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Introduction

The STEVAL-MKI022V1 is a demonstration kit designed to provide the user with a complete, ready-to-use platform for demonstration of the LIS331DLH. The LIS331DLH is a low-power 3-axis linear accelerometer with digital output. The device includes a sensing element and an IC interface capable of translating information from the sensing element into a measured signal that can be used for external applications.

In addition to the MEMS sensor, the demonstration board utilizes an ST7-USB microcontroller which functions as a bridge between the sensor and the PC, on which it is possible to use the graphical user interface downloadable to the website or dedicated software routines for customized applications.

This user manual describes the hardware included with the demonstration kit and provides the information required to install and run the demonstration kit user interface.

For details regarding the features of the LIS331DLH sensor, please refer to the datasheet for this device and application note AN2847.

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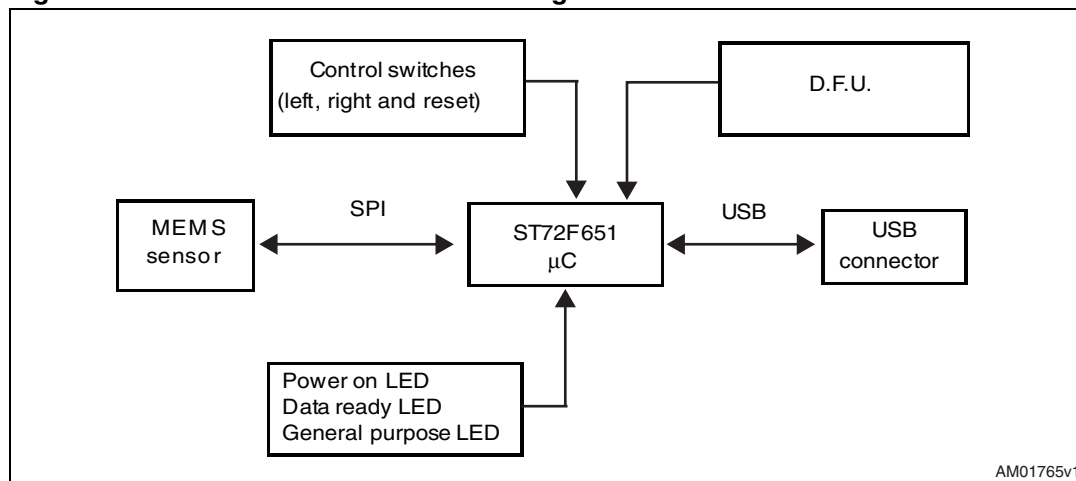
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1 Demonstration kit description

The STEVAL-MKI022V1 is a complete demonstration kit that allows demonstrating the performance of the LIS331DLH low-power 3-axis linear accelerometer with digital output.

The block diagram of the demonstration kit is shown in *Figure 1*.

Figure 1. Demonstration board block diagram



The ST7-USB microcontroller included on the board allows communication between the sensor device and the PC. The user can interact with the hardware either through the GUI provided with the kit or through dedicated software routines to run customized applications.

The device firmware upgrade (DFU) is a feature that allows the customer to upgrade the firmware inside the ST7 microcontroller in case a new firmware release is available on www.st.com/mems.

Switches and LED indicators are used to control and monitor the functionality of the board.

The top silk screen view and photo of the full board, respectively, are shown in *Figure 2* and *Figure 3*.

Figure 2. Top silk screen of the STEVAL-MKI022V1 kit

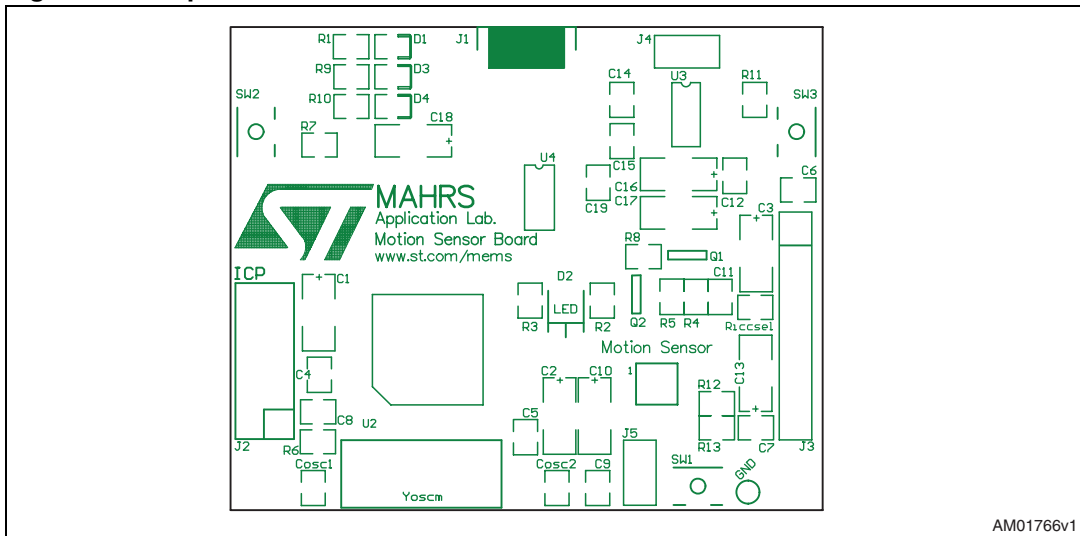
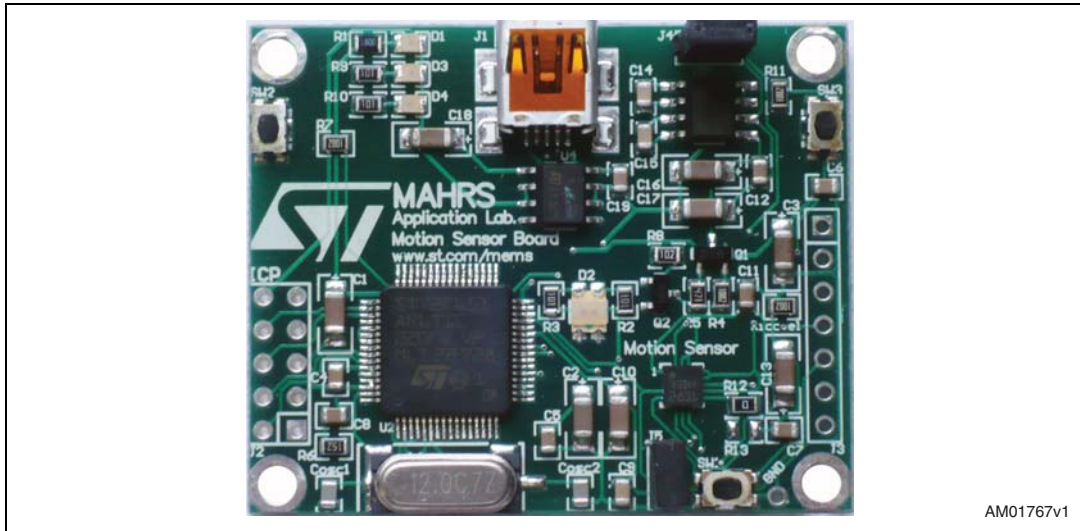


Figure 3. Board photograph



Operation of the STEVAL-MKI022V1 demonstration kit requires the installation of a dedicated driver which is included in the installation pack, together with a GUI interface which allows simple interaction with the sensor. The steps required for driver and software installation are described in the following section.

2 STEVAL-MKI022V1 GUI installation

The installation of the graphical user interface (GUI) for the STEVAL-MKI022V1 requires two steps:

1. installation of the software downloaded from www.st.com/mems
2. installation of the virtual COM driver needed to use the demonstration kit.

