

Evaluating the **ADXL372** Digital Accelerometer

FEATURES

- Flexible inertial sensor platform**
 - Single motherboard 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 GUI**
- Fast, easy installation**

ONLINE RESOURCES

- Evaluation Kit Contents**
 - EVAL-ADXL372Z-M**
 - USB A to Mini-B cable**
 - 18-inch, 20-pin ribbon cable**
- Documents Needed**
 - [ADXL372](#) data sheet**
- Software Needed**
 - [ADXL372](#) Evaluation GUI**
- Design and Integration Files**
 - Schematics, layout files, bill of materials**

EQUIPMENT NEEDED

- PC running Windows® operating system**
- 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 motherboard, and a satellite board for any Analog Devices inertial sensor product. The ISEB connects directly to a PC via a USB cable. The USB connection provides both communications and power to the ISEB.

The ISEB connects to the satellite board through a ribbon cable. The ribbon 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 caused by the temperature and humidity effects of other components.

The ISEB is a universal motherboard for use with various satellite boards for Analog Devices inertial sensors, including analog and digital accelerometers and gyroscopes. The various products are evaluated by means of separate graphical user interfaces (GUIs) that are customized for performance and characterization measurements relevant to the inertial sensor being evaluated. There are two types of motherboards, one named -M and the other named -MLP. The differences between -M and -MLP are the shunt resistor, R13, and the gain resistor, R17, which detect the power consumption of the device under test (DUT). The EVAL-ADXL372Z-M uses the -M motherboard. The EVAL-ADXL372Z-M is a system solution that includes the motherboard, satellite board, cables, and software.

Because the **ADXL372** is pin-to-pin compatible with **ADXL362**, the **ADXL372** and **ADXL362** satellite boards are interchangeable. The EVAL-ADXL372Z-M system contains the ISEB and the EVAL-ADXL372Z-S satellite. Also included is a 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 board.

TABLE OF CONTENTS

Features	1	Evaluation Board Hardware	8
Online Resources	1	Evaluation Purposes.....	8
Equipment Needed	1	Power Supplies.....	8
General Description	1	Jumper Settings.....	8
Revision History	2	Evaluation Board Circuitry.....	8
Evaluation Board Photographs	3	Software for Testing.....	9
Getting Started	4	Real-Time Data Tab	9
Software Installation Procedures.....	4	Power Consumption Tab.....	10
Evaluation Board Setup Procedures.....	6	Configuration Tab	12

REVISION HISTORY

2/2018—Revision 0: Initial Version

EVALUATION BOARD PHOTOGRAPHS



Figure 1. EVAL-ADXL372Z-M ISEB (ADXL362Z Satellite Board Pictured)

16492-001

GETTING STARTED

This section provides quick start procedures for using the EVAL-ADXL372Z-M evaluation system, describing both the default and optional settings. Take the following steps to ensure proper set up and operation of the EVAL-ADXL372Z-M 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 (located at analog.com) into the ISEB hardware. Note that if the default firmware matches the default GUI, Step 3 is unnecessary. However, if the microcontroller unit (MCU) has been reprogrammed for other applications, or the firmware or GUI have been updated by Analog Devices, the corresponding firmware for evaluation [ADXL372](http://analog.com) must be downloaded. The firmware and GUI installer on analog.com are always a match to each other.
4. Install the run-time engine and the [ADXL372](http://analog.com) evaluation GUI.
5. Configure the ISEB hardware.
6. Launch the [ADXL372](http://analog.com) 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/**. Choose the corresponding driver according to your specific operating system.
2. Follow the on-screen instructions to install the drivers.
3. If prompted with a message that the drivers are not tested, click **Continue Anyway**.
4. After completing Step 1 to Step 3, connect the ISEB motherboard to the computer via the USB cable that is included in the kit.
5. The **Device Manager** detects the ISEB automatically in the **Silicon Labs CP210x USB to UART Bridge** under the **Ports (COM & LPT)** selection. 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](http://analog.com) evaluation GUI, requires knowing which communications port is assigned to the ISEB motherboard. After connecting the ISEB motherboard to the PC, 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**.

- a. Click **OK**.
3. Expand the **Ports (COM & LPT)** menu item, as shown in Figure 2. **Silicon Labs CP210x USB to UART Bridge** should be listed with an assigned COM port number in parentheses.
 - a. If the **Silicon Labs CP210x USB to UART Bridge** is not listed, repeat the Install USB Drivers process or change the PC and retry.
 4. Note the COM port number for future use.

