

## *i*MEMS ADXL345 Inertial Sensor Evaluation System

### FEATURES

- Ultralow power **ADXL345** accelerometer
- Inertial sensor evaluation board
- Inertial sensor-specific satellite for evaluation
- Standard USB cable for power and communications
- PC-based graphical user interface (GUI)
- Separates DUT from controller for accurate environmental testing

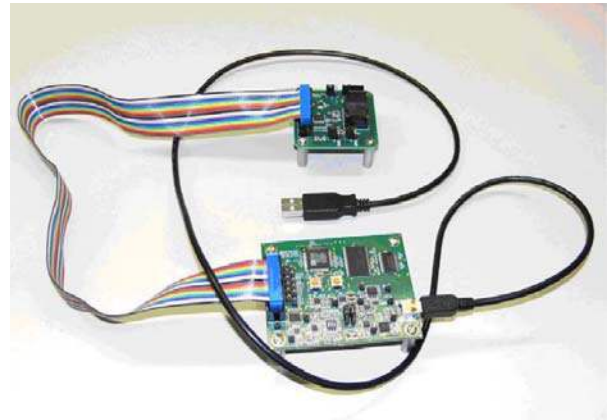


Figure 1. Inertial Sensor Evaluation System

### GENERAL DESCRIPTION

The *i*MEMS® ADXL345 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 its USB, where the USB connection provides both power and communications to the board. The ISEB then connects to the satellite board through a ribbon cable. This cable allows the satellite to be easily manipulated for testing or for being 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 a 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.

The EVAL-ADXL345Z-M system contains the ISEB and the EVAL-ADXL345Z-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. A CD is also included with the necessary drivers and executables to use the system and to quickly begin evaluating the ADXL345.

**TABLE OF CONTENTS**

Features .....	1	Configuration Tab .....	6
General Description .....	1	Real-Time Measurement Tab .....	7
Revision History .....	2	Interrupt Configuration Tab .....	8
Inertial Sensor Evaluation System Setup .....	3	Power Consumption Tab .....	9
Software Configuration .....	3	Temperature Tab .....	10
Hardware Configuration .....	4	Header Pinout .....	11
Updating/Repairing the ISEB Firmware .....	5	ESD Caution .....	11
Inertial Sensor Evaluation System Graphical User Interface .....	6		

**REVISION HISTORY**

**6/09—Revision 0: Initial Revision**

# INERTIAL SENSOR EVALUATION SYSTEM SETUP

## SOFTWARE CONFIGURATION

Software configuration of the inertial sensor evaluation system involves installation of USB drivers for the ISEB and National Instruments LabVIEW® Run-Time and NI-VISA™ Run-Time files. These are available in the /Drivers/ folder on the packaged CD.

### Installing the USB Drivers for the ISEB

To install the USB drivers, follow these steps.

1. Execute the ADI\_ISEB\_USB\_Drivers.exe file located in /Drivers/ISEB\_USB/.
2. Follow the on-screen instructions to install the drivers.
3. Click Continue Anyway when prompted that the drivers are not tested.

It may be necessary to manually select the correct drivers after installation. To select the drivers, follow these steps.

1. Connect the USB A to Mini-B cable to the PC and then to the ISEB. The satellite board does not need to be connected for this step. New hardware is detected upon completion of this step.
2. If prompted to install drivers again, click **Install from a list or specific location (Advanced)**, see Figure 2.

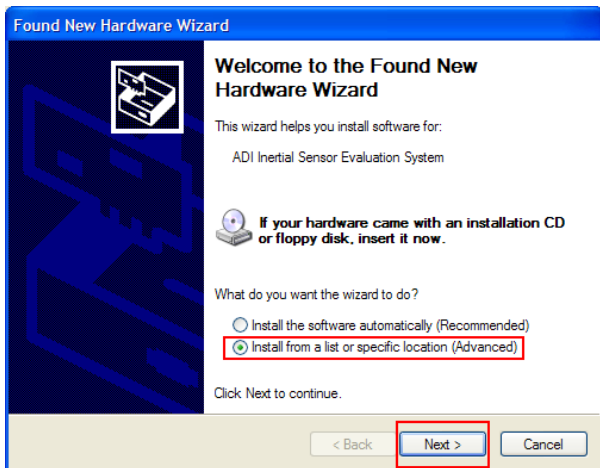


Figure 2. Found New Hardware Prompt

3. Select **Don't search. I will choose the driver to install.** (see Figure 3) and select **ADI Inertial Sensor Evaluation System** from the model list (see Figure 4).