2.1 PC system requirements

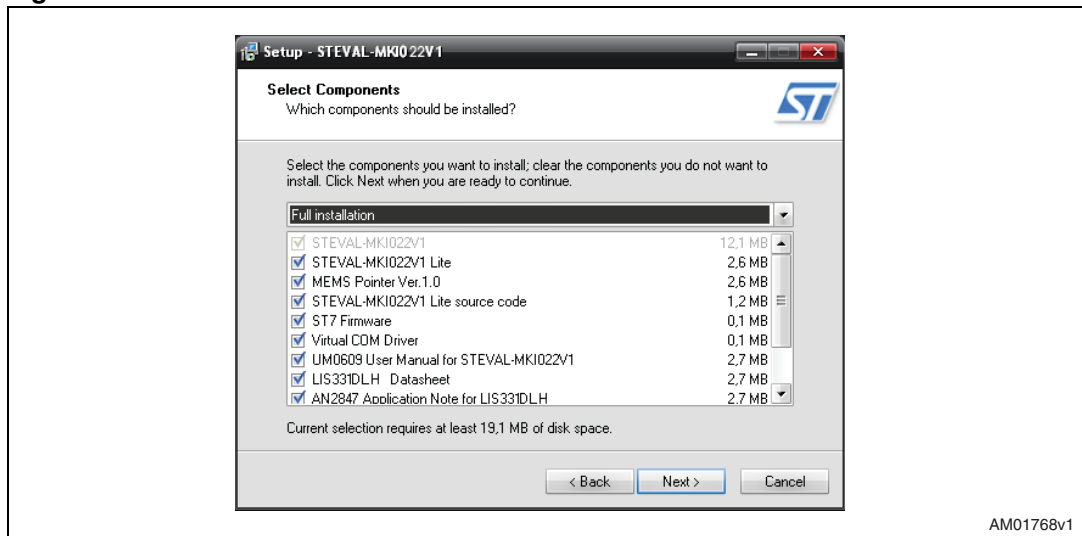
Both the hardware and software that compose the STEVAL-MKI022V1 demonstration kit have been designed to operate with Microsoft® Windows XP.

2.2 Software installation

To install the software downloaded from demonstration kit web page:

1. double-click on "Setup.exe"
2. follow the on-screen instructions (*Figure 4*).

Figure 4. Software installation



2.3 Hardware installation

To install the virtual COM driver, insert the demonstration kit board into a free USB port. The “Notify” icon should appear as in [Figure 5](#).

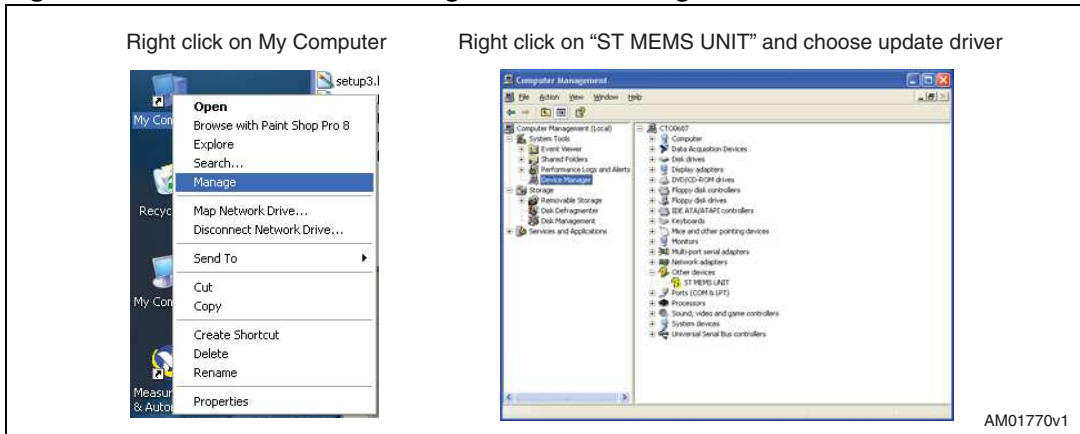
Figure 5. Notify icon



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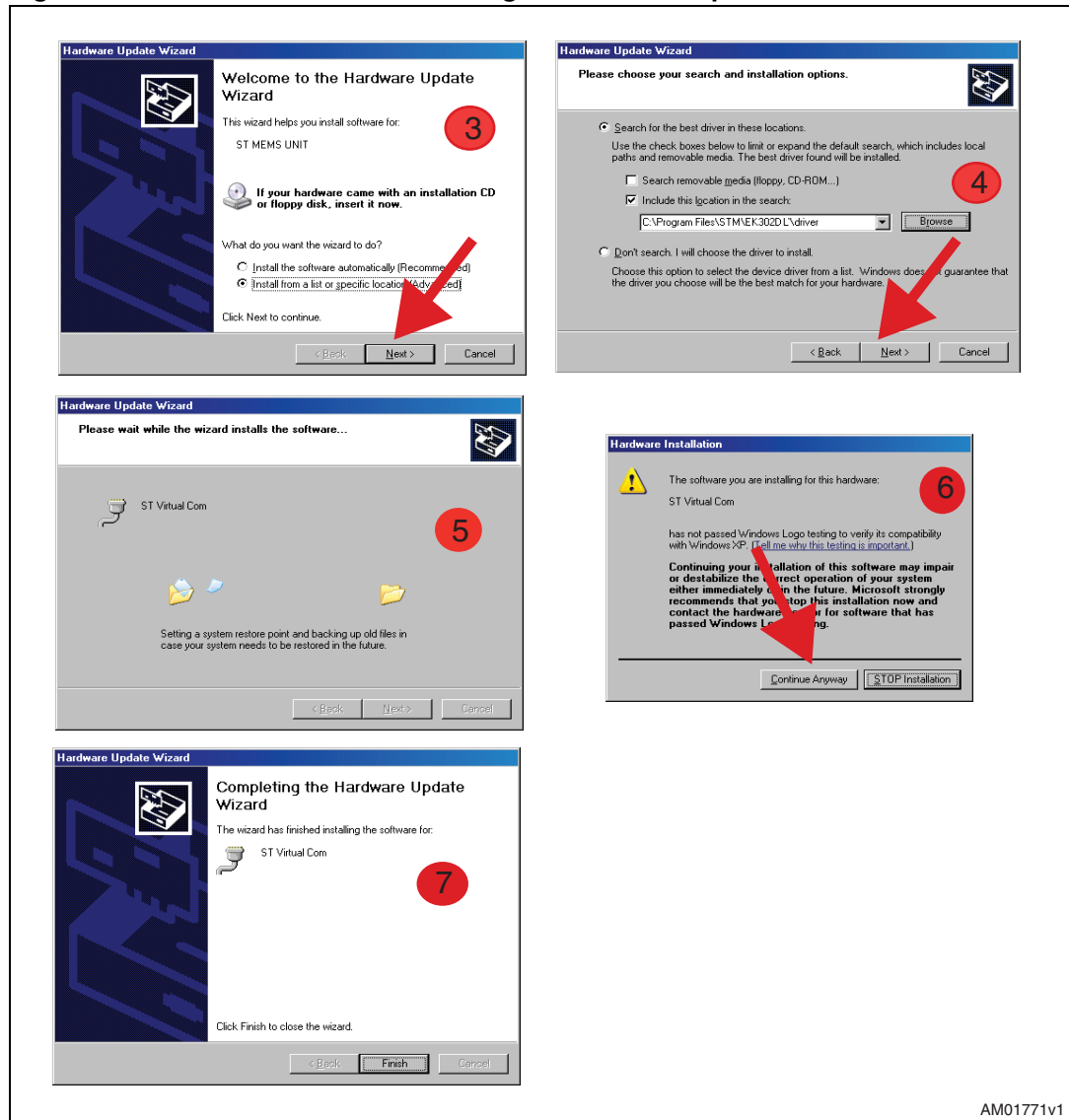
If the “Hardware Update Wizard” window appears ([Figure 7](#)), follow the instructions on the screen, otherwise, the installation can be performed by following the instructions indicated in [Figure 6](#) and then [Figure 7](#).

