UM0223
User manual

STEVAL-IFS001V1 evaluation kit with MEMS

Introduction

This user manual gives an overview of the use of STEVAL-IFS001V1 kit with MEMS (Micro-Electro-Mechanical System) evaluation board.

As shown in the next section, this evaluation board consists of the DK3420 (uPSD evaluation board) and the ST-MEMS-xx-EVAL (MEMS evaluation module). When connected together as an evaluation kit, MEMS applications can be evaluated and measured through a USB connection to a PC. A brief introduction to the MEMS software, MEMS USB Reader 7.x, is also provided.

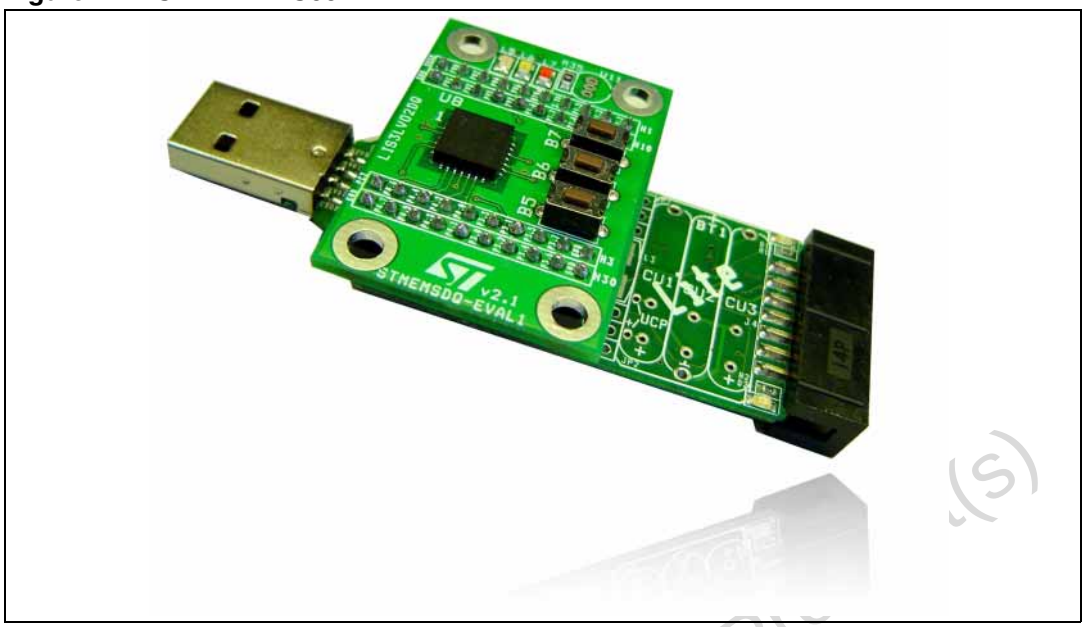
MEMS can be used in a variety of vibration sensor and intelligent movement estimator situations, for example:

- Vibration analysis
  - Motor control
  - High buildings
- Control of position
  - Stability system for caravans
  - Stability for cable cars
- Sport
  - Sport shoes
  - Speedometers
- Automotive
  - Black box
  - Intelligent driver sensors
  - Car alarms
- Navigation
  - Dead reckoning for GPS
- Logistics
  - Blackbox for containers (sensoring)
- Robotics
  - Control of robot arms (welding robots)
- Security
  - Vibration detection (broken window alarm)

