

## Evaluating the ADXL372 Digital Accelerometer

### FEATURES

#### Flexible inertial sensor evaluation platform

Single main board operates with interchangeable satellite boards

#### Separates DUT from controller for accurate environmental testing

#### Continuous stream to file data recording

#### Standard USB cable for power and communications

#### PC-based graphical user interface (GUI)

#### Fast, easy installation

### ONLINE RESOURCES

#### Evaluation Kit Contents

[EVAL-ADXL372Z-M](#)

An USB A to Mini-B cable

An 18-inch, 20-pin ribbon cable

#### Documents Needed

[ADXL372](#) datasheet

#### Required Software

[ADXL372 Evaluation GUI](#)

#### Design and Integration Files

[Schematics, layout files, bill of materials](#)

### EQUIPMENT NEEDED

PC running Windows

USB 2.0 port

### GENERAL DESCRIPTION

The iMEMS® ADXL372 inertial sensor evaluation system is an easy-to-use evaluation tool targeting bench or desktop characterization of Analog Devices, Inc., inertial sensor products. The system consists of the inertial sensor evaluation board (ISEB), or main board, and a satellite board for any Analog Devices inertial sensor product. The ISEB connects directly to a PC via an USB cable, with the USB connection providing both communications and power to the board. The ISEB is connected to the satellite board through a ribbon cable. This cable allows the satellite to be easily manipulated for testing or separately placed into an environmental chamber for temperature or humidity testing. Separating the boards mitigates corruption of data due to the temperature and humidity effects of other components.

The ISEB is an universal main board and is intended to be used with various satellites of Analog Devices inertial sensors, including analog and digital accelerometers, as well as gyroscopes. The different products are evaluated by means of separate GUIs that are customized for performance and characterization measurements relevant to the inertial sensor being evaluated. There are two kinds of mother board, one named -M and the other named -MLP. The difference between -M and -MLP is just the shunt resistor R13 and the gain resistor R17 which are used to detect the power consumption of the DUT (Device Under Test). EVAL-ADXL372-M used the -M mother board. As ADXL372 is pin-to-pin compatible with ADXL362, the ADXL362 satellite board can be reused for ADXL372.

The EVAL-ADXL372Z-M system contains the ISEB and the EVAL-ADXL372Z-S satellite. Also included is an USB A to Mini-B cable to connect the ISEB to a PC and an 18-inch, 20-pin ribbon cable to connect the ISEB to the satellite.

### TYPICAL SETUP



Figure 1. EVAL-ADXL372Z-MLP Evaluation System



# Evaluation Board User Guide

## EVAL-ADXL372Z-M

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### Evaluating the ADXL372 Digital Accelerometer

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## REVISION HISTORY

6/17—Revision 0: Initial Version

## GETTING STARTED

This section provides quick start procedures for using [EVAL-ADXL372Z-M](#) board. Both the default and optional settings are described. The steps below should be followed to successfully set up and run the ADXL372 evaluation system:

1. Install the USB drivers for the inertial sensor evaluation system (ISEB).
2. Connect the ISEB hardware to the PC.
3. Install the latest firmware revision into the ISEB hardware (included on the ADI website). This step is unnecessary for most cases since the default firmware can match the default GUI. If you had ever reprogrammed the MCU for other applications or the firmware / GUI is updated by ADI, you need to download the corresponding firmware for evaluating ADXL372. The firmware and GUI installer on website are always match with each other.
4. Install run time engine and the ADXL372 evaluation GUI.
5. Configure the ISEB hardware.
6. Launch the ADXL372 evaluation GUI and test devices.

## SOFTWARE INSTALLATION PROCEDURES

### Install USB Drivers

To install the USB drivers, follow these steps:

1. Execute the **CP210xVCPInstaller\_x64.exe** file located in **/ISEB\_USB\_Driver/**. Please choose the corresponding driver according to the different operating system.
2. Follow the on-screen instructions to install the drivers.
3. Click **Continue Anyway** when prompted that the drivers are not tested.

After the above steps are complete, you can connect the ISEB main board to the computer via the included USB cable.

The ISEB should be detected automatically in the **Device Manager** as the **Silicon Labs CP210x USB to UART Bridge** under the **Ports (COM & LPT)** selection. It is recommended to open the **Device Manager** to verify hardware detection and to record the communication port associated with the ISEB for use in the GUI.

### Com Port Verification

Installing the latest firmware revision, as well as operating the ADXL372 evaluation GUI, requires that you know the communications port that is assigned to the ISEB main board. With the ISEB main board connected to the PC, you should perform the following steps to determine the assigned COM port number.

1. From the **Start** menu, right click **My Computer** and select **Properties**.
2. Select **Device Manager**, and click **OK**, expand the **Ports (COM & LPT)** menu item as shown in Figur. **Silicon Labs CP210x USB to UART Bridge** should be listed with an assigned COM port number in parenthesis.
3. Note the COM port number for future use.