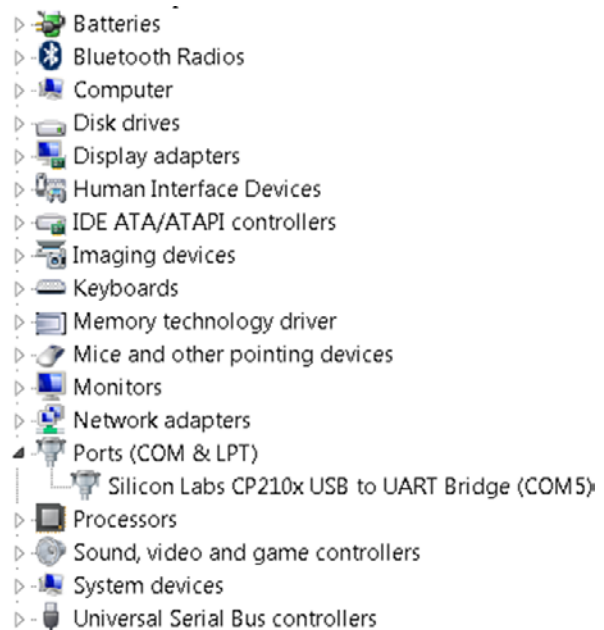


Figure 2. Device Manager Showing the COM Port Number

Installing the Latest ISEB Firmware

The latest ISEB firmware is available on the Analog Devices website, analog.com. To use the ISEB evaluation hardware, the ISEB firmware must be flashed to the ISEB controller. The Analog Devices website contains the firmware and the utility that allows you to flash a new version of the firmware onto the ISEB microcontroller. In addition, as new firmware becomes available, it can be downloaded from 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 must be obtained, as instructed 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 3.

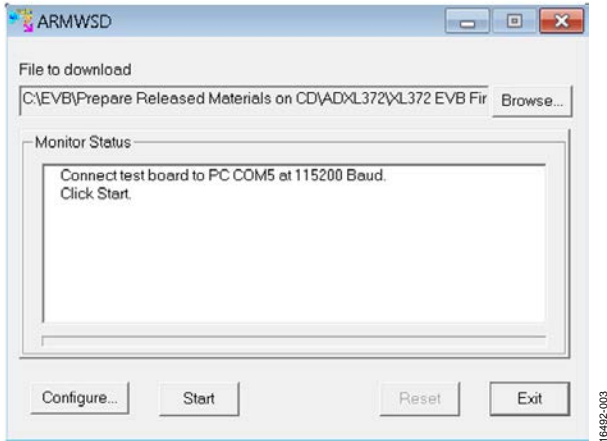


Figure 3. ISEB ARMWSD Firmware Downloader

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 analog.com.
4. Click **Configure** to display the configuration box (see Figure 4).
5. Configure the downloader file for the **ADuC7026** microcontroller on the ISEB. The only option that may require a change is the COM port.
 - a. Select the correct port from the **Serial Port** menu on the **Comms** tab (see Figure 4).
 - b. If the .hex file does not download correctly, lower the baud rate (see the **Baudrate** dropdown box in Figure 4) and retry.
6. After selecting the COM port, click **OK** to accept the changes and return to the **ARMWSD** dialog box (see Figure 3).

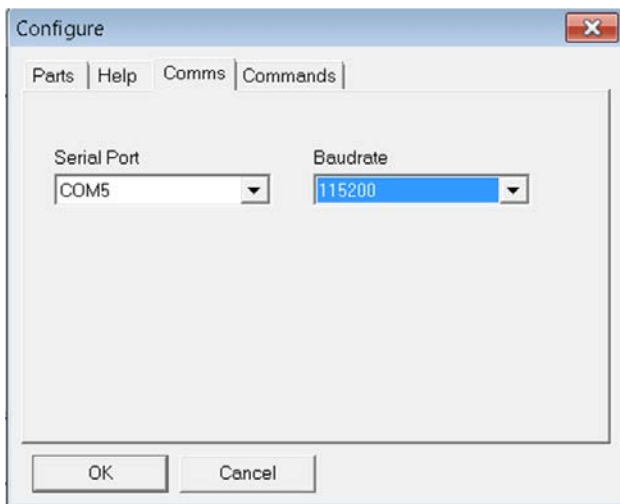


Figure 4. Selecting the Correct COM Port for the Downloader

After connecting the ISEB, selecting the correct firmware, and fully configuring the downloader, follow these steps to flash the firmware:

1. Click **Start** in the **ARMWSD** dialog box (see Figure 3) to initiate the flashing.
2. Click the two buttons, **SW1** and **SW2** (shown in Figure 5) on the ISEB, in the following sequence to flash the firmware (see Figure 6):
 - a. Press and hold **SW1**.
 - b. While holding **SW1**, press and release **SW2**.
 - c. Release **SW1**.