Contents

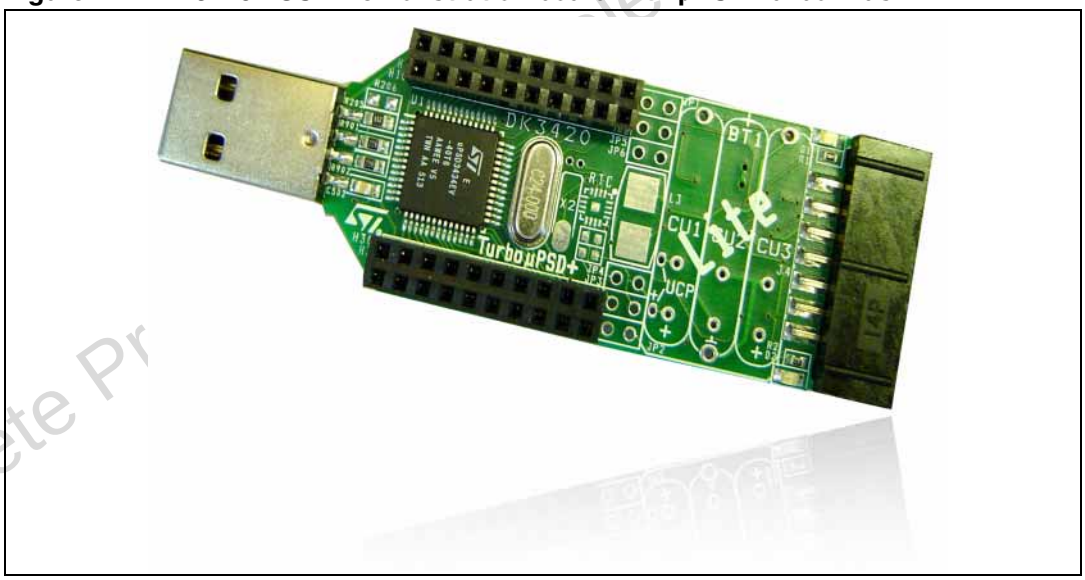
1 Overview of MEMS evaluation boards

Figure 1. STEVAL-IFS001V1



This consists of DK3420 and ST-MEMS-XX-EVAL

Figure 2. DK3420 - USB Demonstration board with µPSD Turbo Plus



For a pin description, see *Section 2*. Further information is available in the uPSD34xx datasheet and online, from http://www.st.com

Figure 3. ST-MEMS-DQ-EVAL

The MEMS module ST-MEMS-DQ-EVAL is designed for the evaluation of a MEMS application which can be used in a variety of vibration sensor and intelligent movement estimator situations.

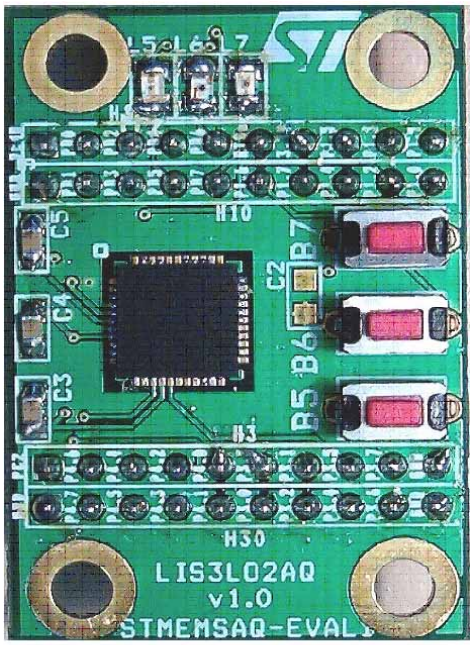
For a pin description, see *Section 2*. Additionally, a description of I^2C and SPI use is provided in *Section 3*.

Additionally, for further information on this module, refer to the user manual UM0152 “MEMS Module STMEMSDQ-EVAL1 Dedicated to uPSD Evaluation Kit DK34XX”.

