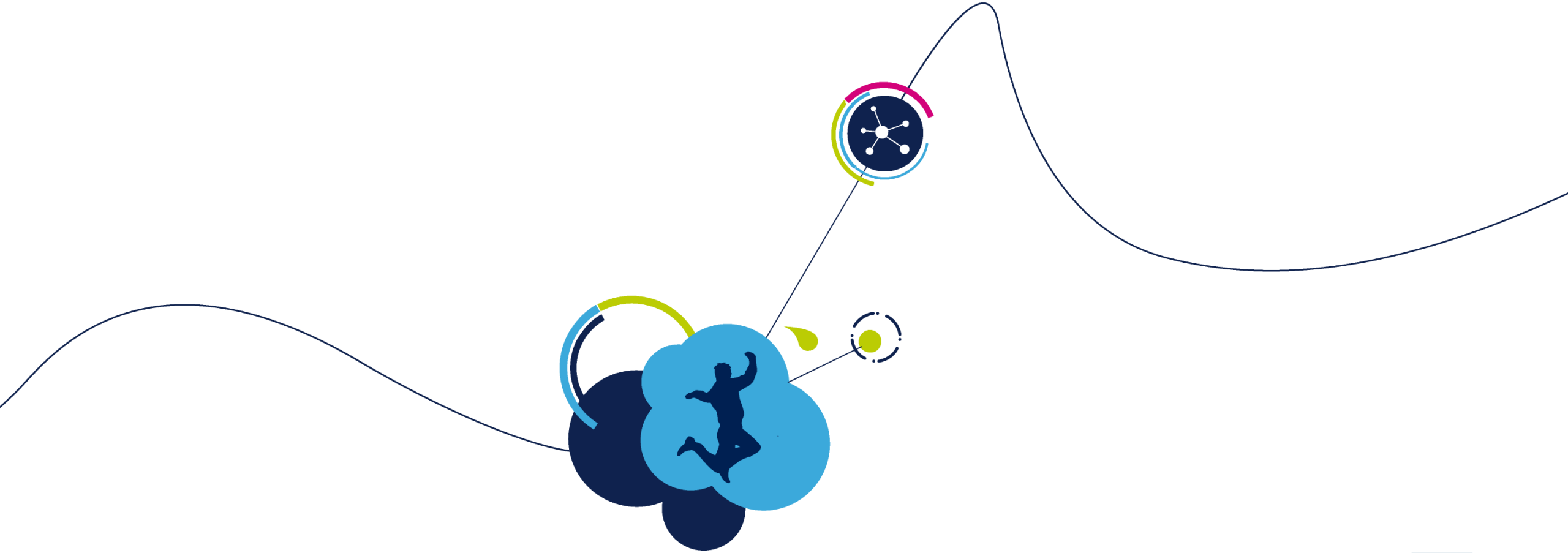
1. Test the functionality.