The ISEB should be detected automatically in the **Device Manager** as the **ADI Inertial Sensor Evaluation System** 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.

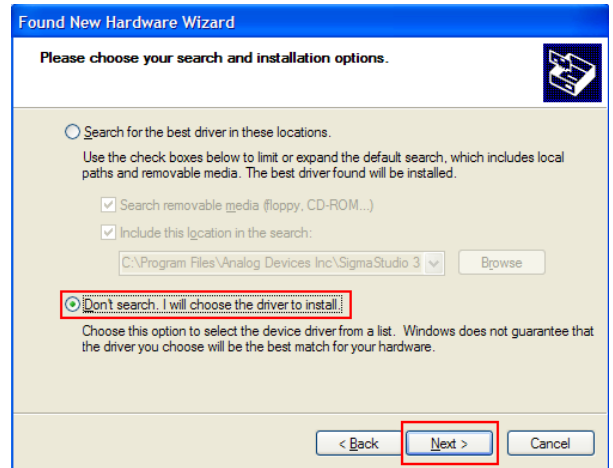


Figure 3. Selection of the Driver to Install

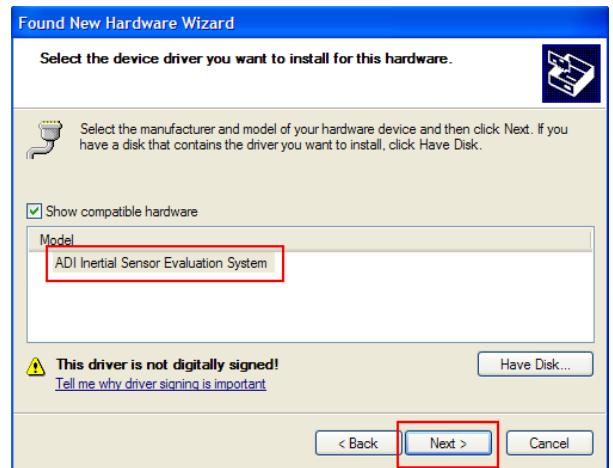


Figure 4. Selection of the ADI Inertial Sensor Evaluation System Drivers

### Installing the LabVIEW and NI-VISA Run-Time Engines

After installing the USB drivers, install the LabVIEW and NI-VISA run-time engines. To ensure that the drivers are installed properly, it is recommended that you reboot when prompted.

1. Execute the LVRTE851std.exe file located in the /Drivers/ folder.
2. Follow the on-screen instructions to complete installation of the LabVIEW run-time engine.
3. Reboot the PC.
4. Locate and execute the visa441runtime.exe file located in the /Drivers/ folder to install the NI-VISA run-time engine.
5. Follow the on-screen instructions to complete the installation.
6. Reboot the PC.

**HARDWARE CONFIGURATION**

To configure the hardware, follow these steps:

1. Plug the USB A to Mini-B cable into the PC, if the cable is not already connected.
2. Connect the ISEB to the USB cable.  
If prompted to install the device, see the Software Configuration section for details on how to install and select the correct driver.
3. Connect the ISEB to the ADXL345 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 ADXL345 satellite to the opposite end of the ribbon cable.
5. Verify that the jumpers located in the center of the ADXL345 satellite are configured as shown in Figure 5.

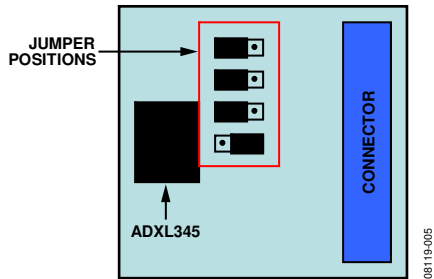


Figure 5. Correct Jumper Positions for the ADXL345 Satellite

6. Place the ADXL345 ultralow power 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 6. This pin indicator should match up with the Pin 1 Indicator on the ADXL345.
7. After positioning the ADXL345 in the socket, firmly close the socket until it latches.