Features include:

- LIS3LV02DQ (QFN28)
- I2C or SPI
- 3x buttons
- 3x LEDs

Figure 4. ST-MEMS-AQ-EVAL (check for availability)



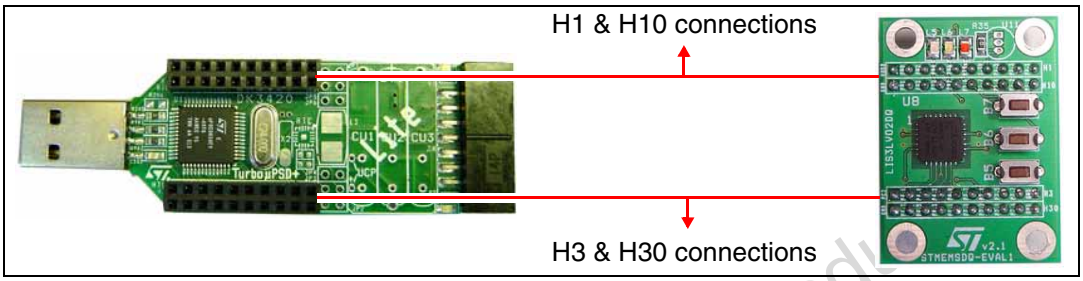
Components include:

- LIS3L02AQ (QFN44)
- 3x analog outputs
- 3x buttons
- 3x LEDs

2 Pin description

Table 1. DK3420 - USB demonstration board with µPSD Turbo Plus and ST-MEMS-DQ-EVAL

H1	5V	PB0	PB2	PB4	PB6 LED6	RESET	3.3V	P1.5 Ain5 BUT5	P1.3 Ain3	P1.1 Ain1
H10	GND	PB1	PB3	PB5 LED5	PB7 LED7	P1.6 Ain6 BUT6	P1.7 Ain7 BUT7	P1.4 Ain4	P1.2 Ain2	P1.0 Ain0



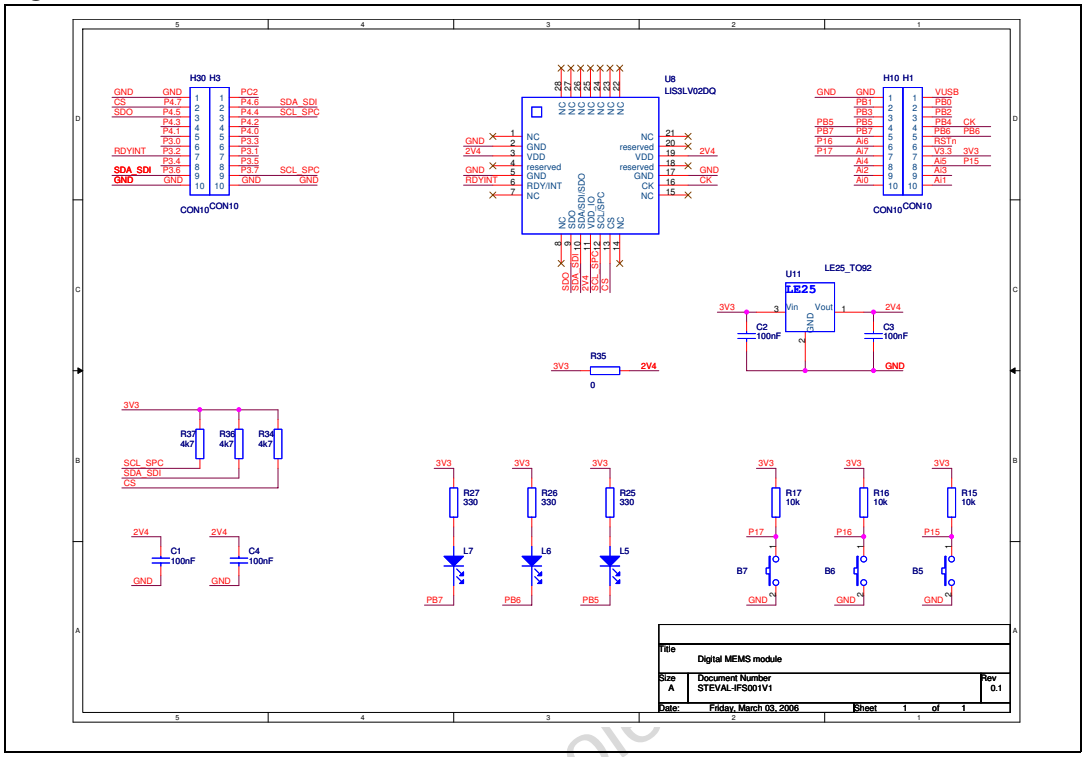
H3	PC2	P4.6 SDO	P4.4 SPC	P4.2	P4.0	P3.3	P3.1 UART0 out	P3.5	P3.7 SCL	GND
H30	GND	P4.7 CS	P4.5 SDI	P4.3	P4.1	P3.0 UART0 in	P3.2	P3.4	P3.6 SDA	GND