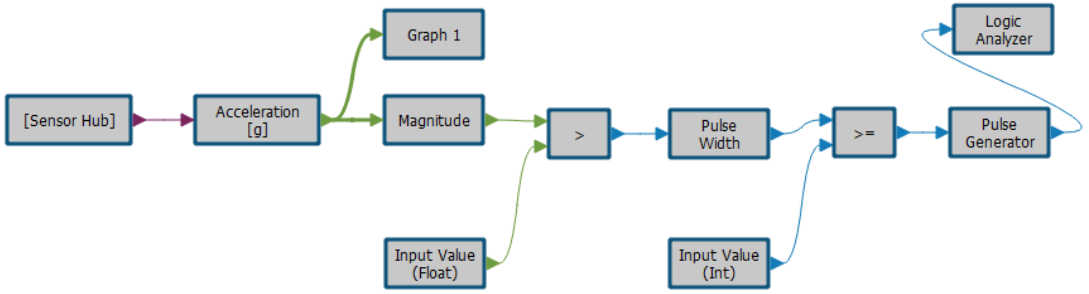


← Autoscale

2. Close Unicleo-GUI when you finished the testing.

life.augmented

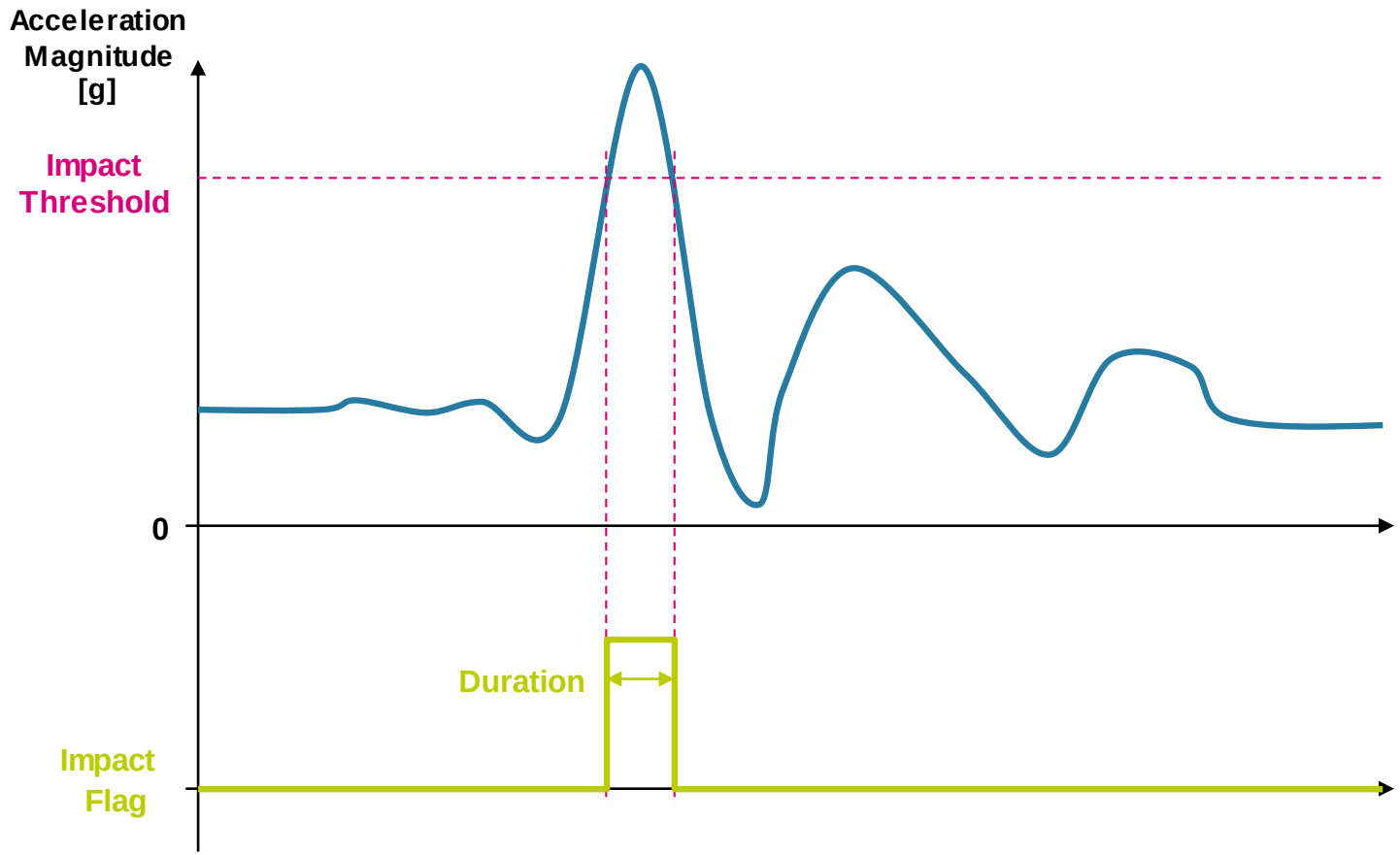


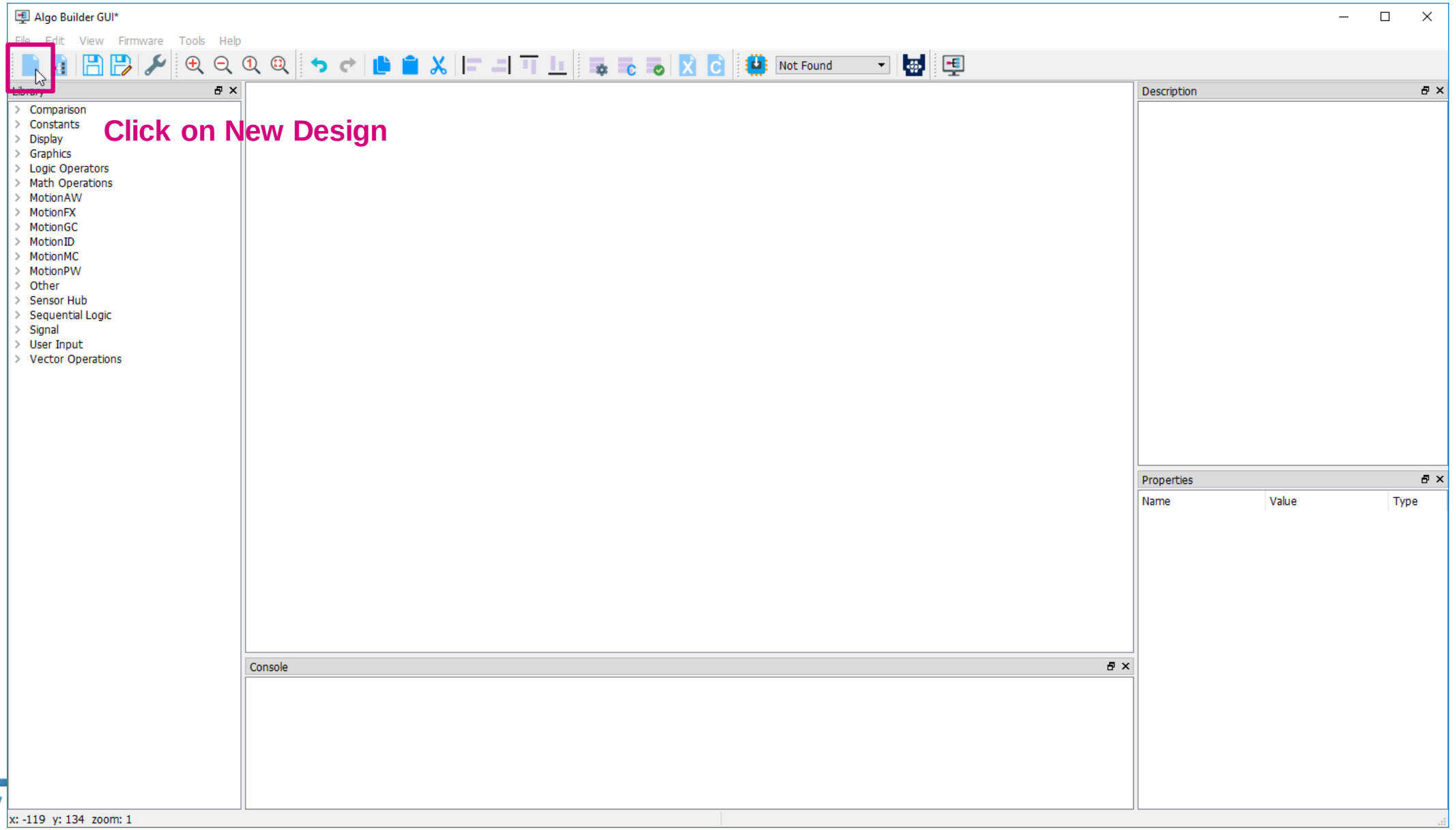


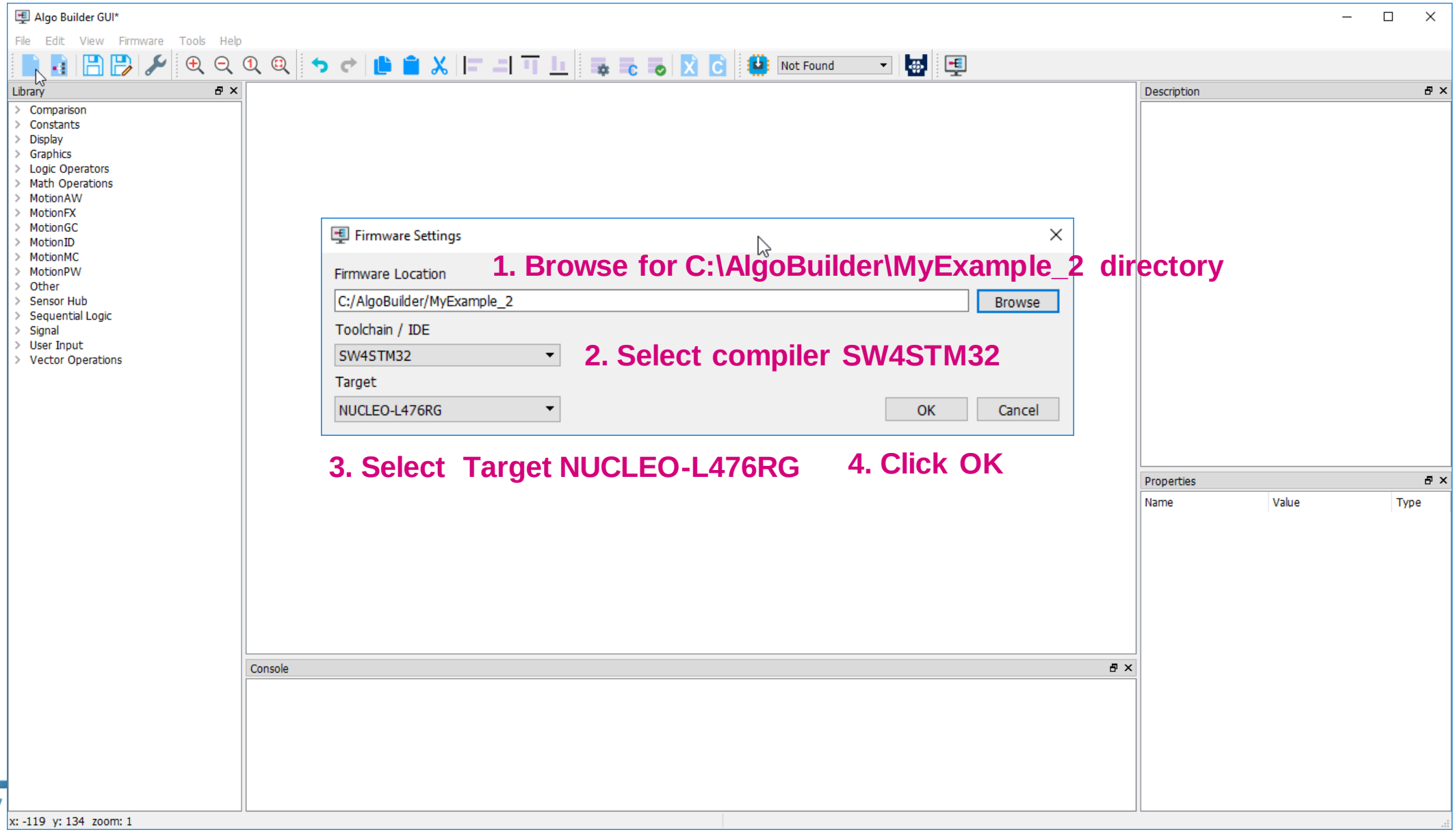
Demo 2
Impact Detection

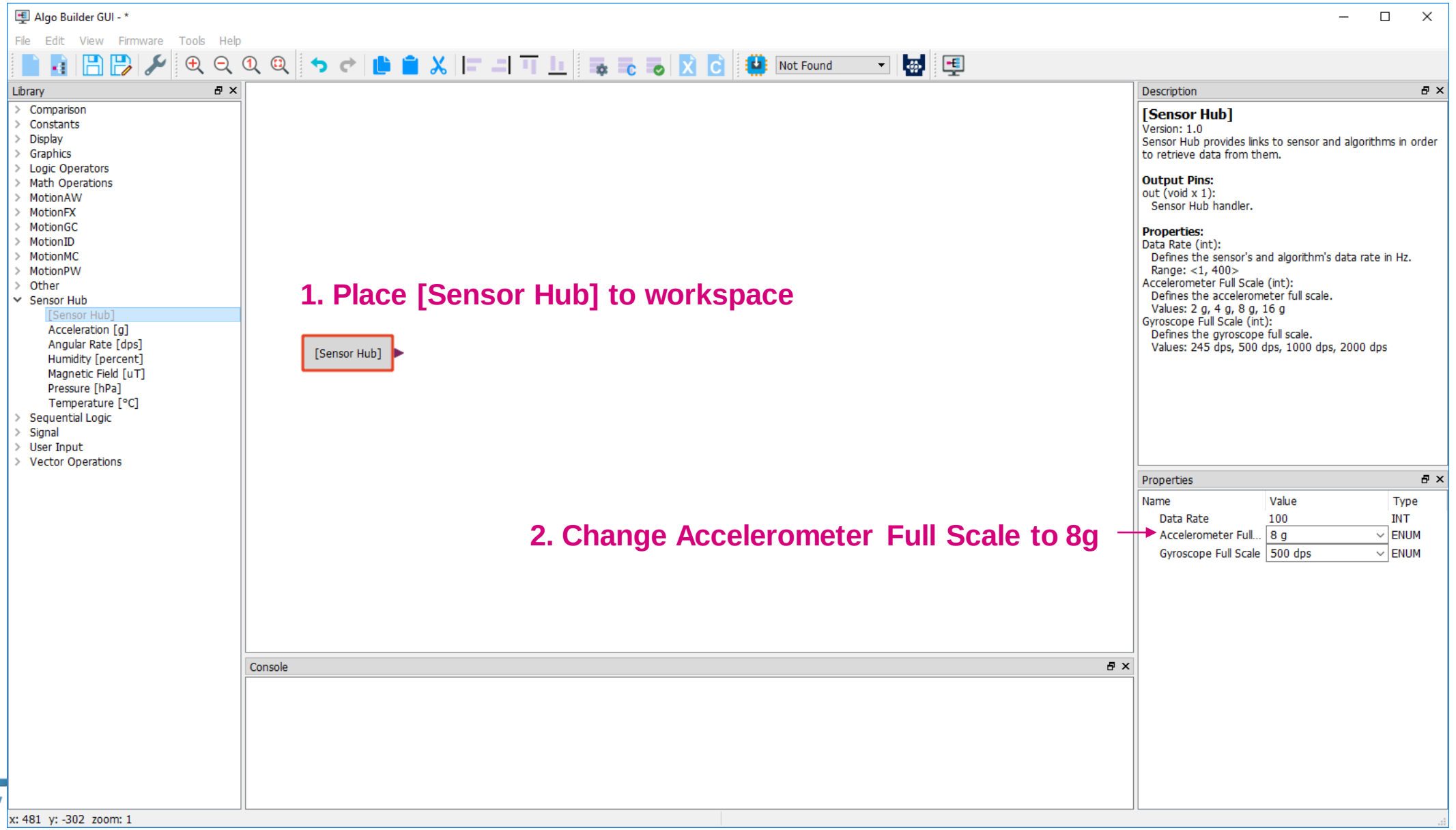
life.augmented

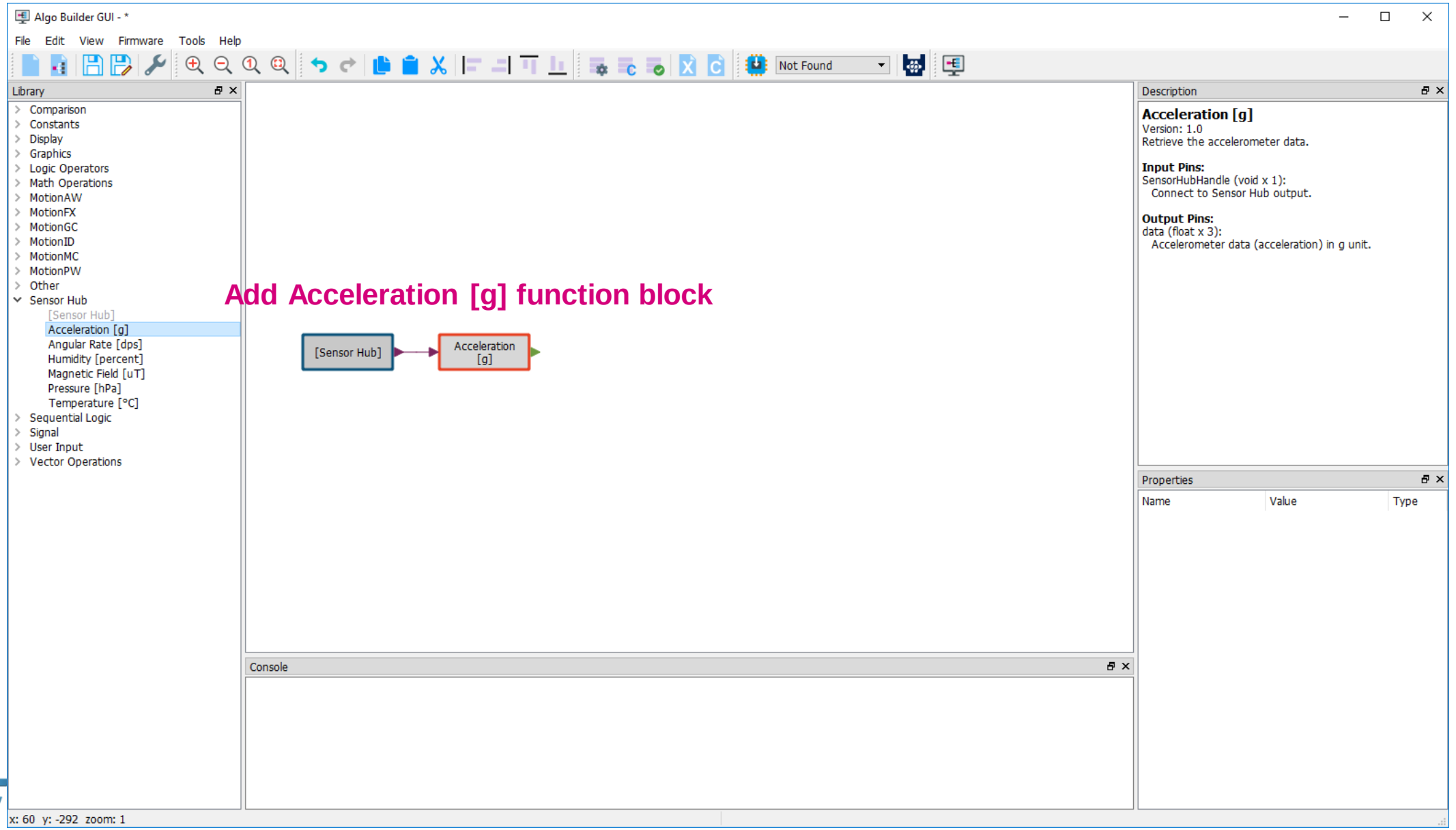
Impact Detection … Evaluate if magnitude of acceleration is above given threshold for certain time.

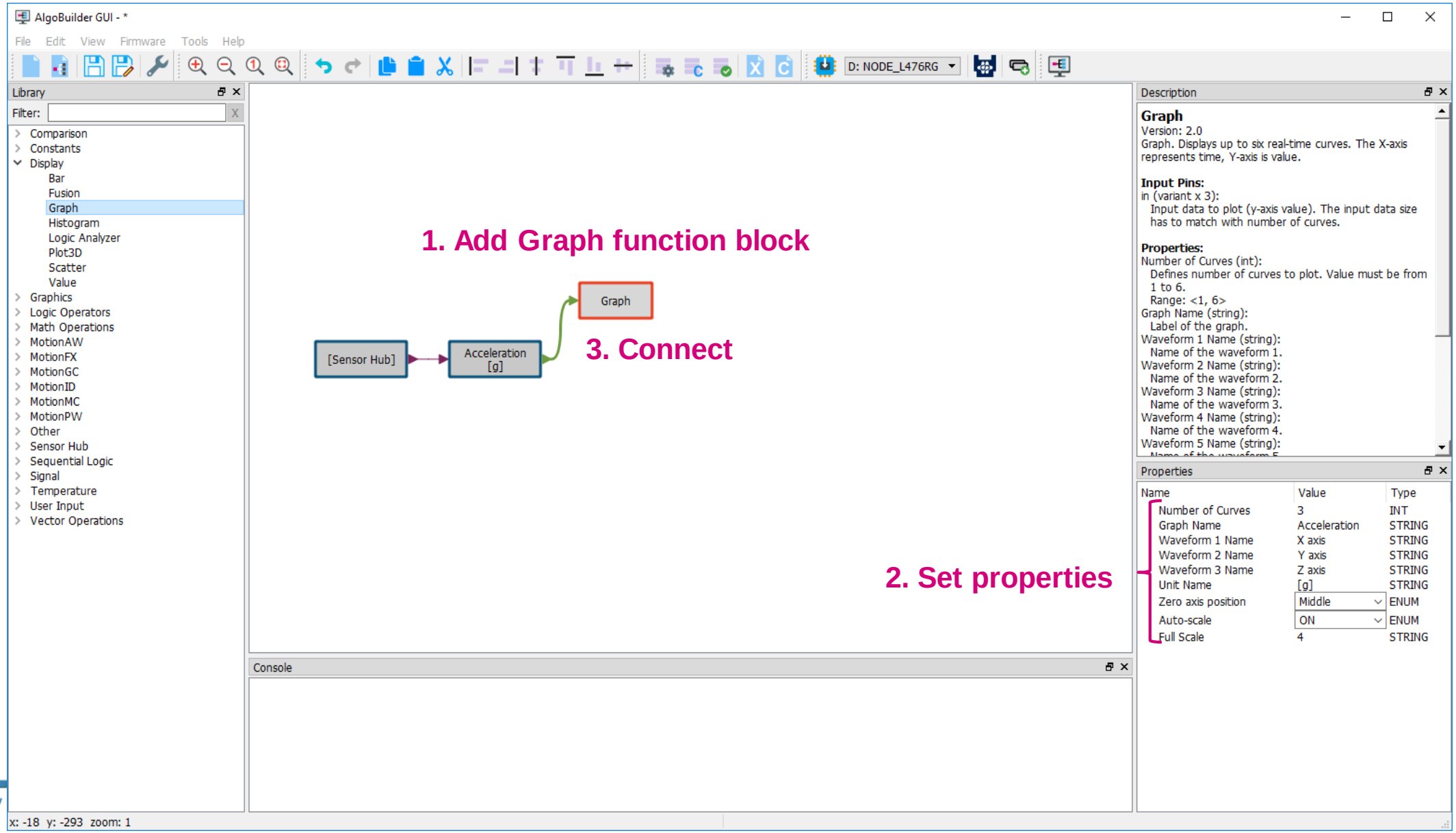


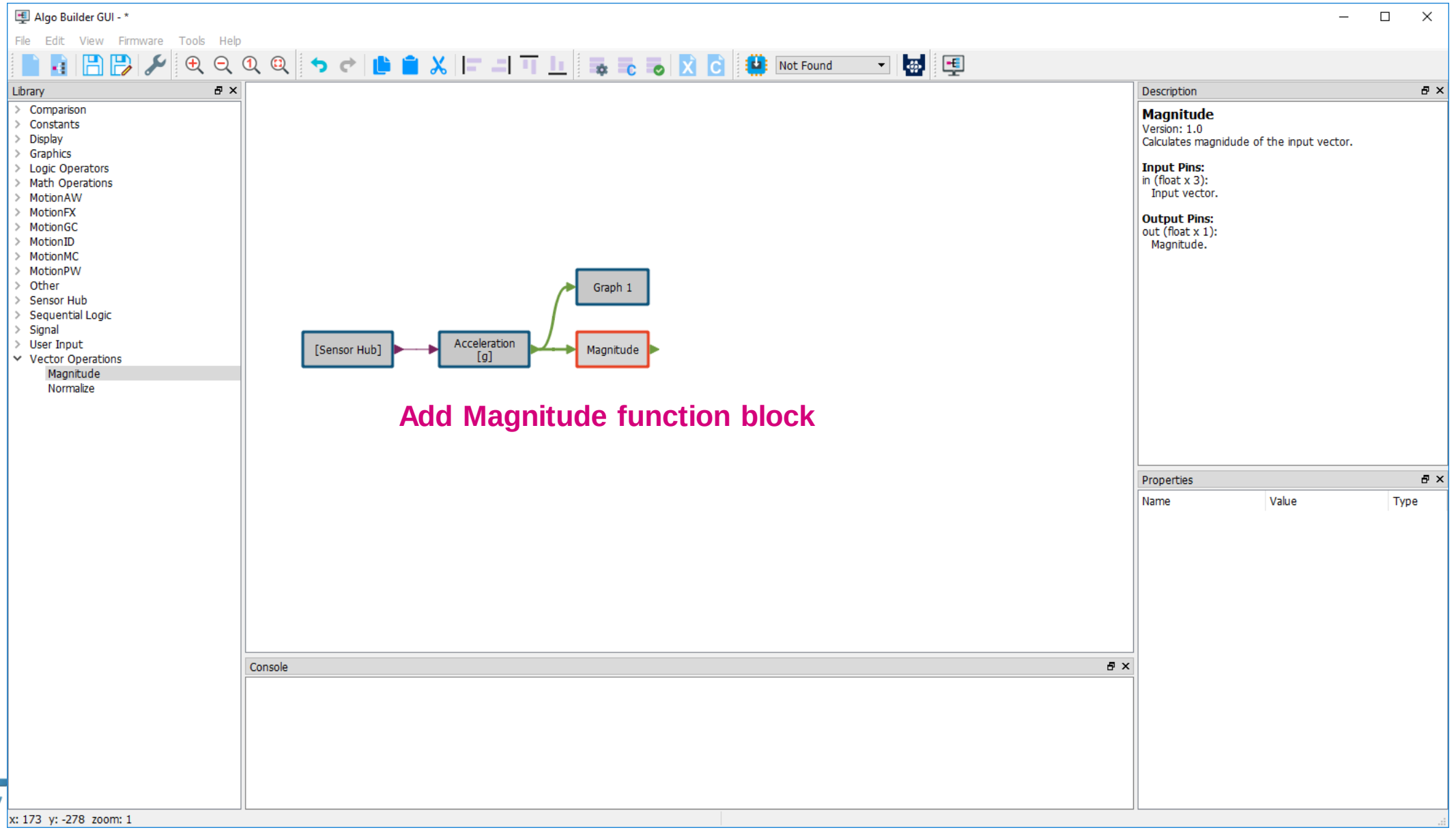

Algo Builder GUI*
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
Click on New Design
Description
Properties
Name
Value
Type
Console
x: -119 y: 134 zoom: 1

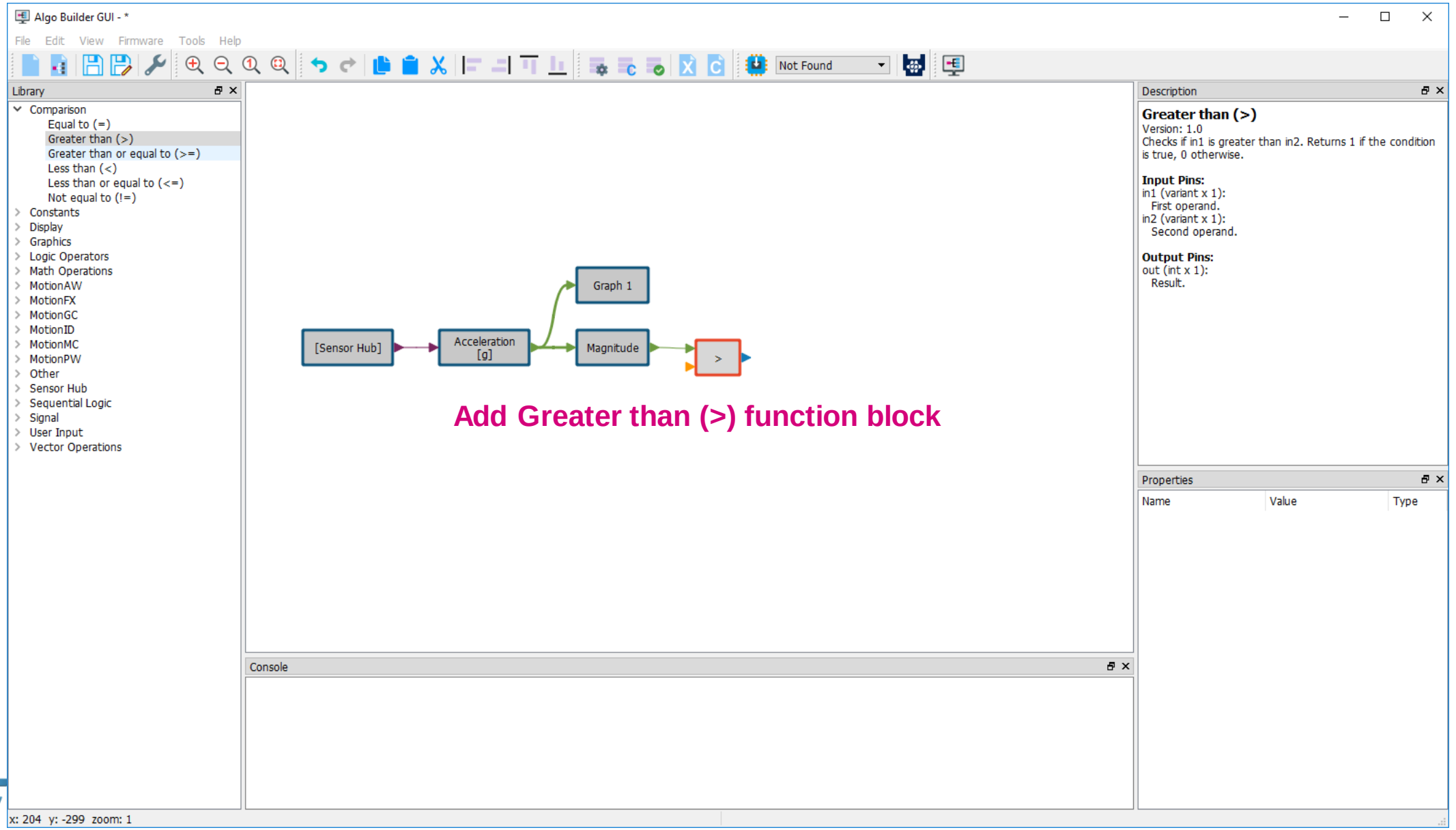

Algo Builder GUI*
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
Description
Properties
Name
Value
Type
Console
x: -119 y: 134 zoom: 1
Firmware Settings
Firmware Location
C:/AlgoBuilder/MyExample_2
Browse
Toolchain / IDE
SW4STM32
Target
NUCLEO-L476RG
OK
Cancel
1. Browse for C:\AlgoBuilder\MyExample_2 directory
2. Select compiler SW4STM32
3. Select Target NUCLEO-L476RG
4. Click OK

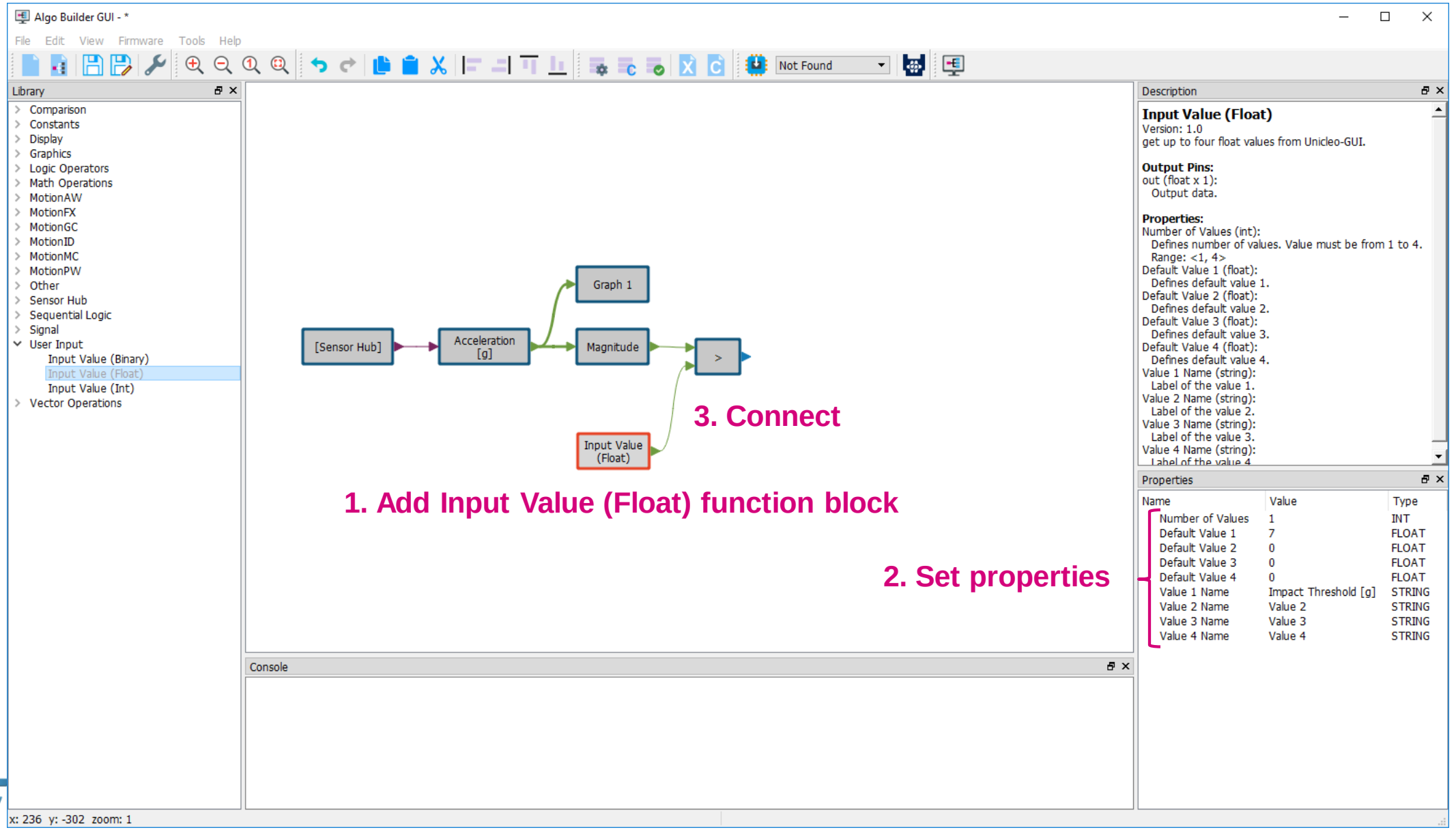

Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
1. Place [Sensor Hub] to workspace
[Sensor Hub]
2. Change Accelerometer Full Scale to 8g
Console
Description
[Sensor Hub]
Version: 1.0
Sensor Hub provides links to sensor and algorithms in order to retrieve data from them.
Output Pins:
out (void x 1):
Sensor Hub handler.
Properties:
Data Rate (int):
Defines the sensor's and algorithm's data rate in Hz.
Range: <1, 400>
Accelerometer Full Scale (int):
Defines the accelerometer full scale.
Values: 2 g, 4 g, 8 g, 16 g
Gyroscope Full Scale (int):
Defines the gyroscope full scale.
Values: 245 dps, 500 dps, 1000 dps, 2000 dps
Properties
Name
Value
Type
Data Rate
100
INT
Accelerometer Full...
8 g
ENUM
Gyroscope Full Scale
500 dps
ENUM
x: 481 y: -302 zoom: 1