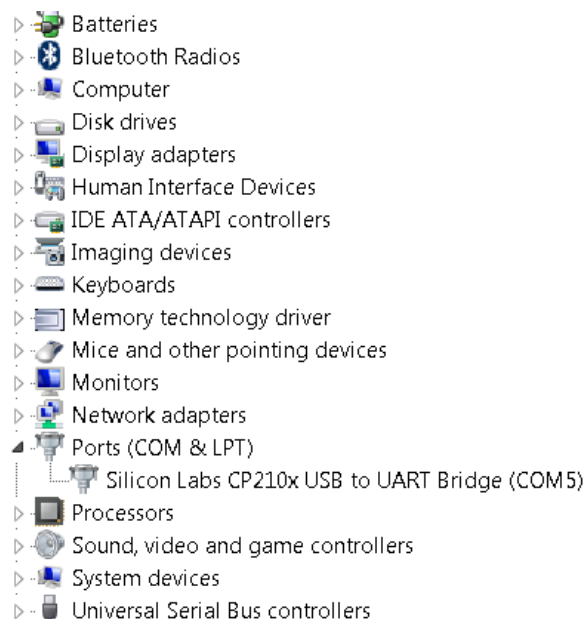


Figure 2. Device Manager Showing the COM Port Number

### Installing the Latest ISEB Firmware

The latest ISEB firmware is included on the website. To successfully use the ISEB evaluation hardware, this firmware should be flashed to the ISEB controller. ADI website contains the firmware itself and the utility that allows you to flash a new version of the firmware onto the ISEB microcontroller. In addition, as new firmware is made available, it can be downloaded from the Analog Devices website ([www.analog.com](http://www.analog.com)).

To flash the ISEB microcontroller, follow these steps:

1. Ensure that the ISEB is connected to and detected by the PC. The COM port on which the device is recognized should also be obtained, as mentioned in the Com Port Verification section.
2. Run the **ARMWSD.exe** program located in the **/ISEB\_USB/FW/** folder; it displays information about the downloader, as shown in Figure .

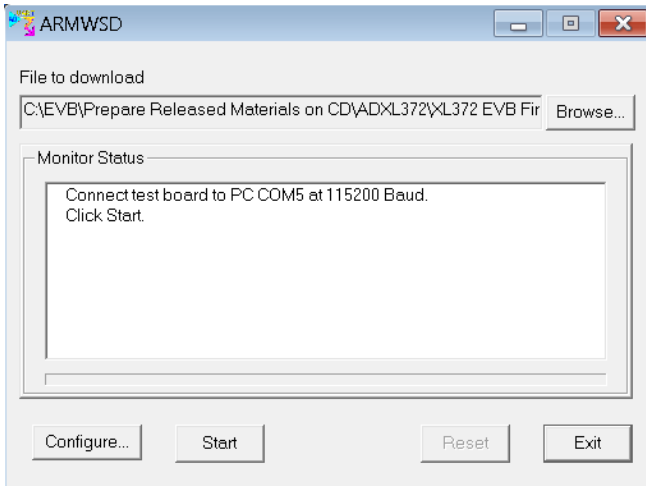


Figure 3. ISEB ARMWSD Firmware Downloader

3. Click **Browse...** and select the **ADI\_ISEB\_FW\_XL372.hex** file located in the **/ISEB\_USB/FW/** folder or the most recent firmware obtained from the Analog Devices website ([www.analog.com](http://www.analog.com)).
4. Click **Configure** to display the box shown in Figure .

The downloader file should be configured for the **ADuC7026** microcontroller on the ISEB. The only option you may need to change is the COM port. You can select the correct port from the **Serial Port** menu on the **Comms** tab (see Figure ). If you cannot download the .hex file correctly, please try to make the **Baudrate** lower and retry.

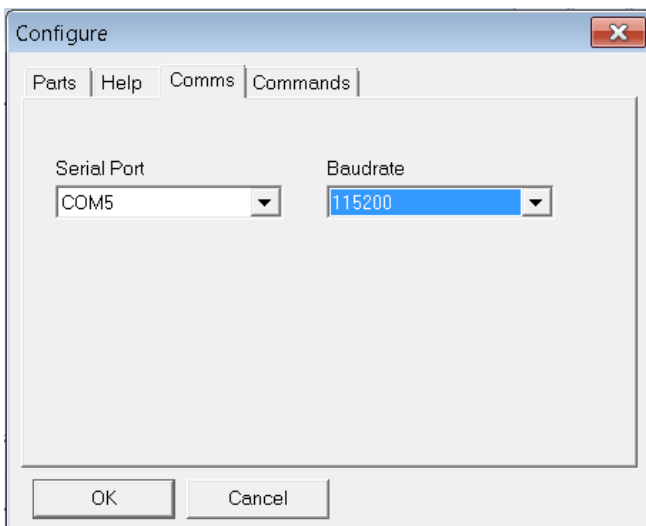


Figure 4. Selecting the Correct COM Port for the Downloader

When the COM port is selected, click **OK** to accept the changes and go back to the ARMWSD box (shown in Figure ).