Figure 6. Driver installation using the device manager



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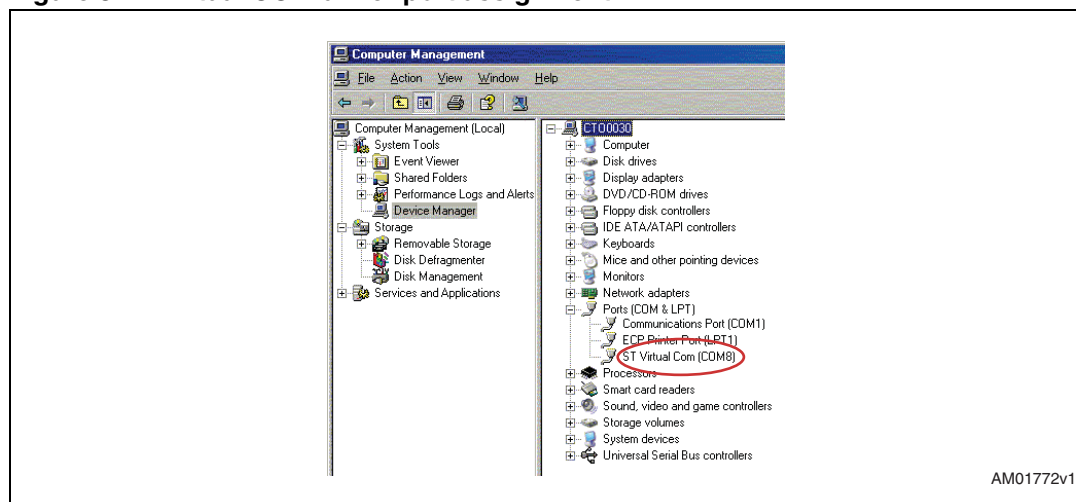
Figure 7. USB driver installation using the hardware update wizard



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Once the installation is complete, a COM port number is assigned to the ST virtual COM driver (*Figure 8*). This number should be retained as it is required to run the STEVAL-MKI022V1 demonstration software GUI. For additional details, see section 3.1.

Figure 8. Virtual COM driver port assignment



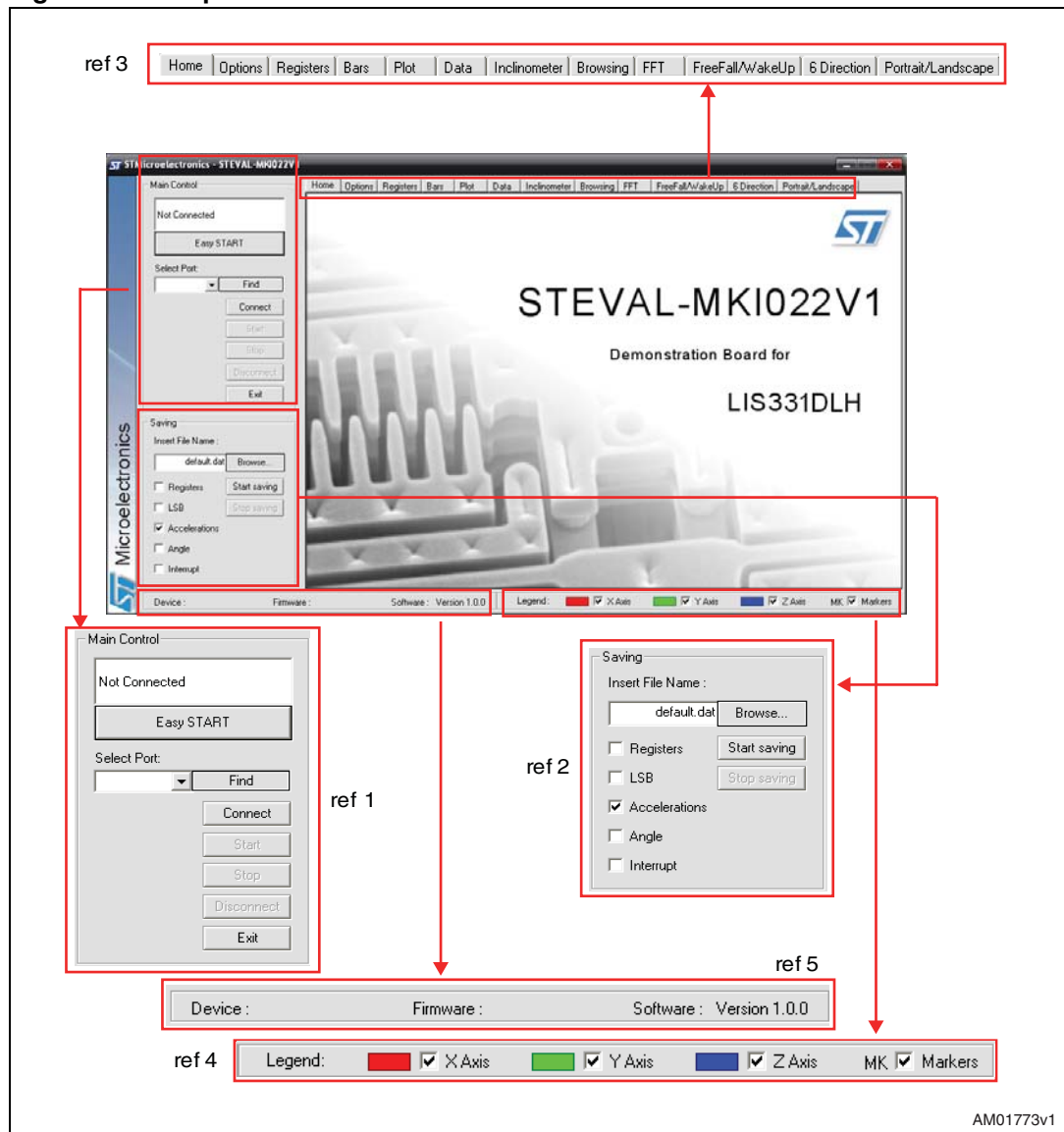
3 Graphical user interface

To execute the STEVAL-MKI022V1 demonstration software GUI:

1. click on Start > All Programs
2. select STEVAL-MKI022V1 > Executables
3. launch the program “STEVAL-MKI022V1 Ver.1.0”.

The GUI main window appears as shown in *Figure 9*.

Figure 9. Graphical user interface: main window



The functions of the four main sections of the window are described below:

1. “Main Control” ([Figure 9](#), ref 1) - connects/disconnects the board and starts acquisition via the Start/Stop buttons
2. “Saving” box ([Figure 9](#), ref 2) - allows the user to save the data to a specified text file, choosing the data type to write. Data types available are:
 - a) RAW: for each axis the software writes the data read directly from the sensor output registers (OUTX_H, OUTX_L, OUTY_H, OUTY_L and OUTZ_H, OUTZ_L)
 - b) LSB: the data read directly from the sensor are converted from 2’s complement to sign and magnitude
 - c) Acceleration: LSB data are multiplied by the sensitivity to obtain the acceleration expressed in mg
 - d) Angle: LSB data converted to the tilting angle of the board expressed in degrees
 - e) Interrupt: status of the interrupt
3. “Tab Selector” ([Figure 9](#), ref 3) - used to toggle between the different functions of the demonstration kit
4. “Legend” ([Figure 9](#), ref 4) - possibility to enable/disable viewing the axes
5. “Details” ([Figure 9](#), ref 5) - shows the details of the demonstration kit, the name of the sensor, the version of the firmware loaded on the microcontroller and the version of the PC software.

