



## 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.

# Contents

<b>1</b>	<b>Demonstration kit description</b>	<b>5</b>
<b>2</b>	<b>STEVAL-MKI022V1 GUI installation</b>	<b>7</b>
2.1	PC system requirements	7
2.2	Software installation	7
2.3	Hardware installation	8
<b>3</b>	<b>Graphical user interface</b>	<b>11</b>
3.1	Connecting to the virtual COM port	12
3.2	“Easy Start” button	12
3.3	“Options” tab	13
3.4	“Register Setup” tab	14
3.5	“Bars” tab	15
3.6	“Plot” tab	17
3.7	“Data” tab	19
3.8	“Inclinometer” tab	20
3.9	“Map Browsing” tab	20
3.10	“FFT” tab	22
3.11	“Interrupt” tab	22
3.12	“6 Direction” tab	23
3.13	“Portrait/landscape” tab	24
<b>4</b>	<b>Data acquisition quick start</b>	<b>25</b>
<b>5</b>	<b>EK lite</b>	<b>26</b>
<b>6</b>	<b>MEMS pointer</b>	<b>27</b>
6.1	GUI description	27
6.1.1	Left side: main control	27
6.1.2	Right side: pointer application controls	28
<b>7</b>	<b>Supported commands</b>	<b>29</b>
7.1	Getting started	29

---

7.2	Supported commands .....	29
7.2.1	Start command .....	30
7.2.2	Debug command .....	30
7.2.3	Stop command .....	30
7.2.4	Register read .....	30
7.2.5	Register write .....	31
7.2.6	Single bit write .....	31
7.2.7	Zon and Zoff .....	31
7.2.8	Device name .....	31
7.2.9	Firmware version .....	31
7.3	Quick start .....	32
<b>8</b>	<b>DFU .....</b>	<b>33</b>
8.1	PC requirements .....	33
8.2	DFU procedure .....	33
<b>9</b>	<b>Schematic diagram .....</b>	<b>36</b>
<b>10</b>	<b>Bill of materials .....</b>	<b>37</b>
<b>11</b>	<b>Revision history .....</b>	<b>39</b>

## List of figures

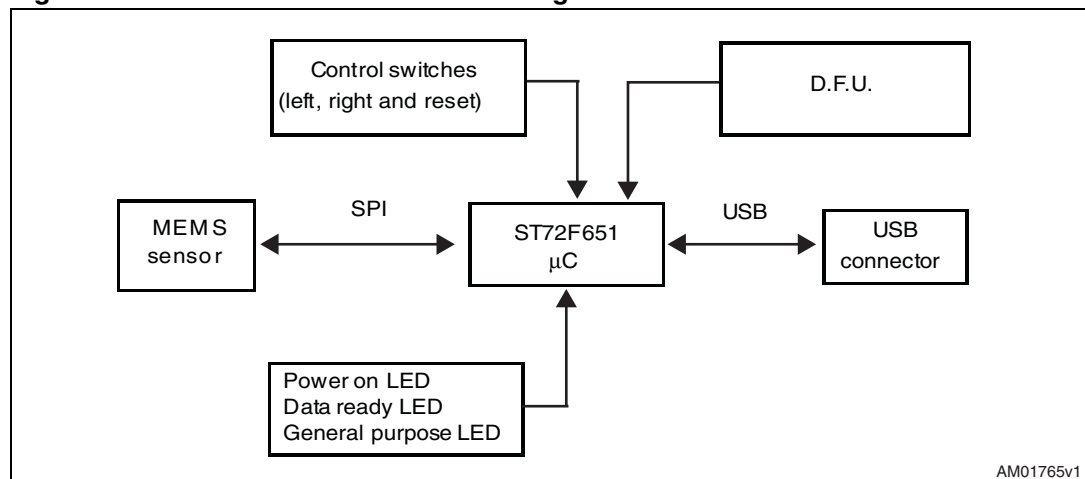
Figure 1.	Demonstration board block diagram . . . . .	5
Figure 2.	Top silk screen of the STEVAL-MKI022V1 kit . . . . .	6
Figure 3.	Board photograph . . . . .	6
Figure 4.	Software installation . . . . .	7
Figure 5.	Notify icon . . . . .	8
Figure 6.	Driver installation using the device manager . . . . .	8
Figure 7.	USB driver installation using the hardware update wizard . . . . .	9
Figure 8.	Virtual COM driver port assignment . . . . .	10
Figure 9.	Graphical user interface: main window . . . . .	11
Figure 10.	Options tab . . . . .	14
Figure 11.	Register setup tab . . . . .	15
Figure 12.	Bars tab - acceleration data . . . . .	16
Figure 13.	Bars tab - selected acceleration as a numerical value . . . . .	16
Figure 14.	Plot tab . . . . .	17
Figure 15.	Plot tab - zoom . . . . .	18
Figure 16.	Data tab . . . . .	19
Figure 17.	Inclinometer tab . . . . .	20
Figure 18.	Axis inclination . . . . .	20
Figure 19.	Map browsing tab . . . . .	21
Figure 20.	FFT tab . . . . .	22
Figure 21.	Interrupt tab . . . . .	23
Figure 22.	6D direction tab . . . . .	24
Figure 23.	Portrait/landscape tab . . . . .	24
Figure 24.	STEVAL-MKI022V1 lite GUI . . . . .	26
Figure 25.	MEMS pointer demonstration . . . . .	27
Figure 26.	Demonstration kit correctly recognized . . . . .	33
Figure 27.	Select new firmware . . . . .	34
Figure 28.	Flash erasing . . . . .	34
Figure 29.	Flash upgrading . . . . .	35
Figure 30.	Schematic diagram of the STEVAL-MKI022V1 board . . . . .	36

# 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**

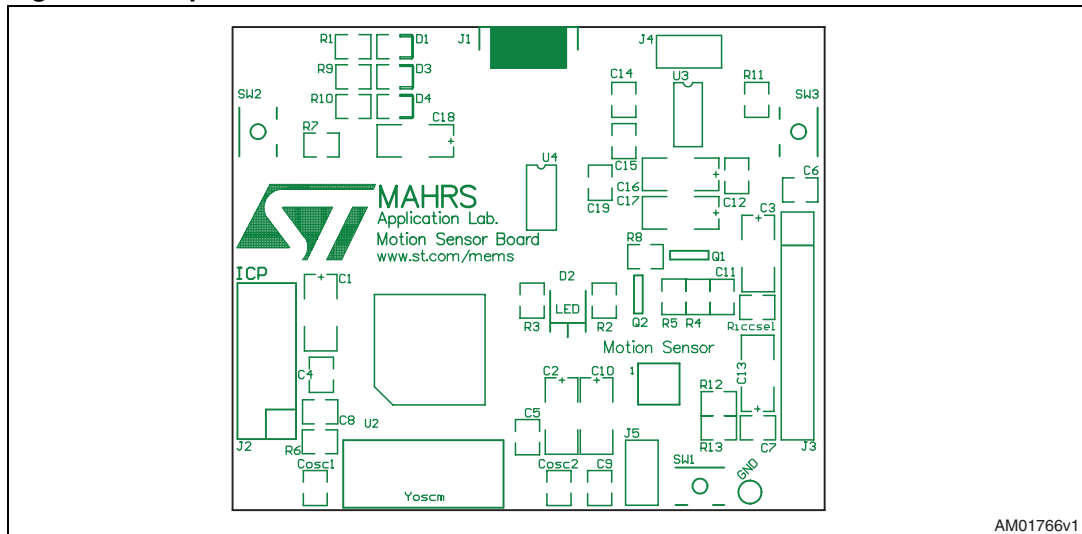
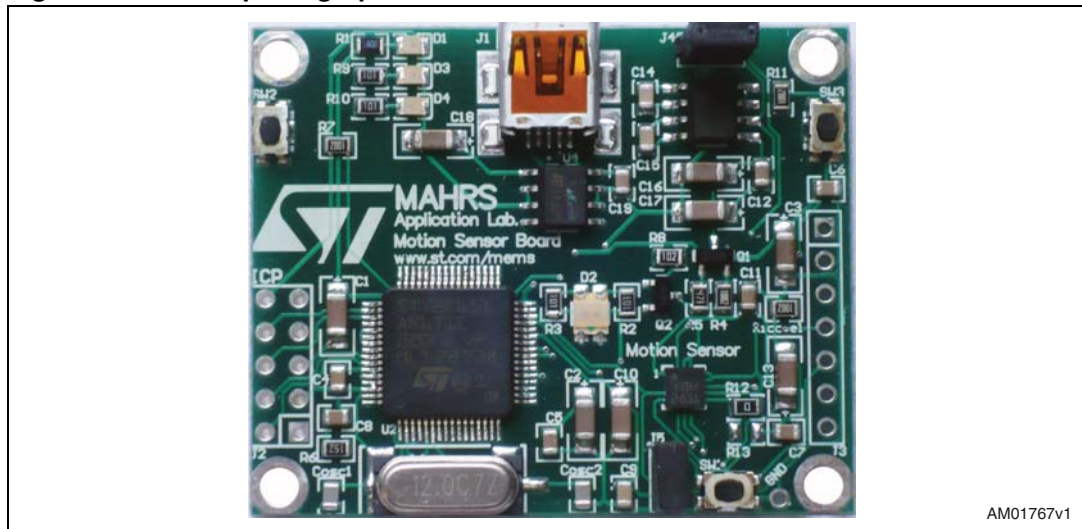


The ST7-USB microcontroller included on the board allows communication between the sensor device and the PC. The user can interact with the hardware either through the GUI provided with the kit or through dedicated software routines to run customized applications.

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](http://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](http://www.st.com/mems)
2. installation of the virtual COM driver needed to use the demonstration kit.