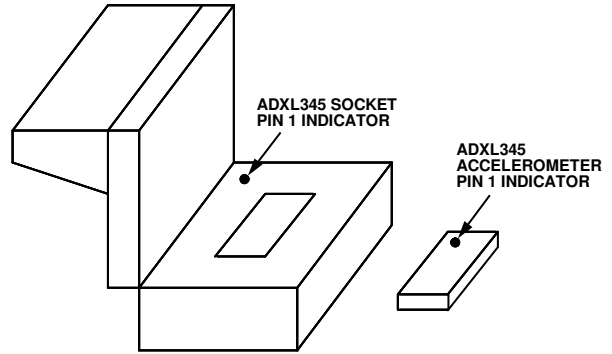


Figure 6. Location of Pin 1 Indicators for the ADXL345 Accelerometer and Socket

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

## UPDATING/REPAIRING THE ISEB FIRMWARE

In the event that the ISEB firmware becomes corrupted or must be updated, the CD contains the necessary programming utility to flash the ISEB microcontroller. Also available on the CD is the version of firmware available at the time of release of the EVAL-ADXL345Z-M system (Version 1.3). 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 that the device is recognized on must also be obtained, as mentioned in the previous sections.
2. Run the **ARMWSD.exe** program located in the **/Drivers/FW/** folder, which displays information about the downloader, as shown in Figure 7.

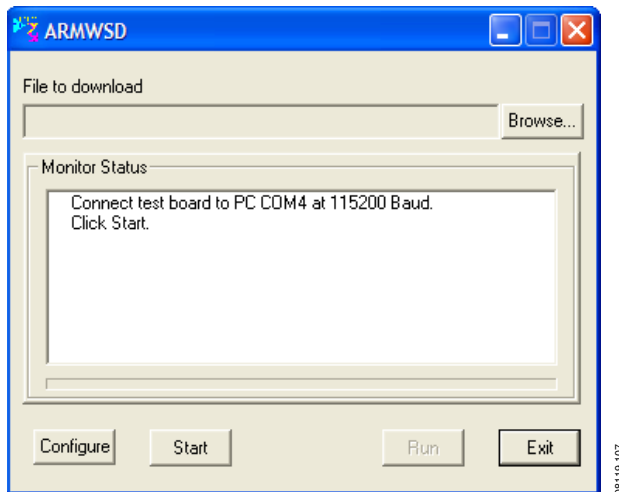


Figure 7. ISEB ARMWSD Firmware Downloader

3. Click **Browse...** and select the **ADI\_ISEB\_FW\_1\_3.hex** file located in the **/Drivers/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 screen shown in Figure 8.

The downloader file should come configured for the **ADuC7026** microcontroller on the ISEB. The only option that may need to be changed is to select the correct COM port from the **Serial Port** menu on the **Comms** tab (see Figure 8). When the COM port is selected, click **OK** to accept the changes and go back to the main screen.

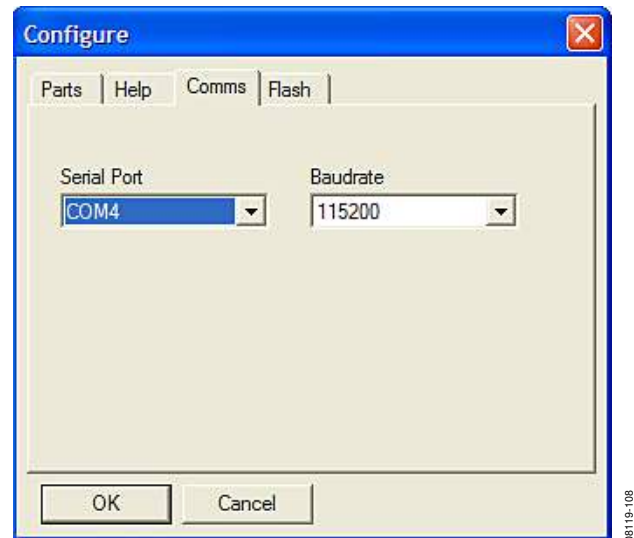


Figure 8. Selecting the Correct COM Port for the Downloader

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**, as shown in Figure 7, to initiate the flashing process. After clicking **Start**, the two buttons on the ISEB shown in Figure 9 must be pressed, in a specific order, to flash the firmware.