3.1 Connecting to the virtual COM port

Before using the functions of the demonstration kit software the connection with the STEVAL-MKI022V1 board must be opened using the following steps:

1. connect the STEVAL-MKI022V1 to the desired USB port
2. in the “Select COM” drop-down menu ([Figure 9](#) ref 1), choose the virtual COM number to which the board has been mapped. For additional information on how to obtain this number, see section [2.3](#)
3. open the connection by clicking on “Connect” ([Figure 9](#) ref 1)

At this point the user can acquire, plot and save the acceleration data measured by the sensor and access the content of the registers embedded in the device.

Clicking the "Find" button ([Figure 9](#) ref 1), the GUI attempts to automatically find the COM number assigned to the demonstration kit and shows it in the list box as a selected item.

The following sections provide details regarding the functions of the tabs in [Figure 9](#), ref 1.

3.2 “Easy Start” button

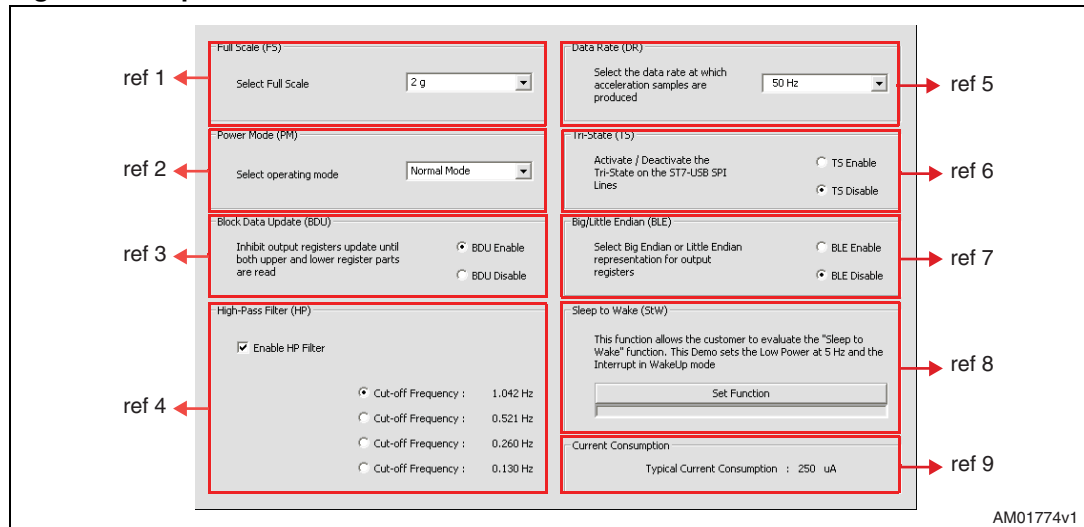
Clicking the "Easy Start" button ([Figure 9](#), ref 1), the GUI attempts to automatically find the COM number assigned to the demonstration kit and starts the acquisition.

3.3 “Options” tab

The options tab allows the user to control the following parameters:

1. Full scale (FS) - Sets the maximum acceleration value measurable by the device. It is possible to select either 2g, 4g or 8g ([Figure 10](#), ref 1)
2. Operating mode (OM) - This control allows the customer to select the operating mode: normal mode, power-down mode and different low-power modes (0.5, 1, 2, 5 or 10 Hz) ([Figure 10](#), ref 2)
3. Block data update (BDU) - BDU function is used to inhibit the output registers update between the reading of upper and lower register parts. After the reading of the lower (upper) part, the content of that output register is not updated until the upper (lower) part is read too ([Figure 10](#), ref 3)
4. High-pass filter (HP) - This control activates the high-pass filter on the device and selects the cut-off frequency ([Figure 10](#), ref 4)
5. Data rate (DR) - In this box the rate at which each acceleration sample is produced can be selected. The possible values are 50, 100, 400 or 1000 Hz ([Figure 10](#), ref 5)
6. Tri-state (TS) - Permits switching the SPI lines of the ST7-USB microcontroller mounted on the demonstration kit between 3-state (i.e. high-impedance) and normal mode ([Figure 10](#), ref 6). This function makes it possible to isolate the sensor mounted on the board from the microprocessor, in case any external control (from a different microcontroller mounted on a separate user board) is needed. This function is inhibited during the acquisition
7. Big/little endian (BLE) - It is used to select big endian or little endian representation for output registers. In big endian representation one MSB acceleration value is located at addresses 28h (X-axis), 2Ah (Y-axis) and 2Ch (Z-axis) while the LSB acceleration value is located at addresses 29h (X-axis), 2Bh (Y-axis) and 2Dh (Z-axis). In little endian representation the order is inverted ([Figure 10](#), ref 7)
8. Sleep to Wake (StW) - This feature allows the user to configure the automatic wakeup feature of the LIS331DLH. When the Sleep to Wake function is activated, the LIS331DLH is able to automatically wake up as soon as the configured interrupt event has been detected, increasing the output data rate and bandwidth. With this feature the system can be efficiently switched from low-power mode to full performance, depending on user-selectable positioning and acceleration events, thus ensuring power saving and flexibility. With the “Set Function” button the software automatically configures the sensor to use the Sleep to Wake with a wakeup interrupt mode ([Figure 10](#), ref 8)
9. Current consumption - It shows the typical current consumption for each operating mode/data rate configuration ([Figure 10](#), ref 9).

Figure 10. Options tab



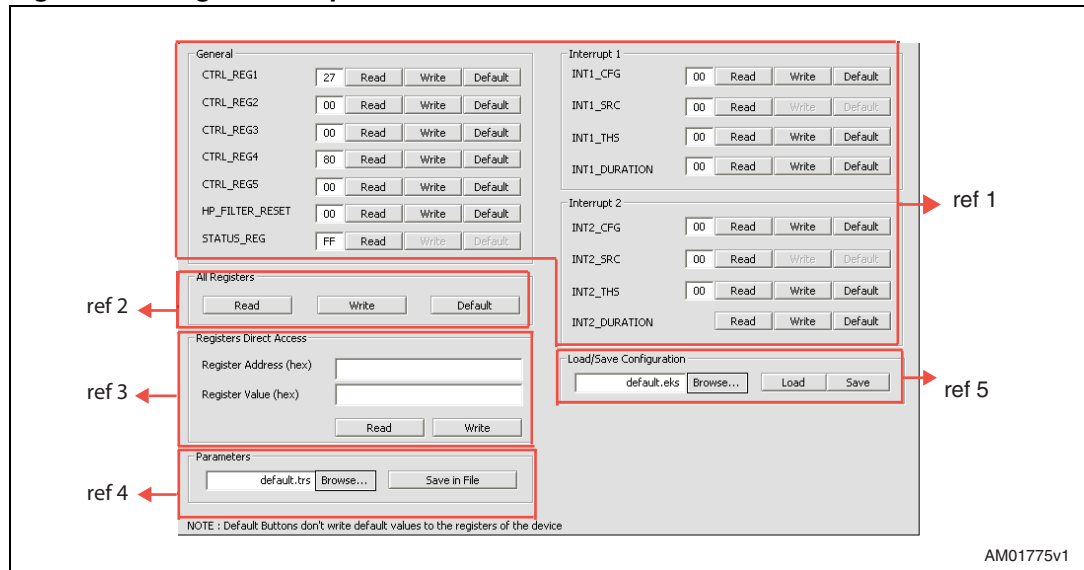
3.4 “Register Setup” tab

The register setup tab shown in [Figure 11](#) allows read/write access to the content of the registers embedded in the LIS331DLH MEMS sensor mounted on the demonstration kit. The tab is divided into five sections:

1. “General” ([Figure 11](#), ref 1) - provides access to the registers which control the main settings of the device. This section contains the control registers (CTRL_REG1, CTRL_REG2 and CTRL_REG3) and the registers that control the generation of inertial interrupt signals. It is possible to read and write the contents of each register. To restore the default value for a given register, press the “Default” button
2. “All Registers” ([Figure 11](#), ref 2) - permits the user to read, write and recall the default content for all the registers shown in ref 1 with a single click on the read/write/default button
3. “Registers Direct Access” ([Figure 11](#), ref 3) - provides access to any register in the device. To read a generic register, insert the address in the “Register Address” textbox, then click on the “Read” button. The retrieved content of the register is displayed in the “Register Value” field. As with writing to a register, the user must specify the address and the data to be written inside the fields marked “Register Address” and “Register Value”, respectively, and then press the “Write” button
4. “Parameters” ([Figure 11](#), ref 4) - allows the user to save the register configuration to a text file, which includes a detailed description of the resulting configuration for each register
5. “Load/save configuration” ([Figure 11](#), ref 5) - lets the user save/load a specific configuration to/from a file

Note: By pressing the "Default" button, the default values for the registers are recalled in the registers field. To write the values to the registers of the device, the user has to press the "Write" button after the "Default" button.