Legend:

- AINx - Analog input x
- SPC - SPI clock
- SDI - SPI data input (view from uPSD)
- SDO - SPI data output (view from uPSD)
- CS - SPI chip select
- UART0out - UART data out
- UART0in - UART data in
- SDA - I^2C data
- SCL - I^2C clock

3 I²C and SPI use

Figure 5. Board schematics for ST-MEMS-DQ-EVAL



3.1 I²C and SPI connections

Signal (on MEMS)	I2C (on uPSD)	SPI (on uPSD)
SCL_SPC	P3.7	P4.4
SDO	NC	P4.5
SDA_SDI	P3.6	P4.6
CS	NC	P4.7

3.2 Recommendations for I^2C use

- With I^2C, the use of R36 & R37 pull-up resistors (4k7) is advised
- The use of resistor R34 (10k) is not normally necessary as uPSD has an internal pull-up of around 100k.
- Because SCL_SPC and SDA_SDI are used for I^2C and SPI together, care should be taken with the following instructions:
  - First (*important*), disable SPI and set the SPI pins as floating inputs
  - Set P4.7 (CS) as GPIO output and write '1' to activate I^2C on the MEMS chip
  - Enable I^2C on your micro and start the communication

3.3 Recommendations for SPI use

- With SPI, the use of resistors R36, R37 is NOT advised
- The use of resistor R34 (10k) is not normally necessary as uPSD has an internal pull-up of around 100k.
- Because SCL_SPC and SDA_SDI are used for I^2C and SPI together, care should be taken with the following instructions:
  - First (*important*), disable I^2C and set the I^2C pins as floating inputs
  - Activate your SPI. P4.7 is a part of SPI and should be '0', otherwise set P4.7 (CS) as GPIO output and write '0' directly. This instructs the MEMS chip to use SPI
  - Start the communication

4 uPSD software use

4.1 Digital or analog module

The program automatically detects whether a module is digital or analog.

The recognition is based on the value on pin P3.3. A digital module has this pin unconnected which is the same as logic '1' because of an internal uPSD pull-up. Analog modules must employ a pull-down resistor to enable the detection of logic '0'.

4.2 LED signalization

- LED5 (green) blinking
  Data is being read. Digital modules are using I^2C, analog modules are using ADC.
- LED6 (yellow) blinking
  This indicates USB communication, data is being sent.
- LED7 (red) blinking
  The program is running, this led is toggled in main.

Immediately after the module is plugged in, all LEDs are lit while initialization is in process. When uPSD, the peripherals (I2C,ADC, etc) and MEMS are initialized, the LEDs are turned off. Immediately following this, the main starts and LED7 blinks.

- If LED7 doesn't start blinking, the initialization will have failed.
  a) Check hardware
  b) Try to restart the PC
  c) Re-program uPSD
  d) If still not working, contact support

4.3 Selection of operation mode

During the initialization an operation mode can be selected by pressing buttons:

- no button is pressed
  On-line measurement (default)
- BUT5 is pressed
  Off-line measurement (it erases the Flash for new measurements which takes around 5s for the 256KB flash)
- BUT6 is pressed
  Read out data from Flash (useful after the off-line measurement)
- BUT7 is pressed
  No effect.

Note: Press the button first and then plug the module into the USB.