The download begins and is verified automatically by the downloader.

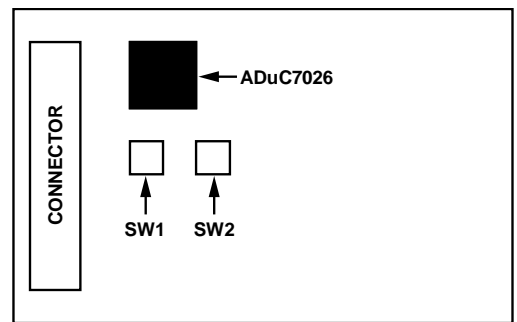


Figure 5. ISEB Switch Locations for Flashing the Microcontroller

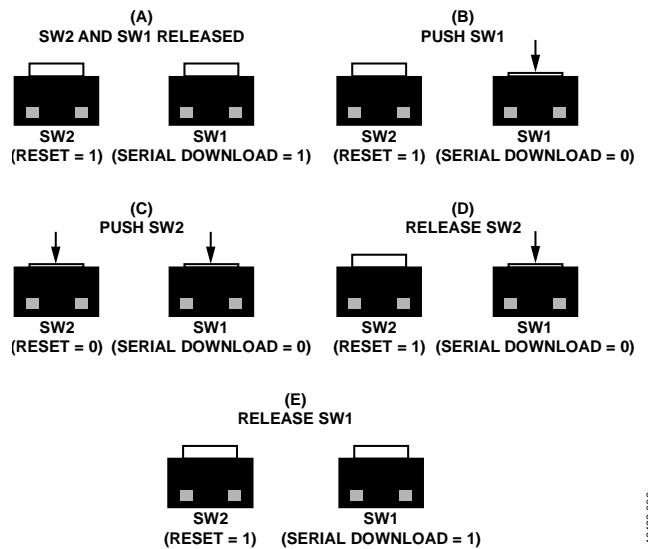


Figure 6. Method to Press, Hold, and Release SW1 and SW2

3. If the downloading process fails, which is indicated in the **Monitor Status** box (see Figure 3), attempt the download again by clicking **Start** and then pressing the appropriate switch combination. It may require a few attempts to reprogram the board.
4. After the download has completed, click **Reset** (as shown in Figure 3) 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, use the most recent version of the evaluation GUI, which is also located on analog.com.

Installing the **ADXL372 Software Evaluation GUI**

For proper operation, additional drivers and run-time engines are necessary. The software GUI installation did not include the requisite National Instruments drivers and run-time engines or VIA. If there are no such run-time engines on your computer, these must be installed before installing the **ADXL372** software evaluation GUI. The run-time engine installer is found in the **/Run Time Engine/** folder on analog.com. To run the software GUI installation routine, double-click the **setup.exe** file located in the **/ADXL372 Evaluation Software/** folder on the website.

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 7). You can change these directories; however, most installations can proceed with the default values.
2. After selecting a directory, click **Next**. The National Instruments Software License Agreement is displayed.
3. Read the license agreement before accepting it. Click **Next**. The installer lists the required components to install on your PC (see Figure 8).
4. Click **Next** to start the installation. 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 dialog box (see Figure 9) is displayed.
5. Click **Finish** to complete the installation.