Figure 11. Register setup tab



3.5 “Bars” tab

The bars tab (*Figure 12*) displays the acceleration data measured by the LIS331DLH sensor in bar chart format. The accelerations along the X, Y and Z axes correspond respectively to the red, green and blue bars.

The height of each bar is determined by the amplitude of the acceleration signal measured along the related axis. The full scale of the graph depends on the FS1/FS0 bits of CTRL_REG4 that may be changed through both the Option (*Figure 10*, ref 1) and the Register Setup tabs (*Figure 11*, ref 1).

Click on the desired bar to zoom. The selected bar is shown at the center of the screen together with the acceleration as a numerical value. To return to the default view, click on the center of the bar (*Figure 13*).

Figure 12. Bars tab - acceleration data

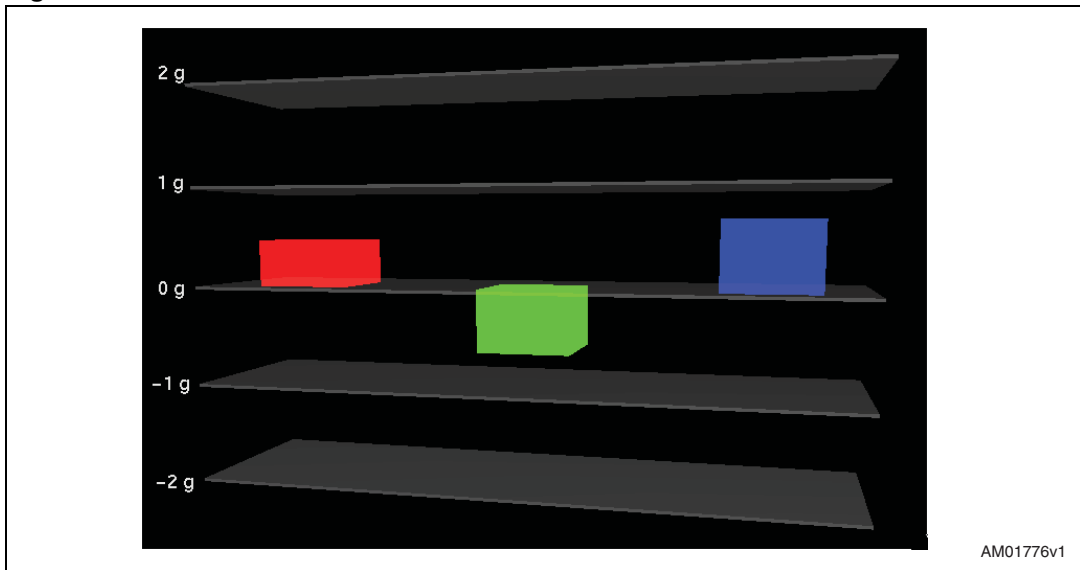
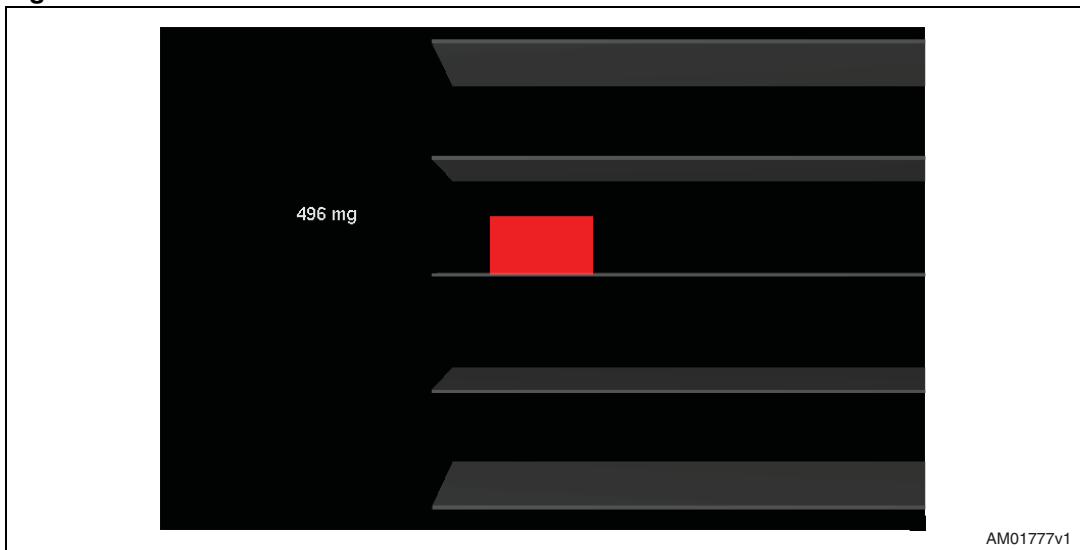


Figure 13. Bars tab - selected acceleration as a numerical value



3.6 “Plot” tab

The plot tab (*Figure 14*) shows the sequence of acceleration samples that have been measured by the LIS331DLH MEMS sensor mounted on the demonstration kit. This tab shows:

1. “Acceleration value” (*Figure 14*, ref 1) - shows the numeric values of acceleration samples that have been measured by the sensor
2. “Information” (*Figure 14*, ref 2) - legend of the current status which gives the operating mode, the data rate and the full scale

To zoom in on the waveform, select the desired zone with the left button of the mouse (*Figure 15*). Click again with the right button to return to the default view.