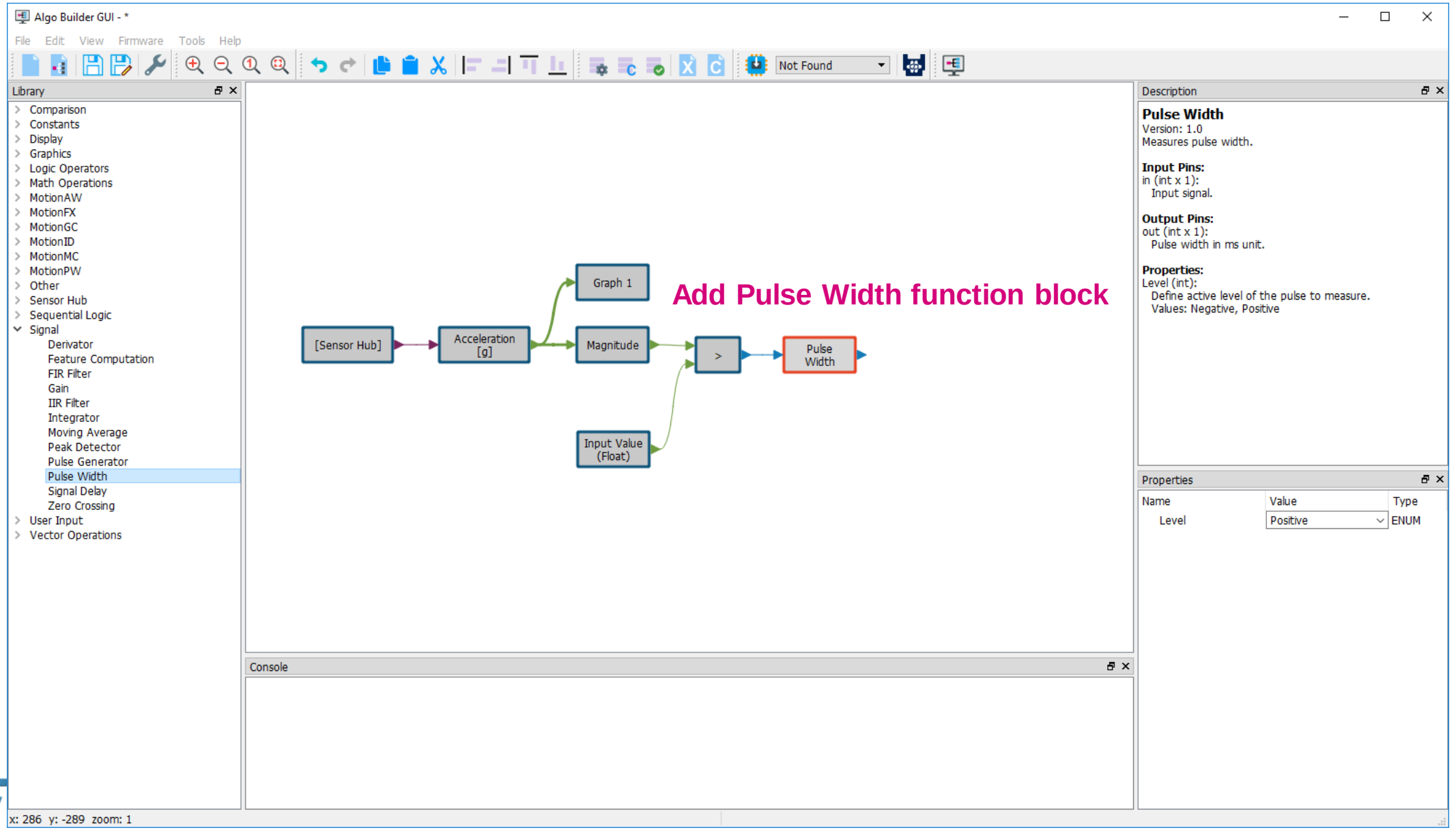

Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
Add Acceleration [g] function block
[Sensor Hub]
Acceleration [g]
Description
Acceleration [g]
Version: 1.0
Retrieve the accelerometer data.
Input Pins:
SensorHubHandle (void x 1):
Connect to Sensor Hub output.
Output Pins:
data (float x 3):
Accelerometer data (acceleration) in g unit.
Properties
Name
Value
Type
Console
x: 60 y: -292 zoom: 1

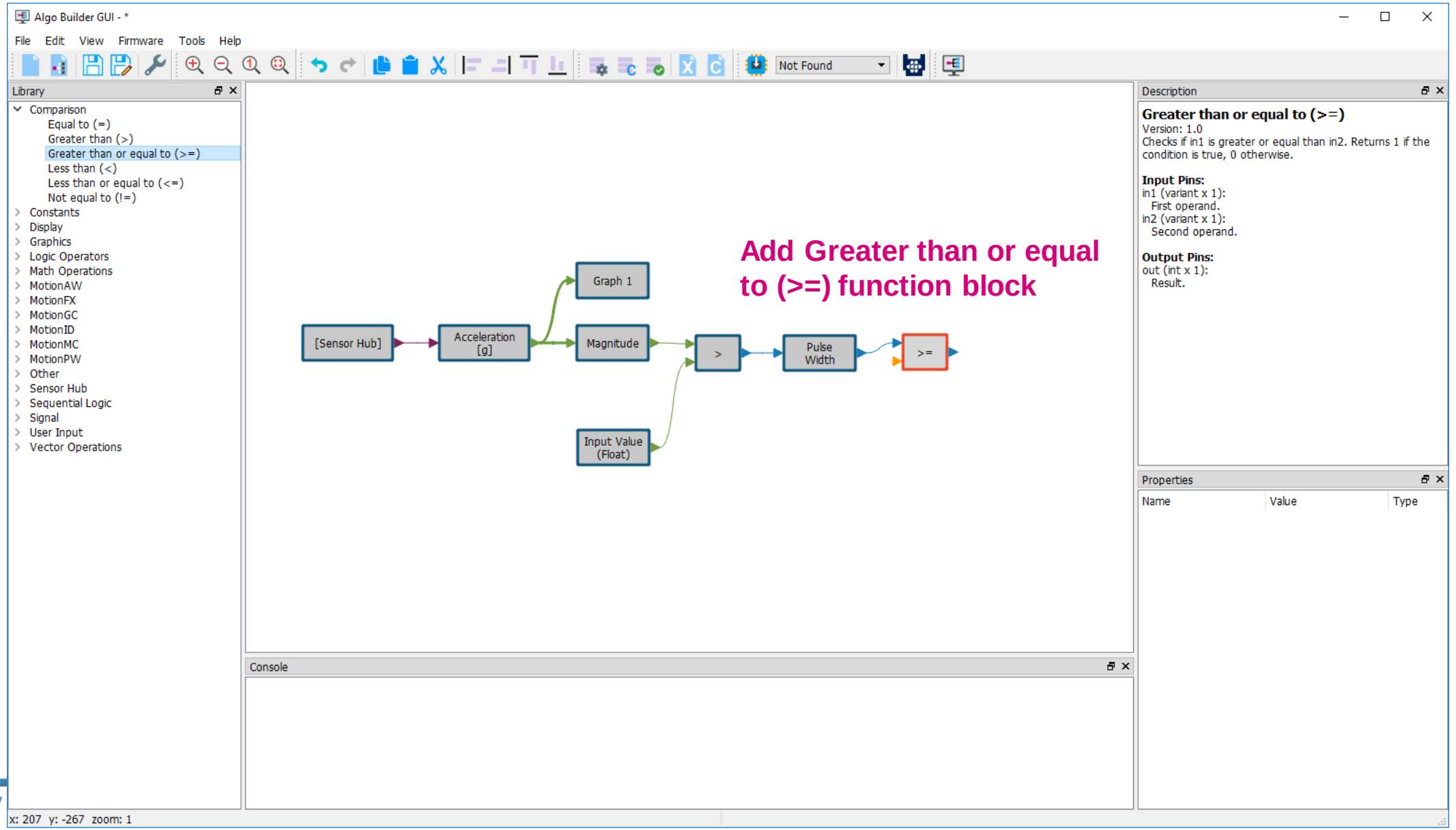

AlgoBuilder GUI - *
File Edit View Firmware Tools Help
D: NODE_L476RG
Library
Filter:
Comparison
Constants
Display
Bar
Fusion
Graph
Histogram
Logic Analyzer
Plot3D
Scatter
Value
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
Temperature
User Input
Vector Operations
1. Add Graph function block
Graph
[Sensor Hub]
Acceleration [g]
3. Connect
2. Set properties
Console
Description
Graph
Version: 2.0
Graph. Displays up to six real-time curves. The X-axis represents time, Y-axis is value.
Input Pins:
in (variant x 3):
Input data to plot (y-axis value). The input data size has to match with number of curves.
Properties:
Number of Curves (int):
Defines number of curves to plot. Value must be from 1 to 6.
Range: <1, 6>
Graph Name (string):
Label of the graph.
Waveform 1 Name (string):
Name of the waveform 1.
Waveform 2 Name (string):
Name of the waveform 2.
Waveform 3 Name (string):
Name of the waveform 3.
Waveform 4 Name (string):
Name of the waveform 4.
Waveform 5 Name (string):
Properties
Name
Value
Type
Number of Curves 3 INT
Graph Name Acceleration STRING
Waveform 1 Name X axis STRING
Waveform 2 Name Y axis STRING
Waveform 3 Name Z axis STRING
Unit Name [g] STRING
Zero axis position Middle ENUM
Auto-scale ON ENUM
Full Scale 4 STRING
x: -18 y: -293 zoom: 1

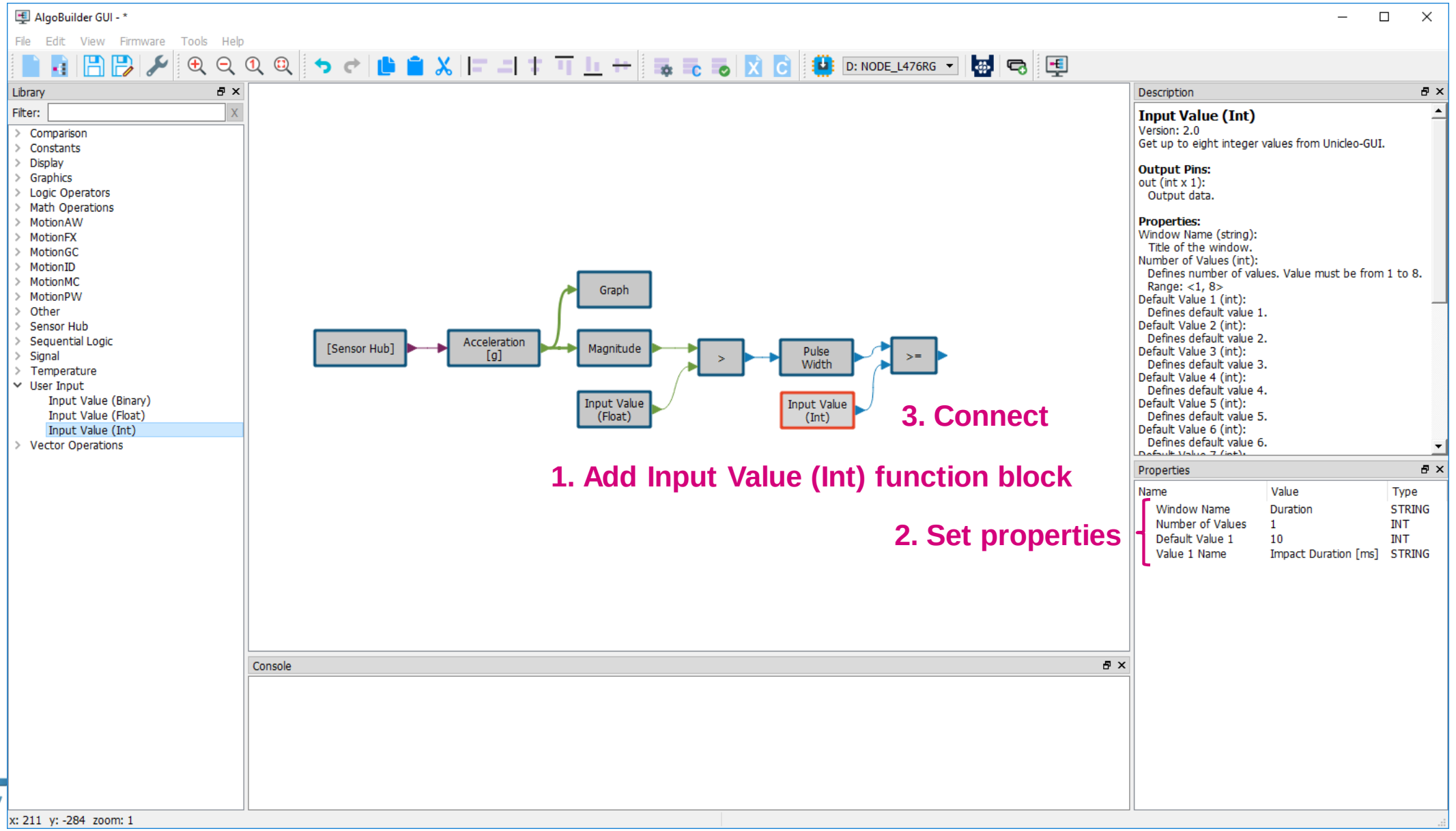

Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
Magnitude
Normalize
[Sensor Hub]
Acceleration [g]
Graph 1
Magnitude
Add Magnitude function block
Description
Magnitude
Version: 1.0
Calculates magnidude of the input vector.
Input Pins:
in (float x 3):
Input vector.
Output Pins:
out (float x 1):
Magnitude.
Properties
Name
Value
Type
Console
x: 173 y: -278 zoom: 1

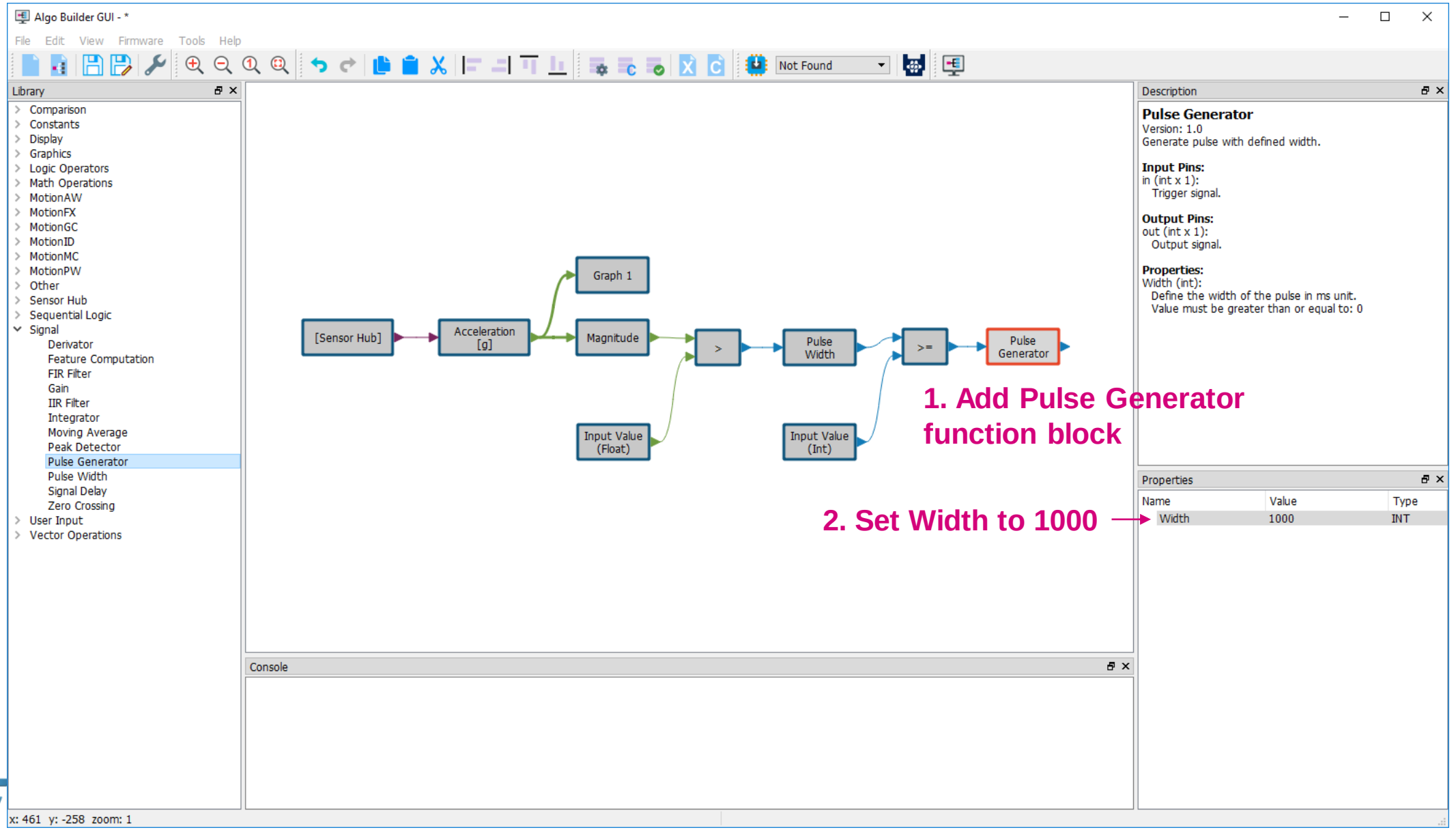

Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Equal to (=)
Greater than (>)
Greater than or equal to (>=)
Less than (<)
Less than or equal to (<=)
Not equal to (!=)
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
[Sensor Hub]
Acceleration [g]
Graph 1
Magnitude
>
Add Greater than (>) function block
Description
Greater than (>)
Version: 1.0
Checks if in1 is greater than in2. Returns 1 if the condition is true, 0 otherwise.
Input Pins:
in1 (variant x 1):
First operand.
in2 (variant x 1):
Second operand.
Output Pins:
out (int x 1):
Result.
Properties
Name
Value
Type
Console
x: 204 y: -299 zoom: 1