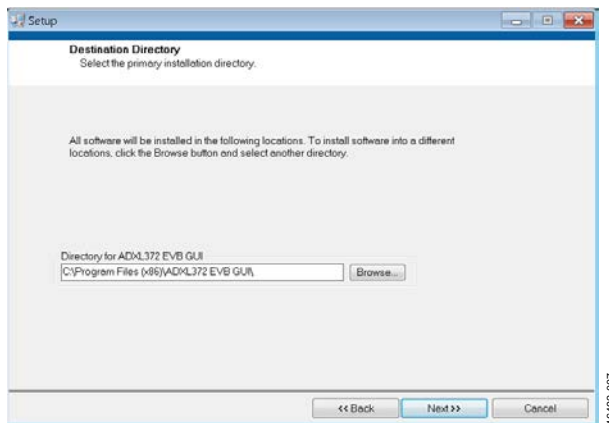


Figure 7. **ADXL372 Evaluation Board GUI Destination Director Selection**

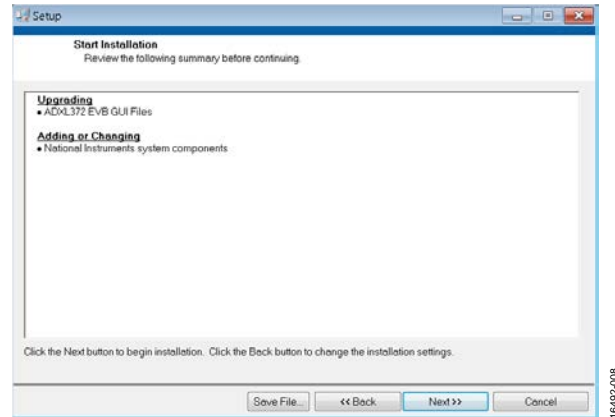


Figure 8. **ADXL372 Evaluation Board GUI Start Installation**
(Listing Varies Based on PC Requirements)

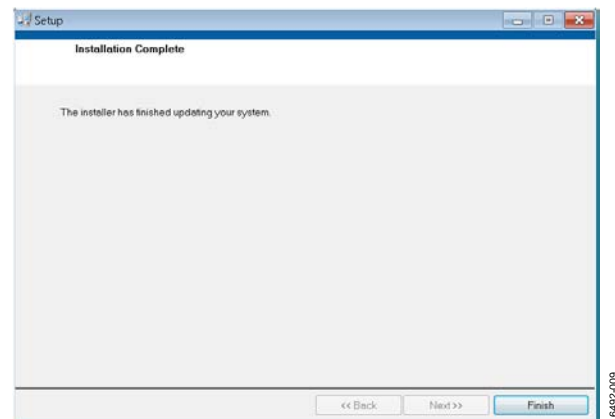


Figure 9. **ADXL372 Evaluation Board GUI Installation Complete**

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 near the hinge, as shown in Figure 10. Ensure that this pin indicator aligns with the Pin 1 indicator on the **ADXL372**.

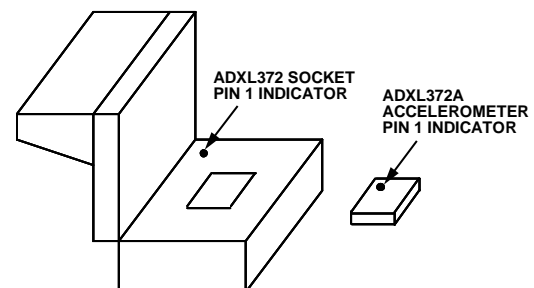


Figure 10. **Location of Pin 1 Indicator for the ADXL372 Accelerometer and Socket**

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. The ribbon 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 regarding how to install and select the correct driver.

The [ADXL372](#) evaluation system is 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 and configurations. Figure 1 shows a typical bench characterization setup to evaluate the [ADXL372](#).

EVALUATION PURPOSES

There are two purposes for using the EVAL-ADXL372Z-M: to study the [ADXL372](#) or for secondary development.

Study the [ADXL372](#)

The EVAL-ADXL372Z-M is useful to study and evaluate the [ADXL372](#). The user can view and save the real-time output of [ADXL372](#) on a PC for the following purposes:

- Algorithm development
- Power consumption under various work modes
- Power supply changes
- Power supply performance using various supplies

Secondary Development

The EVAL-ADXL372Z-M can be used for secondary development. The user can experiment and realize various reference designs, such as a shock detection demonstration.

POWER SUPPLIES

Many of the EVAL-ADXL372Z-M functions are supported by the USB directly, requiring no other power supply to run the board. There are on-board dc-to-dc, low dropout (LDO), and voltage references to adjust the supply for each product on the evaluation board.

JUMPER SETTINGS

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

Table 1. Jumper Settings

Jumper	Description
P1	Interface for connecting motherboard 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 provide an external trigger signal and reprogram the ADXL372 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 provide an external clock and reprogram the ADXL372 themselves.
JP1	This jumper controls whether to show the INT2 pin status of the ADXL372 with an LED.
JP2	This jumper controls whether to show the INT1 pin status of the ADXL372 with an LED.

EVALUATION BOARD CIRCUITRY

The two key products on the EVAL-ADXL372Z-M are the accelerometer and the microcontroller.

Accelerometer

The [ADXL372](#) is an ultra low power, 3-axis, ± 200 g MEMS accelerometer that consumes 22 μ A at a 3200 Hz output data rate. The [ADXL372](#) does not power cycle its front end to achieve its low power operation, thereby eliminating the risk of aliasing the sensor 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 multi-mode output FIFO, several activity detection modes, and a method for capturing only the peak acceleration of overthreshold events.

