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# Quick Start Guide

Artificial Intelligence (AI) condition monitoring function pack for STM32Cube (FP-AI-NANOEDG1)

Version 1.0 (June 26, 2020)

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# 1- Hardware and software overview



# Discovery kit with STM32L562QE MCU (STM32L562E-DK)

## Hardware Overview

### Discovery kit with STM32L562QE MCU Hardware Description

The STM32L562E-DK Discovery kit is a complete demonstration and development platform for Arm® Cortex®-M33 with Arm® TrustZone® and ARMv8-M mainline security extension core-based STM32L562QEI6QU microcontroller, with 512 Kbytes of Flash memory and 256 Kbytes of SRAM.

### Key Features on board

- STM32L562QEI6QU microcontroller featuring 512 Kbytes of Flash memory and 256 Kbytes of SRAM
- 1.54" 240 × 240 pixel-262K color TFT LCD module with parallel interface and touch-control panel
- MEMS digital microphones
- 512-Mbit Octal-SPI Flash memory
- Bluetooth® V4.1 low energy module
- iNEMO LSM6DSO 3D accelerometer and 3D gyroscope
- 2 user LEDs
- User and reset push-buttons
- Board connectors:
  - USB Type-C™
  - microSD™ card
  - Stereo headset jack including analog microphone input
  - JTAG debugger



Latest info available at [www.st.com](http://www.st.com)  
STM32L562E-DK



# FP-AI-NANOEDG1 Software Overview

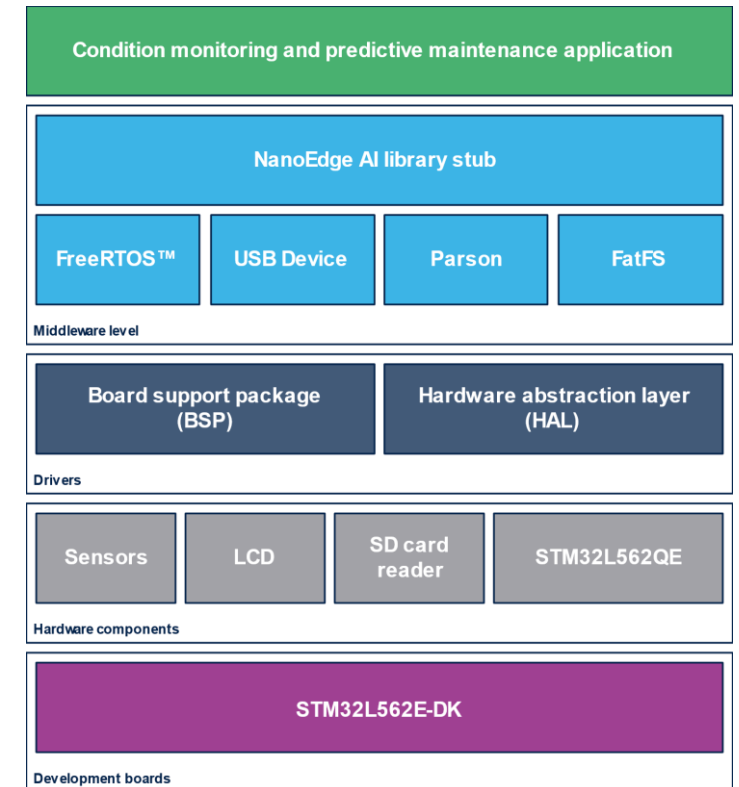
## FP-AI-NANOEDG1 Software Description

FP-AI-NANOEDG1 helps to easily jump-start the development and implementation of condition monitoring applications powered by the NanoEdge™ AI Studio solution from Cartesiam.

## Key features

- Complete firmware to enable a sensor node for condition monitoring and predictive maintenance applications based on vibration data.
- Stub for replacement with a NanoEdge library generated using the NanoEdge™ AI Studio for the desired AI application
- Simple LCD user interface.
- Autonomous mode operable by user button.
- Interactive Command Line Interface (CLI) through serial port with ability to perform:
  - Node configuration
  - AI utility for data logging on a microSD™ card
  - Management of the learning and detection phases of Cartesiam Machine Learning solution
- Free, user-friendly license terms

## Overall Software Architecture



# 2- Setup

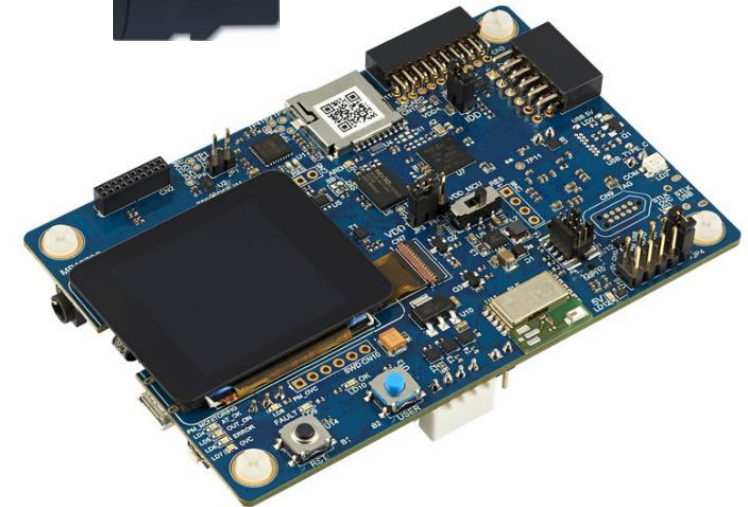


# Setup

## HW prerequisites for STM32L562E-DK

- STM32L562E-DK development board
- Laptop/PC with Windows 7, 8 or 10
- USB cable to connect the PC to the Micro-B USB connector on the board
- A fat32 formatted micro SDcard