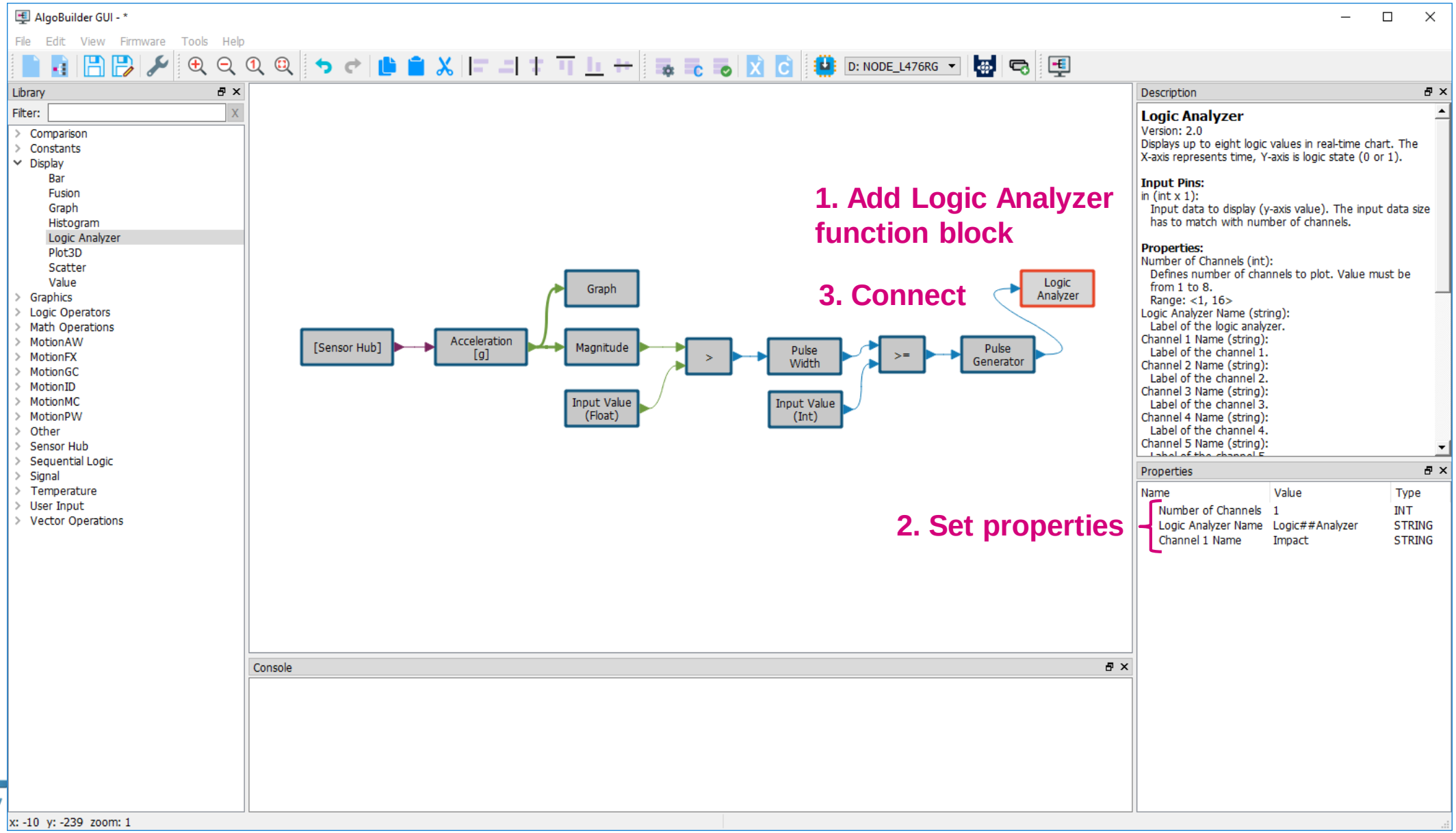

Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Input Value (Binary)
Input Value (Float)
Input Value (Int)
Vector Operations
[Sensor Hub]
Acceleration [g]
Graph 1
Magnitude
>
Input Value (Float)
3. Connect
1. Add Input Value (Float) function block
2. Set properties
Description
Input Value (Float)
Version: 1.0
get up to four float values from Unicleo-GUI.
Output Pins:
out (float x 1):
Output data.
Properties:
Number of Values (int):
Defines number of values. Value must be from 1 to 4.
Range: <1, 4>
Default Value 1 (float):
Defines default value 1.
Default Value 2 (float):
Defines default value 2.
Default Value 3 (float):
Defines default value 3.
Default Value 4 (float):
Defines default value 4.
Value 1 Name (string):
Label of the value 1.
Value 2 Name (string):
Label of the value 2.
Value 3 Name (string):
Label of the value 3.
Value 4 Name (string):
Properties
Name Value Type
Number of Values 1 INT
Default Value 1 7 FLOAT
Default Value 2 0 FLOAT
Default Value 3 0 FLOAT
Default Value 4 0 FLOAT
Value 1 Name Impact Threshold [g] STRING
Value 2 Name Value 2 STRING
Value 3 Name Value 3 STRING
Value 4 Name Value 4 STRING
Console
x: 236 y: -302 zoom: 1

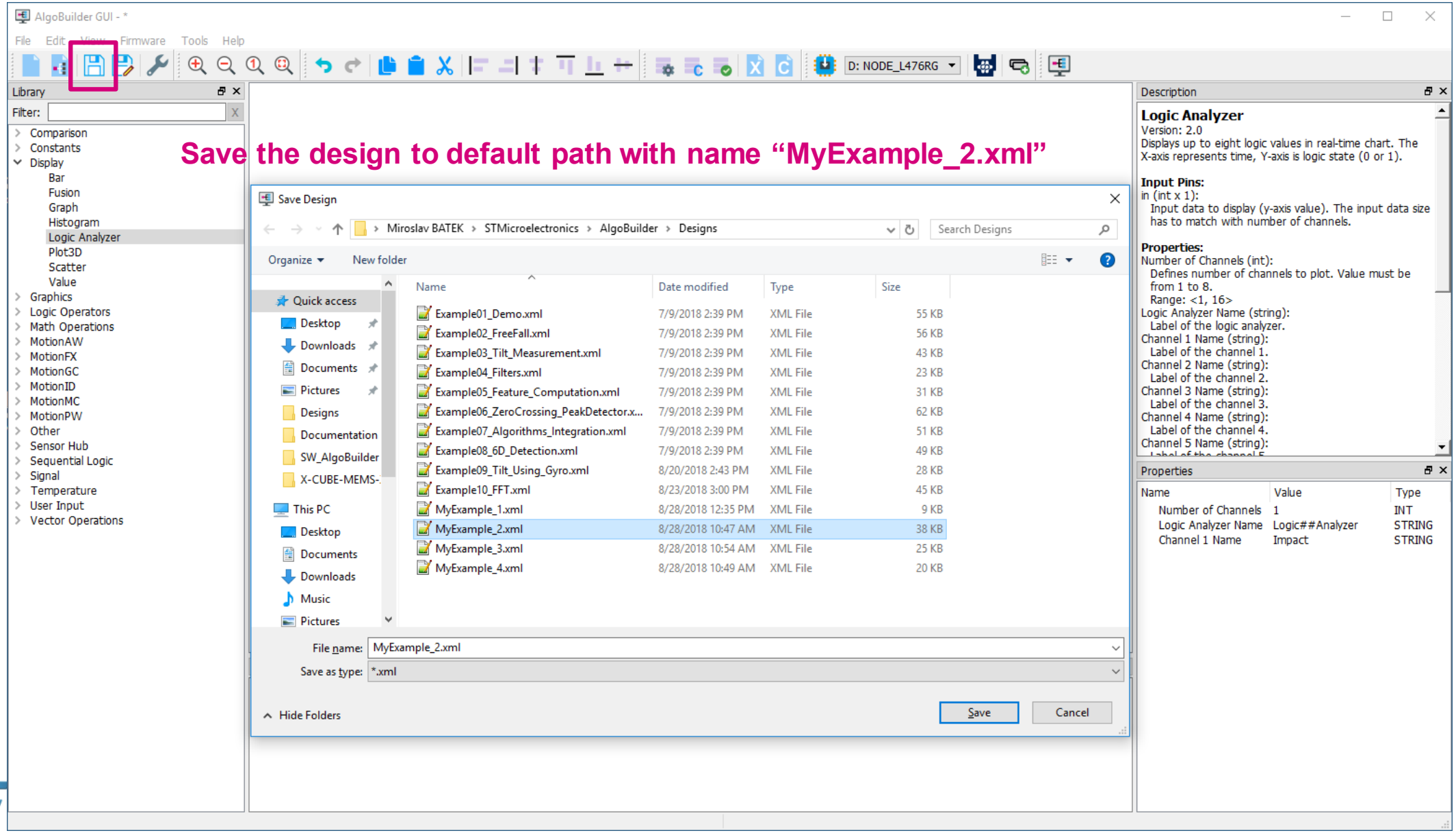

Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
Derivator
Feature Computation
FIR Filter
Gain
IIR Filter
Integrator
Moving Average
Peak Detector
Pulse Generator
Pulse Width
Signal Delay
Zero Crossing
User Input
Vector Operations
Add Pulse Width function block
[Sensor Hub]
Acceleration [g]
Graph 1
Magnitude
>
Pulse Width
Input Value (Float)
Description
Pulse Width
Version: 1.0
Measures pulse width.
Input Pins:
in (int x 1):
Input signal.
Output Pins:
out (int x 1):
Pulse width in ms unit.
Properties:
Level (int):
Define active level of the pulse to measure.
Values: Negative, Positive
Properties
Name
Value
Type
Level
Positive
ENUM
Console
x: 286 y: -289 zoom: 1

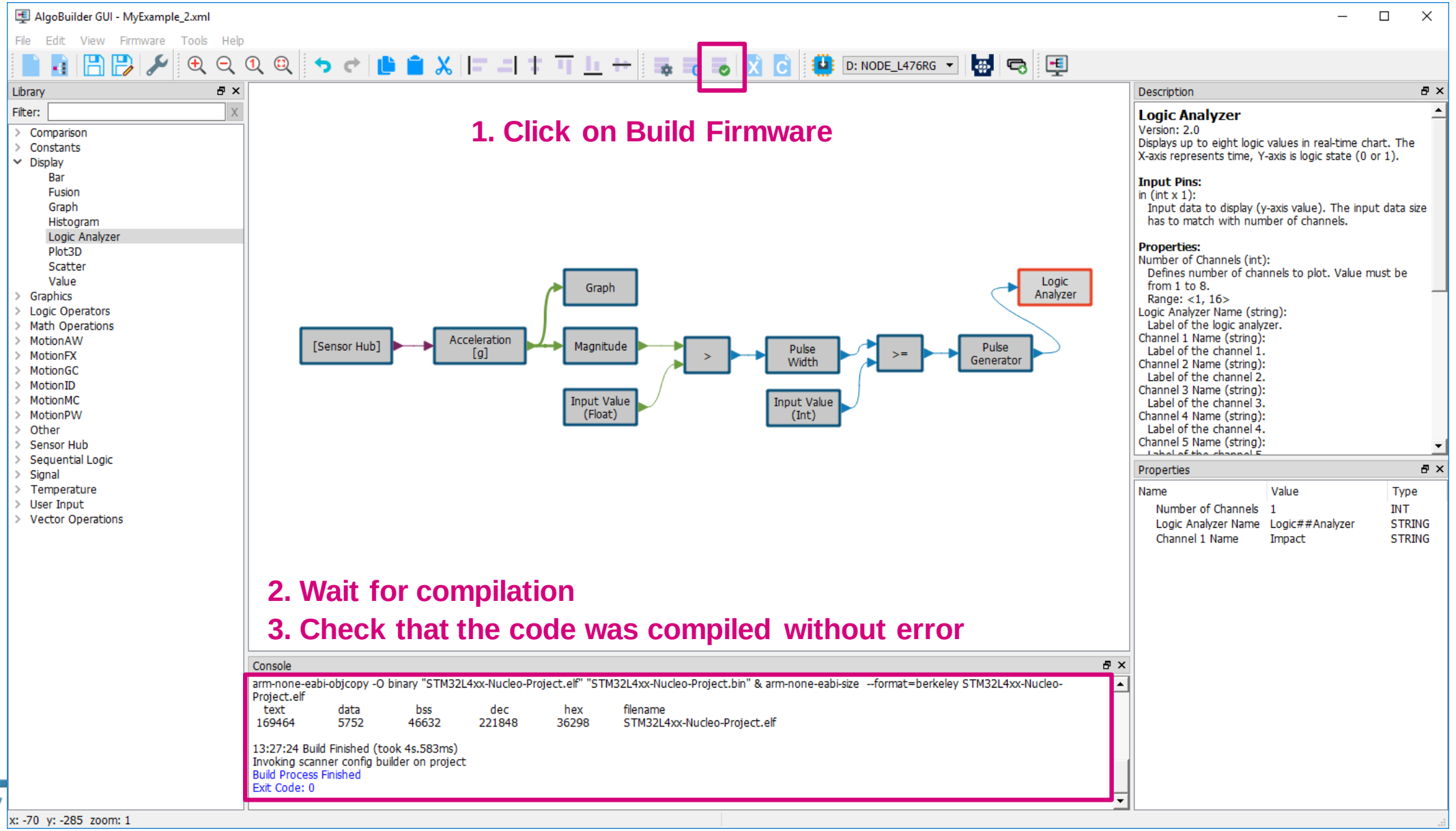

Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Equal to (=)
Greater than (>)
Greater than or equal to (>=)
Less than (<)
Less than or equal to (<=)
Not equal to (!=)
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
Add Greater than or equal to (>=) function block
[Sensor Hub]
Acceleration [g]
Graph 1
Magnitude
Input Value (Float)
>
Pulse Width
>=
Description
Greater than or equal to (>=)
Version: 1.0
Checks if in1 is greater or equal than in2. Returns 1 if the condition is true, 0 otherwise.
Input Pins:
in1 (variant x 1):
First operand.
in2 (variant x 1):
Second operand.
Output Pins:
out (int x 1):
Result.
Properties
Name
Value
Type
Console
x: 207 y: -267 zoom: 1

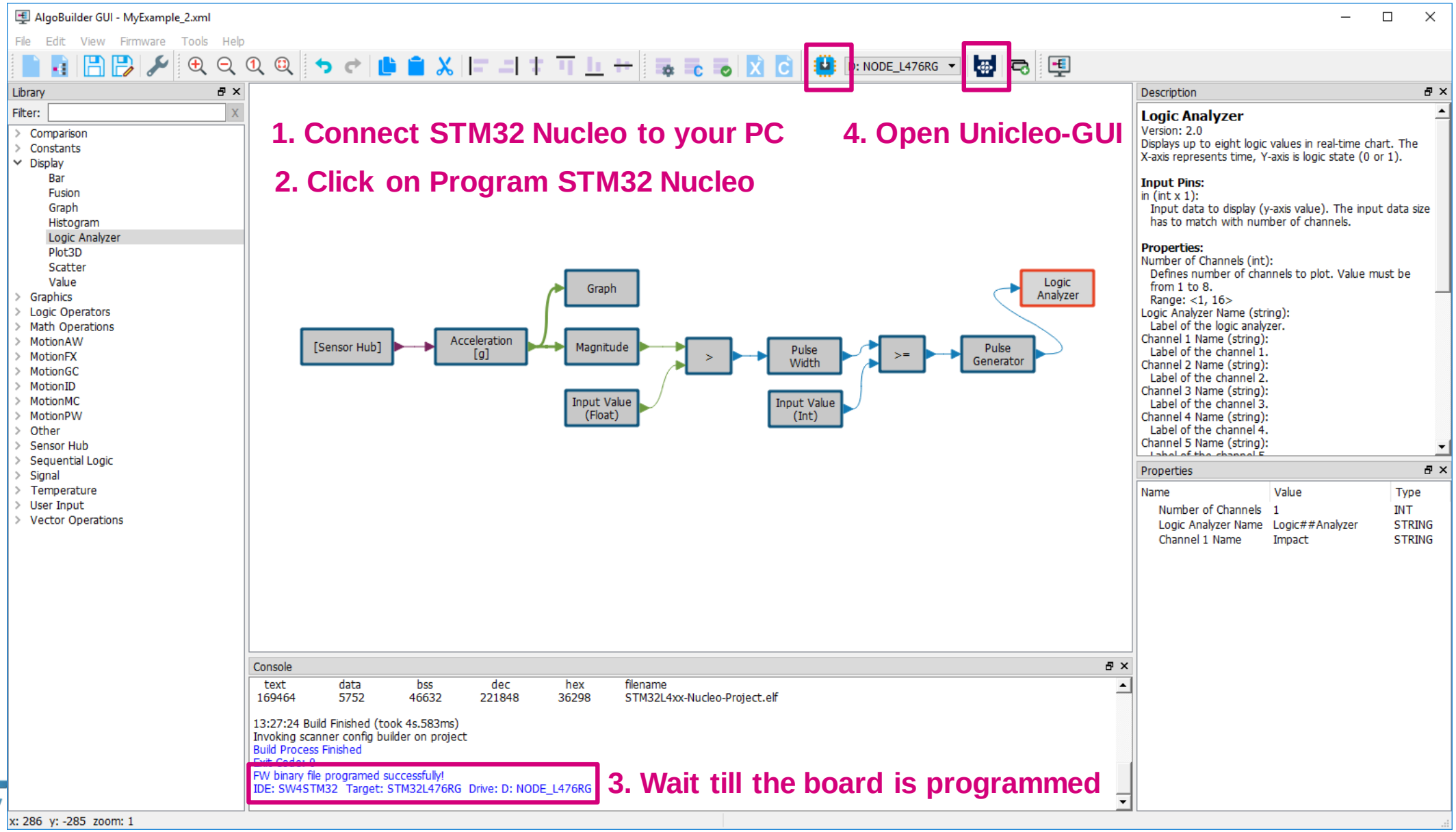

AlgoBuilder GUI - *
File Edit View Firmware Tools Help
D: NODE_L476RG
Library
Filter:
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
Temperature
User Input
Input Value (Binary)
Input Value (Float)
Input Value (Int)
Vector Operations
[Sensor Hub]
Acceleration [g]
Graph
Magnitude
Input Value (Float)
>
Pulse Width
Input Value (Int)
>=
3. Connect
1. Add Input Value (Int) function block
2. Set properties
Description
Input Value (Int)
Version: 2.0
Get up to eight integer values from Unicleo-GUI.
Output Pins:
out (int x 1):
Output data.
Properties:
Window Name (string):
Title of the window.
Number of Values (int):
Defines number of values. Value must be from 1 to 8.
Range: <1, 8>
Default Value 1 (int):
Defines default value 1.
Default Value 2 (int):
Defines default value 2.
Default Value 3 (int):
Defines default value 3.
Default Value 4 (int):
Defines default value 4.
Default Value 5 (int):
Defines default value 5.
Default Value 6 (int):
Defines default value 6.
Properties
Name
Value
Type
Window Name
Duration
STRING
Number of Values
1
INT
Default Value 1
10
INT
Value 1 Name
Impact Duration [ms]
STRING
Console
x: 211 y: -284 zoom: 1


Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
Derivator
Feature Computation
FIR Filter
Gain
IIR Filter
Integrator
Moving Average
Peak Detector
Pulse Generator
Pulse Width
Signal Delay
Zero Crossing
User Input
Vector Operations
[Sensor Hub]
Acceleration [g]
Graph 1
Magnitude
>
Input Value (Float)
Pulse Width
>=
Input Value (Int)
Pulse Generator
1. Add Pulse Generator function block
2. Set Width to 1000
Description
Pulse Generator
Version: 1.0
Generate pulse with defined width.
Input Pins:
in (int x 1):
Trigger signal.
Output Pins:
out (int x 1):
Output signal.
Properties:
Width (int):
Define the width of the pulse in ms unit.
Value must be greater than or equal to: 0
Properties
Name
Value
Type
Width
1000
INT
Console
x: 461 y: -258 zoom: 1