4.4 On-line measurement

During on-line measurement, data is read from MEMS and sent via USB to the PC. Logically, all three LEDs should blink. In this mode, the buttons have the following meanings:

- no button is pressed

  uPSD sends data from MEMS to the PC (a packet with MEMS data)
- BUT5 is pressed

  No effect.
- BUT6 is pressed

  No effect.
- BUT7 is pressed

  In the case of digital MEMS, uPSD reads its registers and sends this information via USB (a packet with registers)

4.5 Off-line measurement

Ready to start the measurement. Normally LED7 blinks.

- no button is pressed

  No effect.
- BUT5 is pressed

  Pause/Stop measurement.
- BUT6 is pressed

  Start measurement, LED5 blinks to indicate data is being read and stored (it stops automatically when the Flash is full).
- BUT7 is pressed

  If measurements have not started, the sample frequency can be changed. Possible frequencies are 40 or 160 Hz. The selection is indicated by the LED7 blinking speed.

Off-line measure time	@40Hz	@160Hz
128KB (uPSD3433)	576s	136s
256KB (uPSD3434)	1092s	273s

4.6 Read out data from Flash

Ready to start sending data stored in Flash via USB. Normally LED7 is blinking.

- no button is pressed

  No effect
- BUT5 is pressed

  Start sending data. uPSD sends data from Flash and LED6 blinks (a packet with MEMS data). It reads the entire Flash. Any part which doesn't contain relevant MEMS data you will get 0xFF. After the end of the Flash range, 0xFF will also be sent. 0xFF

values translate as <-1,-1,-1> readings on the PC MEMS USB Reader, which should be considered to detect both false readings and end of Flash data.

- BUT6 is pressed

  No effect.

- BUT7 is pressed

  No effect.

5 MEMS software - MEMS_USB_Reader_7x

5.1 Initial window and features overview

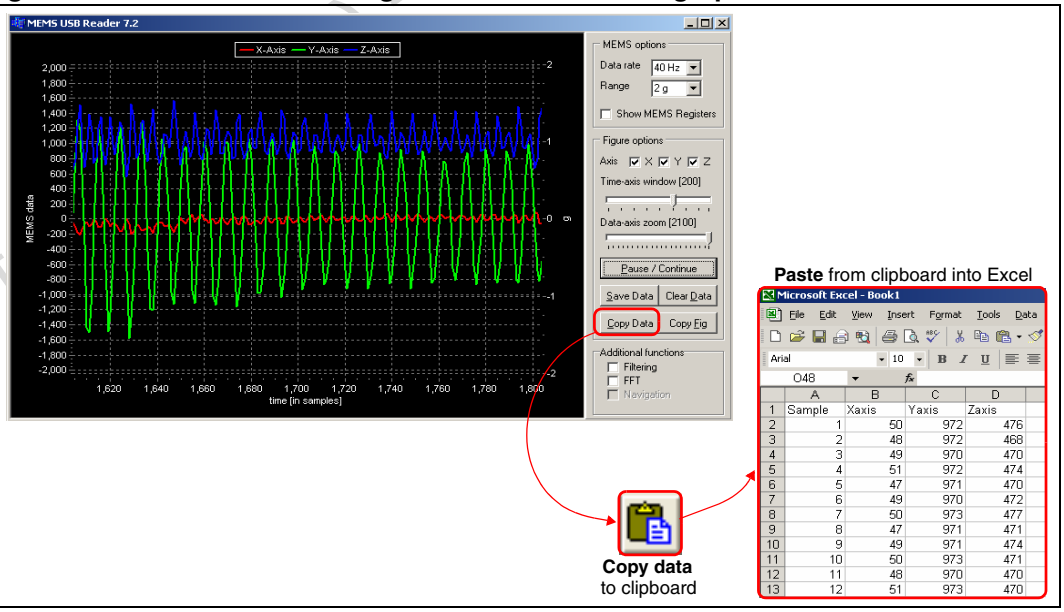
Figure 6. Screenshot of initial screen of MEMS USB Reader 7.1

Main features available in the MEMS USB Reader include:

- MEMS values in time graph
- Butterworth filters
- FFT analysis

5.2 MEMS values

Figure 7. Screenshot showing MEMS values in time graph

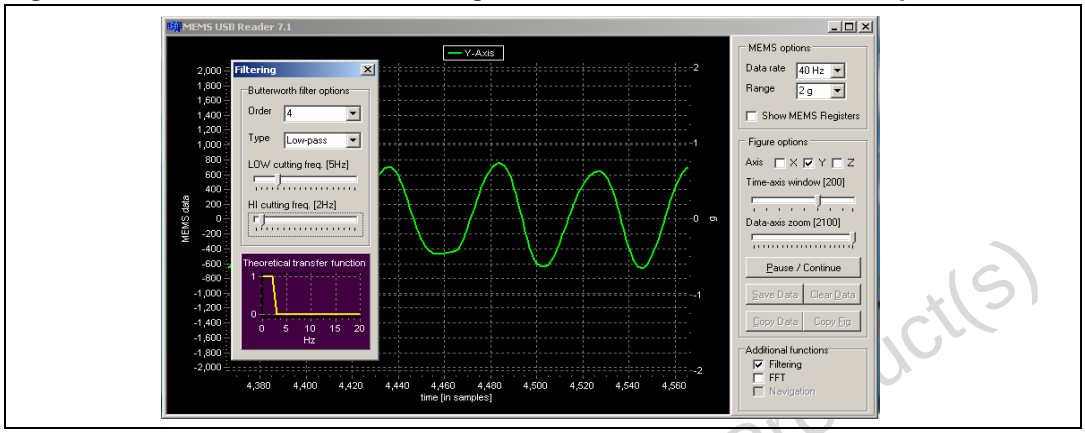


Use the MEMS Values screen to:

- Copy data into the Excel directly via clipboard
- Copy the graphic figure (graph) as a metafile via clipboard
- Save data into a CSV file

5.3 Butterworth filters

Figure 8. Screenshot of the filtering window with Butterworth filter options

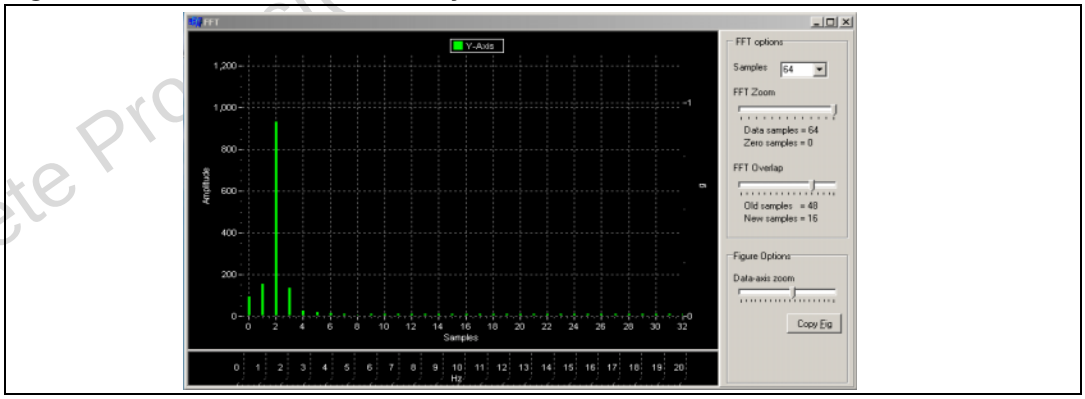


Filtering options include:

- Butterworth low-pass & hi-pass filters order 1-4
- Butterworth band pass filter order 1
- It's possible to hide the axis (currently, only the Y-Axis is shown)

5.4 FFT analysis

Figure 9. Screenshot of FFT analysis



FFT (Fast Fourier Transform) analysis features and options include:

- FFT for 16, 32, 64, 128 samples
- Allows FFT zoom (filling with zeros)
- Allows to change FFT overlap
- Copy of the figure to clipboard as a metafile

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