Microcontroller

The microcontroller on the EVAL-ADXL372Z-M is the [ADuC7026](#). It is a fully integrated, 1 MSPS, 12-bit data acquisition system that incorporates

- High performance, 12-channel, analog-to-digital converters (ADCs)
- 32-bit MCU
- Flash*/EE memory on a single chip
- Four digital-to-analog converter (DAC) outputs to control the power supply of the [ADXL372](#)

The development tools, such as the ARMWSD serial downloader, evaluation version IAR, and evaluation version Keil, are available online from the [MicroConverter® Development Tools](#) page on [analog.com](#).

SOFTWARE FOR TESTING

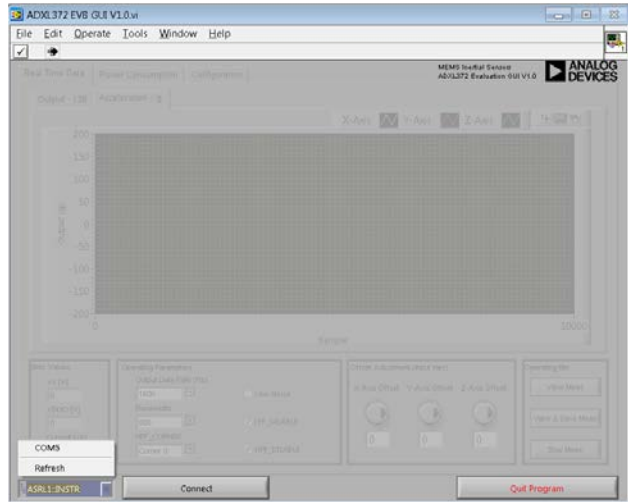


Figure 11. ADXL372 Evaluation GUI Startup

Before running the software evaluation GUI, reset the ISEB by pressing the SW2 button described in the Installing the Latest ISEB Firmware section. Pressing SW2 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 11 displays.

At this point, the functionality of the GUI deactivates completely. Before testing any devices, the software GUI must be associated with the previously installed hardware through the COM port. See the **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 dropdown 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 use. The following sections describe the purpose of each tab of the GUI. Exit the GUI at any time by clicking **Quit Program** located in the lower right side of the startup window.

Note: do not press the reset button (SW2) while the GUI is running because it causes the ISEB and the software GUI to lose sync and the evaluation system to malfunction. Additionally, if for any reason, the ISEB board and the software evaluation GUI do not appear to be properly communicating, perform the following reset routine:

1. Close the software GUI by clicking **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

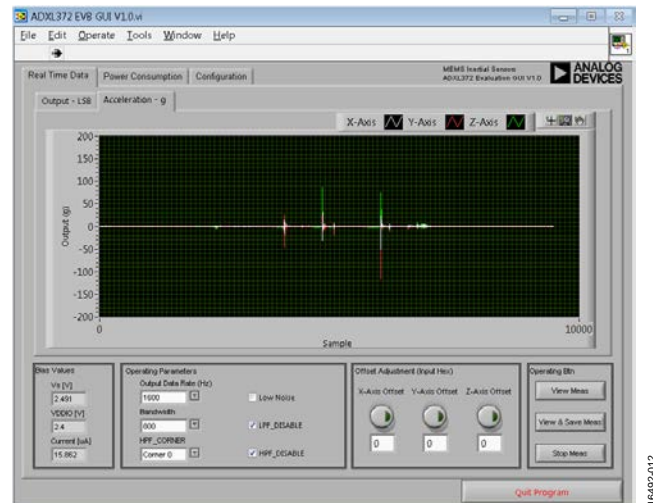


Figure 12. Real-Time Data Tab

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 to view the output of the accelerometer and adjust the relevant parameters, such as output data rate, bandwidth, filter, and offset (see Figure 12).

The **Low Noise** checkbox toggles the **LOW_NOISE** bit of the **ADXL372**. When low noise is activated, the device operates at approximately 1/3 the normal noise level.

The **LFP_DISABLE** and **HPF_DISABLE** checkboxes toggle the digital low-pass filter and digital high-pass filter bits of the **ADXL372**. Activating the high- and low-pass filters disables the internal digital filter of the **ADXL372**.

After configuration, begin real-time measurements by clicking **View Meas**. To prevent software conflicts, clicking **View Meas** causes many of the options and tabs to gray out or to disappear 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** except that it allows continuous data streaming to the eleven .txt files. **View & Save Meas** is useful for recording the response of the **ADXL372** even during long-term events. The first .txt file is named and located by the user, and the other ten .txt files are named based on the first .txt file and located in the same folder.