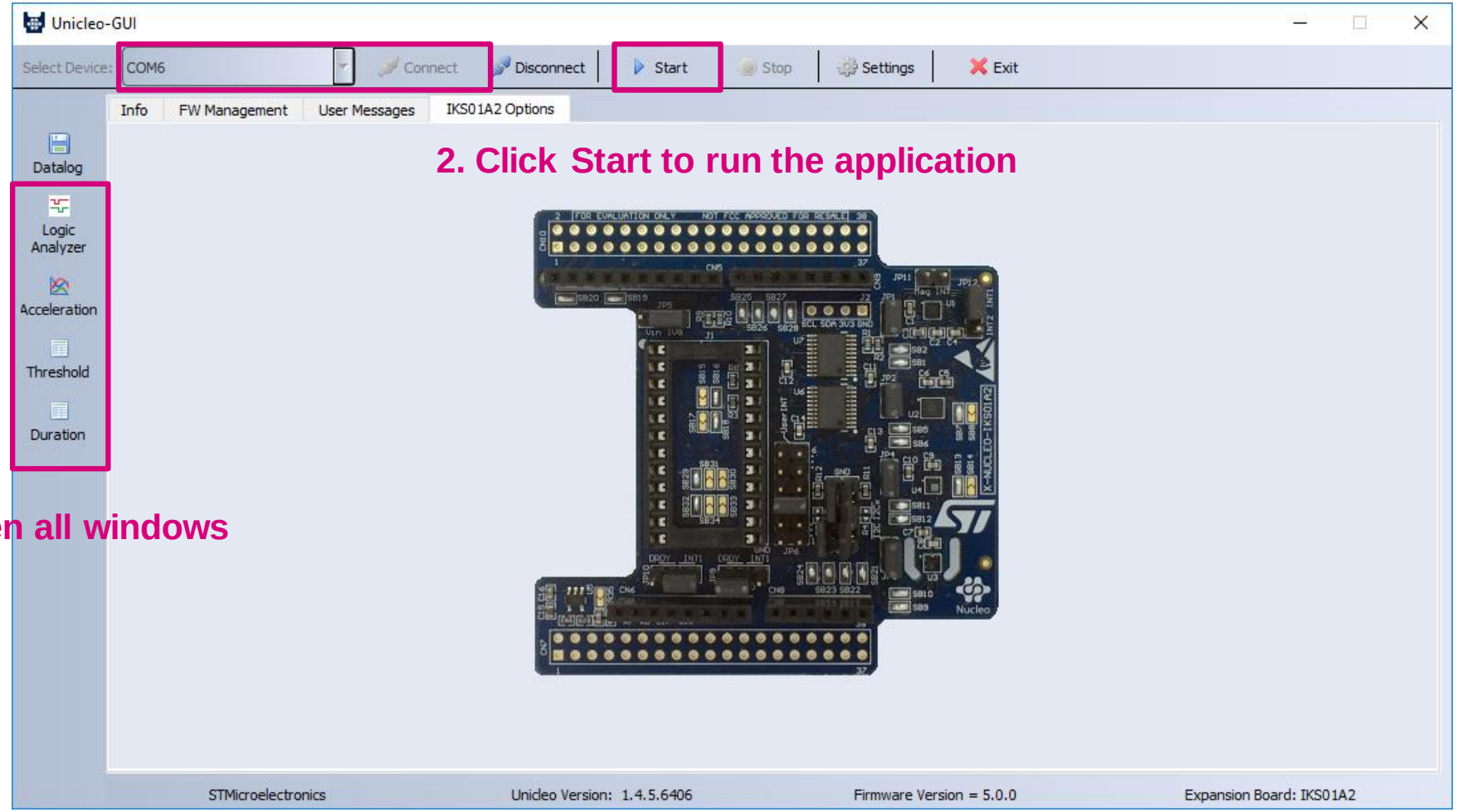

AlgoBuilder GUI - *
File Edit View Firmware Tools Help
D: NODE_L476RG
Library
Filter:
Comparison
Constants
Display
Bar
Fusion
Graph
Histogram
Logic Analyzer
Plot3D
Scatter
Value
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
Temperature
User Input
Vector Operations
1. Add Logic Analyzer function block
3. Connect
[Sensor Hub]
Acceleration [g]
Graph
Magnitude
Input Value (Float)
>
Pulse Width
Input Value (Int)
>=
Pulse Generator
Logic Analyzer
2. Set properties
Console
Description
Logic Analyzer
Version: 2.0
Displays up to eight logic values in real-time chart. The X-axis represents time, Y-axis is logic state (0 or 1).
Input Pins:
in (int x 1):
Input data to display (y-axis value). The input data size has to match with number of channels.
Properties:
Number of Channels (int):
Defines number of channels to plot. Value must be from 1 to 8.
Range: <1, 16>
Logic Analyzer Name (string):
Label of the logic analyzer.
Channel 1 Name (string):
Label of the channel 1.
Channel 2 Name (string):
Label of the channel 2.
Channel 3 Name (string):
Label of the channel 3.
Channel 4 Name (string):
Label of the channel 4.
Channel 5 Name (string):
Properties
Name
Value
Type
Number of Channels
1
INT
Logic Analyzer Name
Logic##Analyzer
STRING
Channel 1 Name
Impact
STRING
x: -10 y: -239 zoom: 1


AlgoBuilder GUI - *
File Edit View Firmware Tools Help
D: NODE_L476RG
Library
Filter:
Comparison
Constants
Display
Bar
Fusion
Graph
Histogram
Logic Analyzer
Plot3D
Scatter
Value
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
Temperature
User Input
Vector Operations
Save the design to default path with name “MyExample_2.xml”
Save Design
Miroslav BATEK › STMicroelectronics › AlgoBuilder › Designs
Search Designs
Organize
New folder
Quick access
Desktop
Downloads
Documents
Pictures
Designs
Documentation
SW_AlgoBuilder
X-CUBE-MEMS-
This PC
Desktop
Documents
Downloads
Music
Pictures
Name
Date modified
Type
Size
Example01_Demo.xml 7/9/2018 2:39 PM XML File 55 KB
Example02_FreeFall.xml 7/9/2018 2:39 PM XML File 56 KB
Example03_Tilt_Measurement.xml 7/9/2018 2:39 PM XML File 43 KB
Example04_Filters.xml 7/9/2018 2:39 PM XML File 23 KB
Example05_Feature_Computation.xml 7/9/2018 2:39 PM XML File 31 KB
Example06_ZeroCrossing_PeakDetector.x... 7/9/2018 2:39 PM XML File 62 KB
Example07_Algorithms_Integration.xml 7/9/2018 2:39 PM XML File 51 KB
Example08_6D_Detection.xml 7/9/2018 2:39 PM XML File 49 KB
Example09_Tilt_Using_Gyro.xml 8/20/2018 2:43 PM XML File 28 KB
Example10_FFT.xml 8/23/2018 3:00 PM XML File 45 KB
MyExample_1.xml 8/28/2018 12:35 PM XML File 9 KB
MyExample_2.xml 8/28/2018 10:47 AM XML File 38 KB
MyExample_3.xml 8/28/2018 10:54 AM XML File 25 KB
MyExample_4.xml 8/28/2018 10:49 AM XML File 20 KB
File name: MyExample_2.xml
Save as type: *.xml
Hide Folders
Save
Cancel
Description
Logic Analyzer
Version: 2.0
Displays up to eight logic values in real-time chart. The X-axis represents time, Y-axis is logic state (0 or 1).
Input Pins:
in (int x 1):
Input data to display (y-axis value). The input data size has to match with number of channels.
Properties:
Number of Channels (int):
Defines number of channels to plot. Value must be from 1 to 8.
Range: <1, 16>
Logic Analyzer Name (string):
Label of the logic analyzer.
Channel 1 Name (string):
Label of the channel 1.
Channel 2 Name (string):
Label of the channel 2.
Channel 3 Name (string):
Label of the channel 3.
Channel 4 Name (string):
Label of the channel 4.
Channel 5 Name (string):
Properties
Name
Value
Type
Number of Channels 1 INT
Logic Analyzer Name Logic##Analyzer STRING
Channel 1 Name Impact STRING

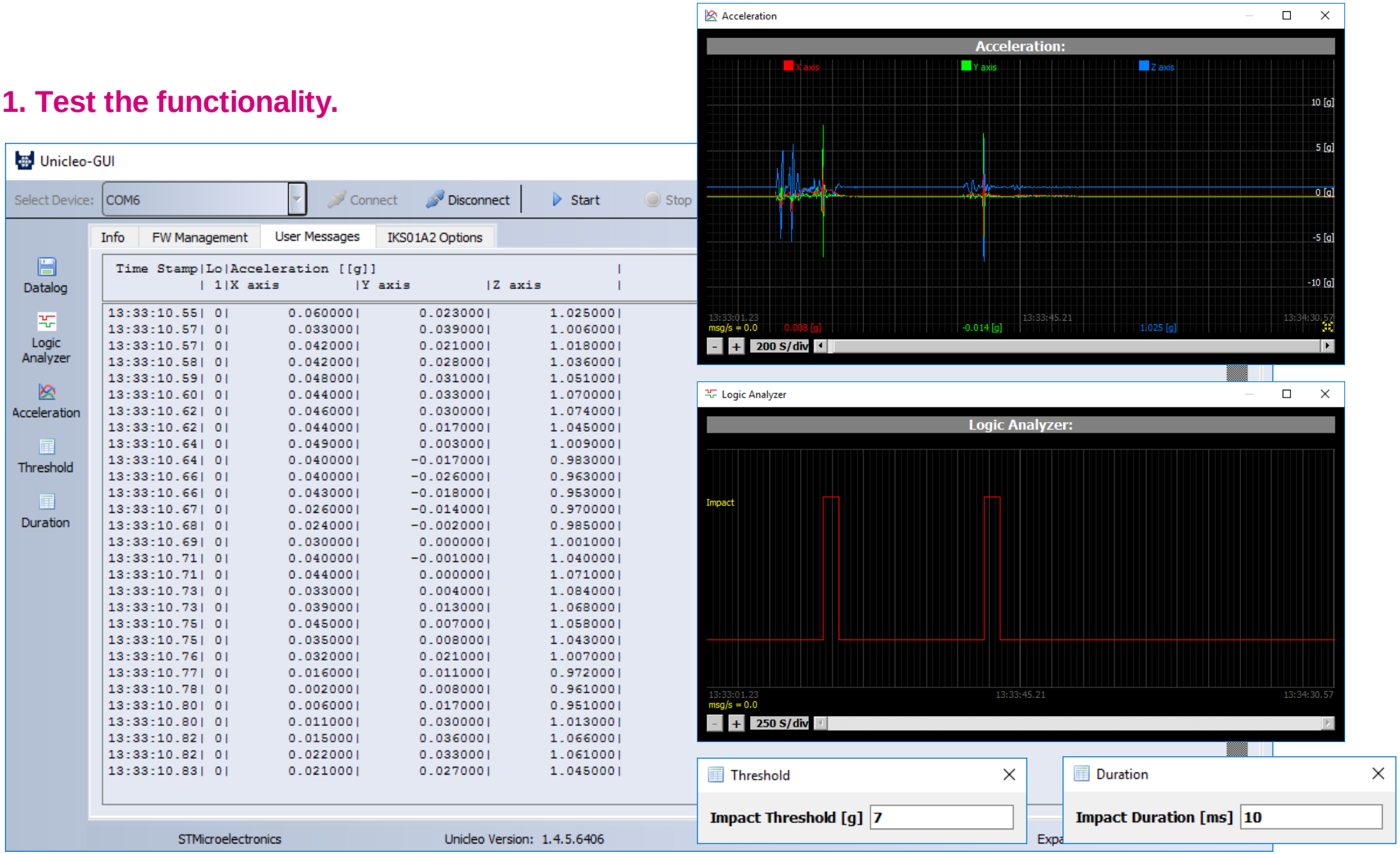

AlgoBuilder GUI - MyExample_2.xml
File Edit View Firmware Tools Help
D: NODE_L476RG
Library
Filter:
Comparison
Constants
Display
Bar
Fusion
Graph
Histogram
Logic Analyzer
Plot3D
Scatter
Value
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
Temperature
User Input
Vector Operations
1. Click on Build Firmware
[Sensor Hub]
Acceleration [g]
Graph
Magnitude
Input Value (Float)
>
Pulse Width
Input Value (Int)
>=
Pulse Generator
Logic Analyzer
2. Wait for compilation
3. Check that the code was compiled without error
Console
arm-none-eabi-objcopy -O binary "STM32L4xx-Nucleo-Project.elf" "STM32L4xx-Nucleo-Project.bin" & arm-none-eabi-size --format=berkeley STM32L4xx-Nucleo-Project.elf
text data bss dec hex filename
169464 5752 46632 221848 36298 STM32L4xx-Nucleo-Project.elf
13:27:24 Build Finished (took 4s.583ms)
Invoking scanner config builder on project
Build Process Finished
Exit Code: 0
Description
Logic Analyzer
Version: 2.0
Displays up to eight logic values in real-time chart. The X-axis represents time, Y-axis is logic state (0 or 1).
Input Pins:
in (int x 1):
Input data to display (y-axis value). The input data size has to match with number of channels.
Properties:
Number of Channels (int):
Defines number of channels to plot. Value must be from 1 to 8.
Range: <1, 16>
Logic Analyzer Name (string):
Label of the logic analyzer.
Channel 1 Name (string):
Label of the channel 1.
Channel 2 Name (string):
Label of the channel 2.
Channel 3 Name (string):
Label of the channel 3.
Channel 4 Name (string):
Label of the channel 4.
Channel 5 Name (string):
Properties
Name Value Type
Number of Channels 1 INT
Logic Analyzer Name Logic##Analyzer STRING
Channel 1 Name Impact STRING
x: -70 y: -285 zoom: 1


AlgoBuilder GUI - MyExample_2.xml
File Edit View Firmware Tools Help
D: NODE_L476RG
Library
Filter:
Comparison
Constants
Display
Bar
Fusion
Graph
Histogram
Logic Analyzer
Plot3D
Scatter
Value
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
Temperature
User Input
Vector Operations
1. Connect STM32 Nucleo to your PC
2. Click on Program STM32 Nucleo
4. Open Unicleo-GUI
[Sensor Hub]
Acceleration [g]
Graph
Magnitude
Input Value (Float)
>
Pulse Width
Input Value (Int)
>=
Pulse Generator
Logic Analyzer
Description
Logic Analyzer
Version: 2.0
Displays up to eight logic values in real-time chart. The X-axis represents time, Y-axis is logic state (0 or 1).
Input Pins:
in (int x 1):
Input data to display (y-axis value). The input data size has to match with number of channels.
Properties:
Number of Channels (int):
Defines number of channels to plot. Value must be from 1 to 8.
Range: <1, 16>
Logic Analyzer Name (string):
Label of the logic analyzer.
Channel 1 Name (string):
Label of the channel 1.
Channel 2 Name (string):
Label of the channel 2.
Channel 3 Name (string):
Label of the channel 3.
Channel 4 Name (string):
Label of the channel 4.
Channel 5 Name (string):
Properties
Name Value Type
Number of Channels 1 INT
Logic Analyzer Name Logic##Analyzer STRING
Channel 1 Name Impact STRING
Console
text data bss dec hex filename
169464 5752 46632 221848 36298 STM32L4xx-Nucleo-Project.elf
13:27:24 Build Finished (took 4s.583ms)
Invoking scanner config builder on project
Build Process Finished
FW binary file programed successfully!
IDE: SW4STM32 Target: STM32L476RG Drive: D: NODE_L476RG
3. Wait till the board is programmed
x: 286 y: -285 zoom: 1

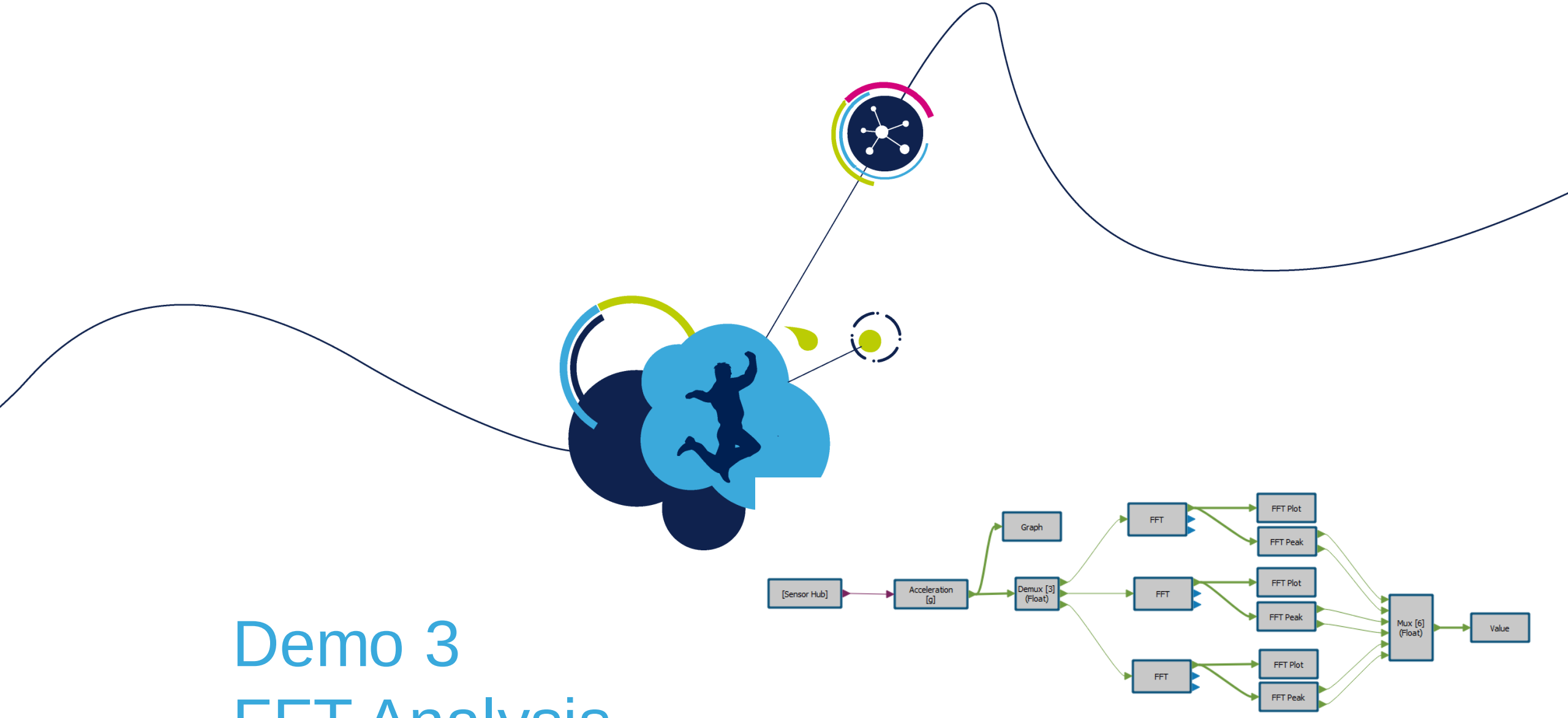
1. Check the boards is connected to Unicleo GUI