Micro SD



STM32L562E-DK

MicroUSB Cable



# Setup

## Software and Other prerequisites

- **FP-AI-NANOEDG1**

- Download the [FP-AI-NANOEDG1](#) package from [www.st.com](http://www.st.com), copy the .zip file contents into a folder on your PC. The package contains binaries and source code with project files (STM32CubeIDE only) based on STM32L562E-DK

- **STM32CubeIDE**

- Integrated Development Environment for STM32
- Download and install [stm32CubeIDE](#) from [www.st.com](http://www.st.com)

- **STM32 ST-Link Utility**

- Full-featured software interface for programming STM32 microcontrollers
- Download and install [STSW-LINK004](#) from [www.st.com](http://www.st.com)

- **TeraTerm**

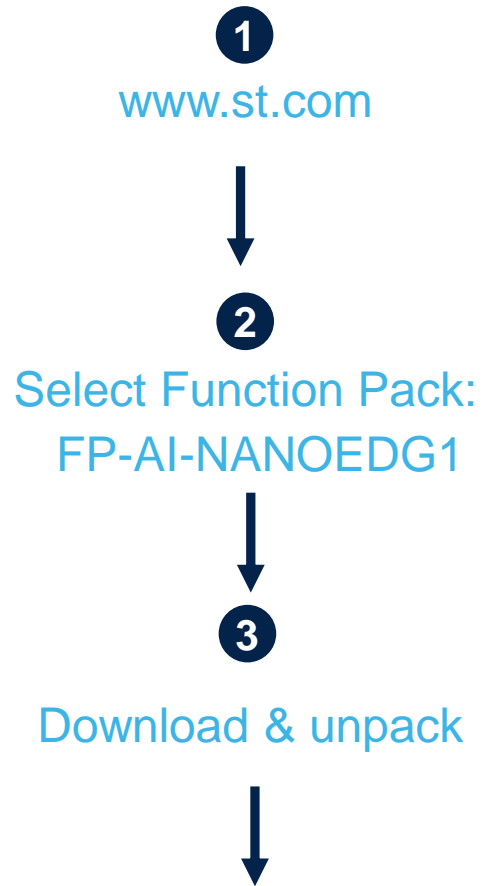
- Open source free software terminal emulator
- Download and install [TeraTerm](#)