### 2.1 PC system requirements

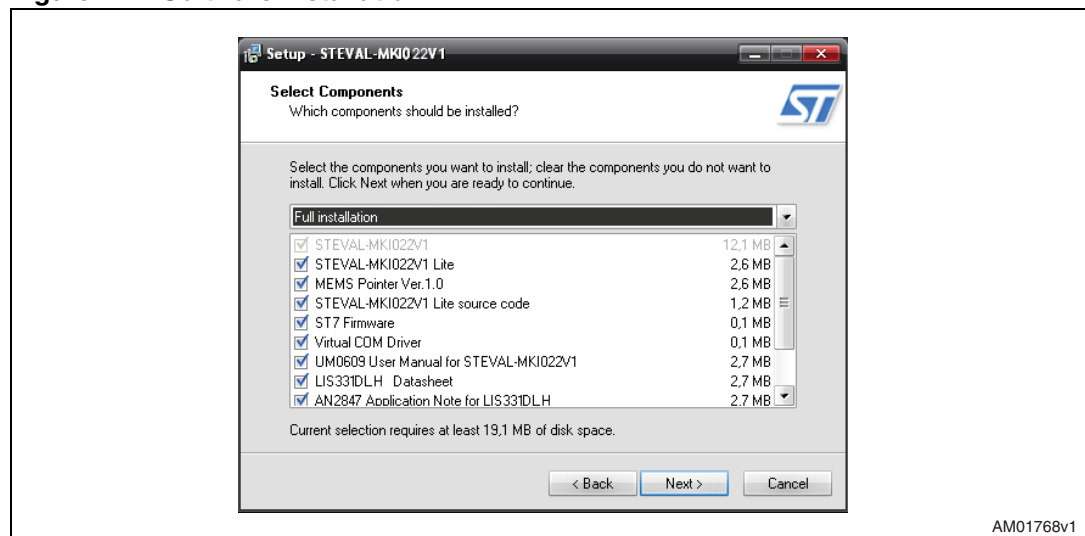
Both the hardware and software that compose the STEVAL-MKI022V1 demonstration kit have been designed to operate with Microsoft® Windows XP.

### 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*).

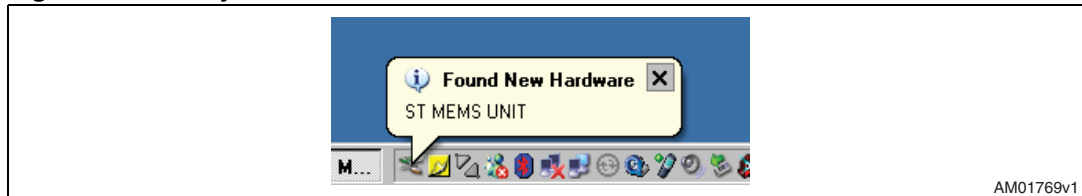
**Figure 4. Software installation**



## 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](#).

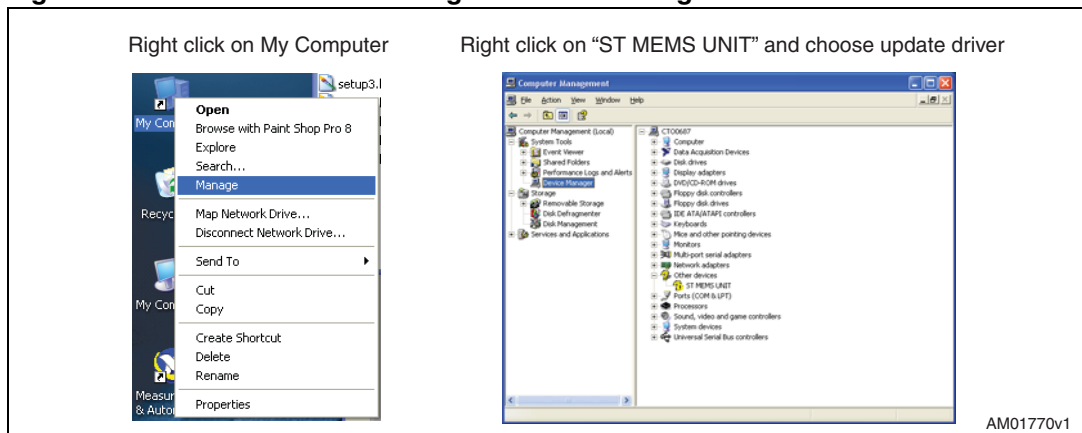
**Figure 5. Notify icon**



AM01769v1

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](#).

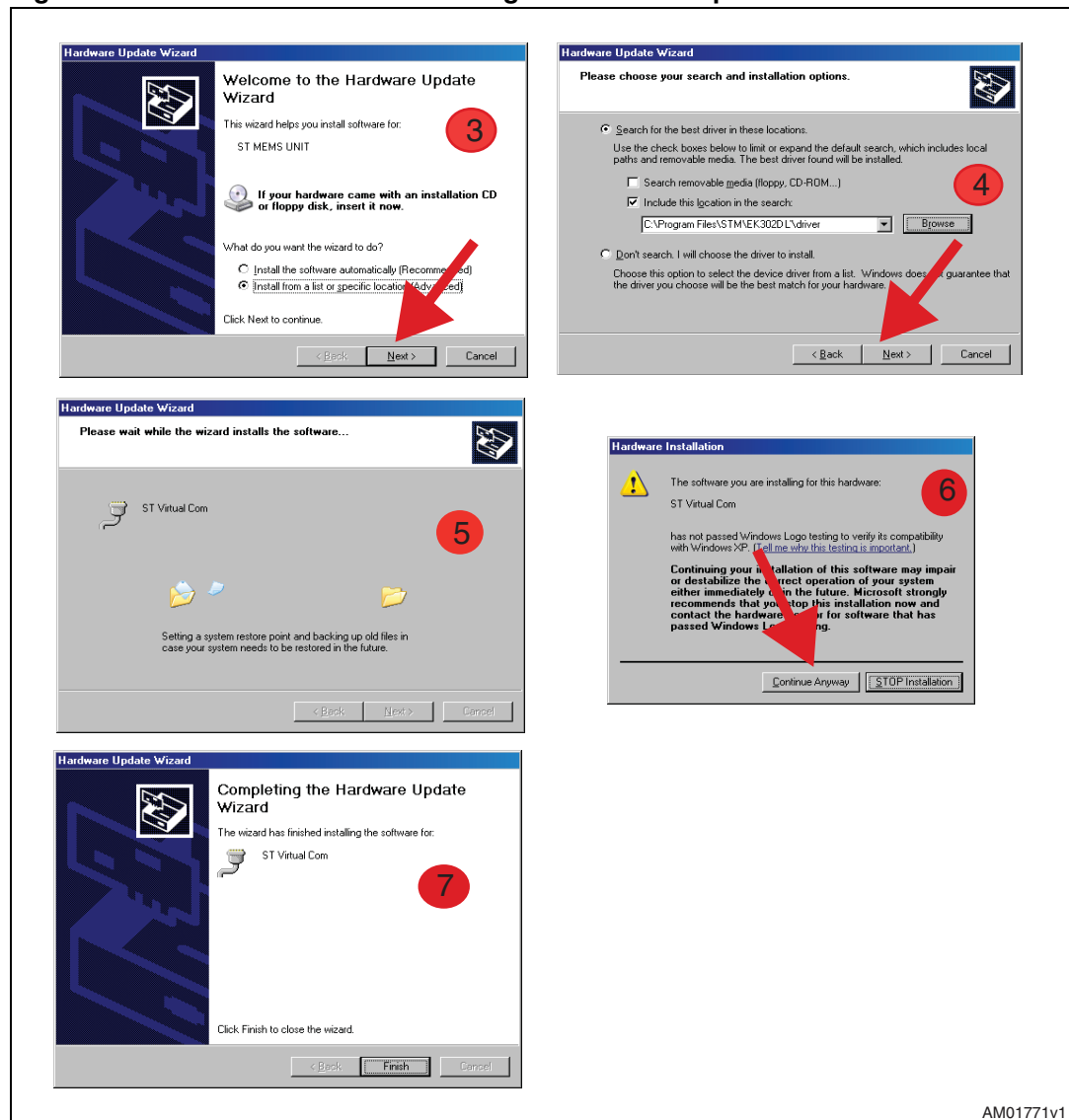
**Figure 6. Driver installation using the device manager**