1. Test the functionality.

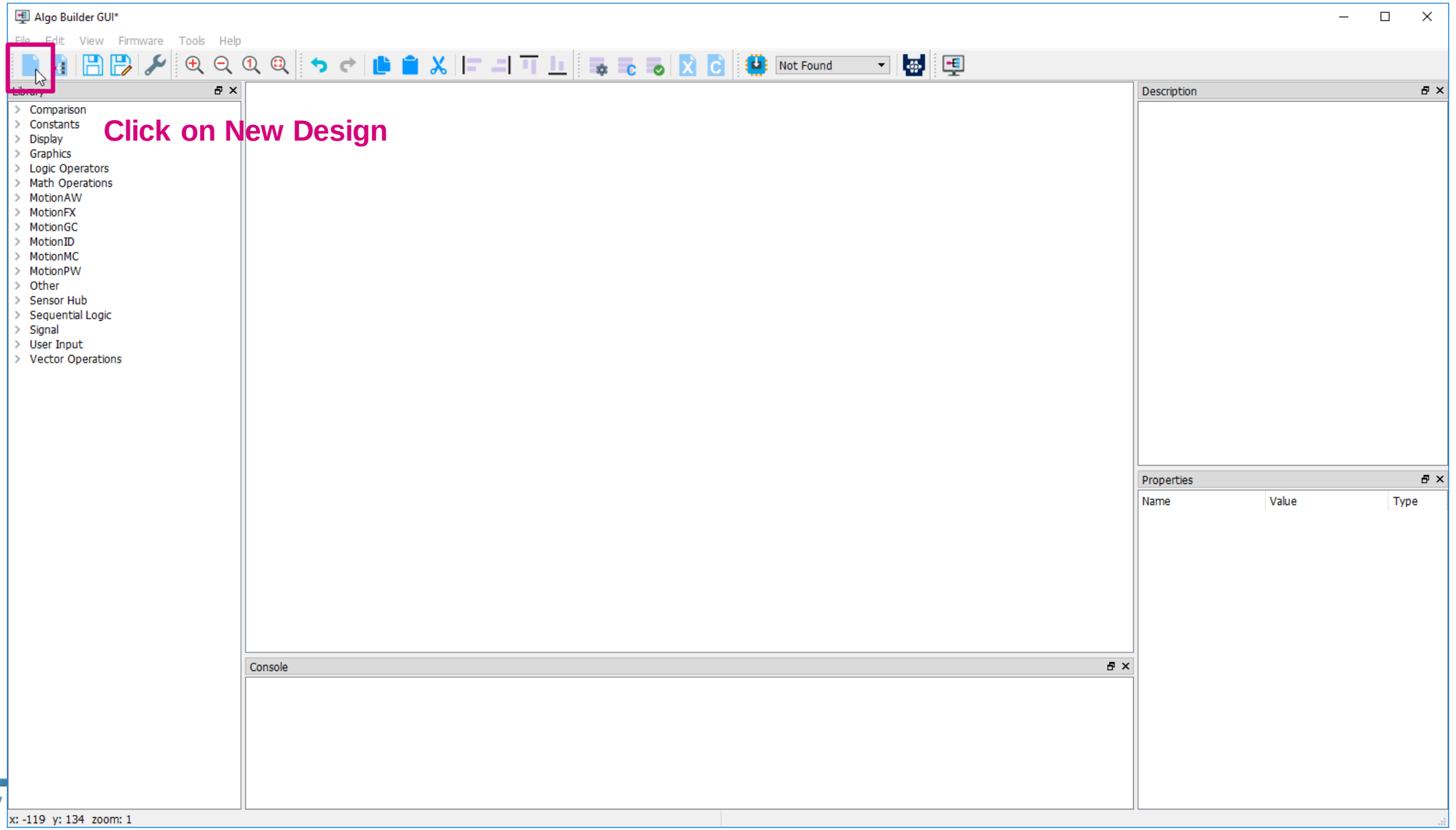


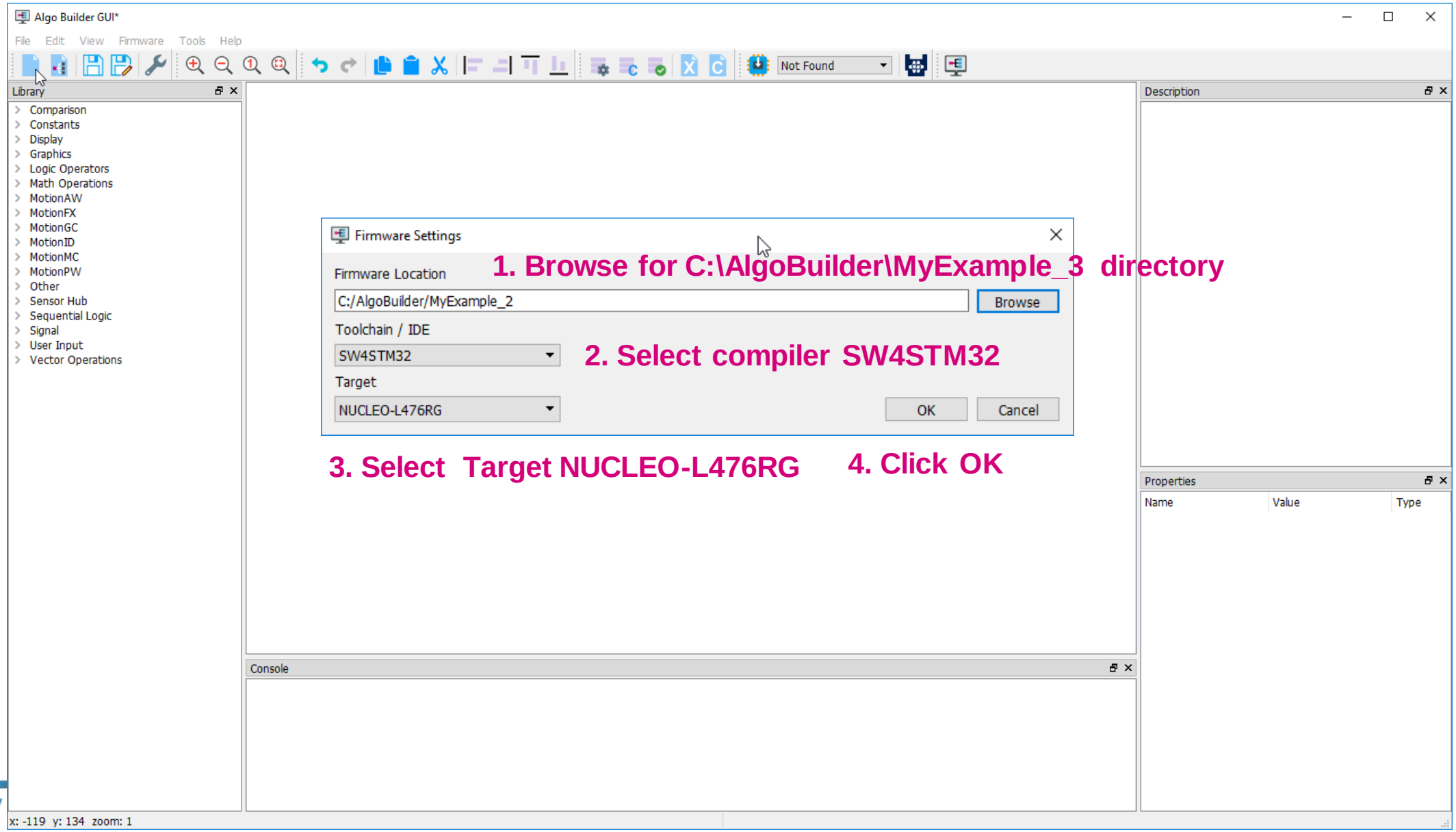
2. Close Unicleo-GUI when you finished the testing.

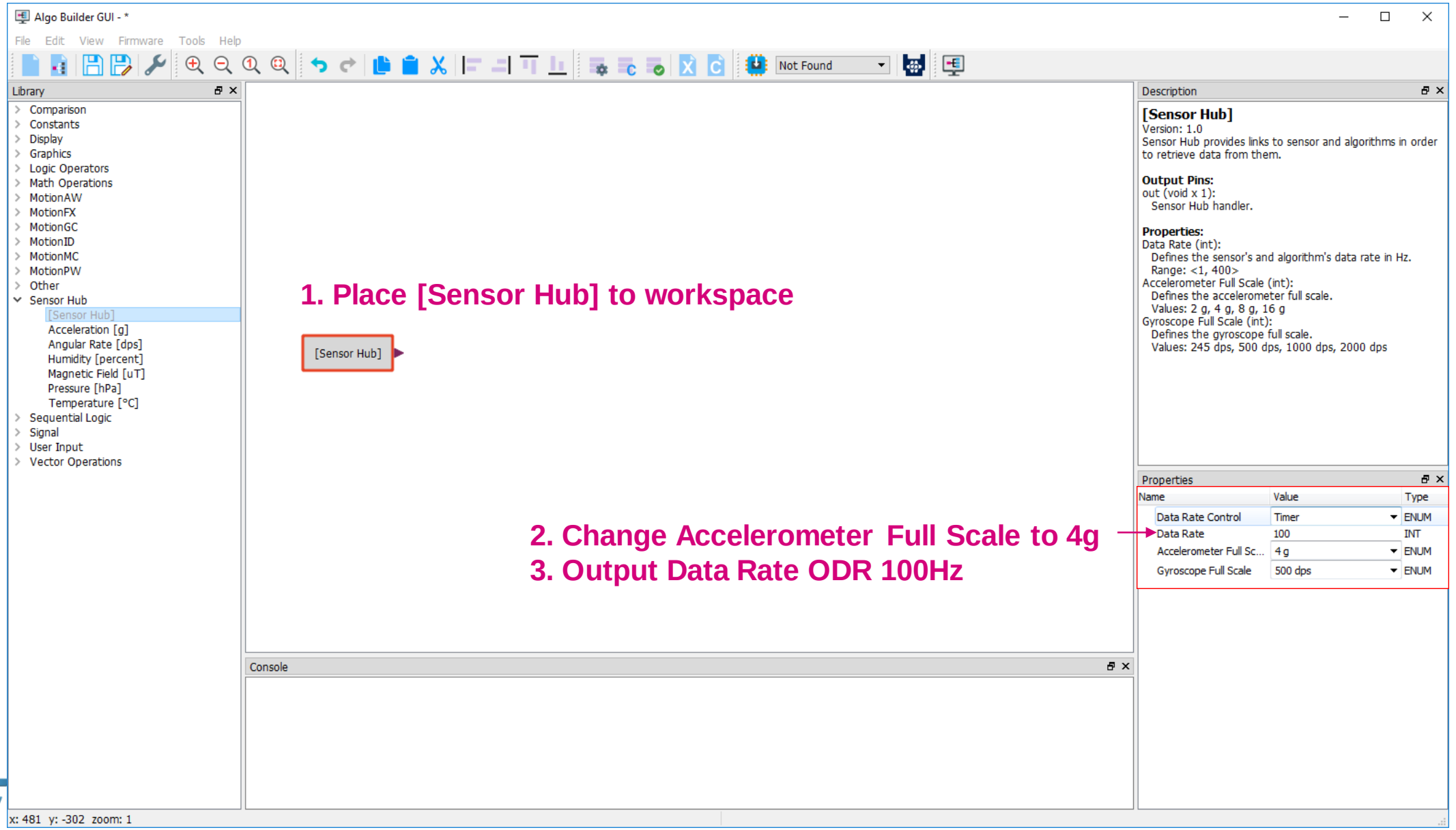


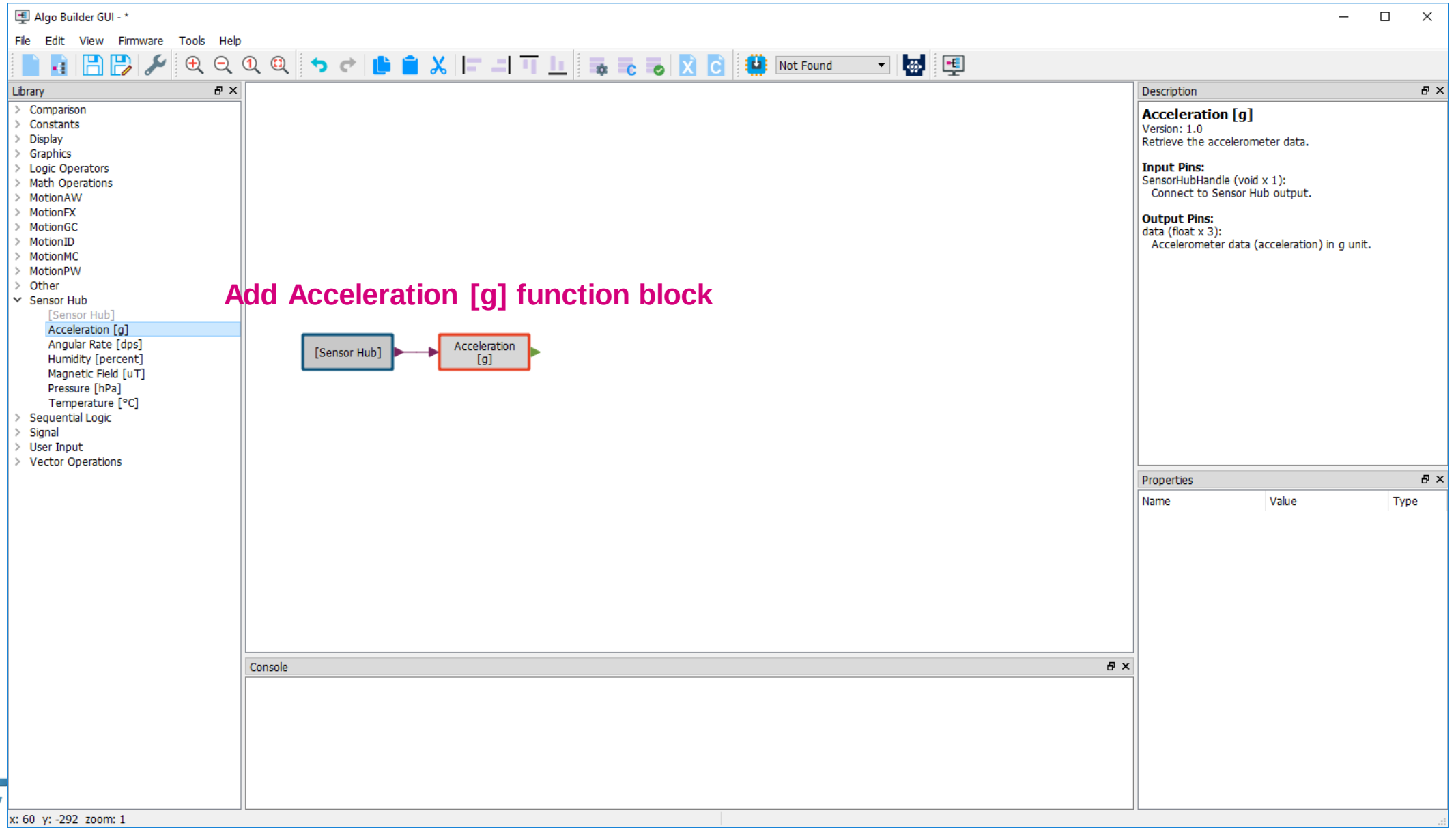
Demo 3
FFT Analysis

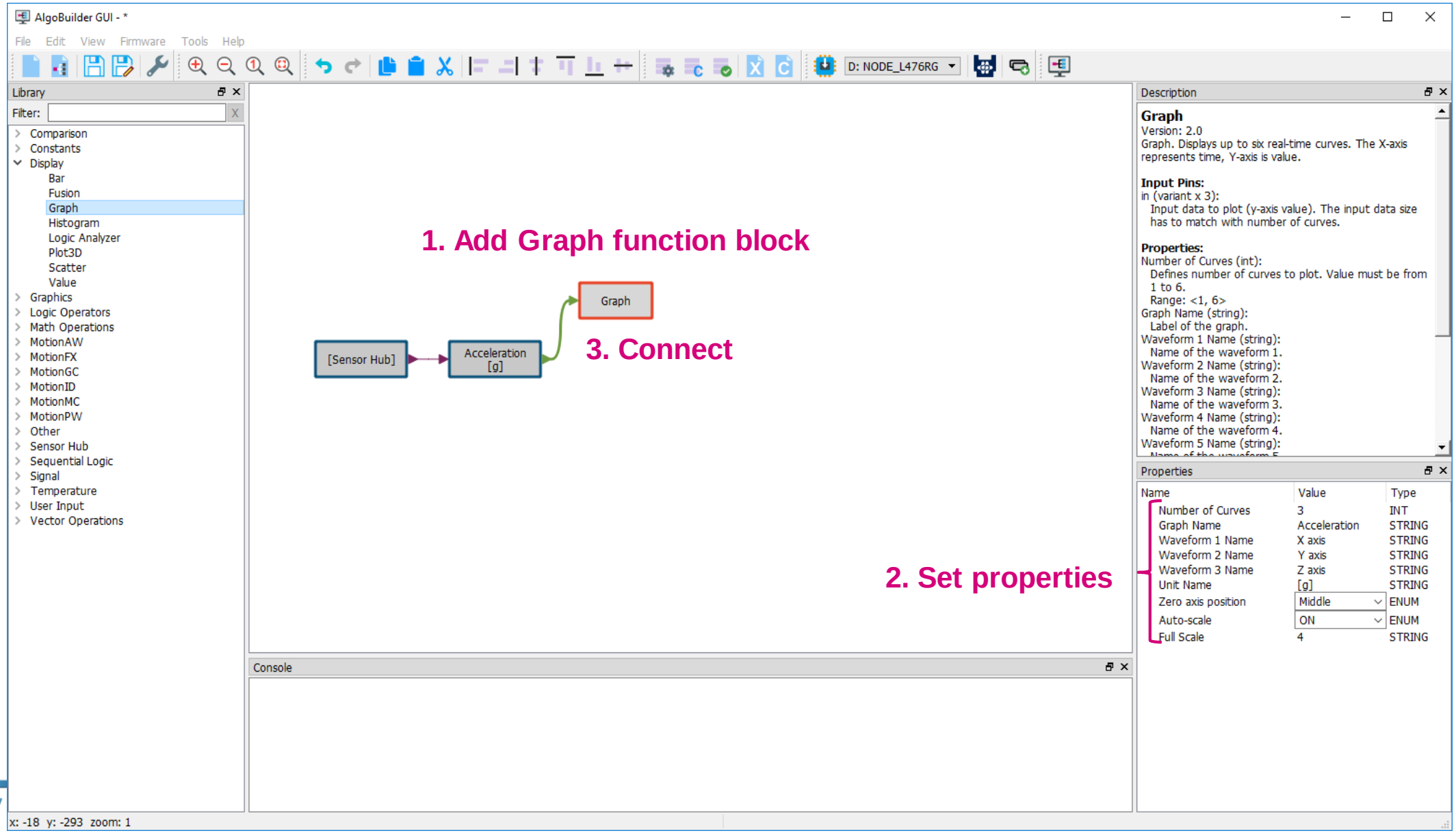
life.augmented

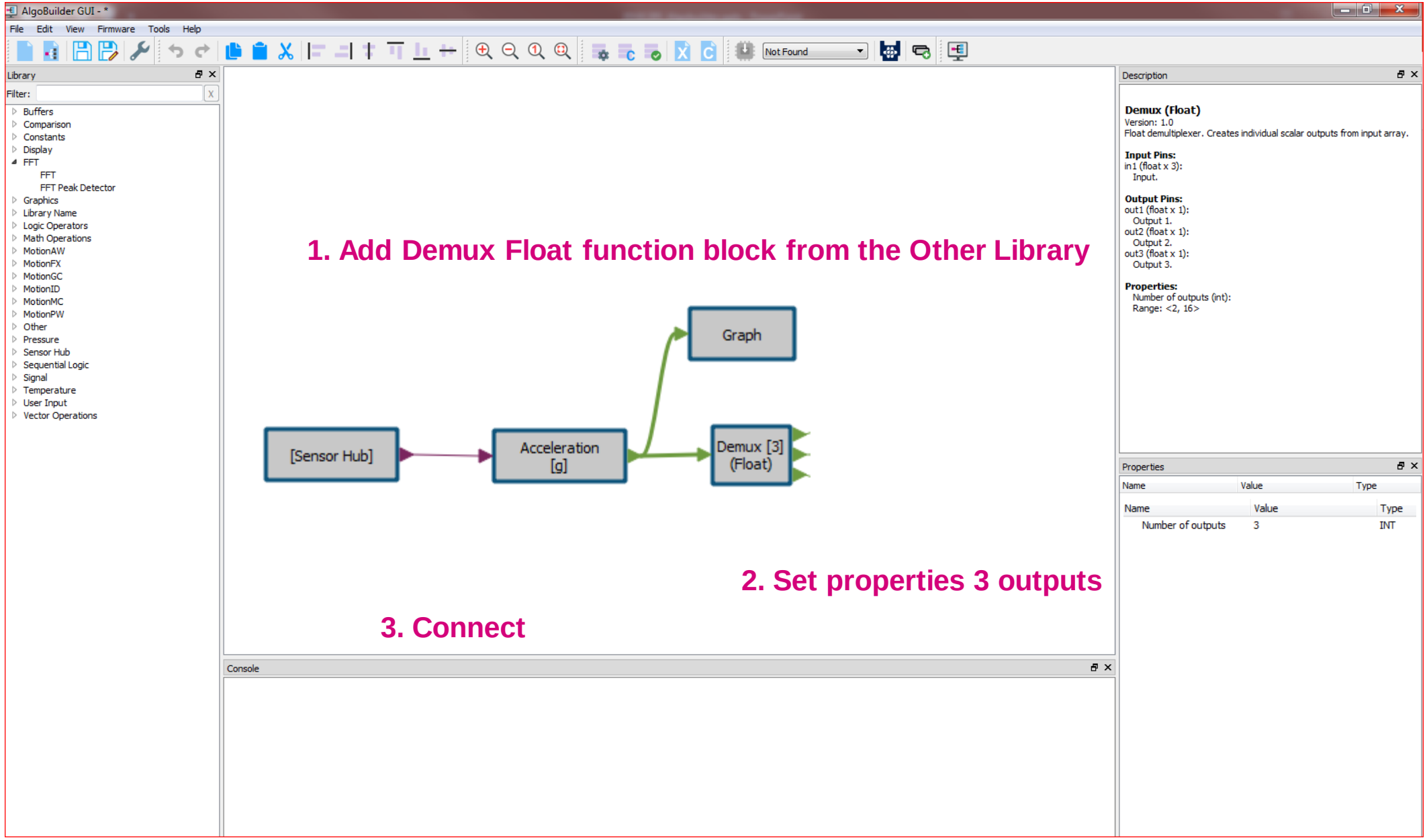

Algo Builder GUI*
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
Click on New Design
Description
Properties
Name
Value
Type
Console
x: -119 y: 134 zoom: 1