When the ISEB is connected, the correct firmware is selected, and the downloader is fully configured, follow these steps to flash the firmware:

1. Click **Start** in the ARMWSD box (see Figure ) to initiate the flashing process. After clicking **Start**, click the two

buttons (shown in Figure ) on the ISEB in the following order to flash the firmware:

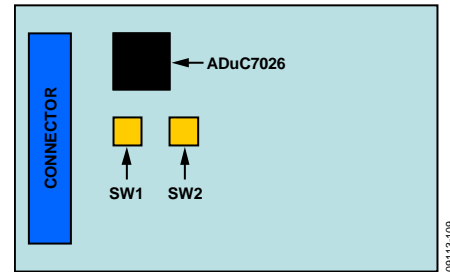
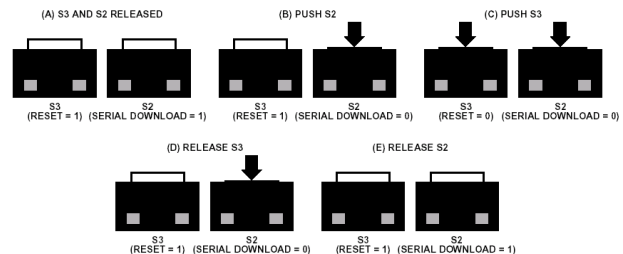


Figure 5. ISEB Switch Locations for Flashing the Microcontroller

- a. Press and hold down **SW1**.
- b. With **SW1** held down, press and release **SW2**.
- c. Release **SW1**.



The download begins and is automatically verified by the downloader.

2. If the downloading process fails, which is indicated in the **Monitor Status** box (see Figure ), attempt the download again by clicking **Start** and then pressing the appropriate switch combination. It may take a few attempts to reprogram the board successfully.
3. After the download has completed successfully, click **Run** (as shown in Figure ) to reset the ISEB and to begin running the new firmware. When this step is complete, the board is updated correctly.

Updating the firmware may require that a new evaluation GUI be obtained. If the firmware on the website is used to flash the ISEB, the evaluation GUI on the corresponding website is sufficient. If the firmware used is obtained from the Analog Devices website ([www.analog.com](http://www.analog.com)), the most recent version of the evaluation GUI, which is also located on the website, should be used.

### Installing the ADXL372 Software Evaluation GUI

The software GUI installation did not include National Instruments drivers and run-time engines and VISA that are necessary for proper operation. If there is no such run-time engines in your computer, please also install it before installing the ADXL372 software evaluation GUI. The run-time engine installer can be found in the **/Run Time Engine/** folder on the ADI website. To run the software GUI installation routine, double-click the **setup.exe** file located in the **/ADXL372 Evaluation Software/** folder on the website.

From this point, complete the following steps to install the evaluation software:

1. Select the destination directory. The installer autopopulates the names of the directories in which to store the software GUI and required National Instruments products (see Figure ). You can change these directories; however, most installations can proceed with the default values.
2. When you finish selecting a directory, click **Next**. The National Instruments Software License Agreement is displayed.
3. Read the license agreement before accepting it; then, click **Next**. The installer lists the required components to install on your PC (see Figure ).
4. To start the installation, click **Next**. The installer completes installation of the software evaluation GUI and all required National Instruments drivers and run-time engines. After the installation is complete, the box shown in Figure is displayed.
5. Click **Finish** to complete the installation.

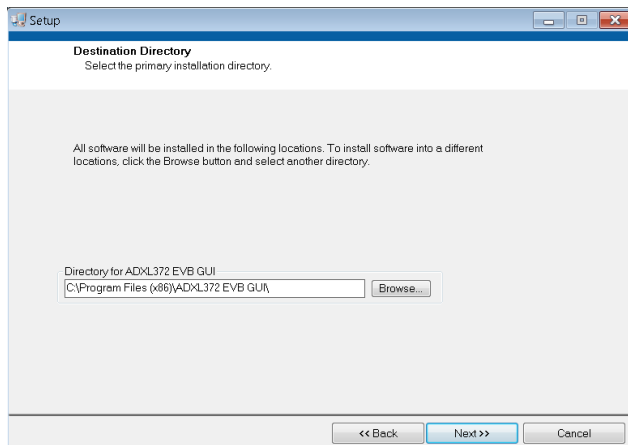


Figure 6. ADXL372 EVB GUI Destination Directory Selection

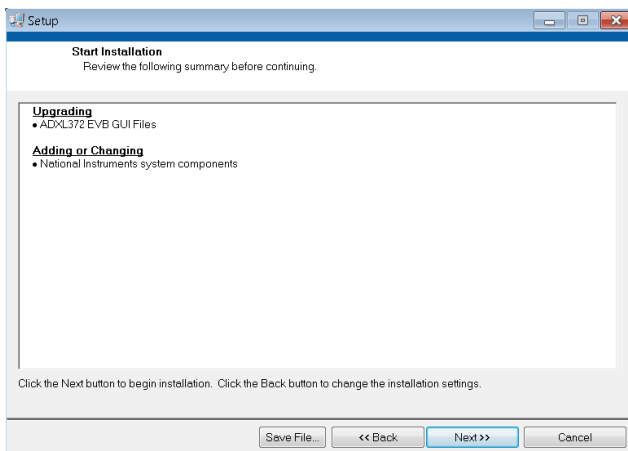


Figure 7. ADXL372 EVB GUI Start Installation (Listing Varies Based on PC Requirements)