Figure 14. Plot tab

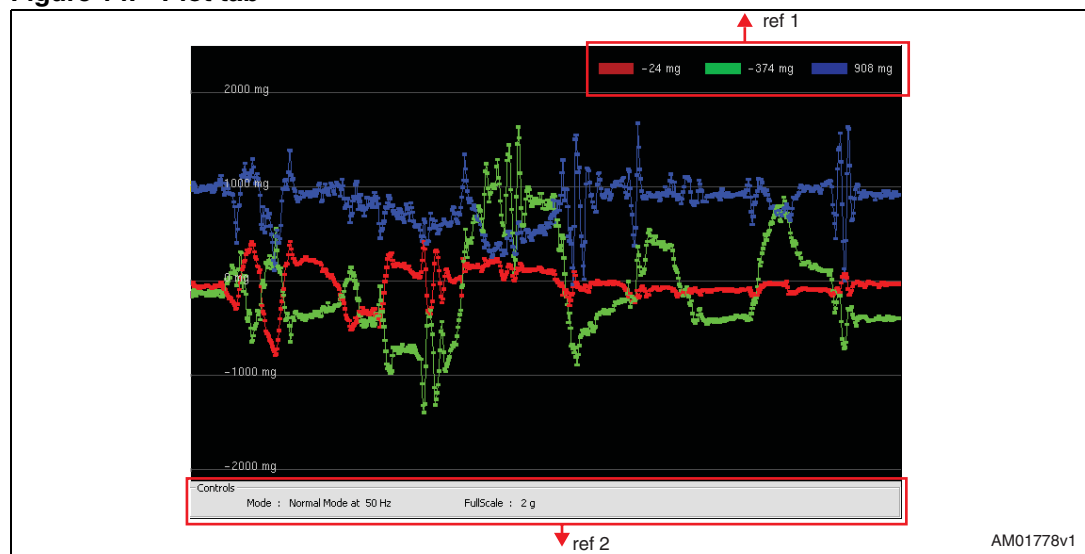


Figure 15. Plot tab - zoom

1) Select one point on the screen and click the LEFT mouse button



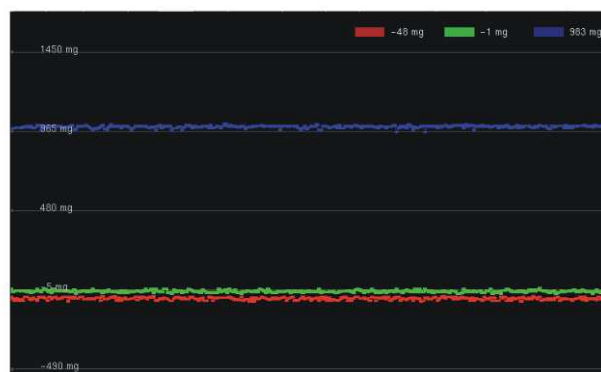
2) Holding the LEFT mouse button clicked, move the cursor to obtain an area on the screen



3) Releasing the button to terminate the Zoom in process, a new area is visualized on the screen



4) To return to the previous view the user has to click the RIGHT mouse button



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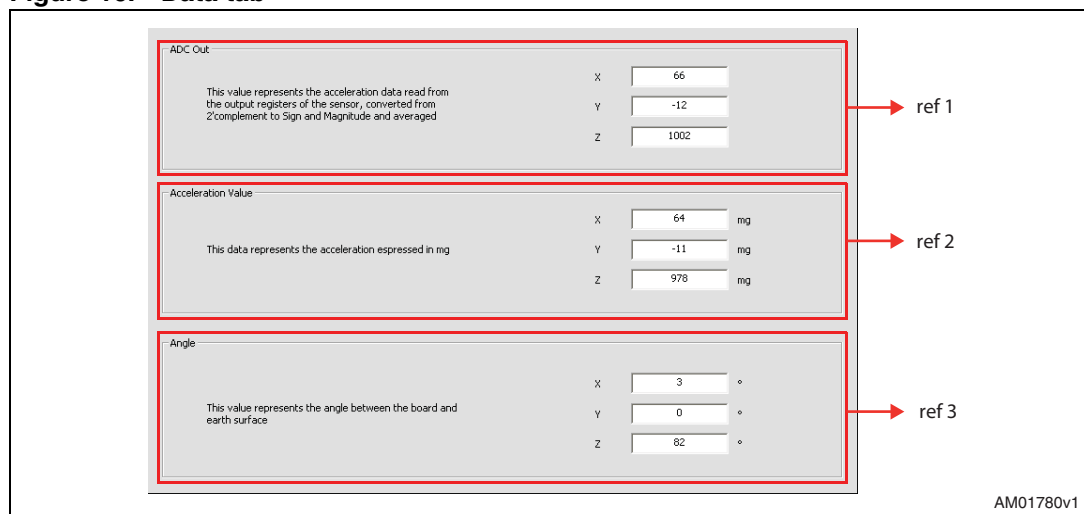
3.7 “Data” tab

The data tab (*Figure 16*) shows the acceleration values measured by the LIS331DLH sensor. It is divided into three sections:

1. “ADC Out” (*Figure 16*, ref 1) - displays the acceleration data provided by the sensor after its conversion from 2’s complement to magnitude and sign
2. “Acceleration Value” (*Figure 16*, ref 2) - represents the acceleration data measured by the sensor, expressed in mg
3. “Angle” (*Figure 16*, ref 3) - returns the tilt angle, expressed in degrees, that is inferred from the “ADC Out” data

Note: To increase data readability, the values shown in the boxes described above are based on an average of 50 samples.

Figure 16. Data tab



3.8 “Inclinometer” tab

The inclinometer tab (*Figure 17*) represents the acceleration data measured by the sensor in the form of an artificial horizon.

Figure 17. Inclinometer tab

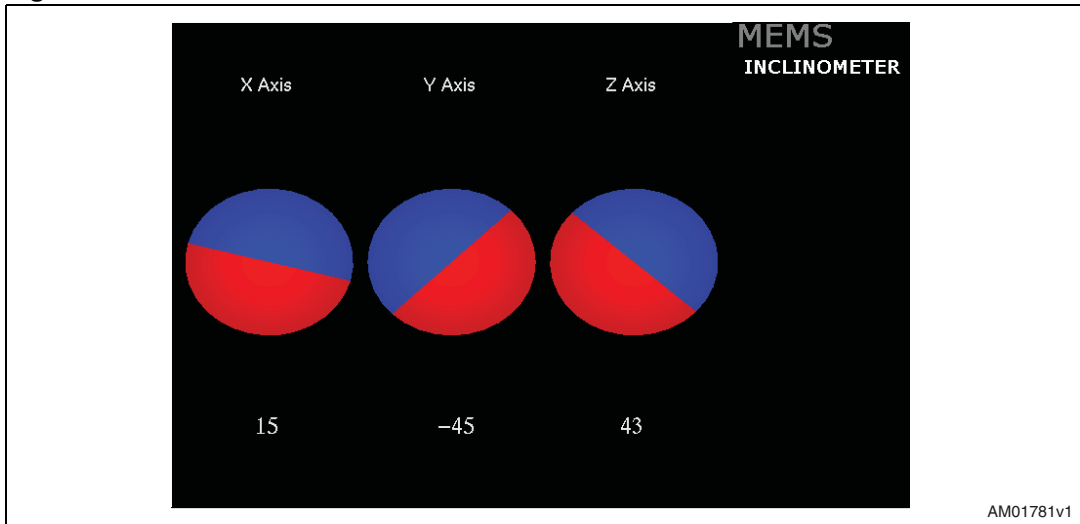
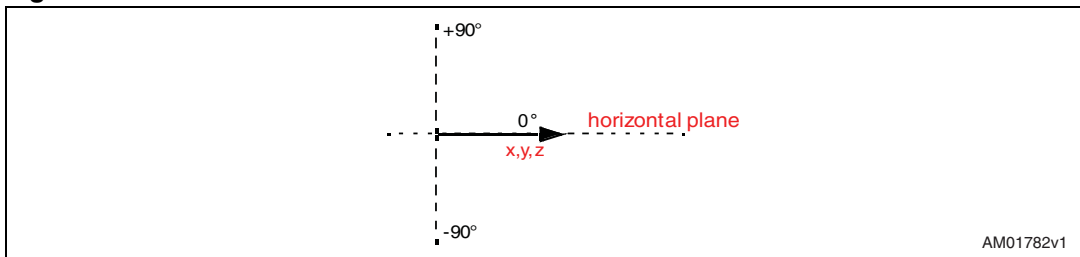