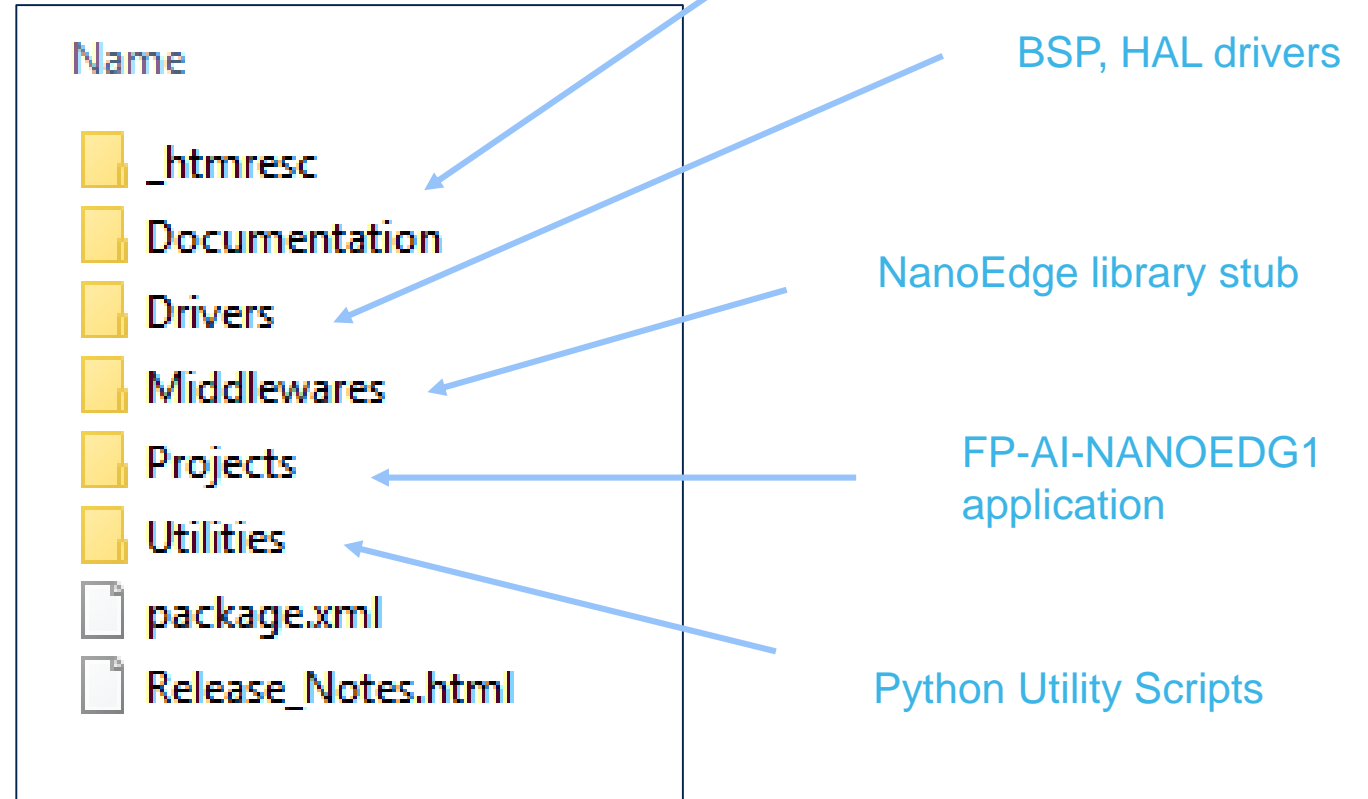


# FP-AI-NANOEDG1 Console Application

## Getting the Pack



FP-AI-NANOEDG1 package structure

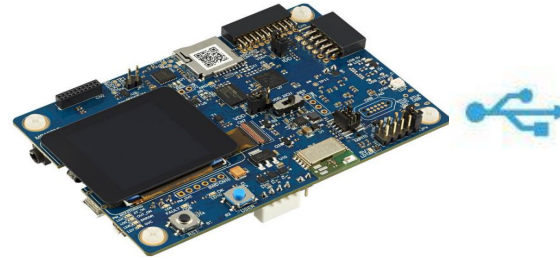


# FP-AI-NANOEDG1 Console Application

## Flash the application

↓  
4

Connect the USB cable between PC and STM32L562E-DK

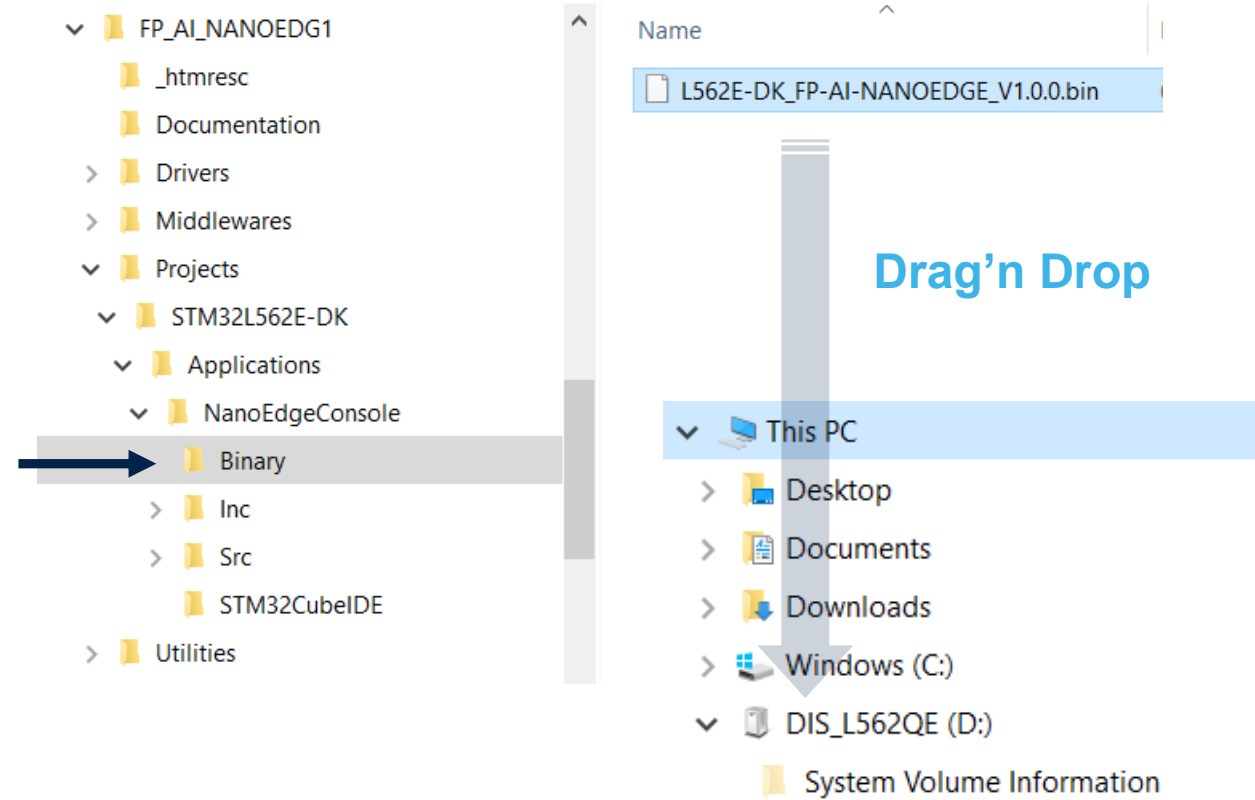


↓  
5

Wait until STM32L562E-DK drive is mounted

↓  
6

Flash the Firmware by  
Drag and drop of NANOEDGE1.bin  
into the STM32L562E-DK associated drive.