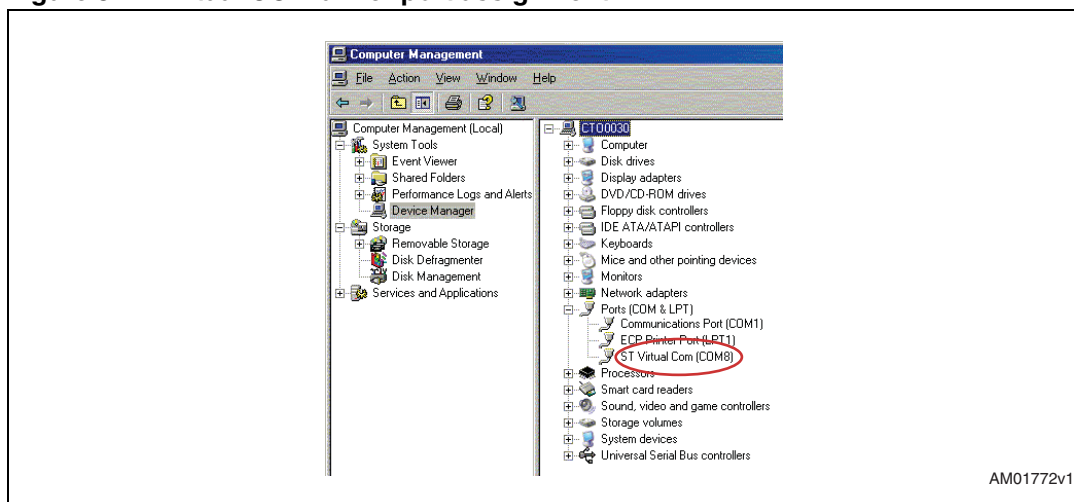
AM01770v1



Figure 7. USB driver installation using the hardware update wizard



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**

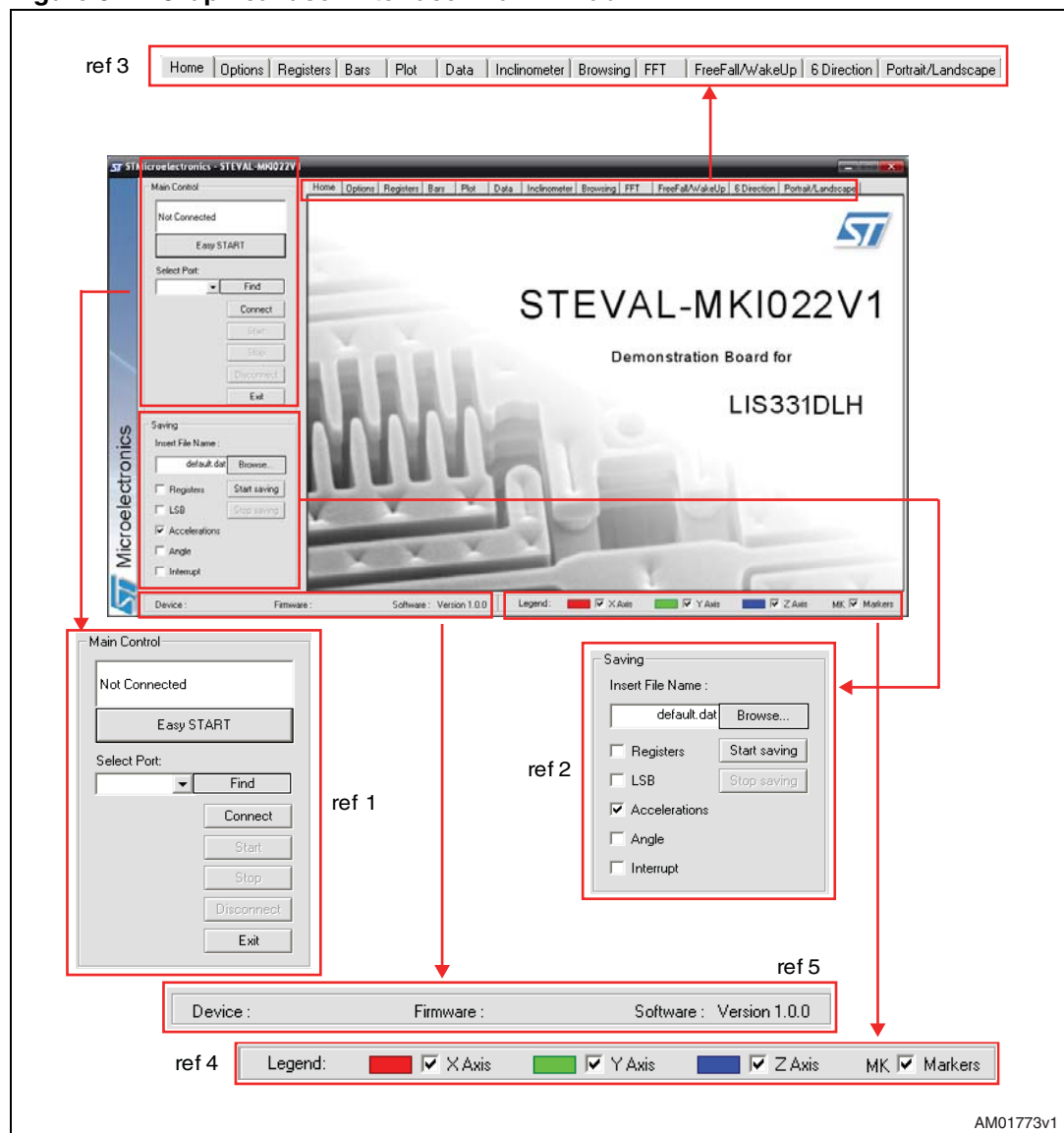
### 3 Graphical user interface

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

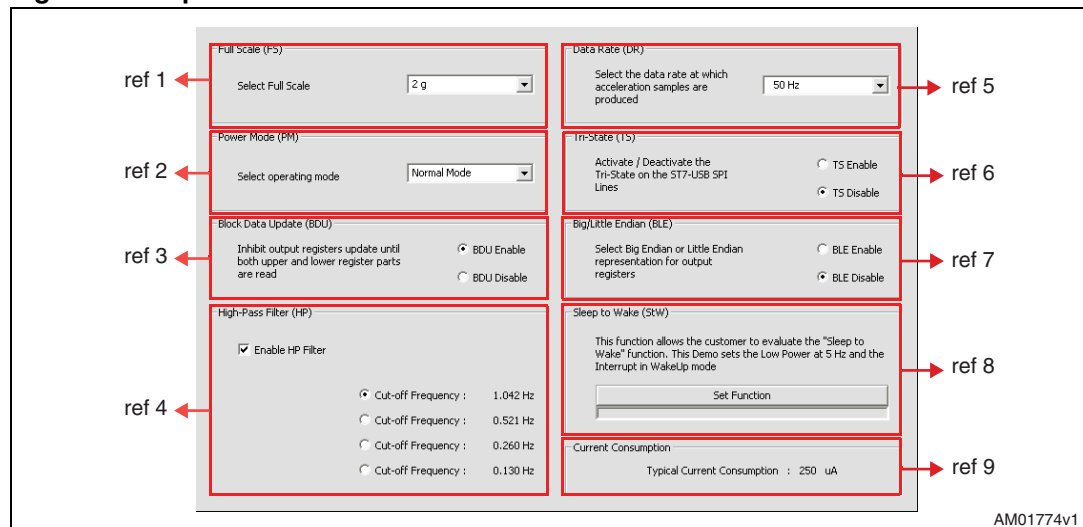
Clicking the "Easy Start" button ([Figure 9](#), ref 1), the GUI attempts to automatically find the COM number assigned to the demonstration kit and starts the acquisition.

### 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

The screenshot shows the 'Register setup tab' with the following sections and highlighted areas:

- General:** A table of registers with their addresses and Read/Write/Default buttons.
 

Register	Address	Read	Write	Default
CTRL_REG1	27	Read	Write	Default
CTRL_REG2	00	Read	Write	Default
CTRL_REG3	00	Read	Write	Default
CTRL_REG4	80	Read	Write	Default
CTRL_REG5	00	Read	Write	Default
HP_FILTER_RESET	00	Read	Write	Default
STATUS_REG	FF	Read	Write	Default
- All Registers:** A section with Read, Write, and Default buttons. (ref 2 points to the Read button)
- Registers Direct Access:** A section with input fields for Register Address (hex) and Register Value (hex), and Read/Write buttons. (ref 3 points to the Register Value field)
- Parameters:** A section with a file browser and a 'Save in File' button. (ref 4 points to the file browser)
- Interrupt 1:** A section with configuration options for INT1\_CFG, INT1\_SRC, INT1\_THS, and INT1\_DURATION. (ref 1 points to the INT1\_DURATION field)
- Interrupt 2:** A section with configuration options for INT2\_CFG, INT2\_SRC, INT2\_THS, and INT2\_DURATION. (ref 1 points to the INT2\_DURATION field)
- Load/Save Configuration:** A section with a file browser and Load/Save buttons. (ref 5 points to the Load button)