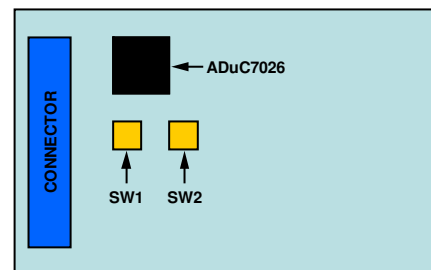


Figure 9. ISEB Switch Locations for Flashing the Microcontroller

2. Press and hold down **SW1**.
3. With **SW1** held down, press and release **SW2**.
4. Release **SW1**.

The download then begins and is automatically verified by the downloader. If the downloading process fails, which will be indicated in the **Monitor Status** box (see Figure 7), attempt the download again by clicking **Start** and then the appropriate switch combination. It may take a few attempts to reprogram the board successfully.

After the download is completed successfully, click **Run**, as shown in Figure 7, 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 CD is used to flash the ISEB, the evaluation GUI on the corresponding CD 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.

# INERTIAL SENSOR EVALUATION SYSTEM GRAPHICAL USER INTERFACE

## CONFIGURATION TAB

When the system is set up and configured, press SW2, which is shown in Figure 9, to reset the ISEB and have it detect the currently connected satellite. This must be done when the satellite connected to the ISEB is replaced by a satellite of a different part only; replacing the satellite with a satellite for the same part, that is, an EVAL-ADXL345Z-S with another EVAL-ADXL345Z-S, does not require SW2 to be pressed.

The inertial sensor evaluation system GUI is opened by executing the **ADXL345 Evaluation GUI.exe** file located in the **/ADXL345 Evaluation GUI/** folder. To exit the GUI, use the **Stop VI** button to disconnect from the ISEB. Then exit the application by selecting **File and Exit** or by pressing **Ctrl+Q**.

The first screen brought up is the **Configuration** tab (see Figure 10). This screen is used for manual configuration of the sensor, for setting up the communication port between the PC and ISEB, and for setting the sensor voltage values. Configuration register values can be saved and reloaded.

It is important to note that the register settings entered on this screen are independent from other GUI screens. Each screen requires a different register setup, and any values that can be altered are made available for that particular screen.

With the **Configuration** tab open, select the correct COM port for the ISEB from the **VISA Resource Name** menu (see Figure 10). The correct COM port can be found by checking the **Device Manager** for the **ADI Inertial Sensor Evaluation System** under the **Ports (COM & LPT)** selection.

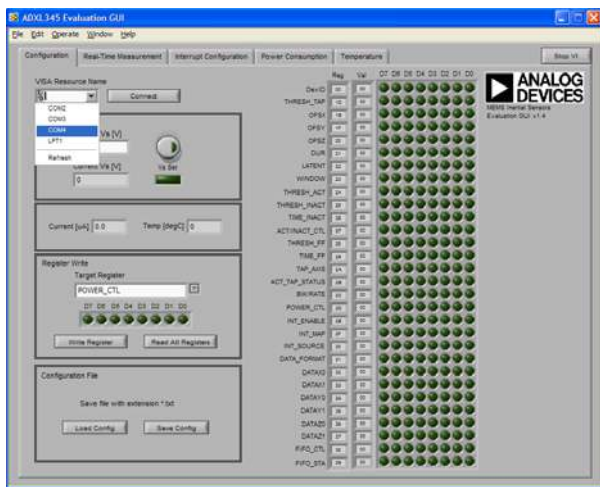


Figure 10. Selecting the Correct COM Port for the ISEB

After selecting the COM port, click on **Connect** to connect to the ISEB. This causes the indicator under **Vs Set** to light up and update the **Current Vs [V]** value, verifying that the board is connected (see Figure 11).