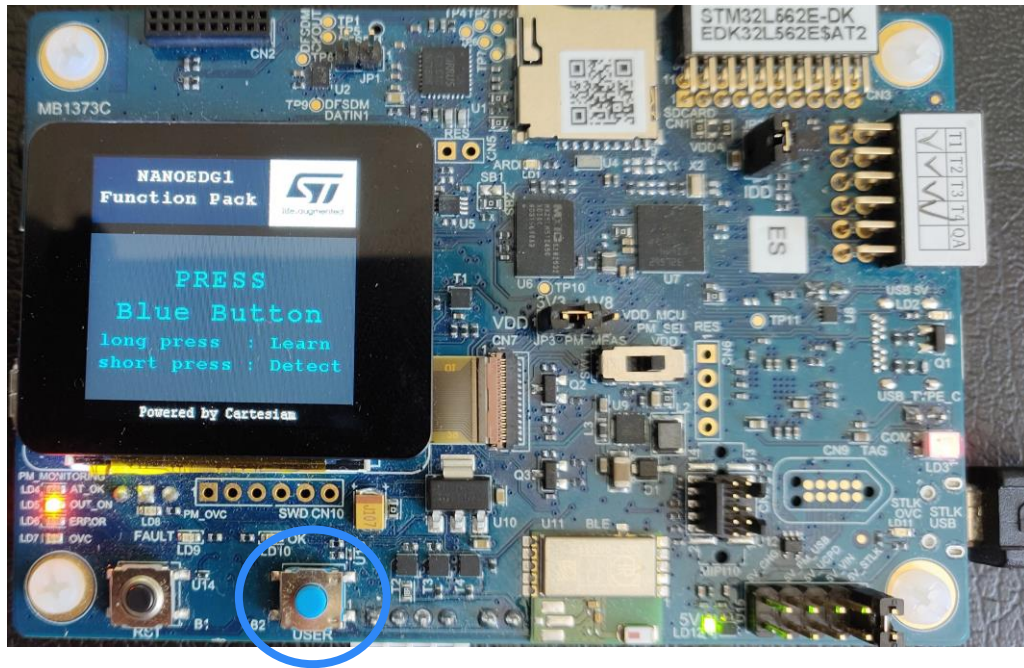


# FP-AI-NANOEDG1 Console Application

## Start the application

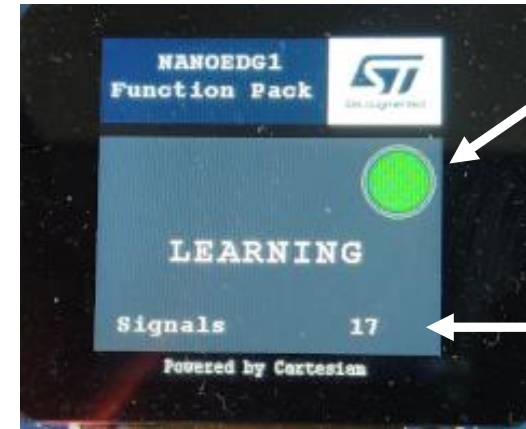
7

Reset STM32L562E-DK and follow LCD instructions



8

Long press to start learning phase



Learning status, green means good

Number of signals used for learning

9

Short press to start detection phase



Condition Indicator: green means nominal condition

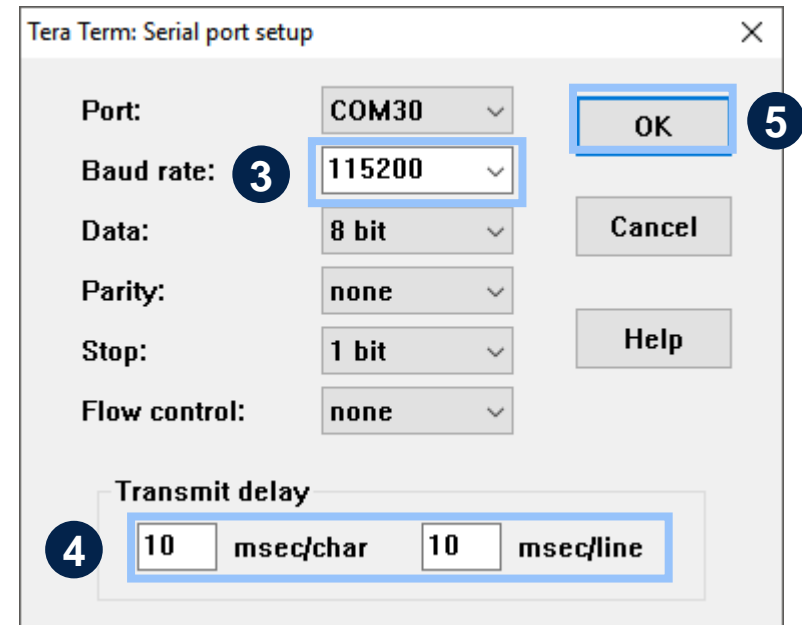
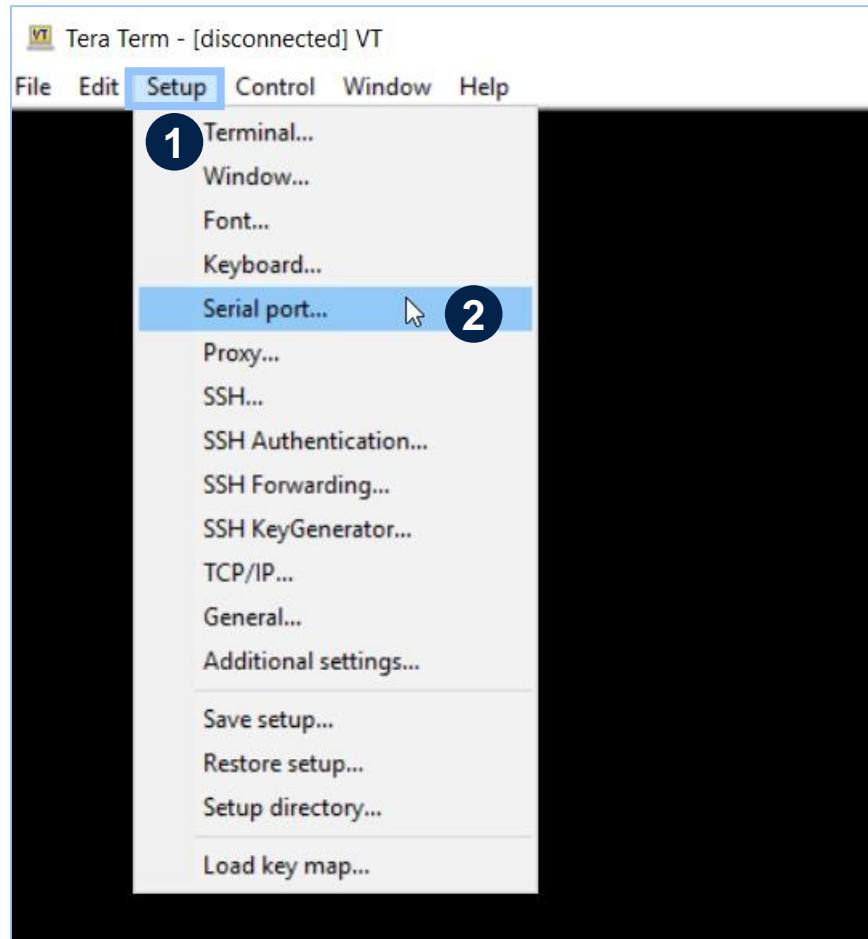
Similarity rating: 100% means maximum similarity