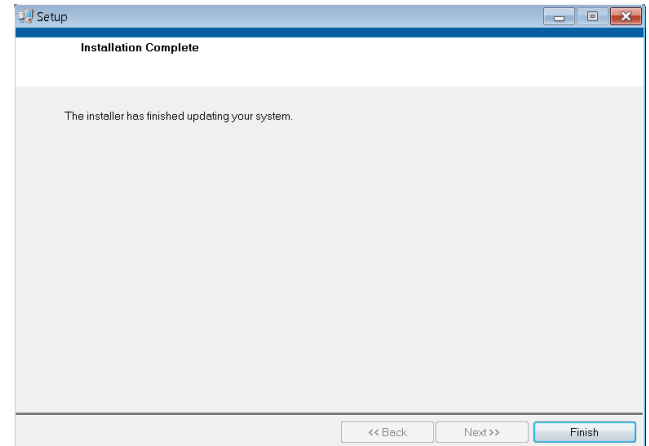


Figure 8. ADXL372 EVB GUI Installation Complete

## EVALUATION BOARD SETUP PROCEDURES

Before using the software for testing, configure the evaluation board as follows:

1. Place the ADXL372 accelerometer into the socket on the satellite board. The Socket Pin 1 Indicator is located inside the socket close to the hinge, as shown in Figure . This pin indicator should match up with the Pin 1 Indicator on the ADXL372.

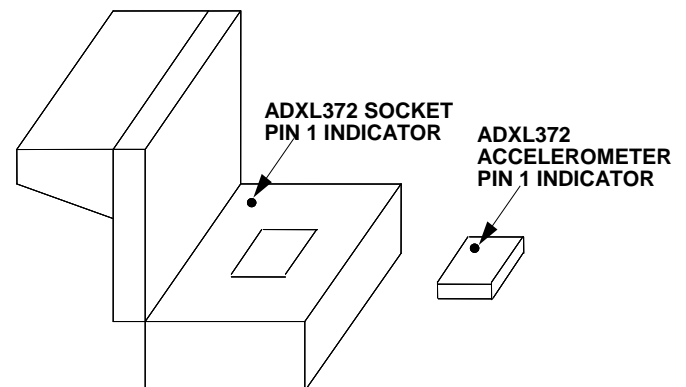


Figure 9. Location of Pin 1 Indicators for the ADXL372 Accelerometer and Socket

2. After positioning the ADXL372 in the socket, firmly close the socket until it latches.
3. Connect the ISEB to the ADXL372 satellite using the 18-inch, 20-pin ribbon cable. This cable is keyed to prevent inserting it backwards and causing damage to the system.
4. Connect the ADXL372 satellite to the opposite end of the ribbon cable.
5. Connect the ISEB to the USB cable.
6. Plug the USB A to Mini-B cable into the PC, if prompted to install the device, see the Install USB Drivers section for details on how to install and select the correct driver.

The ADXL372 evaluation system should now be set up and ready to use.

## EVALUATION BOARD HARDWARE

The EVAL-ADXL372Z-M provides all of the support circuitry required to operate the ADXL372 in its various modes of configurations. Figure 1 shows typical bench characterization setup used to evaluate the EVAL-ADXL372Z-M.

Firstly, the EVAL-ADXL372Z-M could be used to study and evaluate ADXL372. User can view and save the real time output of ADXL372 on PC for algorithm developing; check the power consumption of ADXL372 under different work mode; change the power supply and check the ADXL372 performance under different power supply.

Secondly, the EVAL-ADXL372Z-M could be used to do secondary development by user. You can realize different reference design based on it, like the shock detection demo.

## POWER SUPPLIES

All kinds of EVAL-ADXL372Z-M functions can be supported by USB directly, no other power supply needed to run the board. There are on board DC-DC, LDO and Voltage References to adjust the supply for each part on the evaluation board.

## JUMPER SETTINGS

Set the jumper settings/link options on the evaluation board for the required operating modes before powering on the board. The functions of the jumpers are described in Table 1.

**Table 1. Jumper Settings**

Jumper	Description
P1	Interface for connecting mother board and satellite board.
J1	Interface for sync trigger input. For applications that require a precisely timed acceleration measurement, the ADXL372 features an option to synchronize acceleration sampling to an external trigger. To evaluate this function, customers need to offer external trigger signal and reprogram the ADXL372 by themselves.
J2	Interface for external clock input. ADXL372 has a built-in clock that, by default, is used for clocked internal operations. To use an external clock, customers need to offer external clock and reprogram the ADXL372 by themselves.
JP1	This jumper is used to control whether showing the INT2 pin status of ADXL372 with LED.
JP2	This jumper is used to control whether showing the INT1 pin status of ADXL372 with LED.

## EVALUATION BOARD CIRCUITRY

This section describes the key parts on the development board.

### ACCELEROMETER

The ADXL372 is an ultra-low-power, 3-axis,  $\pm 200$  g MEMS accelerometer that consumes 22  $\mu$ A at a 3200 Hz output data rate. The ADXL372 does not power cycle its front end to achieve its low-power operation and therefore does not run the risk of aliasing the sensor's output.

In addition to its ultra-low power consumption, the [ADXL372](#) has many features to enable impact detection while providing system-level power reduction. The device includes a deep multimode output FIFO, several activity detection modes, and a method for capturing only the peak acceleration of over-threshold events.