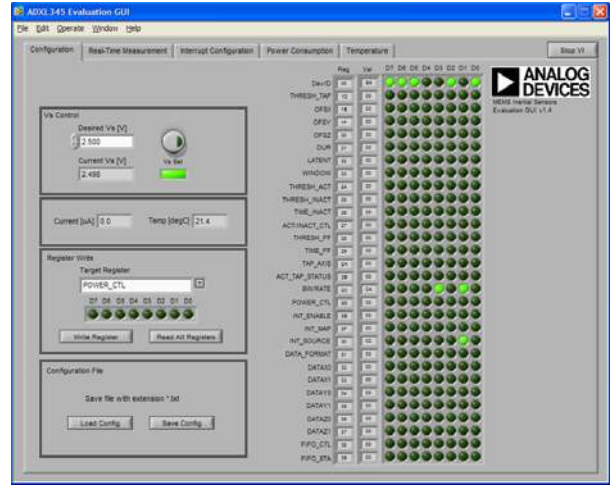


Figure 11. ISEB Connected to PC

Clicking the round button above **Vs Set** causes the supply voltage,  $V_s$ , of the ADXL345 to be updated based on the value in the **Desired Vs [V]** box. The **Current [µA]** and **Temp [degC]** boxes are also updated whenever the **Vs Set** button is clicked.

Read the contents of the ADXL345 registers by clicking the **Read All Registers** button in the **Register Write** box. This action updates all register values and indicators on the right side of the screen. Figure 11 depicts a sensor that is powered on with a **DevID** of 0xE5, a **BW/RATE** value of 0x0A, and an **INT\_SOURCE** value of 0x02. All other registers remain in their default state of 0x00.

To write a value to a register, select the register from the **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 Register** button to send the value to the ADXL345. Note that the D7 through D0 indicators under **Target Register** are not updated based on the value stored in that register.

To save a configuration, click the **Save Config** button in the **Configuration File** box (see Figure 11). Save the file with a .txt extension. After a configuration is saved, you can load the configuration back into the device by clicking the **Load Config** button and selecting the configuration file.

## REAL-TIME MEASUREMENT TAB

The **Real-Time Measurement** tab configures the inertial sensor evaluation system and the ADXL345 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 bandwidth, range, and offset (see Figure 12).

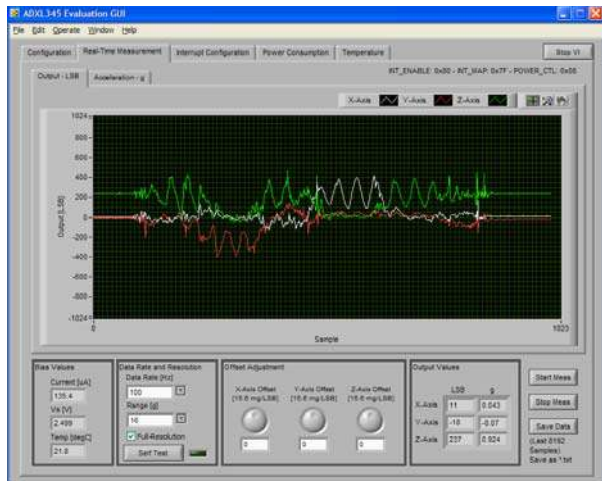


Figure 12. Real-Time Measurement Tab

Within the **Real-Time Measurement** tab, additional tabs exist for displaying the output in terms of least significant bits (LSBs) or acceleration in  $g$ 's. In the **Output – LSB** tab, the output range can be adjusted by using the graph tools in the upper right corner or by selecting the x-axis (labeled **Sample**) or y-axis (labeled **Output [LSB]**) limits and typing a new value. For example, selecting 1024 on the y-axis and typing 2048 adjusts the scale to show +2048 LSBs to –1024 LSBs.

The configuration section is at the bottom of the **Real-Time Measurement** tab. In the **Data Rate and Resolution** box, the output data rate and  $g$  range can be adjusted. Selecting the **Full-Resolution** checkbox places the part into full-resolution mode where the scale factor is fixed. Deselecting this checkbox places the part into fixed 10-bit mode. For more information about the operation of the part, refer to the ADXL345 data sheet.