Number of signals analyzed

# FP-AI-NANOEDG1 Console Application

## Use the Command Line Interface (CLI)

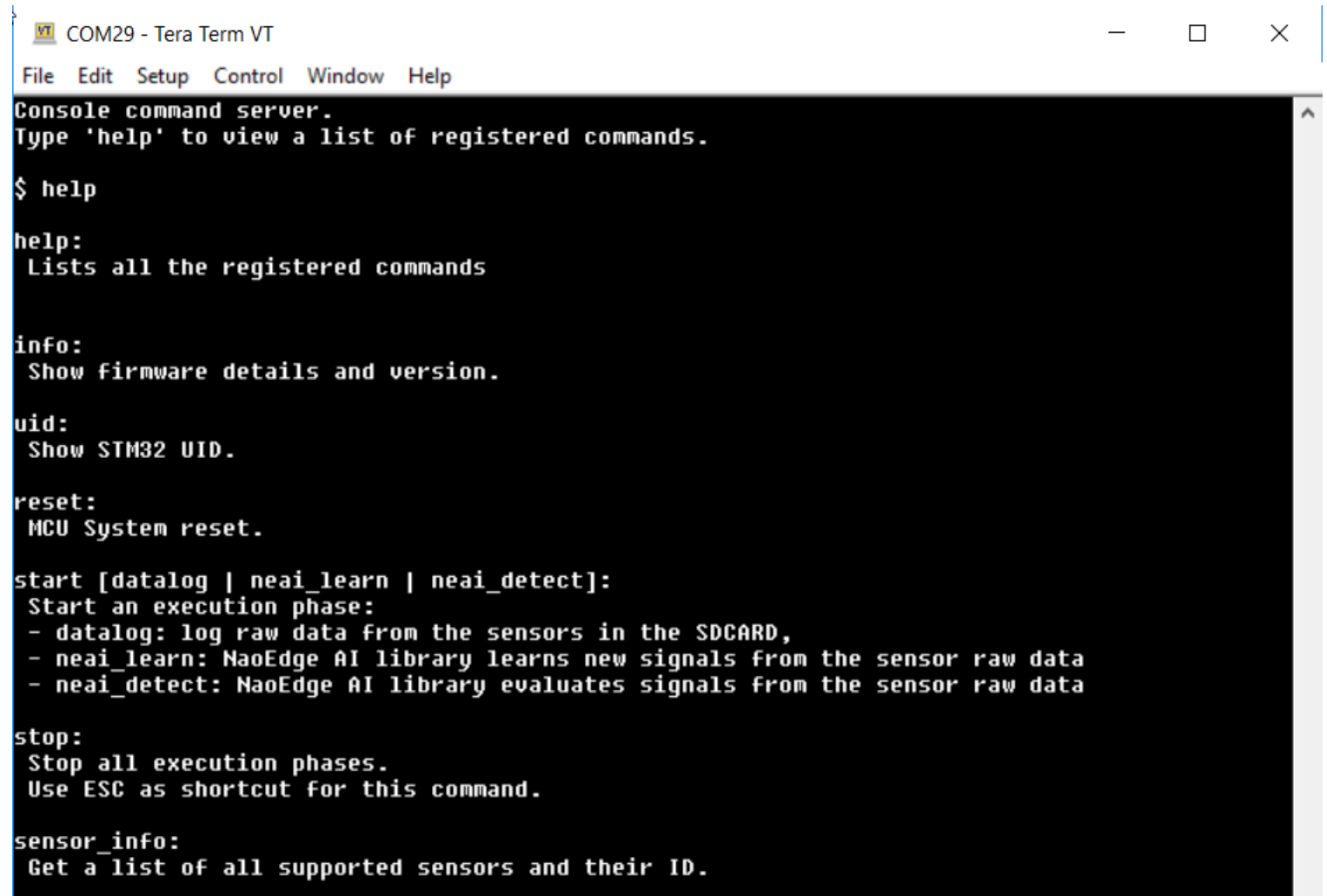
- **Configure Serial Terminal** : Open serial terminal then configure baud rate speed to 115200 (**Setup** → **Serial port** in TeraTerm) and set the Transmit delay:



# FP-AI-NANOEDG1 Console Application

## Usage of the Command Line Interface (CLI)

- After resetting the board the command prompt is displayed
- Type « help » to get info on all available commands



```
COM29 - Tera Term VT
File Edit Setup Control Window Help
Console command server.
Type 'help' to view a list of registered commands.
$ help
help:
Lists all the registered commands

info:
Show firmware details and version.

uid:
Show STM32 UID.

reset:
MCU System reset.

start [datalog | neai_learn | neai_detect]:
Start an execution phase:
- datalog: log raw data from the sensors in the SDCARD,
- neai_learn: NaoEdge AI library learns new signals from the sensor raw data
- neai_detect: NaoEdge AI library evaluates signals from the sensor raw data

stop:
Stop all execution phases.
Use ESC as shortcut for this command.

sensor_info:
Get a list of all supported sensors and their ID.
```

# FP-AI-NANOEDG1 Console Application

## Command List

Command	String	Description
<b>CS1 - Generic commands</b>		
help	help	Lists all registered commands with brief usage guidelines. Including the list of applicable parameters
info	info	Shows firmware details and version.
uid	uid	Show STM32 UID.
date_set	date_set <date&time>	Sets date and time of the MCU system.
date_get	date_get	Gets date and time of the MCU system.
reset	reset	Resets the MCU System.
start	start [ datalog   neai_learn   neai_detect]	Starts an execution phase according to its execution context, i.e. datalog, neai_learn or neai_detect.
stop	stop	Stops the currently active execution phases.
<b>CS2 - PdM specific commands</b>		
neai_init	neai_init	(re)initialize the AI model by forgetting any learning. Used in the beginning and / or to create a new NanoEdge AI model
neai_set	neai_set <param> <value>	Set a PdM specific parameters in an execution context.
neai_get	neai_get <param>	Display the value of the parameters in the execution context.
<b>CS3 - Sensor configuration commands</b>		
sensor_set	sensor_set <id> <parameter> <value>	Sets the 'value' of a 'parameter' for a sensor with sensor id provided in 'id'.
sensor_get	sensor_get <id> <parameter>	Gets the 'value' of a 'parameter' for a sensor with sensor id provided in 'id'.
sensor_info	sensor_info	Lists the type and ID of all supported sensors.

# 3- Data collection

# FP-AI-NANOEDG1 Console Application

## Configuring the sensors for data log

1

Connect the board to the PC through serial port and TeraTerm



2

Get the information about the supported sensors



```
COM29 - Tera Term VT
File Edit Setup Control Window Help
$ sensor_info
LSM6DSO ID=0, sub sensors=2
sub sensor ID=0, type=ACC
sub sensor ID=1, type=GYRO
1 sensors supported
$ sensor_get 0.0 all
enable = true
ODR = 1666.000000 Hz, measured ODR = 0.000000 Hz
Available ODRs:
12.500000 Hz
26.000000 Hz
52.000000 Hz
104.000000 Hz
208.000000 Hz
417.000000 Hz
833.000000 Hz
1666.000000 Hz
3332.000000 Hz
6664.000000 Hz
fullScale = 4.000000 g
Available fullScales:
2.000000 g
4.000000 g
8.000000 g
16.000000 g
$
```

LSM6DSO accelerometer whose Id (given by sensor\_info) is 0.0 is enabled  
ODR (Output Data Rate) is 1666 Hz  
Full scale is 4g (default)



# FP-AI-NANOEDG1 Console Application

## Data log

3

if needed, change the default settings  
using `sensor_set` command

4

Make sure an SD card is present

5

Start the data logging by entering  
`$ start datalog`

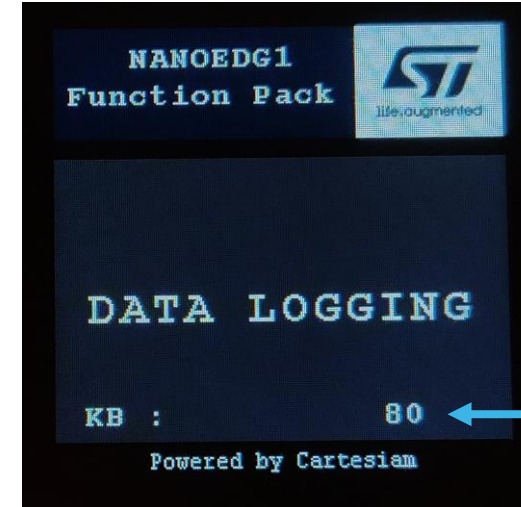
6

Stop datalogging by hitting the ESC key

7

```
COM29 - Tera Term VT
File Edit Setup Control Wind
$ start datalog
datalog started
$ datalog: stopped
$ █
```

LCD



The size of the  
datalog folder in  
runtime

For every datalog, a new folder is created (STM32\_DL\_nnn) and contains two files:

1. DeviceConfig.json: the configurations used for sensors
2. LSM6DSO.dat: the sensor acquisition data

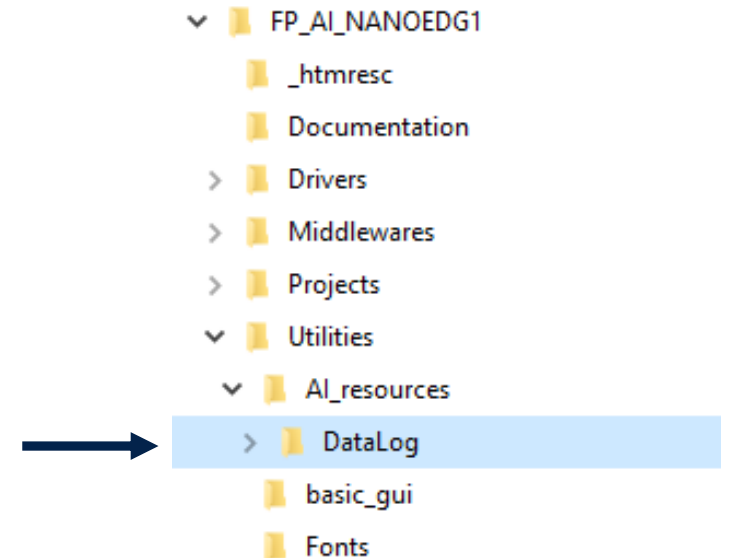
# 4- Installing and testing NanoEdge machine learning library



# FP-AI-NANOEDG1 Install NEAI Library

## Preparing data

- Parsing and preparing the data for Cartesian Library generation
  - For every data log command issued a separate folder of data log will be created
  - We need to parse the data to make it human readable
  - We need to create frames of data to process window by window
  - Sample Python scripts, along with detailed documentation are available in the form of a Jupyter notebook in folder.