NOTE : Default Buttons don't write default values to the registers of the device

AM01775v1

### 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

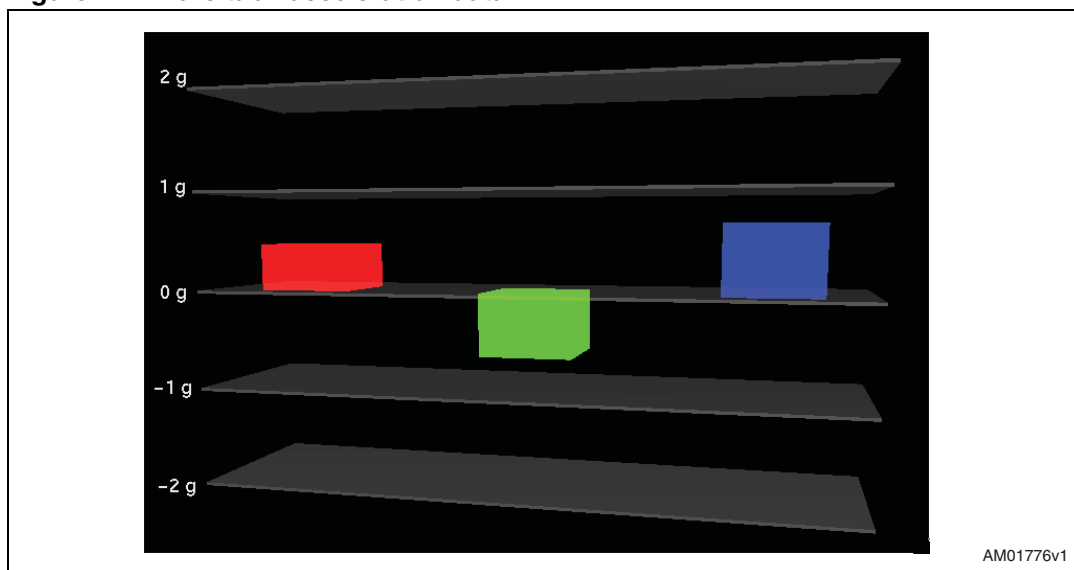


Figure 13. Bars tab - selected acceleration as a numerical value





### 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**

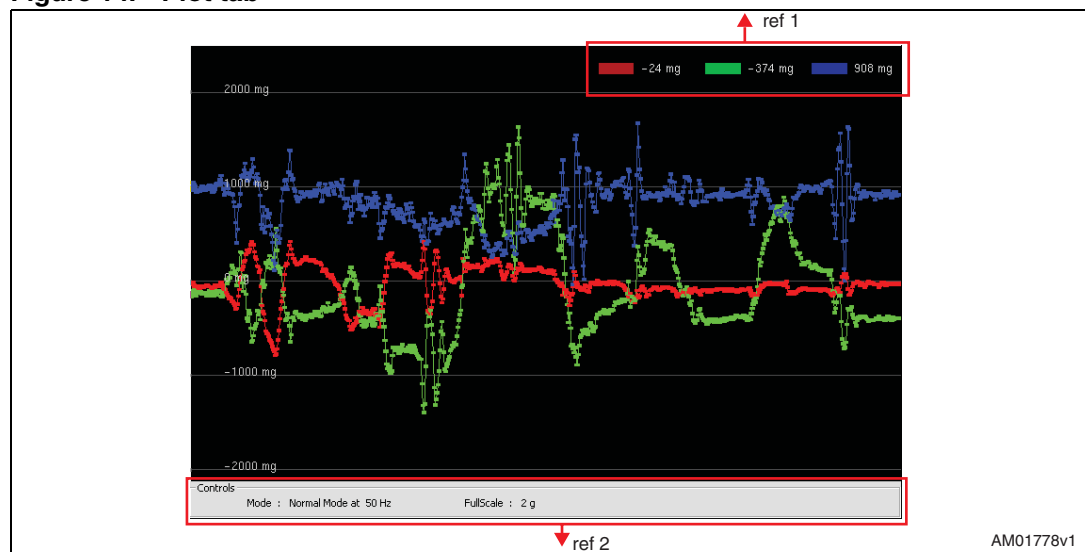


Figure 15. Plot tab - zoom

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



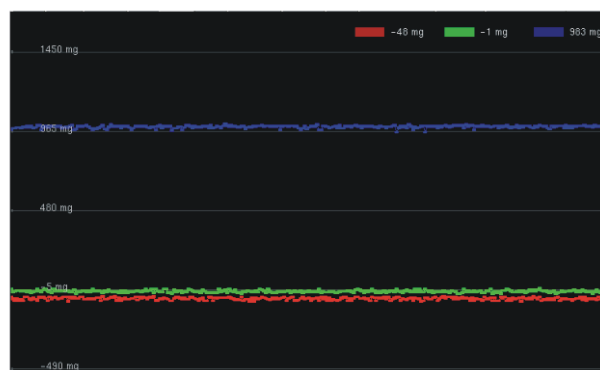
- 2) Holding the LEFT mouse button clicked, move the cursor to obtain an area on the screen