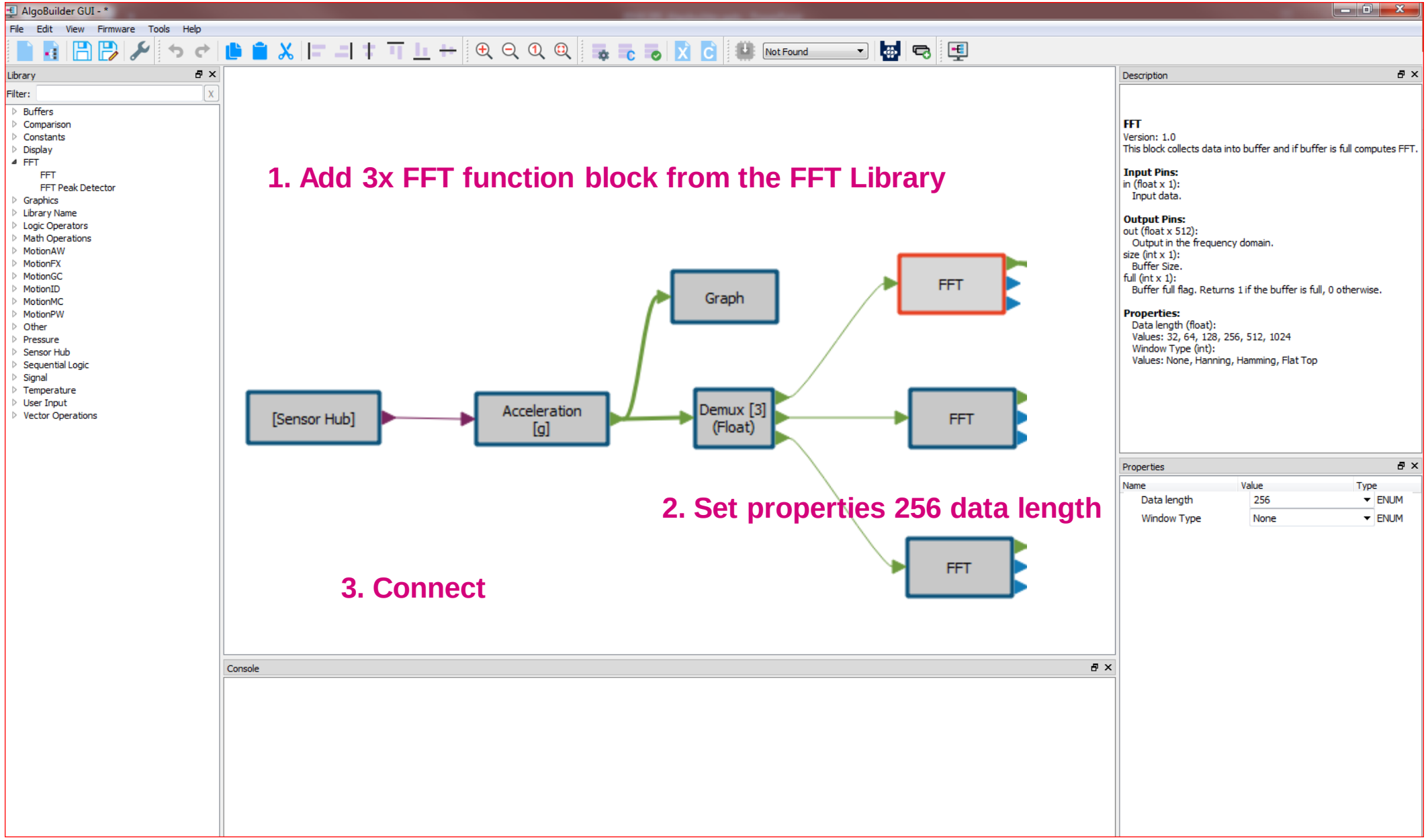

Algo Builder GUI*
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
User Input
Vector Operations
Description
Properties
Name
Value
Type
Console
x: -119 y: 134 zoom: 1
Firmware Settings
Firmware Location
C:/AlgoBuilder/MyExample_2
Browse
Toolchain / IDE
SW4STM32
Target
NUCLEO-L476RG
OK
Cancel
1. Browse for C:\AlgoBuilder\MyExample_3 directory
2. Select compiler SW4STM32
3. Select Target NUCLEO-L476RG
4. Click OK


Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
1. Place [Sensor Hub] to workspace
[Sensor Hub]
2. Change Accelerometer Full Scale to 4g
3. Output Data Rate ODR 100Hz
Console
Description
[Sensor Hub]
Version: 1.0
Sensor Hub provides links to sensor and algorithms in order to retrieve data from them.
Output Pins:
out (void x 1):
Sensor Hub handler.
Properties:
Data Rate (int):
Defines the sensor's and algorithm's data rate in Hz.
Range: <1, 400>
Accelerometer Full Scale (int):
Defines the accelerometer full scale.
Values: 2 g, 4 g, 8 g, 16 g
Gyroscope Full Scale (int):
Defines the gyroscope full scale.
Values: 245 dps, 500 dps, 1000 dps, 2000 dps
Properties
Name
Value
Type
Data Rate Control
Timer
ENUM
Data Rate
100
INT
Accelerometer Full Sc...
4 g
ENUM
Gyroscope Full Scale
500 dps
ENUM
x: 481 y: -302 zoom: 1


Algo Builder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Comparison
Constants
Display
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
[Sensor Hub]
Acceleration [g]
Angular Rate [dps]
Humidity [percent]
Magnetic Field [uT]
Pressure [hPa]
Temperature [°C]
Sequential Logic
Signal
User Input
Vector Operations
Add Acceleration [g] function block
[Sensor Hub]
Acceleration [g]
Description
Acceleration [g]
Version: 1.0
Retrieve the accelerometer data.
Input Pins:
SensorHubHandle (void x 1):
Connect to Sensor Hub output.
Output Pins:
data (float x 3):
Accelerometer data (acceleration) in g unit.
Properties
Name
Value
Type
Console
x: 60 y: -292 zoom: 1


AlgoBuilder GUI - *
File Edit View Firmware Tools Help
D: NODE_L476RG
Library
Filter:
Comparison
Constants
Display
Bar
Fusion
Graph
Histogram
Logic Analyzer
Plot3D
Scatter
Value
Graphics
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Sensor Hub
Sequential Logic
Signal
Temperature
User Input
Vector Operations
1. Add Graph function block
Graph
[Sensor Hub]
Acceleration [g]
3. Connect
2. Set properties
Console
Description
Graph
Version: 2.0
Graph. Displays up to six real-time curves. The X-axis represents time, Y-axis is value.
Input Pins:
in (variant x 3):
Input data to plot (y-axis value). The input data size has to match with number of curves.
Properties:
Number of Curves (int):
Defines number of curves to plot. Value must be from 1 to 6.
Range: <1, 6>
Graph Name (string):
Label of the graph.
Waveform 1 Name (string):
Name of the waveform 1.
Waveform 2 Name (string):
Name of the waveform 2.
Waveform 3 Name (string):
Name of the waveform 3.
Waveform 4 Name (string):
Name of the waveform 4.
Waveform 5 Name (string):
Properties
Name
Value
Type
Number of Curves 3 INT
Graph Name Acceleration STRING
Waveform 1 Name X axis STRING
Waveform 2 Name Y axis STRING
Waveform 3 Name Z axis STRING
Unit Name [g] STRING
Zero axis position Middle ENUM
Auto-scale ON ENUM
Full Scale 4 STRING
x: -18 y: -293 zoom: 1


AlgoBuilder GUI - *
File Edit View Firmware Tools Help
Not Found
Library
Filter:
Buffers
Comparison
Constants
Display
FFT
FFT
FFT Peak Detector
Graphics
Library Name
Logic Operators
Math Operations
MotionAW
MotionFX
MotionGC
MotionID
MotionMC
MotionPW
Other
Pressure
Sensor Hub
Sequential Logic
Signal
Temperature
User Input
Vector Operations
1. Add Demux Float function block from the Other Library
Graph
[Sensor Hub]
Acceleration [g]
Demux [3] (Float)
2. Set properties 3 outputs
3. Connect
Console
Description
Demux (Float)
Version: 1.0
Float demultiplexer. Creates individual scalar outputs from input array.
Input Pins:
in1 (float x 3):
Input.
Output Pins:
out1 (float x 1):
Output 1.
out2 (float x 1):
Output 2.
out3 (float x 1):
Output 3.
Properties:
Number of outputs (int):
Range: <2, 16>
Properties
Name Value Type
Name Value Type
Number of outputs 3 INT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MotionID
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MotionPW
Other
Pressure
Sensor Hub
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Signal
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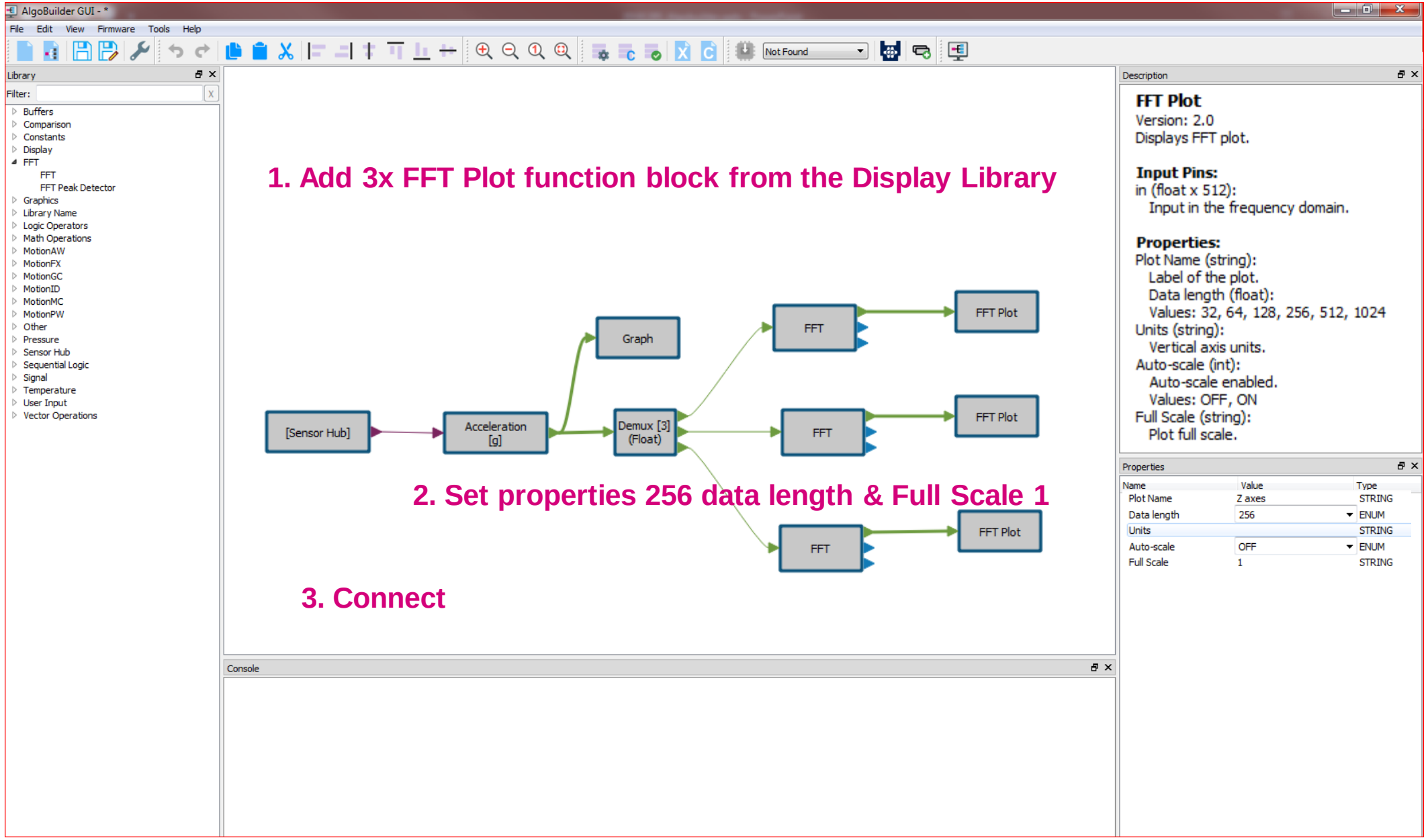
User Input
Vector Operations
1. Add 3x FFT function block from the FFT Library
[Sensor Hub]
Acceleration [g]
Graph
Demux [3] (Float)
FFT
FFT
FFT
2. Set properties 256 data length
3. Connect
Console
Description
FFT
Version: 1.0
This block collects data into buffer and if buffer is full computes FFT.
Input Pins:
in (float x 1):
Input data.
Output Pins:
out (float x 512):
Output in the frequency domain.
size (int x 1):
Buffer Size.
full (int x 1):
Buffer full flag. Returns 1 if the buffer is full, 0 otherwise.
Properties:
Data length (float):
Values: 32, 64, 128, 256, 512, 1024
Window Type (int):
Values: None, Hanning, Hamming, Flat Top
Properties
Name
Value
Type
Data length
256
ENUM
Window Type
None
ENUM