The **Self Test** button toggles the self-test bit of the ADXL345. When self-test is activated, the sensor beam is deflected. The electronics detect this by means of a shift in all three axes. When self-test is enabled, the indicator next to the **Self Test** button is lit. Clicking the **Self Test** button when self-test is enabled turns the self-test feature off and causes the **Self Test** indicator to dim. Self-test is enabled as long as the indicator is lit.

The ADXL345 provides three offset registers that are used for calibration and offset adjustment. On the **Real-Time Measurement** tab, these registers are easily accessible for programming offset values. This can be done in the **Offset Adjustment** box by typing a value into the text box below the corresponding axis knob or by clicking and holding the knob and rotating it on the screen with the mouse cursor. The value entered is directly written into the offset registers.

After configuration, you can begin real-time measurement by clicking the **Start Meas** button. 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.

Up to the last 8192 samples (x-, y-, and z-axis) of accelerometer output data can be saved to a .txt file. Each file created contains a header with the date, bias values, and accelerometer data, in LSBs, aligned in tab-delimited columns. To save the data, you must enable the **Save Data** button. Click this button and type in or select a file name with a .txt extension.

Each time a measurement is performed, the new data is appended to the old data. This means that saving data also saves old data, if new data is less than 8192 samples, unless the old data is first cleared. The data saved to a file is the LSB data; therefore, the **Output – LSB** window must be cleared so that old data is not saved. To clear the **Output – LSB** window, right-click the x-axis (labeled **Sample**) in the space between **Sample** and the window and select the **Clear Chart** option.

### INTERRUPT CONFIGURATION TAB

The **Interrupt Configuration** tab is used to demonstrate the built-in functions of the ADXL345. By selecting the functions to enable and configuring the appropriate parameters, the benefits and uses of the interrupts can be examined. This tab is updated whenever an interrupt occurs. This means that some interrupts, such as inactivity, if enabled alone, will not appear to be updated.

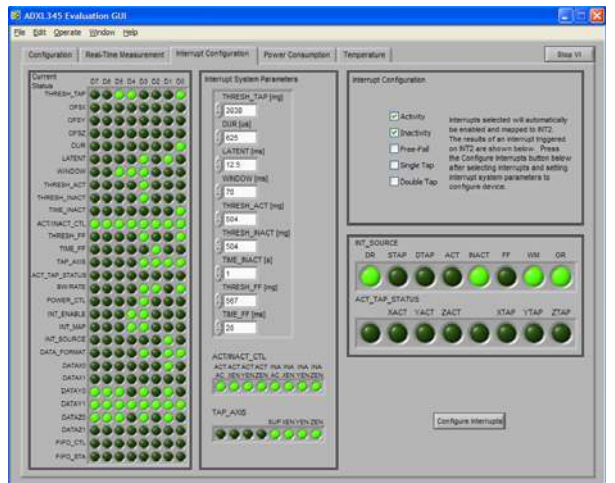


Figure 13. Interrupt Configuration Tab

The **Current Status** indicators are updated when the panel is first activated and when the **Configure Interrupts** button is clicked. They show the register values at the time of the read.

The **Interrupt System Parameters** box is used to set the built-in interrupt parameters. Here, the thresholds for tap or activity events can be set, as well as the many timer values for the interrupt parameters. The units of each are shown after the register parameter name, and entered values are automatically rounded to the nearest valid value.

The indicators for **ACT\_INACT\_CTL** and **TAP\_AXIS** are used to select the axes to include in activity, inactivity, and tap events. For more details, refer to the ADXL345 data sheet. Clicking an indicator causes it to toggle values. A lit indicator causes a value of 1 to be written to that bit, and an unlit indicator causes a value of 0 to be written to that bit.

In the **Interrupt Configuration** box, you can select the interrupts to enable. For purposes of the GUI, all enabled interrupts are mapped to the INT2 pin. Selecting the checkbox next to the appropriate interrupt enables it.

Note that no registers or parameters are updated after setting any individual box or indicator. To configure the interrupts based on new values entered in this box, you must click the **Configure Interrupts** button in the bottom right corner. Clicking this button updates the **Current Status** indicators and configures the interrupts as set.