For example, if a user named a file XL372Test.txt in the pop-up dialog box and saved it onto his or her desktop, then ten additional .txt files are built automatically on the desktop and named as XL372Test_1.txt, XL372Test_2.txt, ... XL372Test_10.txt.

A single .txt file can save up to 64,000 samples. For test runs that generate more than 64,000 samples, each .txt file fills sequentially with 64,000 samples per file until the test run completes. Thus, in this example, the first .txt file, XL372Test.txt, saves the first 64,000 samples. The next 64,000 samples generated by the test are saved to XL372Test_1.txt, and so forth until the test completes.

For a large test where there are more than 64,000 samples to be saved in the tenth .txt file, the tenth .txt file possesses unlimited storage potential. Therefore, the data marked for storage in the tenth .txt file is saved continuously, even when its size exceeds 64,000 samples. In this way, no data is lost and all data is organized uniformly across all .txt files until the tenth .txt file.

For tests of the sensor that are of a short duration and the samples do not fill all ten .txt files, the empty .txt files are deleted automatically when the **Stop Meas** button is clicked. In this way, the program saves only those files that contain data.

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

To examine the details of a shock waveform, click the **Zoom In** button and use this function, as shown in the callout box in Figure 13. After clicking the **Zoom In** link (outlined in the callout in Figure 13), choose the area of interest. Alternatively, analyze the waveform in Excel® or MATLAB based on the saved .txt files.

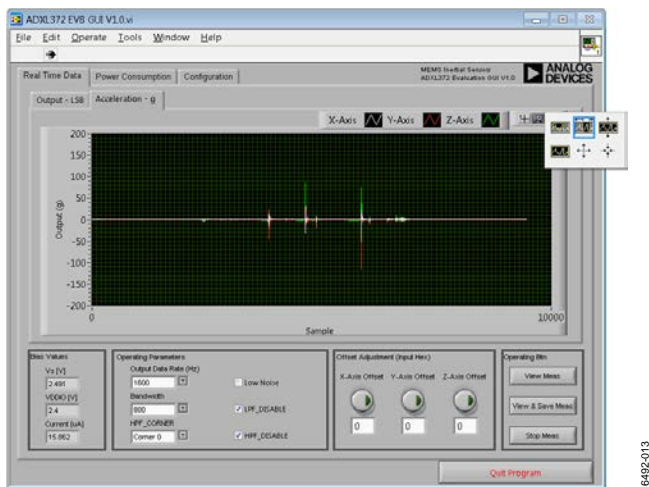


Figure 13. Zoom In Function

To display the entire waveform again after zooming into a particular section of the waveform, use the icon (circled in Figure 14).



Figure 14. Display Whole Waveform Function

POWER CONSUMPTION TAB

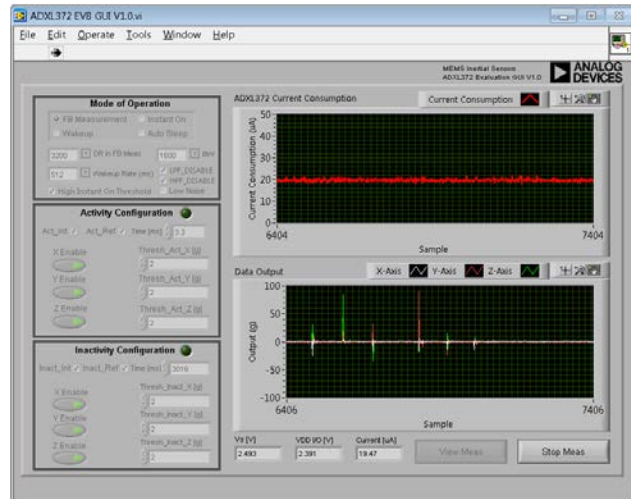


Figure 15. Power Consumption Tab

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

The following functionality is available within the **Power Consumption** tab:

- **Mode of Operation** configures the device for full bandwidth measurement, instant on, wake-up, or autosleep mode. Each of these options corresponds to different device behaviors and different power consumption levels.
- **Activity and Inactivity Configuration** options are enabled when autosleep mode and full bandwidth mode are selected. In autosleep mode, the **Activity Interrupt Configuration** options (shown in Figure 15) adjust the settings that determine the level of activity and the length of time required to wake the device from sleep mode. The

Inactivity Interrupt Configuration options (shown in Figure 15) adjust the settings that control the level of inactivity and how much time is required to put the device into sleep mode. For example, the ADXL372 transitions from activity to inactivity mode when the ADXL372 remains stable for a long enough time. When the ADXL372 enters inactivity mode, the ADXL372 continues to operate while in sleep mode or while in the low speed sampling rate mode.