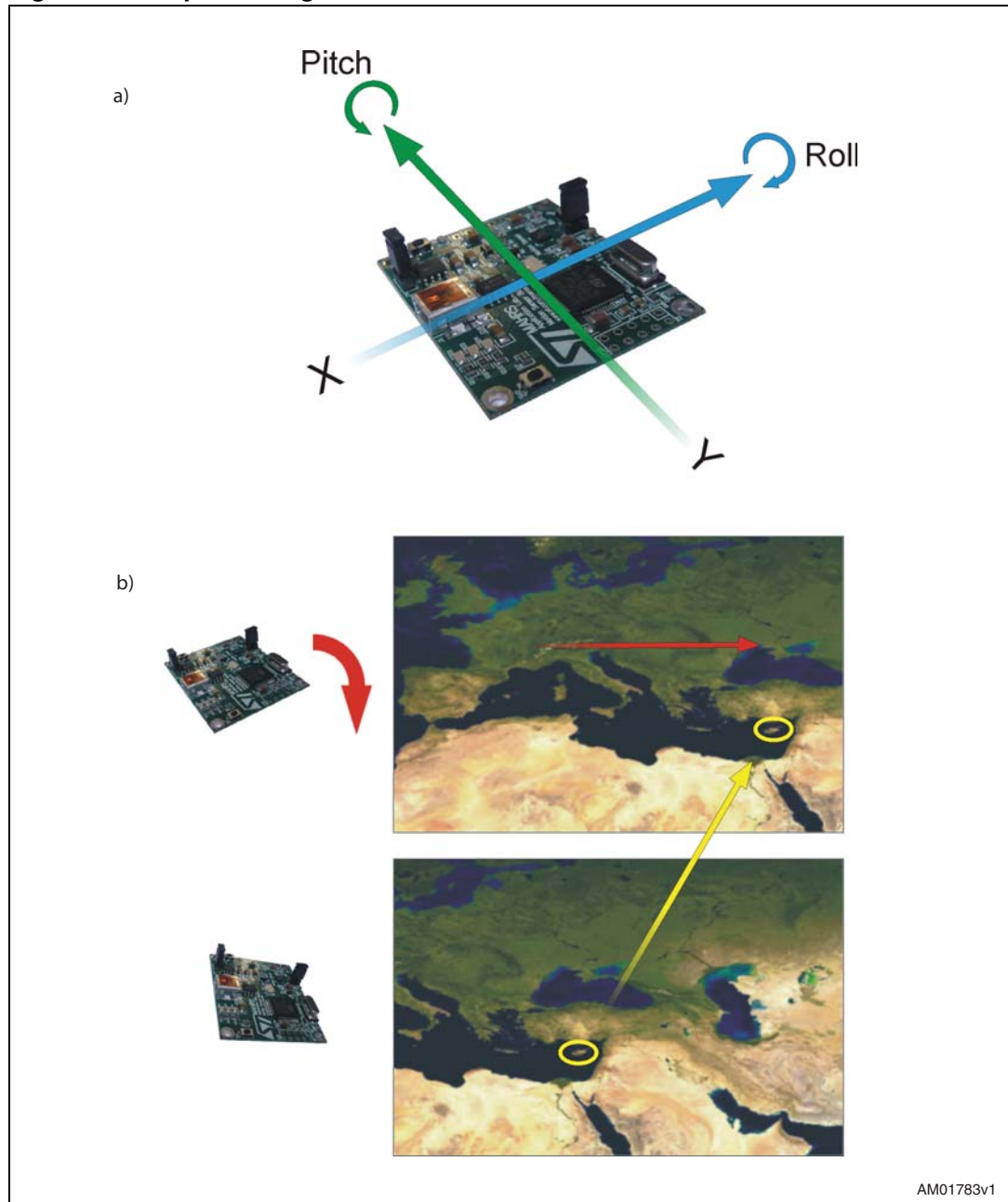
Figure 18. Axis inclination



3.9 “Map Browsing” tab

The map browsing tab demonstrates the possibility of using the acceleration data obtained from the sensor to scroll a map (or another type of document) on the screen.

Figure 19. Map browsing tab



To move the map on the screen, the user must tilt the demonstration kit.

Figure 19, (a) illustrates:

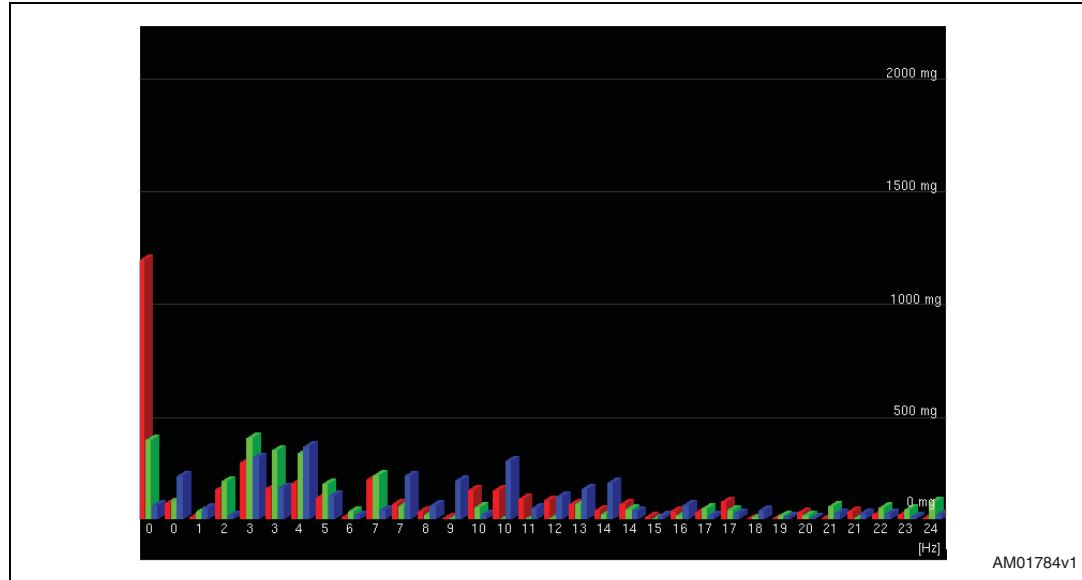
1. a tilt along the X-axis (roll) causes the map to move in a left/right direction on the screen
2. a tilt along the Y-axis (pitch) causes the map to move in a top/bottom direction on the screen

Figure 19 (b) shows an example. The board is tilted along the X-axis (positive roll) and the map on the screen is moved to the right.

3.10 “FFT” tab

The FFT tab (*Figure 20*) shows the FFT of the acceleration signals acquired by the sensor. The spectral data are updated every sample and are calculated on a 64-sample moving window.

Figure 20. FFT tab



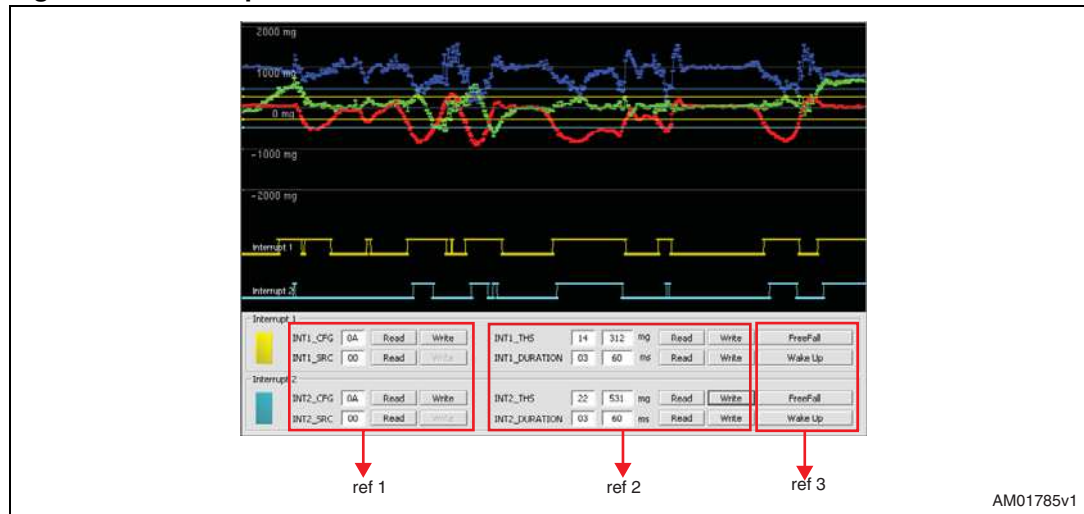
3.11 “Interrupt” tab

The interrupt tab (*Figure 21*) provides a tool for evaluating the interrupt generation features of the LIS331DLH MEMS sensor. In this section of the GUI it is possible to configure the characteristics of the inertial events that must be recognized by the device and to visualize, in real-time, the level of the two interrupt lines together with the acceleration signals that are measured by the device.