- 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



AM01779v1

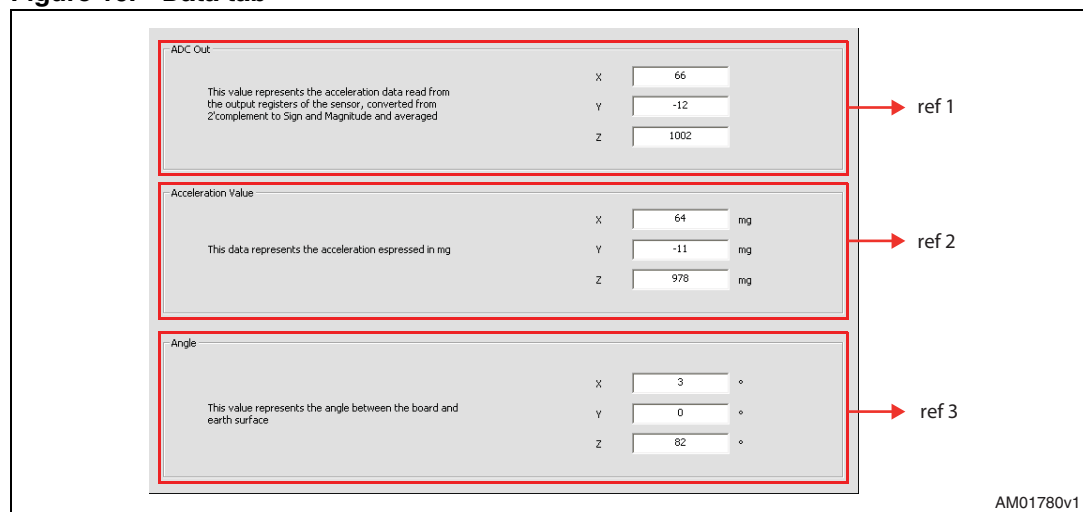
### 3.7 “Data” tab

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.*

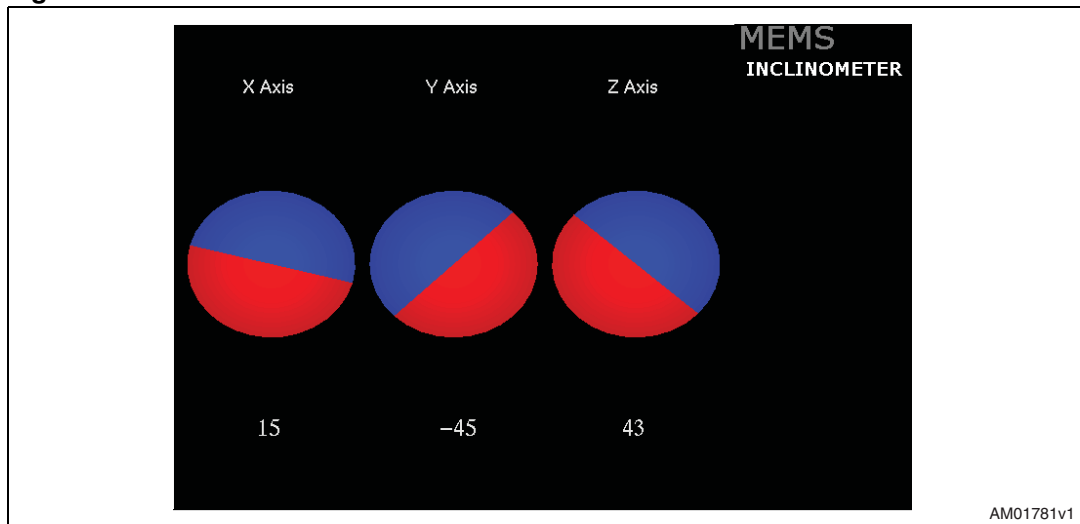
**Figure 16. Data tab**



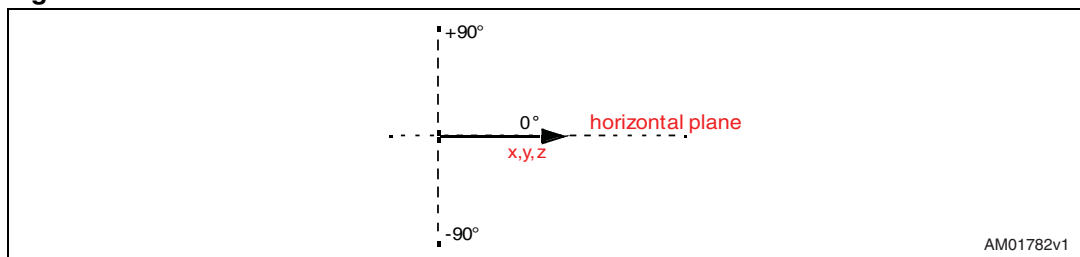
### 3.8 “Inclinometer” tab

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

**Figure 17. Inclinometer tab**

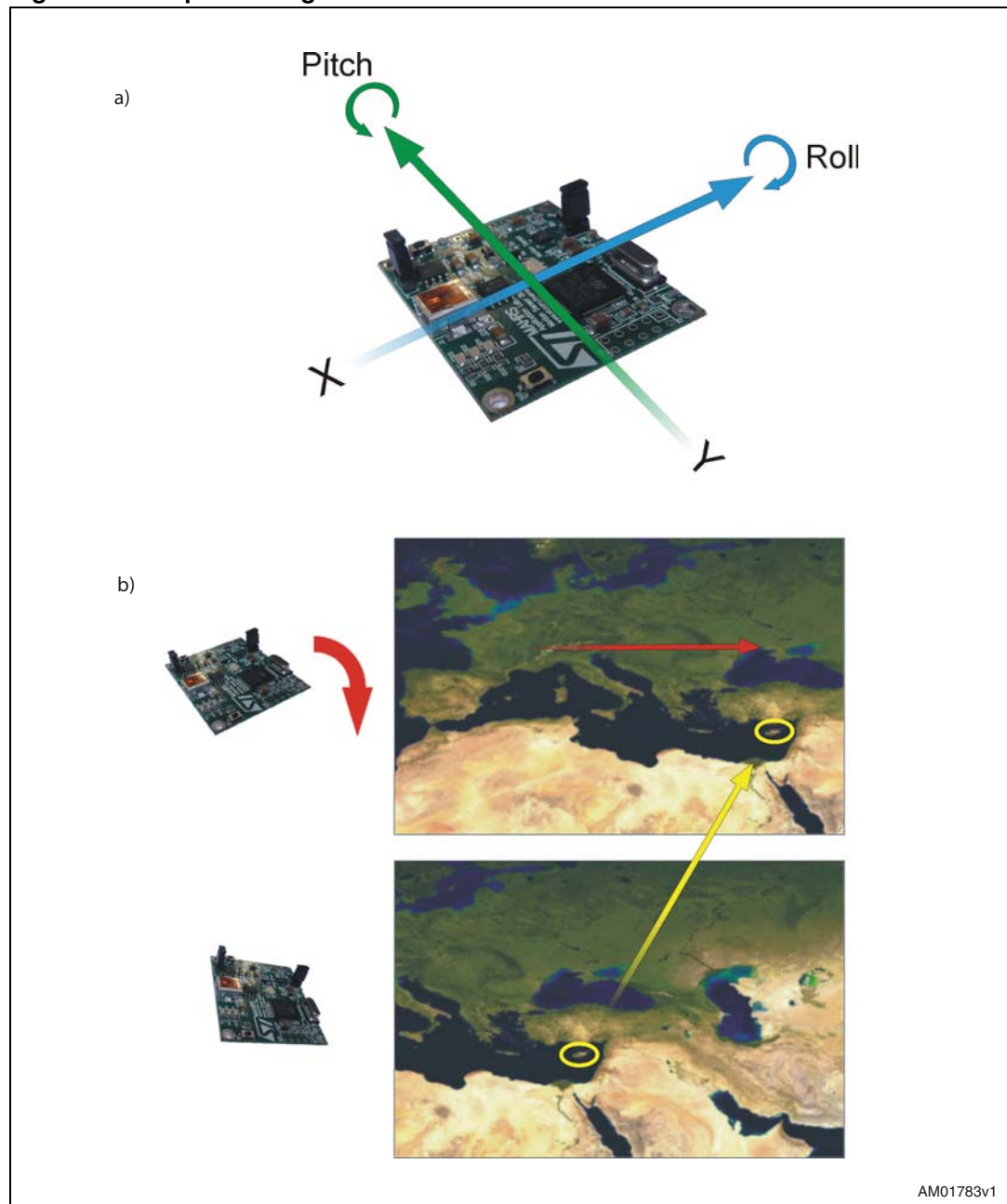


**Figure 18. Axis inclination**



### 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**

AM01783v1

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

*Figure 19, (a)* illustrates:

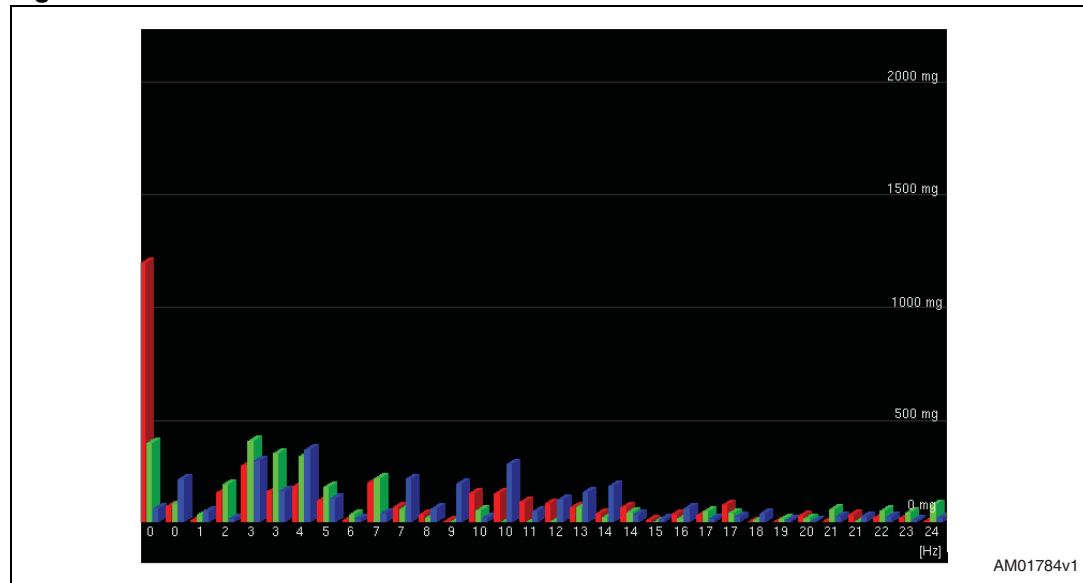
1. a tilt along the X-axis (roll) causes the map to move in a left/right direction on the screen
2. a tilt along the Y-axis (pitch) causes the map to move in a top/bottom direction on the screen

*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**



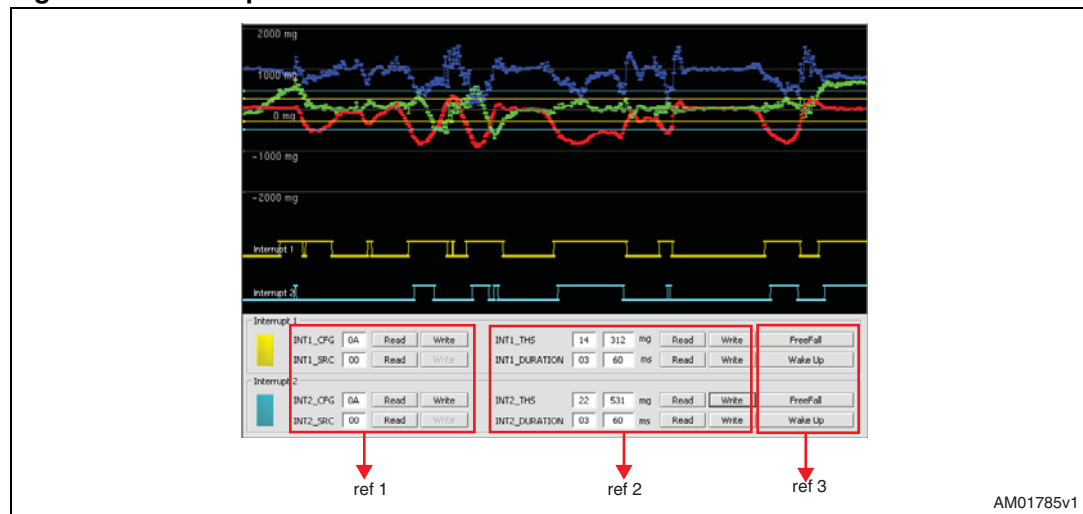
### 3.11 “Interrupt” tab

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.

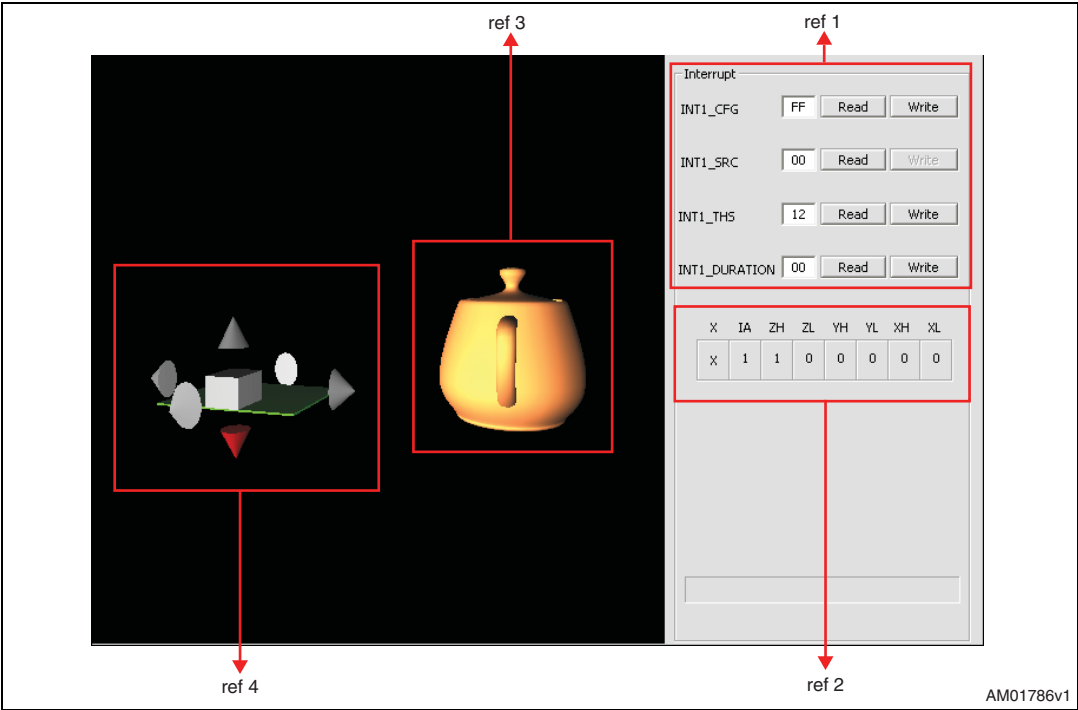
In this tab it is possible to configure the interrupt with the related registers (INTx\_CFG, INTx\_THS, INTx\_DURATION) ([Figure 22](#), ref 1) and visualize in real time the status of INTx\_SRC ([Figure 22](#), ref 2). In our example INT1 has been configured.

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.