### MICROCONTROLLER

The microcontroller on EVAL-ADXL372Z-M is [ADUC7026](#). It is fully integrated, 1MSPS, 12-bit data acquisition systems incorporating high performance twelve channel ADCs, 32-bit MCU, and Flash/EE memory on a single chip. There are also four channel 12-bit voltage output DAC on ADUC7026 which are used to control the power supply of ADXL372. The development tools, like ARMWSD serial downloader, evaluation version IAR, evaluation version Keil etc., are available online and they can be found from the address: [http://www.analog.com/en/processors-dsp/analog-microcontrollers/ADUC7026/products/dt-software-configurable-products/MicroConverter\\_Development\\_Tools/resources/fca.html](http://www.analog.com/en/processors-dsp/analog-microcontrollers/ADUC7026/products/dt-software-configurable-products/MicroConverter_Development_Tools/resources/fca.html).



## HOW TO USE THE SOFTWARE FOR TESTING

### GETTING STARTED

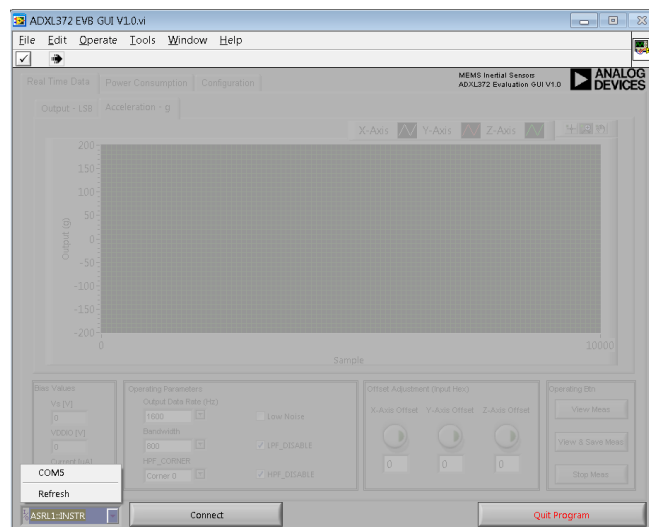


Figure 2. ADXL372 Evaluation GUI Startup

Before running the software evaluation GUI, it is a good idea to reset the ISEB by pressing the SW2 button described in the Installing the Latest ISEB Firmware section. This removes any errors that may be lingering due to an improper shutdown or disconnection from the PC.

After completion of the software GUI installation routine, a shortcut to launch the executable is added to the **Program Menu->Analog Devices – Inertial Sensor Eval**. To launch the evaluation GUI, click **ADXL372 EVB GUI**. A window similar to the one shown in Figure 2 is displayed.

At this point, the functionality of the GUI is completely deactivated. Before testing any devices, you must associate the software GUI with the previously installed hardware through the COM port. See **PC Device Manager** under the **Ports (COM & LTP)** submenu to determine which COM port is assigned to the Analog Devices inertial sensor evaluation system. Select this COM port from the drop-down menu, and click **Connect** to begin using the GUI.

After the COM port is connected, the full functionality of the software evaluation GUI is available for you to use. The following sections describe the purpose of each tab of the GUI. You can exit the GUI at any time by clicking **Quit Program** located in the lower right of the startup window.

Note that you should not press the reset button (SW2) while the GUI is running. This causes the ISEB and the software GUI to lose sync and also causes the evaluation system to no longer function properly. Additionally, if for any reason the ISEB board and the software evaluation GUI do not appear to be properly communicating, you should perform the following reset routine:

1. Close the software GUI by clicking the **Quit Program** or by selecting **File/Exit**.

2. When the software GUI is closed, reset the ISEB evaluation board by pressing the reset button (SW2).
3. Restart the software GUI.

### REAL TIME DATA TAB

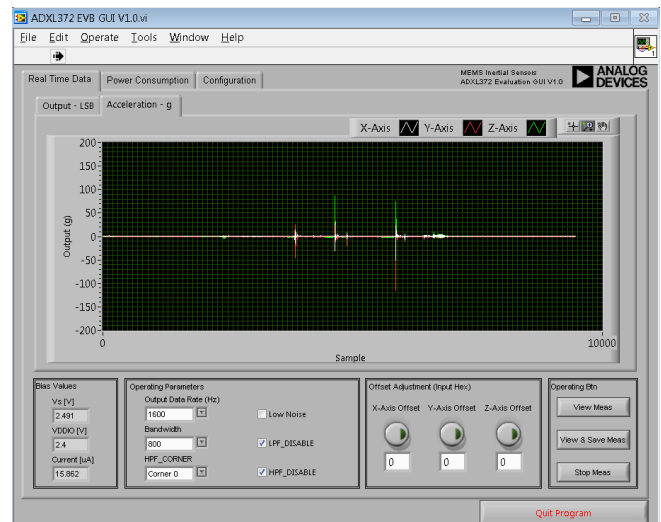


Figure 3. Real Time Data Tab

The **Real Time Data** tab configures the inertial sensor evaluation system and the ADXL372 for real-time acceleration monitoring. The tab contains an oscilloscope-like interface that you can use to view the output of the accelerometer and adjust the relevant parameters, such as output data rate, bandwidth, filter, and offset (see Figure 3).