# FP-AI-NANOEDG1 Install NEAI Library

## Generating a library with NanoEdge Studio

- Using NanoEdge™ AI Studio, the library generation is done in five steps
  1. Choosing a hardware setting
    1. Microcontroller type: ARM® Cortex® M33
    2. Maximum amount of RAM: usually few KBs suffice (depends on the frame size)
    3. Sensor type: accelerometer
  2. Contextual data are needed to adjust the models' performances . This step requires datasets for both nominal and abnormal conditions
  3. Optimize and Benchmark
  4. Validating the performance of the model through an emulator
  5. Compiling the model and downloading the library
- Full documentation of NanoEdge™ AI Studio be found [here](#).

# FP-AI-NANOEDG1 Install NEAI Library

## Installing the generated library

1

Copy NanoEdge library & its header file( replace existing files )

- FP\_AI\_NANOEDG1
  - \_htmresc
  - Documentation
  - Drivers
  - Middlewares
  - Third\_Party
    - Cartesiam\_NanoEdge\_AI\_Library
      - Inc
      - lib
      - Projects
      - FatFs
      - FreeRTOS
      - parson
      - Projects
      - Utilities
      - AI\_resources
        - DataLog
        - basic\_gui
        - Fonts

Download from Cartesiam

- NanoEdgeAI.h
- metadata
- libneai\_metadata.json
- libneai.a
- emulators
- docs



2

Open Project with Cubelde

- FP\_AI\_NANOEDG1
  - \_htmresc
  - Documentation
  - Drivers
  - Middlewares
  - Projects
    - STM32L562E-DK
      - Applications
        - NanoEdgeConsole
          - Binary
          - Inc
          - Src
          - STM32CubeIDE
- Utilities

Name
.cproject
.project
STM32L562QEIXQ_FLASH.Id
STM32L562QEIXQ_RAM.Id



# FP-AI-NANOEDG1 Install NEAI Library

## Installing the generated library & test

↓  
3

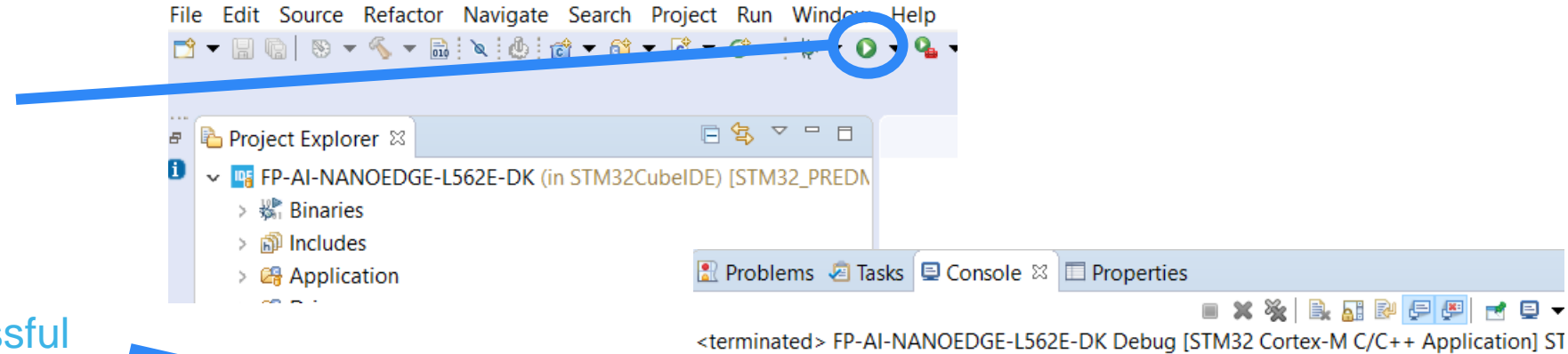
Rebuild & download

↓  
4

Check build & download is successful

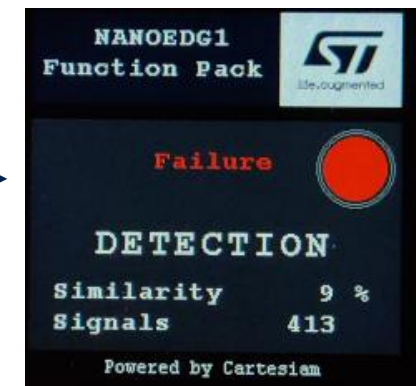
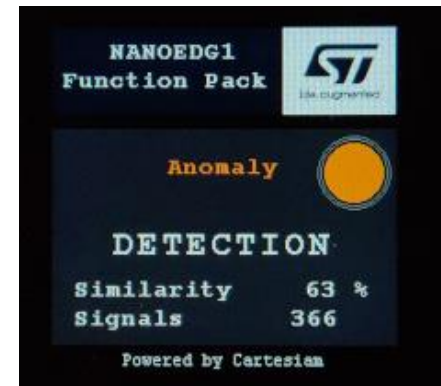
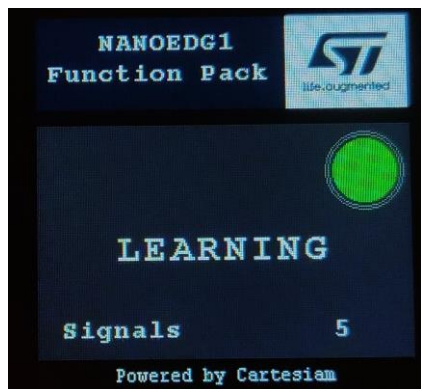
↓  
5

Start Testing



Download verified successfully

Debugger connection lost.  
Shutting down...