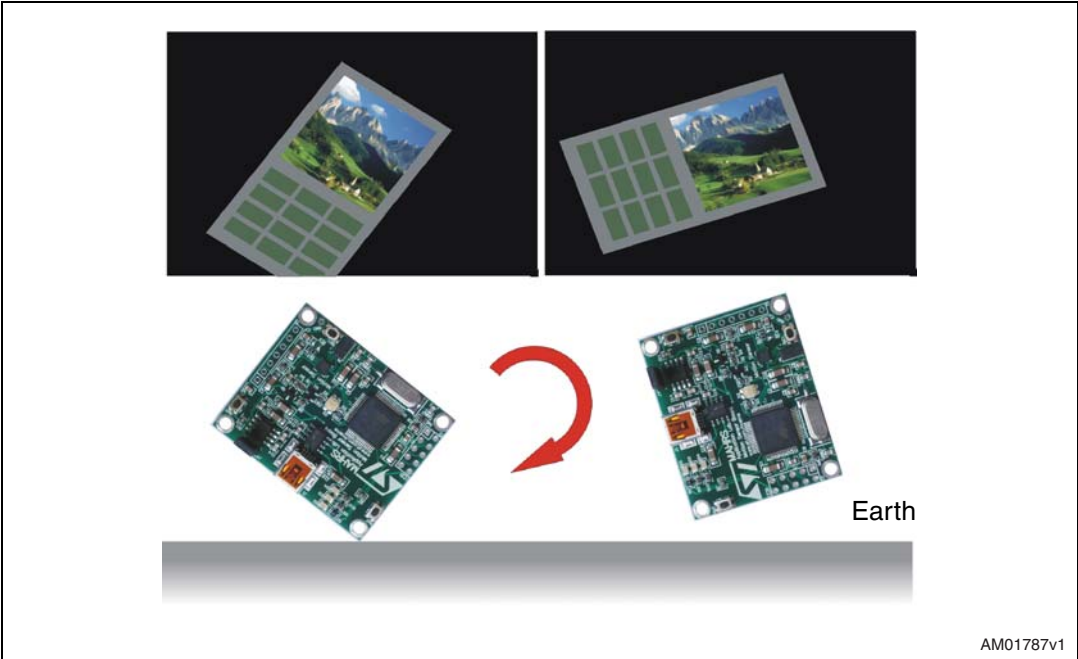
Figure 22. 6D direction tab



### 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”.

## 5 EK lite

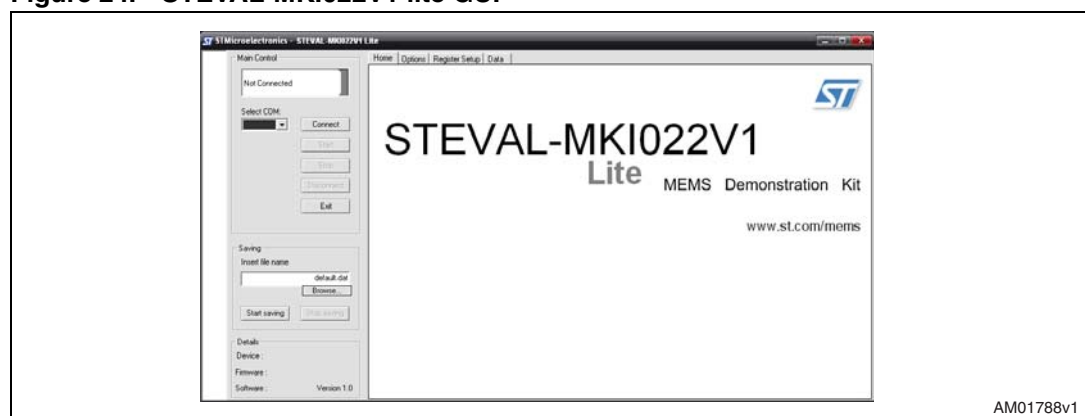
A lite version of the previous GUI together with its source code is also included in the installation pack. The source code can be found in the directory: (\$Home)\STM\STEVAL-MKI022V1\STEVAL-MKI022V1\_lite, where (\$Home) is the directory in which the software that came with the demonstration kit was installed (C:\Program Files by default).

The purpose of the lite version is to provide the user with a base for the development of a customized application.

The lite version of the demonstration kit is started by launching the STEVAL-MKI022V1 lite executable file located in the STEVAL-MKI022V1 > Executables folder.

An example of the GUI of the EK lite application is shown in [Figure 24](#).

**Figure 24. STEVAL-MKI022V1 lite GUI**



Follow these instructions to use the software:

1. connect the STEVAL-MKI022V1 to the USB port
2. launch the GUI for STEVAL-MKI022V1 lite
3. select the virtual COM port and click on the “Connect” button
4. select the destination file to which the acceleration data must be saved (optional)
5. click on the “START” (or “STOP”) button to activate (or stop) the sensor data collection, saving to file, and screen plotting functions
6. to close the application, click on “Disconnect” and then click on “Exit”.

The GUI also gives read/write access to the registers embedded in the LIS331DLH device and allows a single read of the acceleration data measured by the sensor.

## 6 MEMS pointer

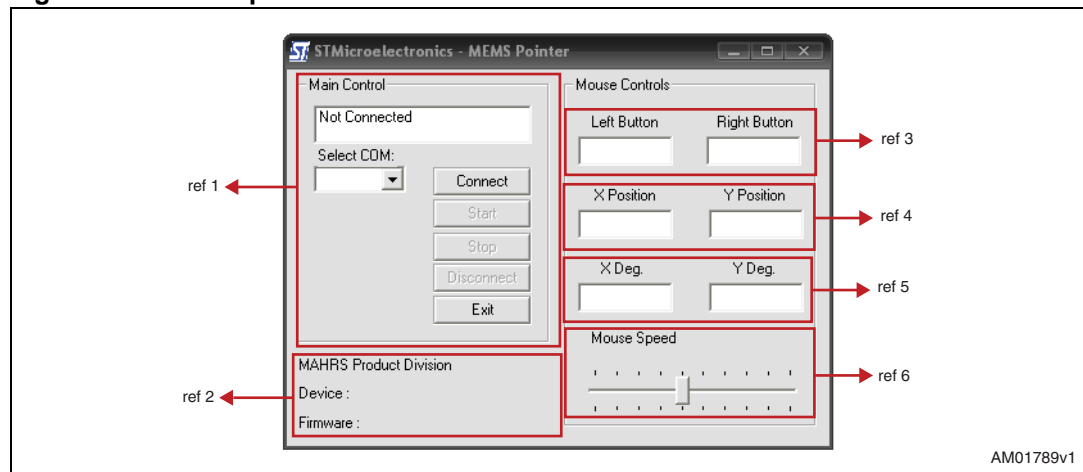
This section describes how to use a simple pointer application which utilizes acceleration data provided by the LIS331DLH MEMS 3-axis linear accelerometer to control the position of a pointer on the screen of the PC. The software provided with the kit allows the STEVAL-MKI022V1 demonstration kit to be used as an inertial mouse, where the tilt of the board is translated into movement of the pointer. The board also emulates the left and right buttons of the mouse.

### 6.1 GUI description

The GUI window (see [Figure 25](#)) is divided into two sections. The left section contains the main controls to open the connection to the demonstration kit and to start/stop the data acquisition (ref 1). The bottom section contains the demonstration kit details (device and firmware, ref 2).

The right section shows the same data and the mouse speed control.

**Figure 25. MEMS pointer demonstration**



#### 6.1.1 Left side: main control

The buttons on the left side of the GUI and their related functions are described below:

1. Connect/disconnect control - selects the COM port to which the EK board is connected
2. Acquisition control - starts and stops acquisition
3. Exit - exits the MEMS pointer demonstration application.

### 6.1.2 Right side: pointer application controls

The controls on the right side of the GUI and their related functions are as follows:

1. Left button/right button - indicates when the left/right button on the demonstration kit is pressed (ref 3)
2. X/Y-position - shows the current x/y coordinates of the mouse pointer on the PC screen (ref 4)
3. X/Y-deg - shows the tilt of the demonstration kit along the X and Y axes (ref 5)
4. Pointer speed - sets the sensitivity of the pointer to the inclination of the board (ref 6).

## 7 Supported commands

The microcontroller mounted on the STEVAL-MKI022V1 board is equipped with dedicated firmware which supports a set of commands that allow the control of the 3-axis digital output MEMS sensor and permit the acquisition of the measured acceleration data. The firmware also handles the communication between the EK board and the PC through the USB bus. These features allow users to easily write their own applications to exploit the capabilities of the accelerometer.

This section describes the commands that are supported by the firmware for the microcontroller of the STEVAL-MKI022V1 demonstration kit.

### 7.1 Getting started

Before using the commands supported by the firmware, the following procedure must be performed:

1. connect the STEVAL-MKI022V1 to the USB port
2. launch an application which allows the sending of commands through the Virtual serial port. The remainder of this document assumes the use of the Microsoft® Hyper Terminal program integrated in the Windows XP operating system
3. create a new connection, enter a name (ex. "STEVAL-MKI022V1"), and click "OK"
4. in the "Connect Using" field, select the Virtual COM port to which the USB port has been mapped, and click "OK"
5. in port settings, set bits per second to 115200, data bits to 8, parity to none, stop bits to 1, and flow control to none. Click "OK"
6. in the hyper terminal select files > properties > settings and then click on the "ASCII Setup" button
7. select "Send line ends with line feeds" and "Echo typed characters locally"
8. click the "OK" button to close the "ASCII Setup" window
9. click the "OK" button to close the "Properties" window.

Once this procedure has been completed the user can utilize the commands described in the following sections by typing them into the "hyper terminal" window.

### 7.2 Supported commands

The table below lists the commands supported by the STEVAL-MKI022V1 firmware:

**Table 1. Supported commands**

Command	Description	Returned value
*start	Starts continuous data acquisition	s t xh xl yh yl zh zl l1 l2 s
*debug	Returns the acceleration data in readable text format	x=XX y=YY z=ZZ
*stop	Stops data acquisition	
*rAA	Register read	RAAhDDh

**Table 1. Supported commands (continued)**

Command	Description	Returned value
*wAADD	Register write	
*bwAA<0:7><0 1>	Single bit write	
*Zon	Force 3-state	
*Zoff	Exit from 3-state	
*dev	Device name	LIS331DLH
*ver	Firmware version	331DLH 1.0

*Note:* AA: register address  
DD: data  
S: service field  
Xh and Xl, Yh and Yl, Zh and Zl: Acceleration data returned for the X, Y and Z axes  
I1, I2 : interrupt value on each axis.

### 7.2.1 Start command

The \*start command initiates the continuous data acquisition. When this command is sent to the board, it returns the acceleration data measured by the LIS331DLH device. The acceleration data are packed in a string composed of eight bytes: "s t xh xl yh yl zh zl I1 I2 s". The first two bytes are always "s" and "t" which correspond to the hexadecimal values {73 74}, while "X" "Y" "Z" represent, respectively, the acceleration data for the X, Y, Z axes.

"I1" and "I2" contain the values of INT1\_SRC and INT2\_SRC, where each bit is a specific interrupt.