The **Low Noise** checkbox toggles the LOW\_NOISE bit of the ADXL372. When low noise is activated, the device operates at ~1/3 the normal noise level. The **LFP\_DISABLE** and **HPF\_DISABLE** checkbox toggles the digital low-pass filter and digital high-pass filter bit of the ADXL372. When they are activated, the ADXL372 internal digital filter is disabled.

After configuration, you can begin real-time measurement by clicking the **View Meas**. This causes many of the options and tabs to be grayed out or to disappear, to prevent software conflicts, until the **Stop Meas** button is clicked. The accelerometer output data then begins to flow across the screen at the selected output data rate.

Clicking **View & Save Meas** performs the same basic function as **View Meas**; however, it allows you to continuously stream the data to eleven .txt file. This is useful for recording the response of the part even during long term events. The first .txt file is named and located by user, the other ten .txt files are named based on the first .txt file and located in the same folder.

Eg: If user named XL372Test.txt in pop-up dialog box and saved it on desktop, then other ten .txt files which named XL372Test\_1.txt, XL372Test\_2.txt, ... XL372Test\_10.txt will be built automatically on desktop. Once XL372Test.txt saved 64K samples, the following data will be saved in XL372Test\_1.txt, the rest can be deduced by analogy. When go to the last file XL372Test\_10.txt, the data will be saved continuously even its

size is bigger than 64K samples. If user just test the sensor in short time and the samples smaller than 64K, then the files without any data saved will be deleted automatically when **Stop Meas** button is clicked.

Each .txt file created contains a header with the date and time. X, Y, Z axes acceleration data, in gravity, are aligned in tab-delimited columns.

When interested in the details of some shock waveform, user can click the “Zoom In” button and use the function as showed in Figure 12. After that, choose the interested area. Or, user can analyze the waveform in Excel or Matlab based on the saved .txt file.

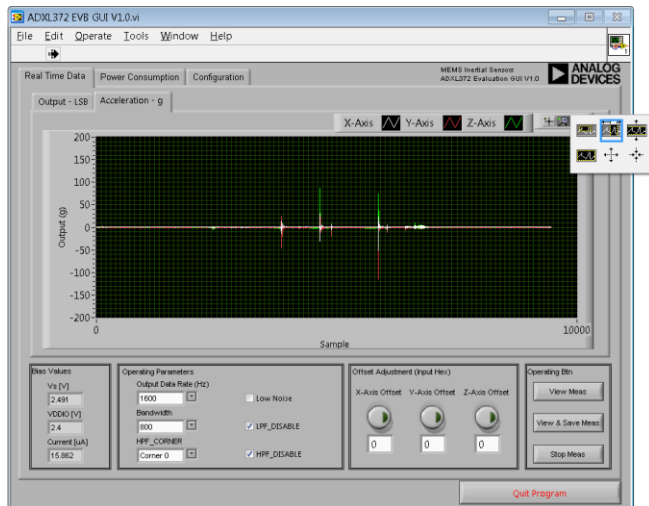


Figure 3. Zoom In Function

As showed in Figure 13, the function in red circle can be used to display the whole waveform again after the “Zoom In”.



Figure 3. Display Whole Waveform Function

## POWER CONSUMPTION TAB

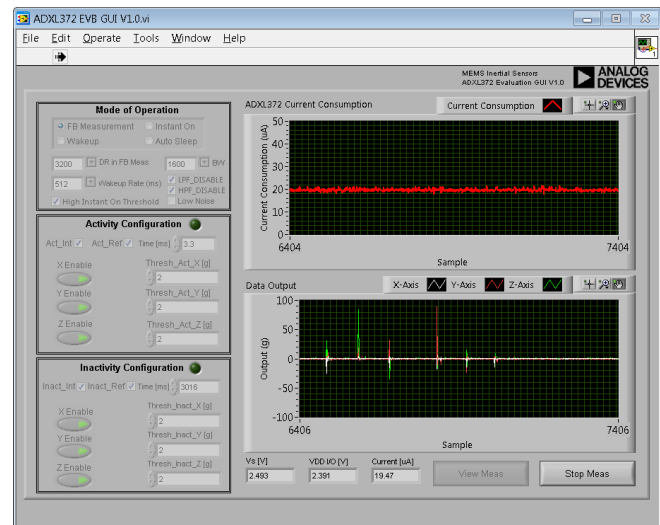


Figure 4. Power Consumption Tab

When used properly, the ADXL372 offers extremely low system level power consumption. The innovative Instant On and Auto Sleep functionality allows the device to sleep and wake up based on externally applied acceleration. Additionally, ADXL372 provides one lower noise operating mode at the expense of only a small increase in current consumption.

The following functionality is available to user within the Power Consumption tab:

The **Mode of Operation** allows you to configure the device for Full Bandwidth Measurement, Instant On, Wakeup, or Auto Sleep mode. Each of these options corresponds to different device behaviors and different power consumption levels.