Power Consumption Tab, Common Uses

Two commonly used power consumption conditions can be applied to the ADXL372 evaluation system: instant on behavior and autosleep behavior.

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 detecting an impact, the device switches into full measurement mode and captures the impact profile.

In Figure 16, when the acceleration is lower than the built-in threshold, there is no digitized acceleration output and the power consumption is lower than 2 μ A. Adding a shock event on the board to make the acceleration exceed the built-in threshold causes the ADXL372 to switch immediately into full bandwidth measurement mode and captures the impact profile.

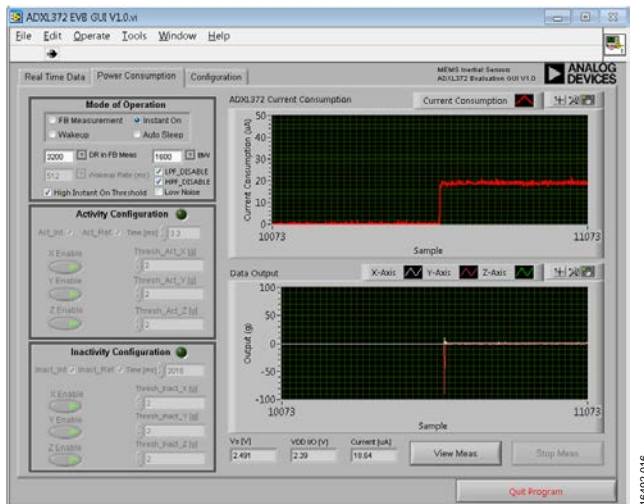


Figure 16. Instant-On Mode

The built-in threshold is either 10 g to 15 g or 30 g to 40 g. A user can choose the threshold by disabling or enabling the **High Instant On Threshold** checkbox. Checking **High Instant On Threshold** sets the threshold at 30 g to 40 g. Unchecking **High Instant On Threshold** sets the threshold at 10 g to 15 g. To use the other threshold and still monitor the shock or vibration event with just several μ A, use the autosleep mode.

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

Autosleep Behavior

To observe the behavior of the device when in autosleep mode, apply the settings listed in Table 2.

Table 2. Recommended Settings for Autosleep Operation

Parameter	Setting
Mode of Operation	Autosleep
Data Rate in Full Bandwidth Measurement Mode	3200 Hz
Bandwidth	1600 Hz
Wake-Up Rate	512 ms
Low Noise Mode	Normal operation
Low-Pass Filter	Enable
High-Pass Filter	Disable
Activity Configuration	
Activity Interrupt	On
Activity Threshold	2 g
Activity Time	3.3 ms
Coupling	AC
Inactivity Configuration	
Inactivity Interrupt	On
Inactivity Threshold	2 g
Inactivity Time	3016 ms
Coupling	AC

After the settings are applied, click **View Meas**. As shown in Figure 17, when there is no motion to trigger the activity interrupt the ADXL372 works in wake-up mode. The device powers down for a duration of time equal to the **WakeUp Rate (ms)** setting and then turns on to sample the front end.

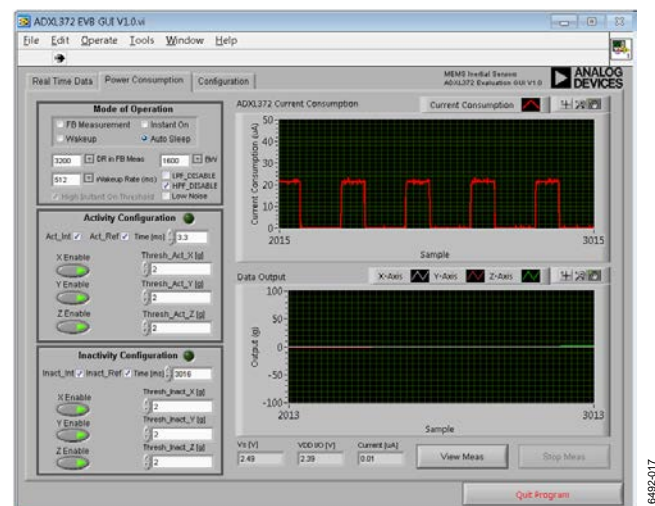


Figure 17. Wake-Up Mode

If sustained motion is detected (for example, continuous shaking of the board), the **ADXL372** recognizes the activity event and switches automatically to full bandwidth measurement mode, as shown in Figure 18.