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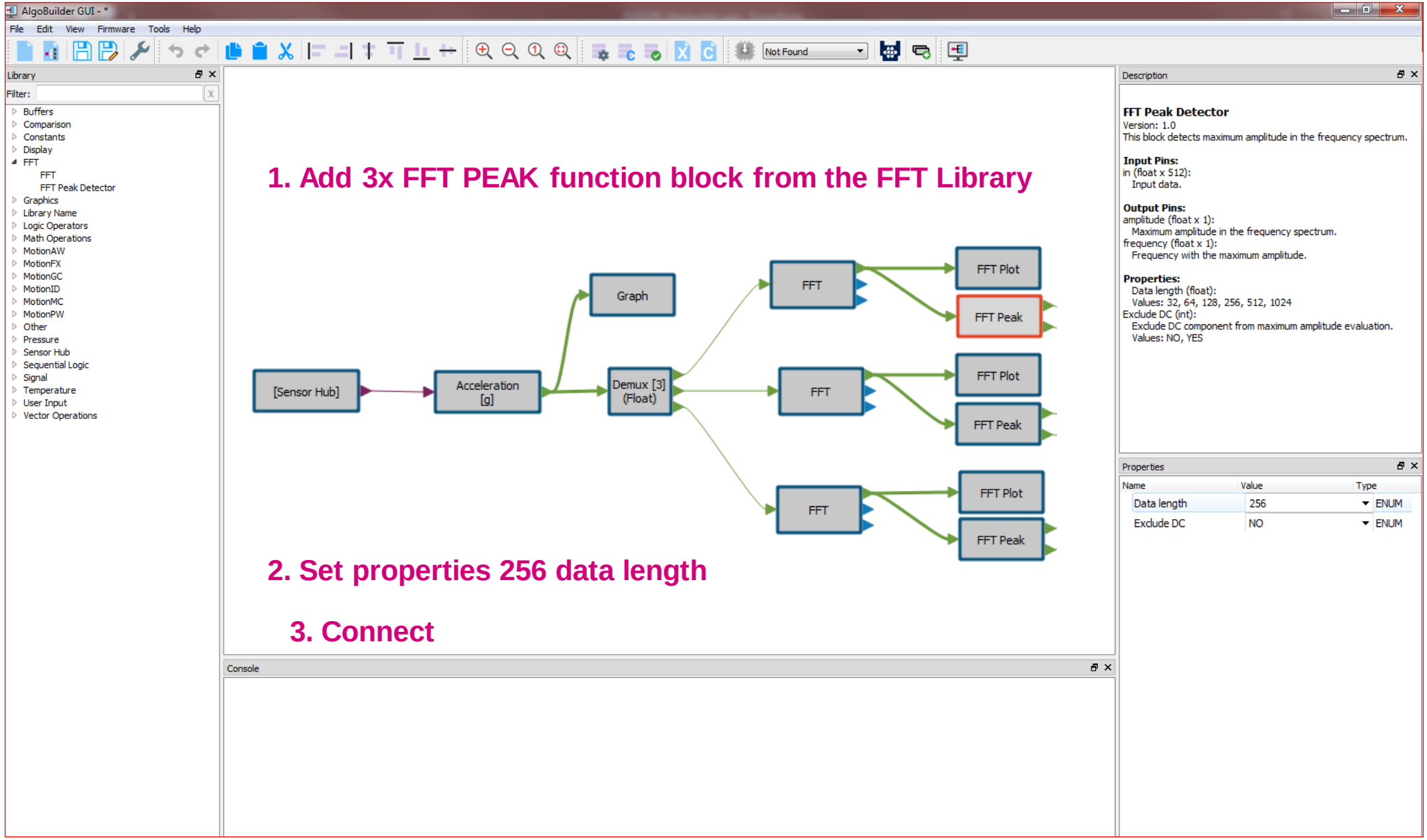
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FFT
FFT Peak Detector
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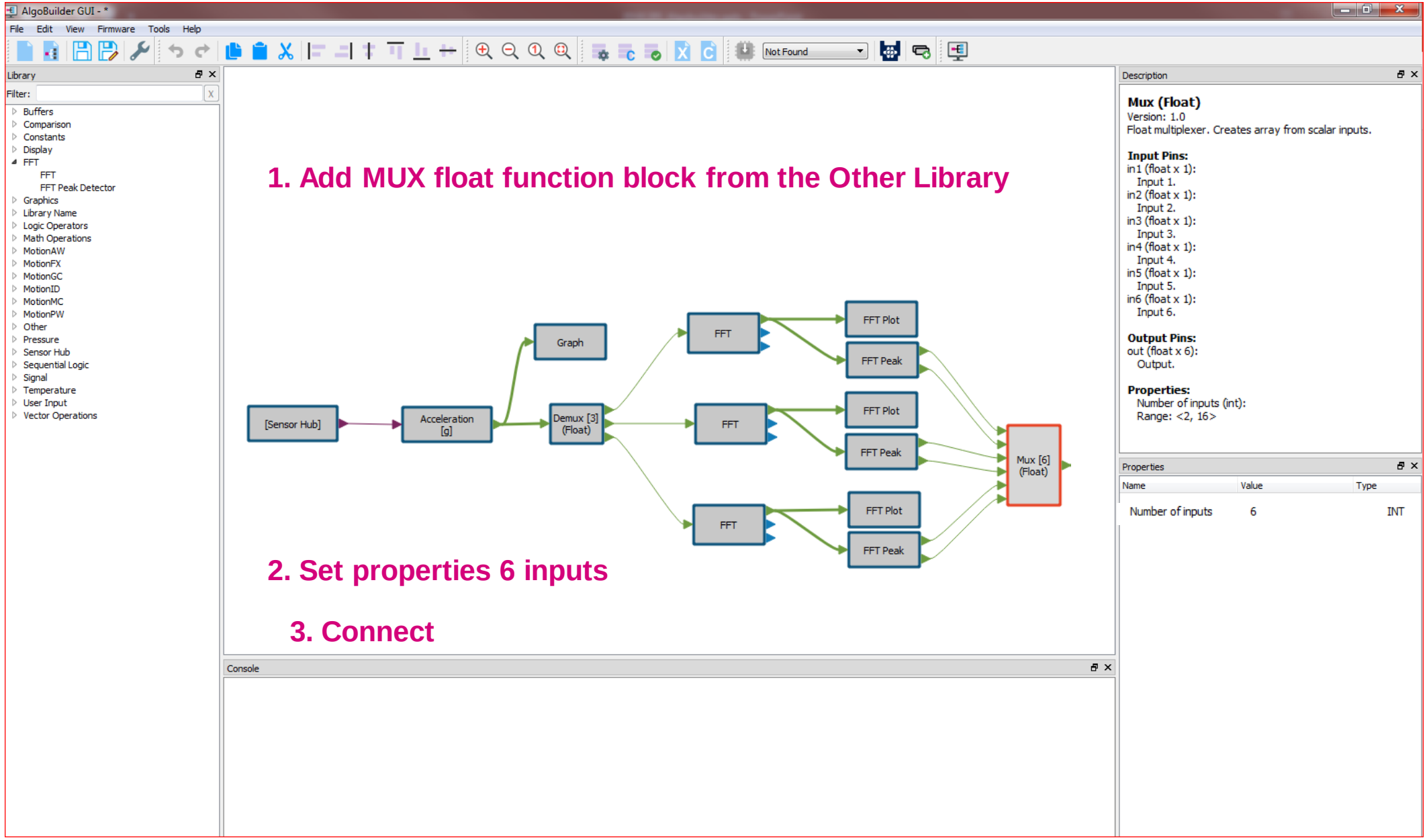
MotionID
MotionMC
MotionPW
Other
Pressure
Sensor Hub
Sequential Logic
Signal
Temperature
User Input
Vector Operations
1. Add 3x FFT PEAK function block from the FFT Library
[Sensor Hub]
Acceleration [g]
Graph
Demux [3] (Float)
FFT
FFT
FFT
FFT Plot
FFT Peak
FFT Plot
FFT Peak
FFT Plot
FFT Peak
2. Set properties 256 data length
3. Connect
Console
Description
FFT Peak Detector
Version: 1.0
This block detects maximum amplitude in the frequency spectrum.
Input Pins:
in (float x 512):
Input data.
Output Pins:
amplitude (float x 1):
Maximum amplitude in the frequency spectrum.
frequency (float x 1):
Frequency with the maximum amplitude.
Properties:
Data length (float):
Values: 32, 64, 128, 256, 512, 1024
Exclude DC (int):
Exclude DC component from maximum amplitude evaluation.
Values: NO, YES
Properties
Name
Value
Type
Data length
256
ENUM
Exclude DC
NO
ENUM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MotionPW
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Pressure
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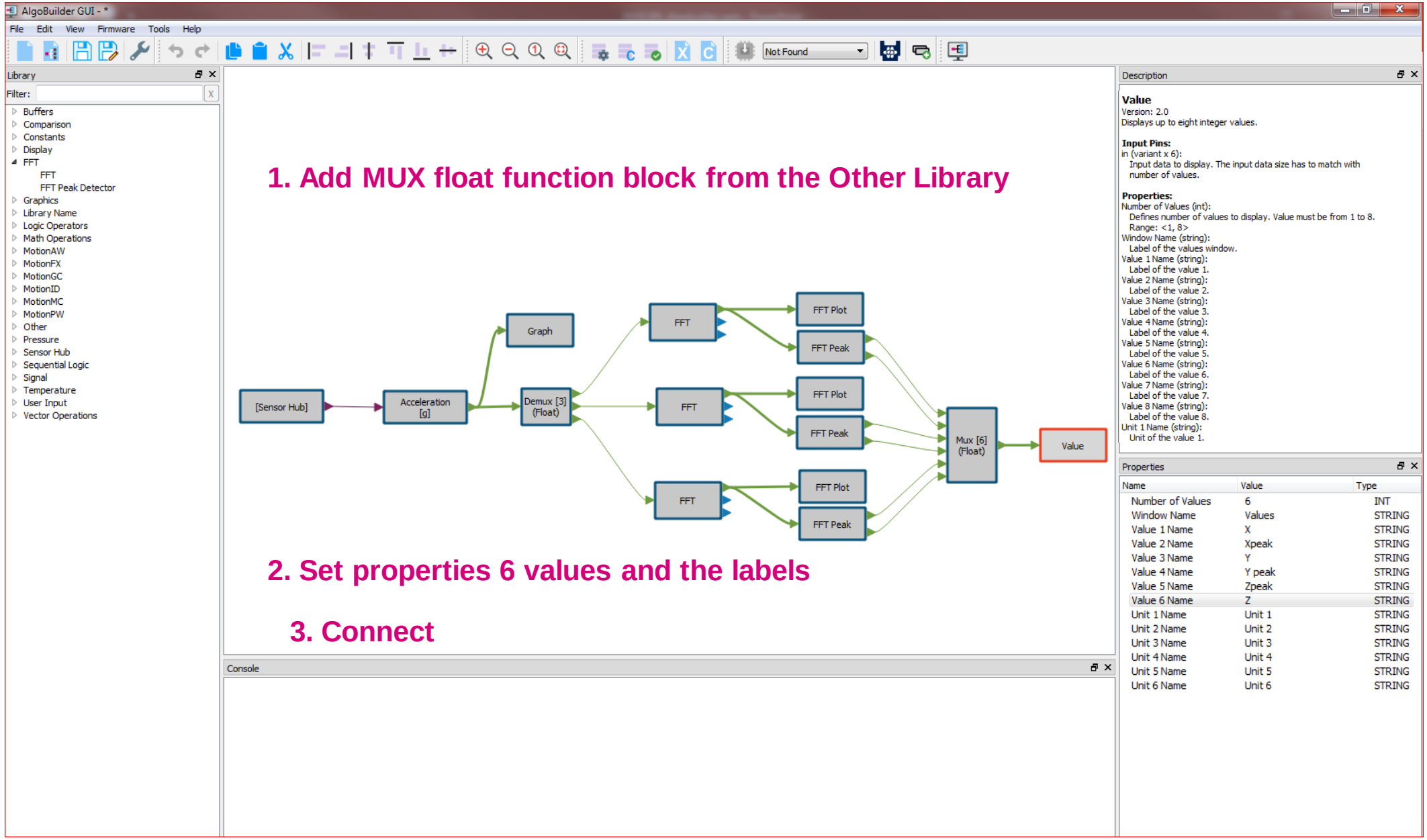
Vector Operations
1. Add MUX float function block from the Other Library
[Sensor Hub]
Acceleration [g]
Graph
Demux [3] (Float)
FFT
FFT
FFT
FFT Plot
FFT Peak
FFT Plot
FFT Peak
FFT Plot
FFT Peak
Mux [6] (Float)
2. Set properties 6 inputs
3. Connect
Console
Description
Mux (Float)
Version: 1.0
Float multiplexer. Creates array from scalar inputs.
Input Pins:
in1 (float x 1):
Input 1.
in2 (float x 1):
Input 2.
in3 (float x 1):
Input 3.
in4 (float x 1):
Input 4.
in5 (float x 1):
Input 5.
in6 (float x 1):
Input 6.
Output Pins:
out (float x 6):
Output.
Properties:
Number of inputs (int):
Range: <2, 16>
Properties
Name
Value
Type
Number of inputs
6
INT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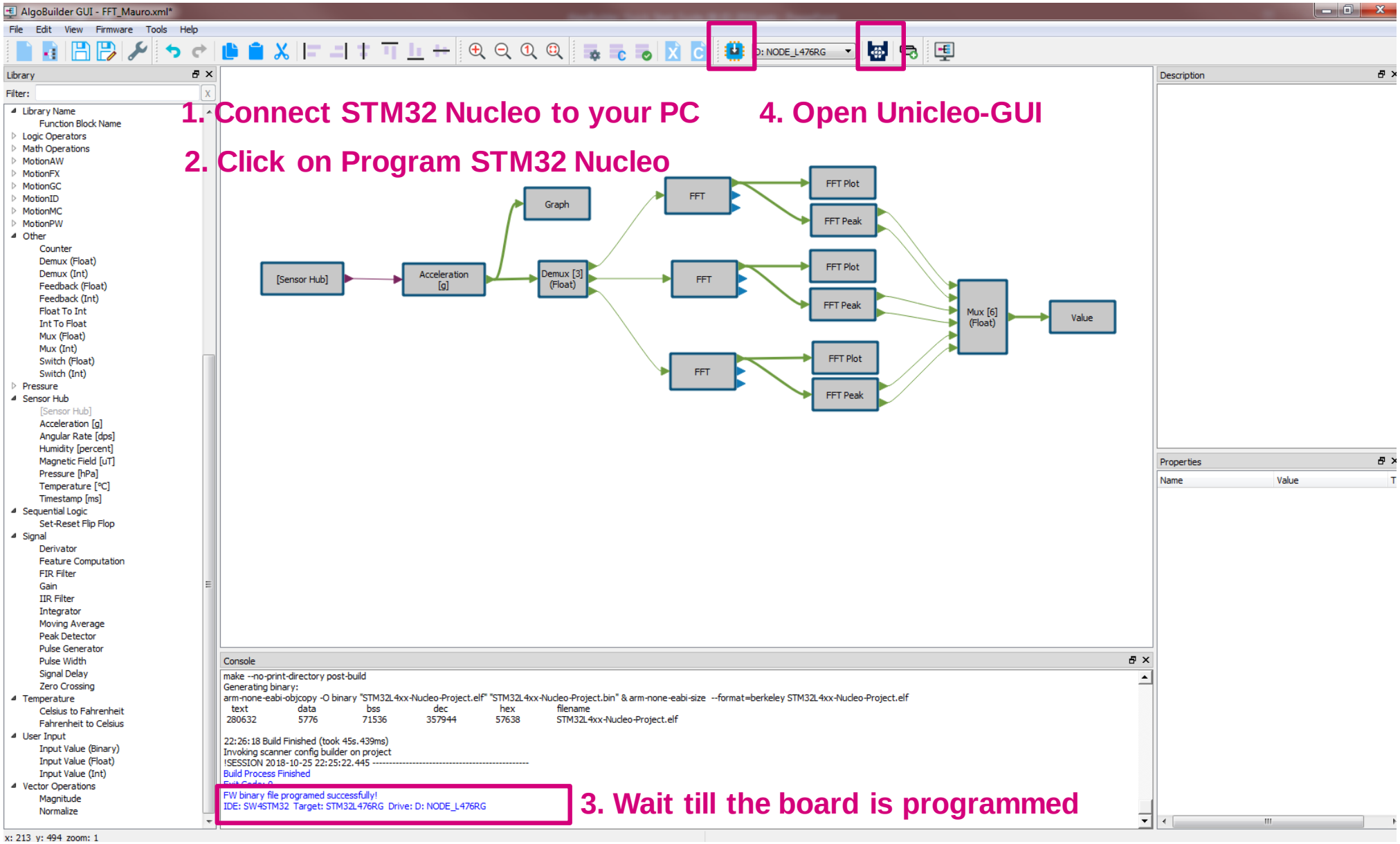
Vector Operations
1. Add MUX float function block from the Other Library
[Sensor Hub]
Acceleration [g]
Graph
Demux [3] (Float)
FFT
FFT
FFT
FFT Plot
FFT Peak
FFT Plot
FFT Peak
FFT Plot
FFT Peak
Mux [6] (Float)
Value
2. Set properties 6 values and the labels
3. Connect
Console
Description
Value
Version: 2.0
Displays up to eight integer values.
Input Pins:
in (variant x 6):
Input data to display. The input data size has to match with number of values.
Properties:
Number of Values (int):
Defines number of values to display. Value must be from 1 to 8.
Range: <1, 8>
Window Name (string):
Label of the values window.
Value 1 Name (string):
Label of the value 1.
Value 2 Name (string):
Label of the value 2.
Value 3 Name (string):
Label of the value 3.
Value 4 Name (string):
Label of the value 4.
Value 5 Name (string):
Label of the value 5.
Value 6 Name (string):
Label of the value 6.
Value 7 Name (string):
Label of the value 7.
Value 8 Name (string):
Label of the value 8.
Unit 1 Name (string):
Unit of the value 1.
Properties
Name Value Type
Number of Values 6 INT
Window Name Values STRING
Value 1 Name X STRING
Value 2 Name Xpeak STRING
Value 3 Name Y STRING
Value 4 Name Y peak STRING
Value 5 Name Zpeak STRING
Value 6 Name Z STRING
Unit 1 Name Unit 1 STRING
Unit 2 Name Unit 2 STRING
Unit 3 Name Unit 3 STRING
Unit 4 Name Unit 4 STRING
Unit 5 Name Unit 5 STRING
Unit 6 Name Unit 6 STRING



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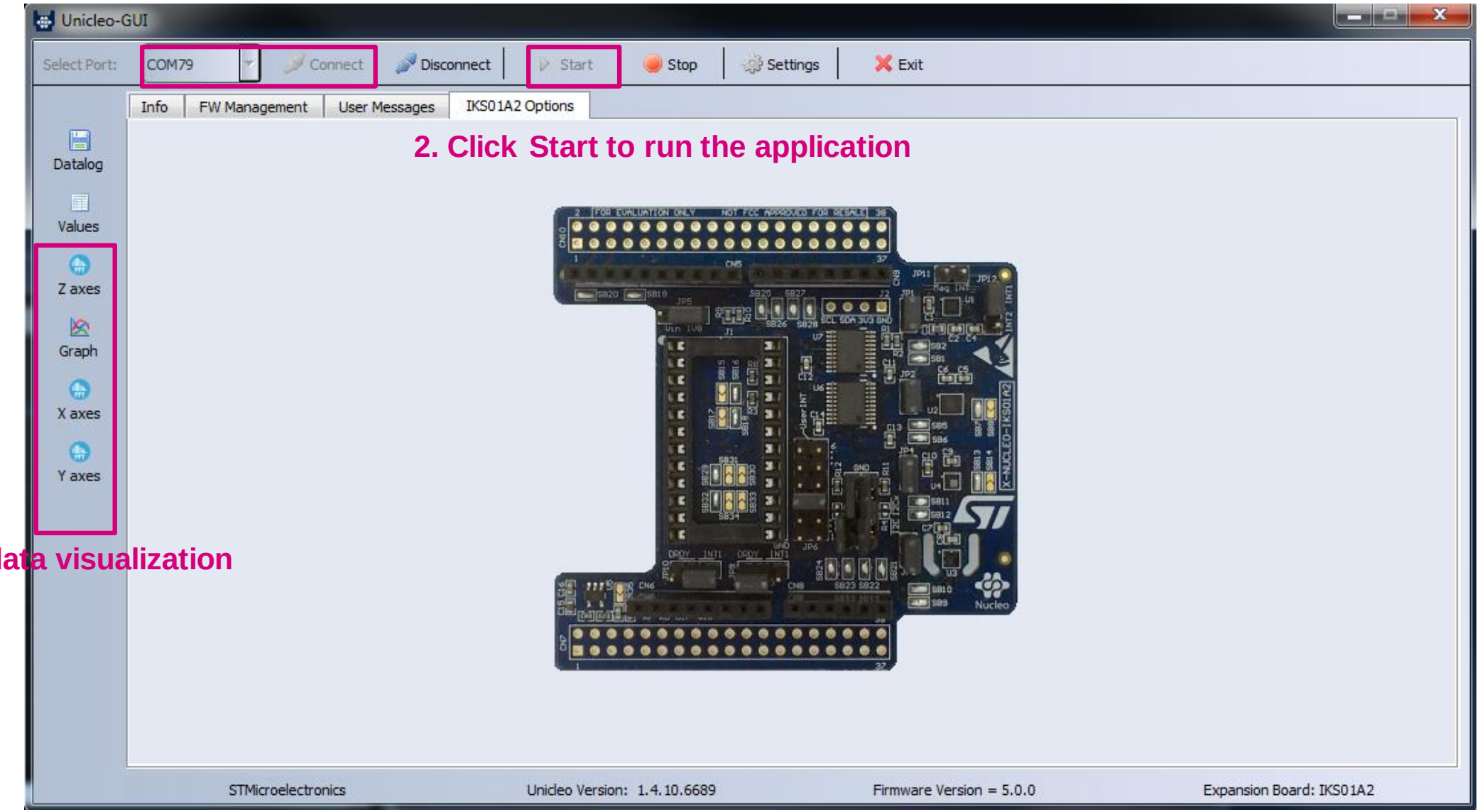
1. Check the boards is connected to Unicleo GUI



2. Click Start to run the application

3. Open data visualization

1. Test the functionality.

2. Remove the DC
3. Move the board
4. FFT , check the peak and frequency

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ST MEMS complete software solution

From drivers to software development tools

Low-level Drivers

Standard C Platform Independent drivers

Windows drivers

Linux drivers

MEMS and Sensors Software - STMicroelectronics

X-CUBE-MEMS-XT1
X-CUBE_MEMS1

Development Tool based on Low level drivers

Runs on STM32

Sample implementation of device embedded features

Go to st.com

Libraries

Generic SW libraries

Accuracy, Calibration, Positioning, Activity tracking, Health monitoring

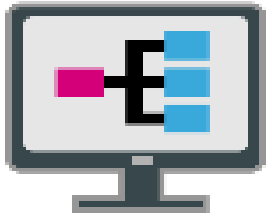
Dedicated SW libraries

Open.MEMS - STMicroelectronics

AlgoBuilder Tool

Dedicated software Tool for libraries development

Graphical design apps to build and use algorithms



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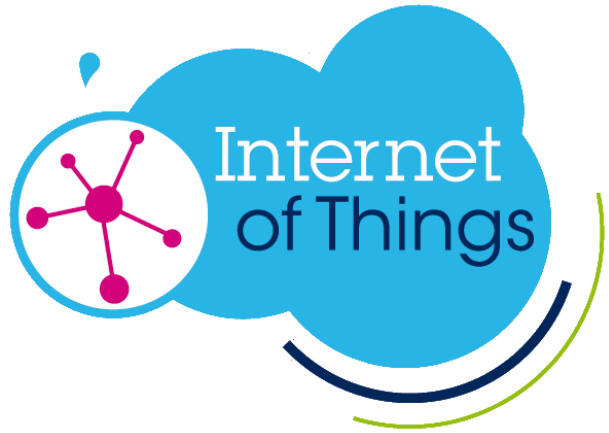
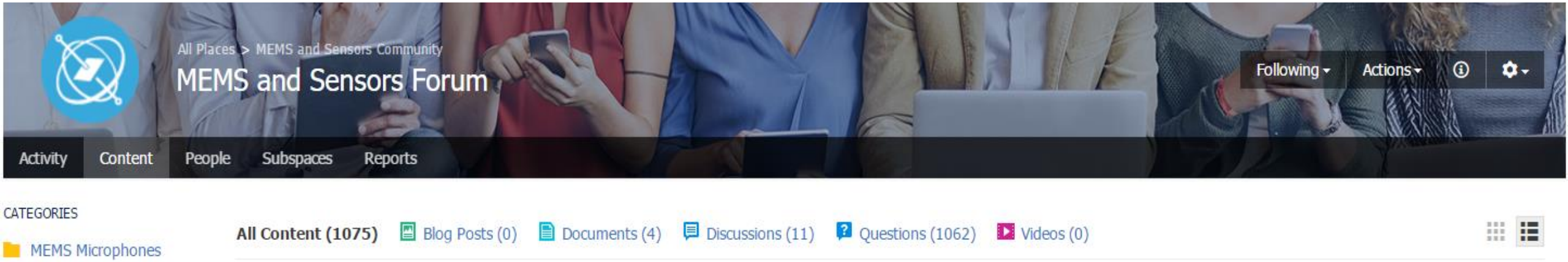
Takeaways

- Internet of Things offers many opportunities for ST from Sensor to Cloud
- ST has all the building blocks for the IoT
  - MEMS and Analog portfolio from consumer to industrial applications
  - AlgoBuilder allows fast proof of concept of Sensor based algorithms
- We keep the commitment on MEMS innovation
- Our constantly expanding development ecosystem makes design fast



ST Community – Mass Market Support



Mass Market Support: **MEMS Forum**

For more information on sensors: **www.st.com/sensors**

Information on longevity: **10yr Longevity Program**

Android / Linux / Open Drivers: **Drivers for MEMS**

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Thank You!

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