The **Activity** and **Inactivity Configuration** options are enabled when Auto Sleep mode and Full Bandwidth mode is selected. In Auto Sleep mode, the Activity Interrupt Configuration options adjust the settings that determine what level of activity and how long is required to wake the device from Sleep mode. The Inactivity Interrupt Configuration options adjust the settings that control what level of inactivity and how long is required to put the device into Sleep mode.

## POWER CONSUMPTION TAB, COMMON USES

Here are some Power Consumption common use conditions that can be applied with the ADXL372 evaluation system.

### Instant On Behavior

The ADXL372 Instant-On mode is an ultra-low power mode that continuously monitors the environment for impact events that exceed a built-in threshold. When an impact is detected, the device switches into full measurement mode and captures the impact profile.

In Figure 15, when the acceleration lower than the built in threshold, there is no digitized acceleration output and the power consumption is lower than 2uA. When add a shock event on the board to make the acceleration exceed the built in



threshold, the ADXL372 switches into full bandwidth measurement mode immediately and can capture the impact profile.

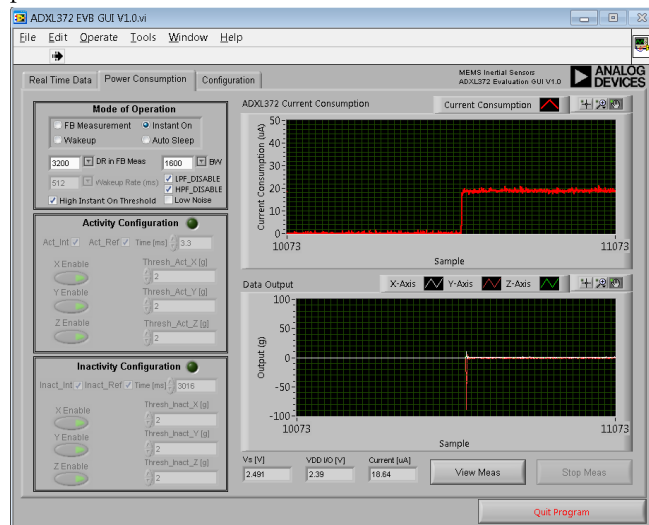


Figure 4. Instant On Mode

The built in threshold is either 10g to 15g or 30g to 40g. User can choose by disabling or enabling the **High Instant On Threshold** checkbox. If you want to use the other threshold and still monitor the shock or vibration event with just several  $\mu$ A. The Auto Sleep Mode can be used.

Once the accelerometer is in full bandwidth measurement mode, it must be set back into instant-on mode manually by clicking **Stop Meas** button and then click **View Meas** button again. It cannot return to instant-on mode automatically.

### Auto Sleep Behavior

To observe the behavior of the device when in Auto Sleep mode, the setting in Table 2 can be applied.

Table 2. Recommended Settings for Auto Sleep Operation

Parameter	Setting
Mode of Operation	Auto Sleep
Data Rate in Full BW Measure Mode	3200 Hz
Bandwidth	1600 Hz
Wakeup Rate	512 ms
Low Noise Mode	Normal Operation
Low Pass Filter	Enable
High Pass Filter	Disable
Activity Configuration	
Activity Interrupt	On
Activity Threshold	2 gee
Activity Time	3.3 ms
Coupling	AC

### Inactivity Configuration

Inactivity Interrupt	On
Inactivity Threshold	2 gee
Inactivity Time	3016 ms
Coupling	AC

After the settings are applied, click **View Meas**. As shown in Figure 16, when there is no motion to trigger the activity interrupt, the ADXL372 works in wakeup mode. The device is powered down for a duration of time equal to the **Wakeup Rate** setting and then turns on to sample the front end.

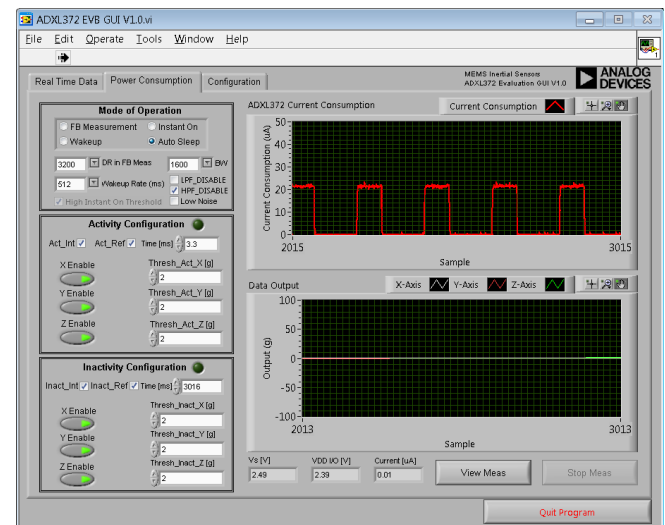


Figure 5. Work in Wakeup Mode

If the sustained motion is detected (eg: keep on shaking the board), the ADXL372 will recognize the activity event and switch to Full Bandwidth Measurement Mode automatically as shown in Figure 17.