The **INT\_SOURCE** and **ACT\_TAP\_STATUS** indicators are updated when an interrupt occurs. The data ready (**DR**), watermark (**WM**), and overrun (**OR**) bits are always set because this tab does not service data-related interrupts. In the configuration shown in Figure 13, the accelerometer has detected inactivity. If the accelerometer were moved with enough force to exceed the 504 mg activity threshold, the **INACT** indicator would dim and the **ACT** indicator would light up. If the accelerometer were put down and undisturbed for the 1 sec inactivity timer, the **ACT** indicator would dim and the **INACT** indicator would again light up.



## POWER CONSUMPTION TAB

The **Power Consumption** tab shows the advantages of using the inactivity and activity functions to modulate system power and obtain overall power savings (see Figure 14).

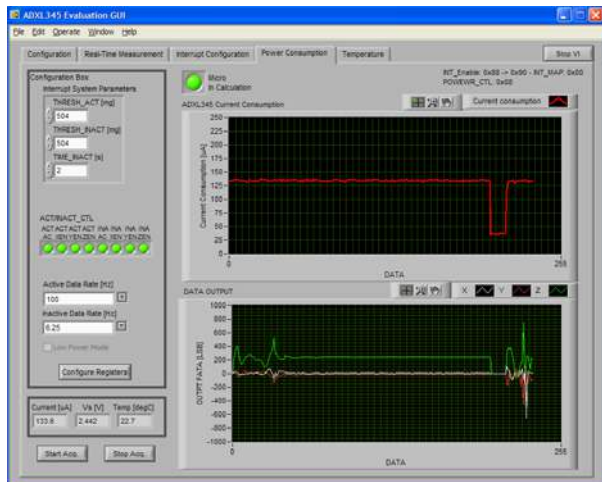


Figure 14. Power Consumption Tab

When inactivity is detected, caused by acceleration below the amount set in the **THRESH\_INACT [mg]** box for the amount of time set in the **TIME\_INACT [s]** box, the accelerometer is placed into a lower data rate as set in the **Inactive Data Rate [Hz]** menu. Because the power of the ADXL345 is modulated with data rate, an immediate power savings is achieved. When activity is detected (an acceleration above that set in **THRESH\_ACT [mg]** box), the part is placed back into a higher data rate as specified in the **Active Data Rate [Hz]** menu.

Additionally, the **Micro In Calculation** indicator lights up, signifying that a controller or microprocessor is actively pulling data from the part or processing it. In addition to power savings from the ADXL345, more power can be saved by powering down the microprocessor during periods of inactivity and using the ADXL345 activity interrupt to wake the microprocessor up during periods of activity.

The **ACT/INACT\_CTL** indicators can be used to enable different axes in the activity or inactivity events. After updating the participating axes, thresholds, timers, or data rates, click the **Configure Registers** button. The registers are not updated until the button is clicked. Additionally, the button updates the registers only when data acquisition is active. If the button is clicked when no acquisition is occurring, the button remains inactive until it is clicked again or until acquisition is started.

To begin data acquisition, click the **Start Acq.** button in the bottom left corner of the screen. To end data acquisition, click the **Stop Acq.** button in the bottom left corner of the screen.

## TEMPERATURE TAB

The **Temperature** tab is used to examine the performance of the ADXL345 over temperature. By plotting the acceleration vs. temperature while the ADXL345 is not experiencing dynamic acceleration, the offset temperature coefficient can be determined by taking the slope of the best-fit line to the acceleration vs. temperature data. The inertial sensor evaluation system assists in the accuracy of this measurement by putting the accelerometer on a separate satellite. Only the satellite has to be placed in an environmental chamber, which eliminates inaccuracies due to the temperature effects of voltage sources, converters, and other biasing circuits.

The **Temperature** tab, shown in Figure 15, allows a maximum number of points to be set and at what rate data is acquired. The testing can be stopped before reaching the maximum number of points. The data rate for the accelerometer can also be set to ensure that the testing is performed under conditions most like those that the part would be configured for in a system.

After selecting the values in the **Sample Points**, **Time Interval [s]**, and **Data Rate [Hz]** boxes, data acquisition begins by clicking the **Start Meas** button. When testing is in progress, the **Meas. In Progress** indicator lights up. To end the test before the maximum number of points, click the **Stop Meas** button.

