Quick Start Guide

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

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1- Hardware and software overview
Discovery kit with STM32L562QE MCU Hardware Overview

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
STM32L562E-DK
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

Latest info available at www.st.com
2- Setup
• 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 SD card
Setup

Software and Other prerequisites

• **FP-AI-NANOEDG1**
  • Download the [FP-AI-NANOEDG1](http://www.st.com) package from 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](http://www.st.com) from www.st.com

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

• **TeraTerm**
  • Open source free software terminal emulator
  • Download and install [TeraTerm](http://www.st.com)
FP-AI-NANOEDG1 Console Application

Getting the Pack

1. www.st.com
2. Select Function Pack: FP-AI-NANOEDG1
3. Download & unpack

FP-AI-NANOEDG1 package structure:
- Docs
- BSP, HAL drivers
- NanoEdge library stub
- FP-AI-NANOEDG1 application
- Python Utility Scripts

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

Select Function Pack:

FP-AI-NANOEDG1
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 NANOEDG1.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
Condition Indicator: green means nominal condition
Similarity rating: 100% means maximum similarity
Number of signals analyzed

9
Short press to start detection phase

Learning status, green means good
Number of signals used for learning
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:

1. Open TeraTerm
2. Click on Setup → Serial port...
3. Set Baud rate to 115200
4. Set Transmit delay...
5. Click OK

Life. augmented
• After resetting the board the command prompt is displayed
• Type « help » to get info on all available commands
<table>
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<tr>
<th>Command</th>
<th>String</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CS1 - Generic commands</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>help</td>
<td>help</td>
<td>Lists all registered commands with brief usage guidelines. Including the list of applicable parameters</td>
</tr>
<tr>
<td>info</td>
<td>info</td>
<td>Shows firmware details and version.</td>
</tr>
<tr>
<td>uid</td>
<td>uid</td>
<td>Show STM32 UID.</td>
</tr>
<tr>
<td>date_set</td>
<td>date_set &lt;date&amp;time&gt;</td>
<td>Sets date and time of the MCU system.</td>
</tr>
<tr>
<td>date_get</td>
<td>date_get</td>
<td>Gets date and time of the MCU system.</td>
</tr>
<tr>
<td>reset</td>
<td>reset</td>
<td>Resets the MCU System.</td>
</tr>
<tr>
<td>start</td>
<td>start [ datalog</td>
<td>Starts an execution phase according to its execution context, i.e. datalog, neai_learn or neai_detect.</td>
</tr>
<tr>
<td>stop</td>
<td>stop</td>
<td>Stops the currently active execution phases.</td>
</tr>
<tr>
<td><strong>CS2 - PdM specific commands</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>neai_init</td>
<td>neai_init</td>
<td>(re)initialize the AI model by forgetting any learning. Used in the beginning and / or to create a new NanoEdge AI model</td>
</tr>
<tr>
<td>neai_set</td>
<td>neai_set &lt;param&gt; &lt;value&gt;</td>
<td>Set a PdM specific parameters in an execution context.</td>
</tr>
<tr>
<td>neai_get</td>
<td>neai_get &lt;param&gt;</td>
<td>Display the value of the parameters in the execution context.</td>
</tr>
<tr>
<td><strong>CS3 - Sensor configuration commands</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sensor_set</td>
<td>sensor_set &lt;id&gt; &lt;parameter&gt; &lt;value&gt;</td>
<td>Sets the ‘value’ of a ‘parameter’ for a sensor with sensor id provided in ‘id’.</td>
</tr>
<tr>
<td>sensor_get</td>
<td>sensor_get &lt;id&gt; &lt;parameter&gt;</td>
<td>Gets the ‘value’ of a ‘parameter’ for a sensor with sensor id provided in ‘id’.</td>
</tr>
<tr>
<td>sensor_info</td>
<td>sensor_info</td>
<td>Lists the type and ID of all supported sensors.</td>
</tr>
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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

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

1. If needed, change the default settings using sensor_set command.

2. Make sure an SD card is present.

3. Start the data logging by entering:
   `$ start datalog`

4. Stop datalogging by hitting the ESC key.

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
• Parsing and preparing the data for Cartesiam 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.
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_AL_NANOEDG1
  - _htmresc
  - Documentation
  - Drivers
  - Middlewares
  - Third_Party
  - Cartesiam_NanoEdge_AI_Library
    - Inc
    - lib
      - libneai.library
    - Projects
    - FatFs
    - FreeRTOS
    - parson
    - Projects
    - Utilities
    - AI_resources
    - Datalog
      - basic_gui
      - Fonts

2. Open Project with CubeIDE

Download from Cartesiam
**FP-AI-NANOEDG1 Install NEAI Library**

Installing the generated library & test

1. Rebuild & download
2. Check build & download is successful
3. Download verified successfully
4. Start Testing
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

Consult www.st.com for the complete list
6- STM32 Open Development Environment: Overview
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