The last byte "s" returns information about the switches mounted on the board. Specifically, bit#1 and bit#0 of the "service data" correspond to the status of SW3 and SW2 on the demonstration kit board, and they are set to 1 when the corresponding switch is pressed.

### 7.2.2 Debug command

The debug command starts the continuous data acquisition in debug mode. When this command is sent to the board, it returns the acceleration data measured by the LIS331DLH device in readable text format. The values shown on the screen correspond to the content of the output data registers and are shown as a decimal number. A tab is employed as a separator between the different fields.

### 7.2.3 Stop command

The \*stop command interrupts any acquisition session that has been started with either the \*start or \*debug commands.

### 7.2.4 Register read

The \*rAA command allows the contents of the LIS331DLH device registers in the demonstration kit board to be read. AA, expressed as hexadecimal value and written upper-case, represents the address of the register to be read.

Once the read command is issued, the board returns RAAhDDh, where AA is the address sent by the user and DD is the data present in the register.

For example, to read the CTRL\_REG1 the user would issue the command \*r20, which returns R20hC7h.

### 7.2.5 Register write

The \*wAADD command permits writing to the contents of the LIS331DLH device registers in the demonstration kit board. AA and DD, expressed as hexadecimal values and written upper-case, represent respectively the address of the register and the data to be written. To write 0xC7 to the CTRL\_REG1, for example, the user would issue the command \*w20C7.

### 7.2.6 Single bit write

Using this command it is possible to set/reset a single bit in a given register. The command \*bwAA<0:7><0|1> requires the user to specify the address AA of the register in which to change the bit, with AA expressed as a hexadecimal value and written in lower-case, followed by the position of the bit to be changed, an integer between 0 and 7, and the value, either 0 or 1, to be associated to the specified bit.

For example, to set the FS bit to 1 within the CTRL\_REG2, the user would issue the command \*bw2171.

### 7.2.7 Zon and Zoff

The \*Zon and \*Zoff commands are employed respectively to put into 3-state (i.e. high-impedance) and to exit (i.e. normal mode) the SPI lines of the ST7-USB microcontroller mounted on the demonstration kit. These commands allow the isolation of the sensor from the microprocessor in the event that an external control (from a different microcontroller mounted on a separate board) is needed.

By default, when the kit is first turned on, the SPI lines are in 3-state mode and the user is required to send the command \*Zoff to allow communication between the sensor and the microcontroller.

### 7.2.8 Device name

The \*dev command retrieves the name of the device mounted on the demonstration kit connected to the PC. For the STEVAL-MKI022V1, the returned value is "LIS331DLH".

### 7.2.9 Firmware version

The \*ver command queries the demonstration kit and returns the version of the firmware loaded in the microprocessor.

## 7.3 Quick start

This section shows the basic sequence of commands to start a data communication session and to retrieve the acceleration data from the demonstration kit:

1. connect the STEVAL-MKI022V1 to the USB port
2. start “Microsoft® Hyper Terminal” and configure it as described in [Section 7.1](#)
3. inside the “Hyper Terminal” window, enter the command \*Zoff to enable the control of the SPI line from the ST7-USB microcontroller
4. send the \*debug command to get the acceleration data measured by the sensor
5. send \*stop to end the continuous acquisition and visualization.



## 8 DFU

The MEMS device firmware update GUI is a graphical interface that allows the user to download and replace the firmware of a MEMS product division demonstration board directly from a PC through the USB port.

The MEMS demonstration boards that mount an ST7-USB microcontroller have the capability of reprogramming an application through the USB, in accordance with the DFU class specification defined by the USB Implementers Forum. This capability is useful because it allows reprogramming the microcontroller directly in the field and is particularly well-suited in the USB applications where the same USB connector can be used both for the standard operating mode and for the reprogramming process.

Connector J4 must be shorted to allow the DFU procedure. If the demonstration kit is going to be reprogrammed through the ICP connector and the ST7 dedicated tools, J4 must be open.

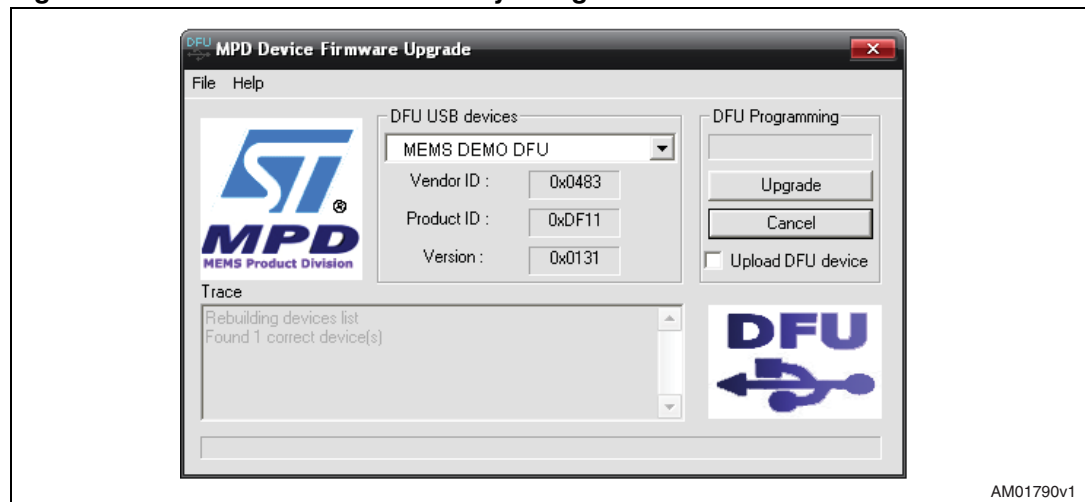
### 8.1 PC requirements

In order to use the device firmware upgrade (DFU) software with the Windows operating system, a recent version of Windows, such as Windows 98, Windows 98SE, Windows Millennium, Windows 2000 or Windows XP must be installed on the PC.

### 8.2 DFU procedure

Run the DFU.exe file. To enter the firmware update mode the user must plug in the USB cable to the demonstration kit while pressing Button 2 ([Figure 26](#)).

**Figure 26. Demonstration kit correctly recognized**



The DFU driver must be installed before using this feature. The driver can be found in “firmwareupdate.zip” in the driver installation folder of the demonstration kit.

After installation, “MEMS demonstration DFU” appears in the DFU USB devices list ([Figure 26](#)).

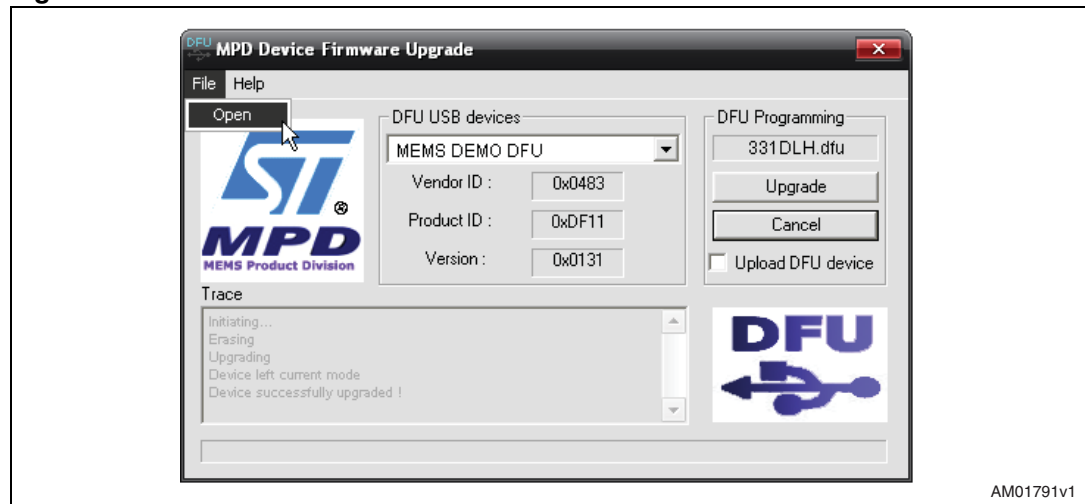
To execute the firmware upgrade:

- click on File > Open, then select the correct directory where the “.dfu” file has been downloaded and select it (*Figure 27*)
- click on “Upgrade”
- the internal flash memory erased (*Figure 28*)
- and reflashed with the new firmware (*Figure 29*).

Once the procedure is finished, a windows message appears, stating that a USB device is not recognized. You can then unplug the USB cable from the EK demonstration board and use it with the new firmware.

In order to back up your actual firmware before flashing the demonstration kit with a new one, flag “Upload DFU device” (*Figure 26*) before clicking on “Upgrade”. You will be prompted to save the current firmware in your preferred directory before the erasing of the internal flash.