The GUI provides direct access to the registers (INT_CFG, INT_SRC, THS and duration) that allow the configuration (*Figure 21*, ref 1) of the two independent interrupt sources of the device. Conversion boxes are located on the right-most side of the THS and DURATION registers (*Figure 21*, ref 2). These boxes are intended to show, respectively, the threshold value expressed in mg and the duration value converted in msec for better readability and understanding.

Finally, two buttons are provided for each interrupt line to set the suggested default values for free-fall and wakeup detection. Those buttons are marked “Set FreeFall Default” and “Set Wake Up Default”, respectively (*Figure 21*, ref 3).

Figure 21. Interrupt tab



3.12 “6 Direction” tab

The 6 direction tab (*Figure 22*) gives an example of usage of the “6D Position” function available on the LIS331DLH.

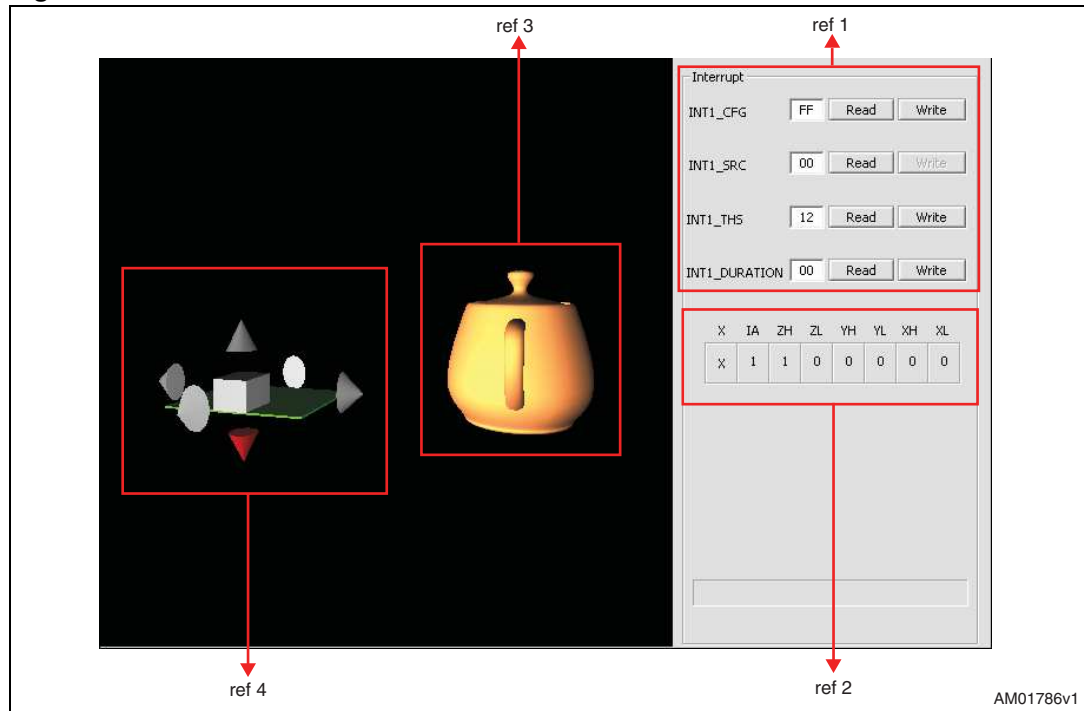
In this tab it is possible to configure the interrupt with the related registers (INTx_CFG, INTx_THS, INTx_DURATION) (*Figure 22*, ref 1) and visualize in real time the status of INTx_SRC (*Figure 22*, ref 2). In our example INT1 has been configured.

Referring to *Figure 22*, the teapot (ref 3) changes its orientation according to INT1_SRC content.

The grey arrows around the board turn from grey to red according to the orientation of the board with respect to gravity (*Figure 22*, ref 4).

If no position has been recognized, INTx_SRC is equal to 0x00h and the message “Undefined Position” appears.

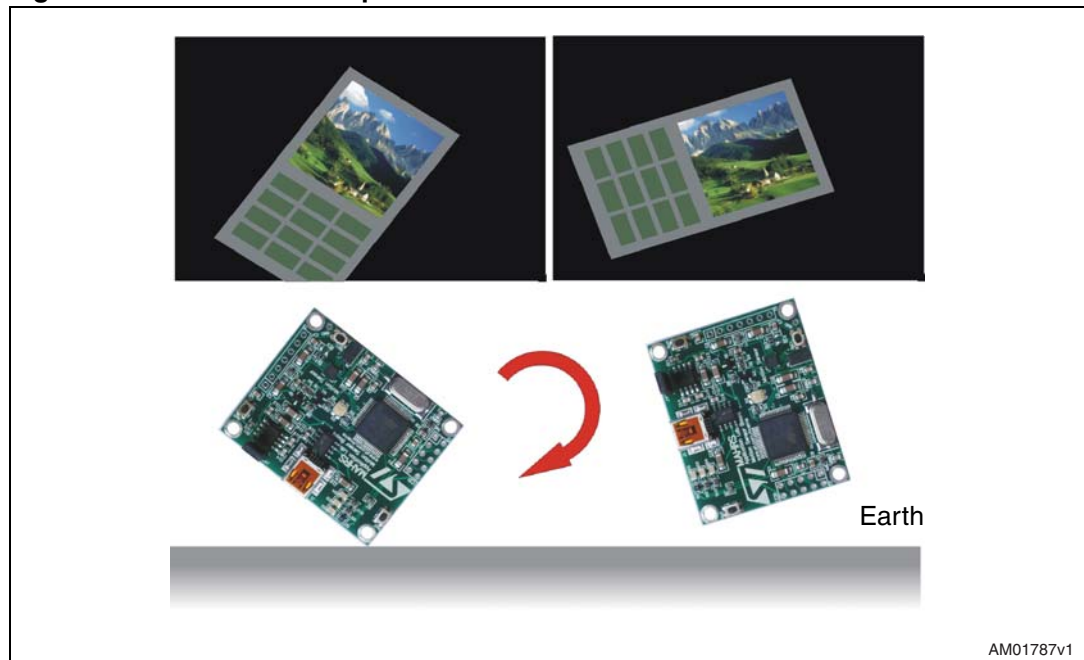
Figure 22. 6D direction tab



3.13 “Portrait/landscape” tab

This tab shows an example of the portrait/landscape function. The image shown on the screen of the mobile phone (*Figure 23*) is always horizontal regardless of the orientation of the device.

Figure 23. Portrait/landscape tab



4 Data acquisition quick start

This section describes the basic steps that must be performed to acquire the acceleration data from the STEVAL-MKI022V1:

1. connect the STEVAL-MKI022V1 to the USB port
2. start the STEVAL-MKI022V1 GUI
3. select the Virtual COM port and click on the “Connect” button (*Figure 9*, ref 1)
4. select the destination file to which the acceleration data must be saved by clicking “Save” (*Figure 9*, ref 2) in the main control section (optional)
5. use the tab menu to display the desired function
6. click on the “START” (or ”STOP”) button to activate (or stop) the sensor data collection, saving to file, and screen plotting functions
7. to close the application, click on “Disconnect” and then click on “Exit”.