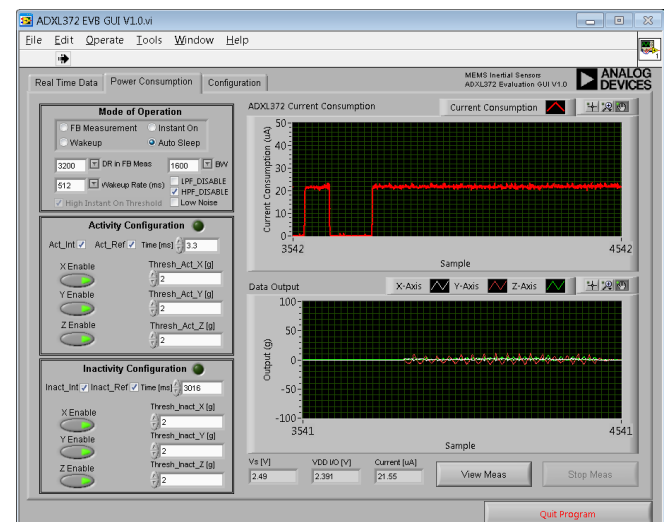


Figure 5 Sustained Motion Trigger Activity Interrupt

After that, if keep the board stable for more than specified time (it is 3016 ms in the example), the device will back to wakeup mode automatically as shown in Figure 18.

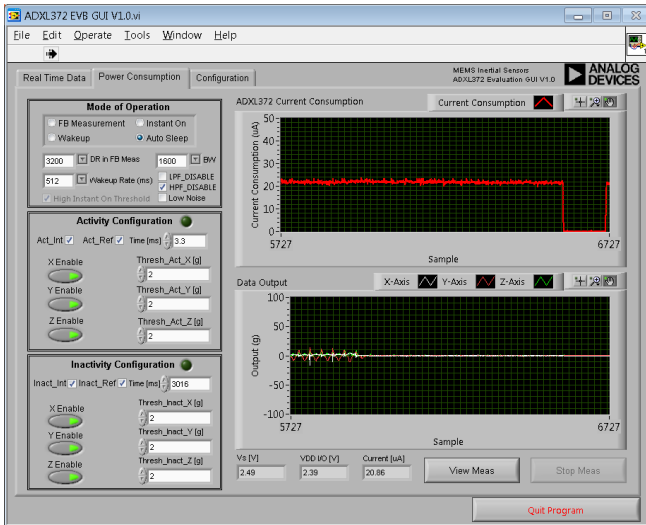


Figure 5. Auto Sleep Operation

## CONFIGURATION TAB

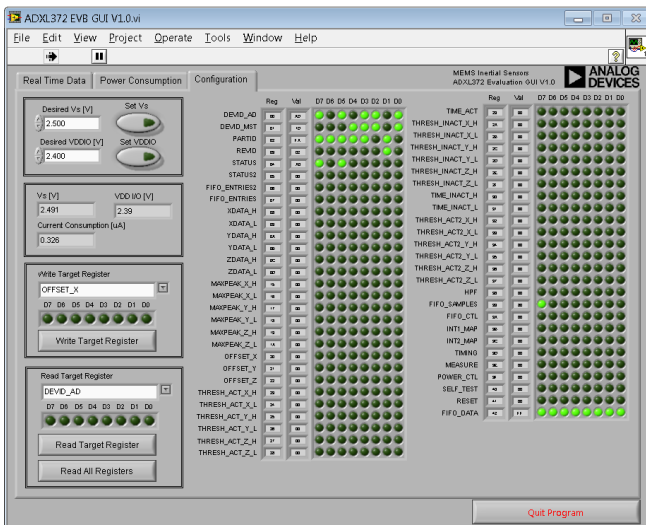


Figure 19. Configuration Tab

The **Configuration** tab allows user to set the operating conditions for the ADXL372, as well as read/write the contents of the memory map. Figure shows the **Configuration** tab after the COM port verification step has been completed.

The following actions are available in the **Configuration** tab:

**Set Vs** sets the main voltage of the ADXL372. The default value is 2.5V. When the **Set Vs** knob is clicked, the ISEB applies the

desired supply voltage, and then reads back the ADXL372 operating voltage, interface voltage and current consumption.

**Set VDD I/O** sets the interface voltage of the ADXL372. The default value is 2.4V. When the **Set VDD I/O** knob is clicked, the ISEB applies the desired interface voltage, and then reads back the ADXL372 operating voltage, interface voltage and current consumption.

To write a value to a register, select the register from the **Write Target Register** menu and click the D7 through D0 indicators to set the value. If an indicator is lit, the value written to that bit is a Logic 1, whereas an unlit indicator indicates a Logic 0. When the register is configured correctly, click the **Write Target Register** button to send the value to the ADXL372. Note that the D7 through D0 indicators under **Write Target Register** are not updated based on the value stored in that register.

To read a value from a register, select the register from the **Read Target Register** menu and click the **Read Target Register** button, the indicators in **Register Read** box will be refreshed to reflect the target register content.

Clicking the **Read All Registers** button performs a read back of the entire ADXL372 memory map. This action updates all register values and indicators on the right side of the screen.

## NOTES



### ESD Caution

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

### Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. **CONFIDENTIALITY.** This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. **ADDITIONAL RESTRICTIONS.** Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. **TERMINATION.** ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. **LIMITATION OF LIABILITY.** THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). **EXPORT.** Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. **GOVERNING LAW.** This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

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