**Figure 27. Select new firmware**



**Figure 28. Flash erasing**

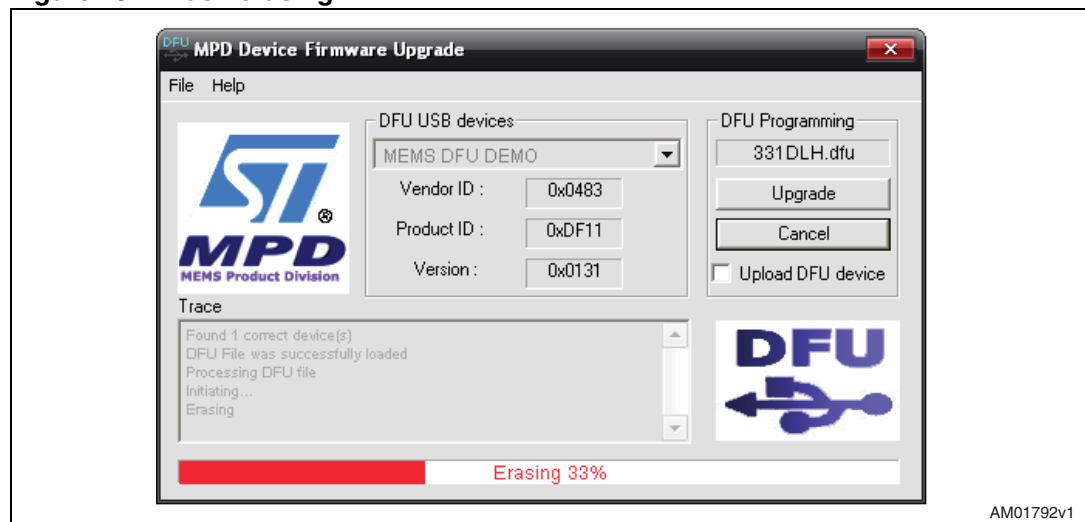
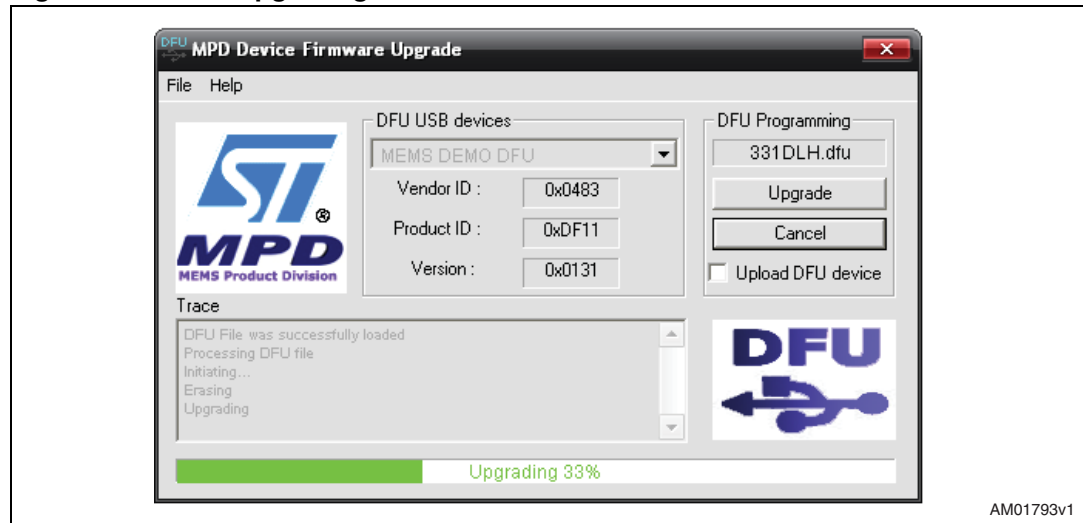


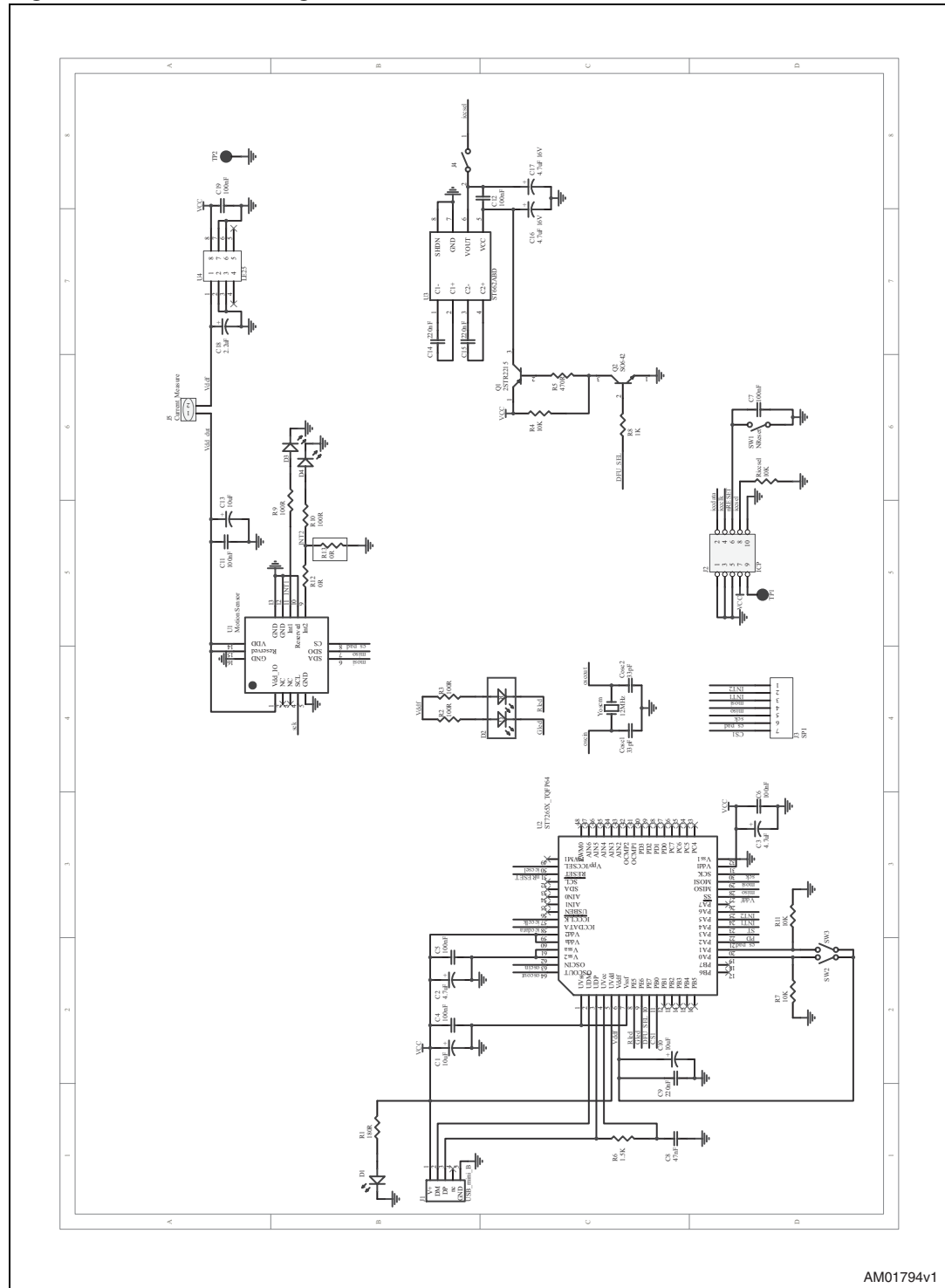
Figure 29. Flash upgrading



## 9 Schematic diagram

The schematic diagram of the STEVAL-MKI022V1 demonstration kit is shown in [Figure 30](#).

**Figure 30. Schematic diagram of the STEVAL-MKI022V1 board**



## 10 Bill of materials

The bill of materials for the STEVAL-MKI022V1 demonstration kit is provided in [Table 2](#).

**Table 2. Bill of materials**

Designator	Description	Comment	Footprint
C1	Capacitor	10 $\mu$ F	C1206 POL
C2	Capacitor	4.7 $\mu$ F	C1206 POL
C3	Capacitor	47 $\mu$ F	C1206 POL
C4	Capacitor	100 nF	0805
C5	Capacitor	100 nF	0805
C6	Capacitor	100 nF	0805
C7	Capacitor	100 nF	0805
C8	Capacitor	47 nF	0805
C9	Capacitor	220 nF	0805
C10	Capacitor	10 $\mu$ F	C1206 POL
C11	Capacitor	100 nF	0805
C12	Capacitor	100 nF	0805
C13	Capacitor	10 $\mu$ F	C1206 POL
C14	Capacitor	220 nF	0805
C15	Capacitor	220 nF	0805
C16	Capacitor	4.7 $\mu$ C 16 V	C1206 POL
C17	Capacitor	4.7 $\mu$ C 16 V	C1206 POL
C18	Capacitor	2.2 $\mu$ C	C1206 POL
C19	Capacitor	100 nF	0805
Cosc1	Capacitor	33 pF	0805
Cosc2	Capacitor	33 pF	0805
D1	LED	SMD LED green	SMD LED
D2	LED	SMD LED 3C	SMD LED 3C
D3	LED	SMD LED green	SMD LED
D4	LED	SMD LED red	SMD LED
J1	USB connector	USB B mini	USB B mini
J2	Header, 5X2	ICP	HEADER 5X2 A
J3	Header, 7-pin	SPI	HDR1X7
J4	Header, 2-pin	DFU jumper	HDR1X2
Q1	Transistor		2STR2215
Q2	Transistor		SO624
R1	Resistor	180 $\Omega$	0805
R2	Resistor	100 $\Omega$	0805
R3	Resistor	100 $\Omega$	0805
R4	Resistor	10 k $\Omega$	0805

Table 2. Bill of materials (continued)

Designator	Description	Comment	Footprint
R5	Resistor	470 $\Omega$	0805
R6	Resistor	1k5	0805
R7	Resistor	10 k $\Omega$	0805
R8	Resistor	1 k $\Omega$	0805
R9	Resistor	100 $\Omega$	0805
R10	Resistor	100 $\Omega$	0805
R11	Resistor	10 k $\Omega$	0805
R12	Resistor	0 $\Omega$	0805
R13	Resistor	0 $\Omega$	0805
Riccsel	Resistor	10 k $\Omega$	0805
SW1	Button	NReset	SMT button
SW2	Button	SMT button	SMT button
SW3	Button	SMT button	SMT button
TP1	Test point	TP	TP
TP2	Test point	GND	TP
U1		LIS331DLH	TLGA 3x3x1
U2		ST72F651AR6T1E	TQFP64 10x10
U3		ST662ABD	SO-G8
U4		LE25	SO-8
Yoscm1	Crystal	12 MHz	OSC SMD

## 11 Revision history

**Table 3. Document revision history**

Date	Revision	Changes
05-Mar-2009	1	Initial release

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2009 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)