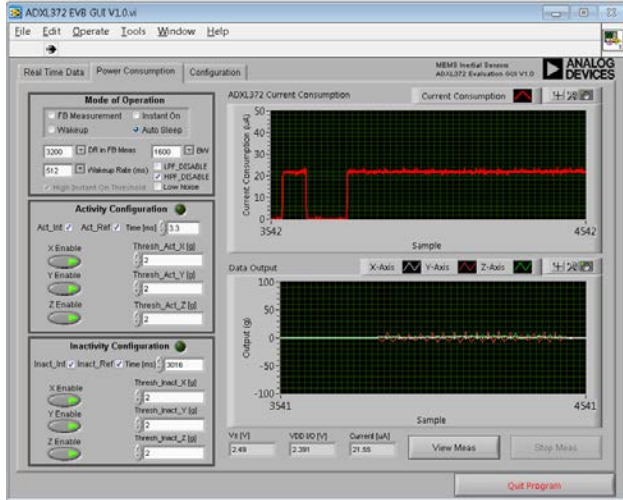


Figure 18. Sustained Motion Trigger Activity Interrupt

Following this sustained motion event, if the board remains stable for more than its specified time (it is 3016 ms in the example), the device returns to wake-up mode automatically, as shown in Figure 19.

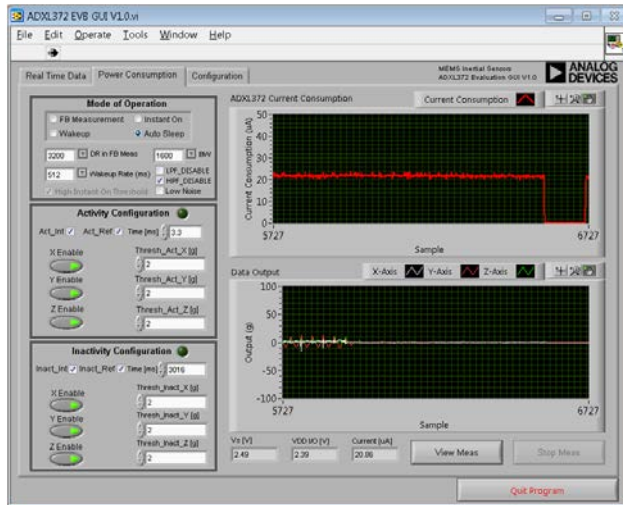


Figure 19. Autosleep Operation

CONFIGURATION TAB

The **Configuration** tab allows the user to set the operating conditions for the **ADXL372**, as well as read/write the contents of the memory map. Figure 20 shows the **Configuration** tab after the COM port verification step has been completed.

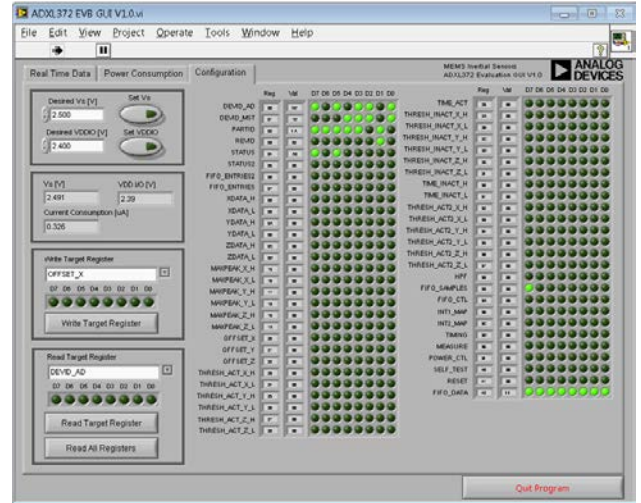


Figure 20. Configuration Tab

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

- **Set V_S** sets the main voltage of the **ADXL372**. The default value is 2.5 V. When the **Set V_S** button 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 2.4 V. When the **Set VDD I/O** button is clicked, the ISEB applies the desired interface voltage, and then reads back the **ADXL372** operating voltage, interface voltage, and current consumption.
- **Write Target Register** performs a write to a register. 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. When an indicator is lit, the value written to that bit is Logic 1. When the indicator is unlit, the value written to that bit is 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 in the **Write Target Register** are not updated based on the value stored in that register.
- **Read Target Register** performs as a read from a 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 the **Register Read** box refresh to reflect the target register content.
- **Read All Registers** performs a readback of the entire **ADXL372** memory map. Clicking **Read All Registers** 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.

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