# 5- Documents & Related Resources

# Documents & Related Resources

All documents are available in the DESIGN tab of the related products webpage

## FP-AI-NANOEDG1 :

- **DB4196**: Artificial Intelligence (AI) condition monitoring function pack for STM32Cube – [databrief](#)
- **UM2721**: Artificial Intelligence (AI) condition monitoring function pack for STM32Cube – [user manual](#)

## STM32L562E-DK :

- [Gerber files, BOM, Schematic](#)
- **DB3937**: Discovery kit with STM32L562QE MCU – [databrief](#)
- **UM2617**: Discovery kit with STM32L562QE MCU– [user manual](#)

## STM32 Wiki : Getting started with Predictive Maintenance Using FP-AI-NanoEdg1 on STM32

- [https://wiki.st.com/stm32mcu/wiki/Getting\\_started\\_with\\_Predictive\\_Maintenance\\_Using\\_FP-AI-NanoEdg1\\_on\\_STM32](https://wiki.st.com/stm32mcu/wiki/Getting_started_with_Predictive_Maintenance_Using_FP-AI-NanoEdg1_on_STM32)



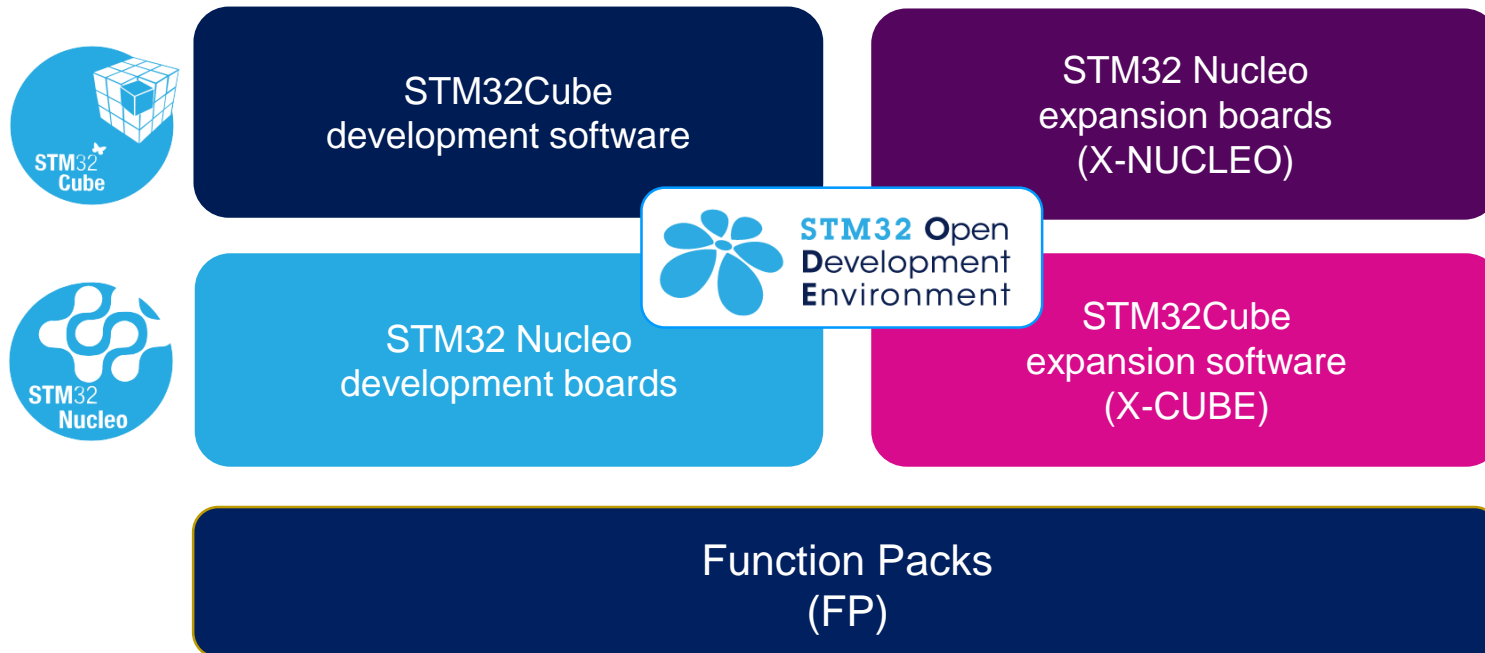
# 6- STM32 Open Development Environment: Overview



# STM32 Open Development Environment

## Fast, affordable Prototyping and Development

- The STM32 Open Development Environment (STM32 ODE) is an open, flexible, easy, and affordable way to develop innovative devices and applications based on the STM32 32-bit microcontroller family combined with other state-of-the-art ST components connected via expansion boards. It enables fast prototyping with leading-edge components that can quickly be transformed into final designs



For further information, please visit [www.st.com/stm32ode](http://www.st.com/stm32ode)

# Thank you

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