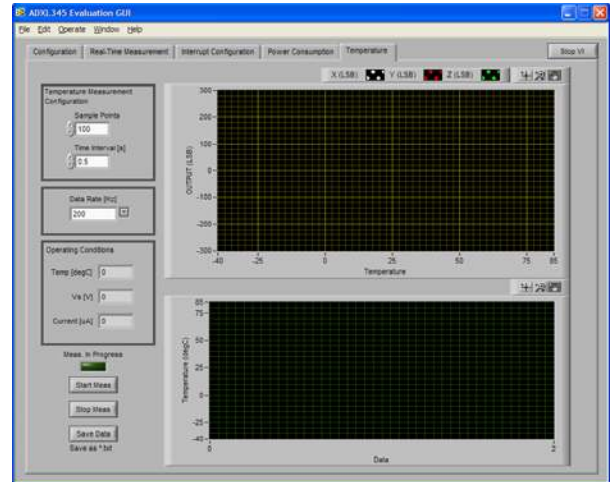


Figure 15. Temperature Tab

The data in the top graph in Figure 15 is used for determining the offset temperature coefficient. The bottom graph displays the temperature over time. To save data, a measurement cannot be in progress. When the measurement ends or is stopped, click the **Save Data** button to save the data to a .txt file.

# HEADER PINOUT

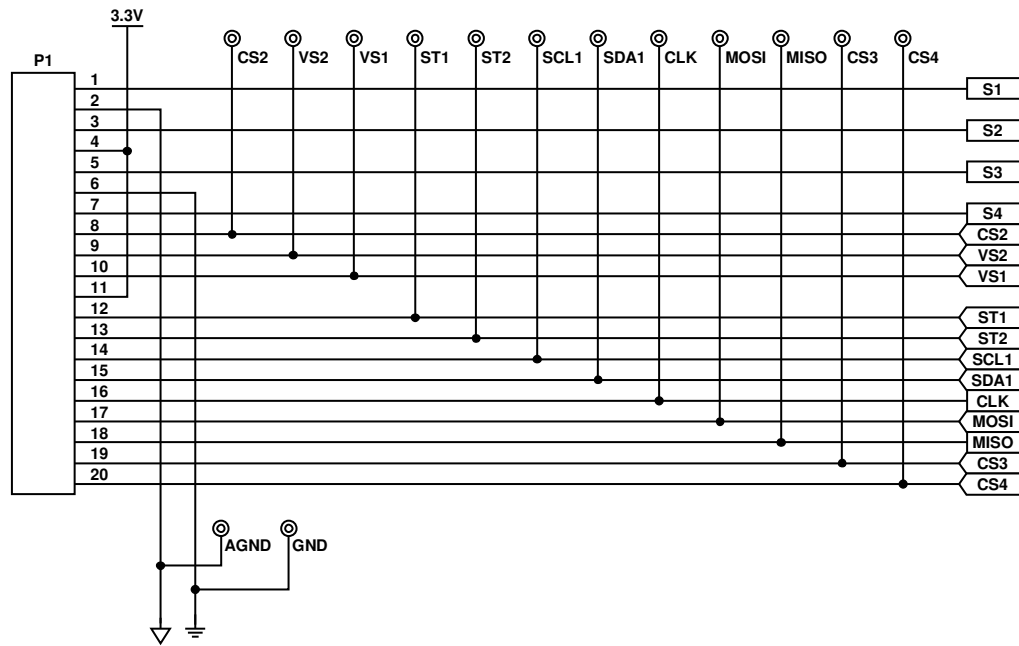


Figure 16. ISEB 20-Pin Header Pinout

08115-013

## 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.

## NOTES

Evaluation boards are only intended for device evaluation and not for production purposes. Evaluation boards are supplied "as is" and without warranties of any kind, express, implied, or statutory including, but not limited to, any implied warranty of merchantability or fitness for a particular purpose. No license is granted by implication or otherwise under any patents or other intellectual property by application or use of evaluation boards. Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties that may result from its use. Analog Devices reserves the right to change devices or specifications at any time without notice. Trademarks and registered trademarks are the property of their respective owners. Evaluation boards are not authorized to be used in life support devices or systems.