

Using the **EVAL-ADXRS290Z-M** Inertial Sensor Evaluation System for the **ADXRS290**

FEATURES

Flexible inertial sensor evaluation platform

Single main board operates with interchangeable satellite boards

Separates device under test (DUT) from the larger main

board 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

DOCUMENTS NEEDED

[ADXRS290 data sheet](#)

EQUIPMENT NEEDED

Evaluation kit contents

Main (mother) board and satellite board

A USB A to mini-B cable

An 18-inch, 20-pin ribbon cable

PC running Windows®

USB 2.0 port

Required software

[ISEB USB Driver](#)

[ISEB Run-Time Engine](#)

[ADXRS290 Evaluation GUI Installer](#)

[Design and integration files](#)

[Schematics and layout files](#)

GENERAL DESCRIPTION

The *i*MEMS® **ADXRS290** inertial sensor evaluation system is an easy-to-use evaluation tool targeting bench or desktop characterization of Analog Devices, Inc., inertial sensor products. The **EVAL-ADXRS290Z-M** system contains the inertial sensor evaluation board (ISEB) and the **EVAL-ADXRS290Z-S** satellite board. In addition, a USB A to mini-B cable is included to connect the ISEB to a PC, and an 18-inch, 20-pin ribbon cable is included to connect the ISEB to the satellite board. The USB connection provides both communications and power to the board. The ribbon cable allows users to easily manipulate the satellite board for testing or to be separately placed into an environmental chamber for temperature or humidity testing.

Separate the boards to mitigate corruption of data due to the temperature and humidity effects of other components.

TYPICAL SETUP FOR THE INERTIAL SENSOR EVALUATION SYSTEM

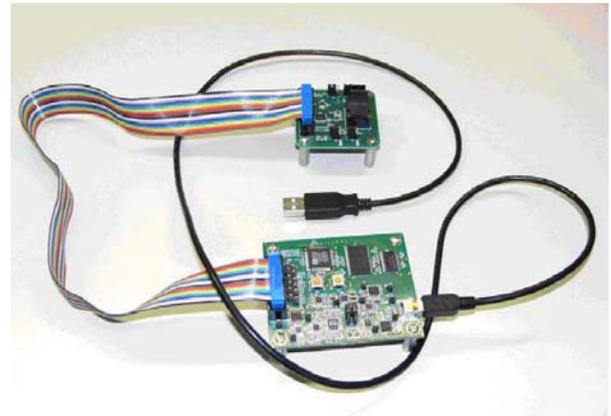


Figure 1.

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The ISEB is a universal main board and is used with various satellite boards of Analog Devices inertial sensors, including accelerometers and 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. Different shunt resistors are used to detect power consumption because the power consumption of the gyroscope is relatively high compared to that of the accelerometers. The differences between the **ADXRS290Z-M** and other -M devices, such as **ADXL345Z-M** or **ADXL362Z-M**, are only in the circuit used to detect power consumption.

Full details about the parts are available in the **ADXRS290** data sheet, which should be consulted when using the **EVAL-ADXRS290Z-M**.

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REVISION HISTORY

1/15—Revision 0: Initial Version

GETTING STARTED

This section provides quick start procedures for using the [EVAL-ADXRS290Z-M](#) board and describes both the default and optional settings. Follow these steps to set up and run the [ADXRS290](#) evaluation system:

1. Install the USB drivers for the ISEB.
2. Connect the ISEB hardware to the PC.
3. Install the latest ISEB firmware revision onto the ISEB hardware from the [FTP](#) site. This step is unnecessary for most cases because the default firmware matches the default GUI. If you have ever reprogrammed the microcontroller unit (MCU) for other applications, or the firmware or GUI is updated by Analog Devices, you need to download the corresponding firmware for evaluating the [ADXRS290](#). The firmware and GUI installer on the [FTP](#) site must always match each other. When installing the firmware, ensure that the satellite board is disconnected from the main board.
4. Install the run time engine and the [ADXRS290](#) evaluation GUI.
5. Configure the ISEB hardware.
6. Launch the [ADXRS290](#) software evaluation GUI and test the devices.

SOFTWARE INSTALLATION PROCEDURES

Install USB Drivers

The USB driver supports Windows 7 and its previous operating systems. To install the USB drivers, follow these steps:

1. Execute the `ADI_ISEB_USB_Drivers.exe` file located in ftp://ftp.analog.com/pub/iMEMS_Sensor_Eval/ISEB_USB_Driver/.
2. Follow the on-screen instructions to install the drivers.
3. Click **Continue Anyway** when prompted that the drivers are not tested.

After the previous steps are complete, connect the ISEB to the computer via the included USB A to mini-B cable. If the previously installed drivers are not automatically associated with the device, you may need to select the drivers manually, as follows:

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)**, and then click **Next** (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 click **Next**.

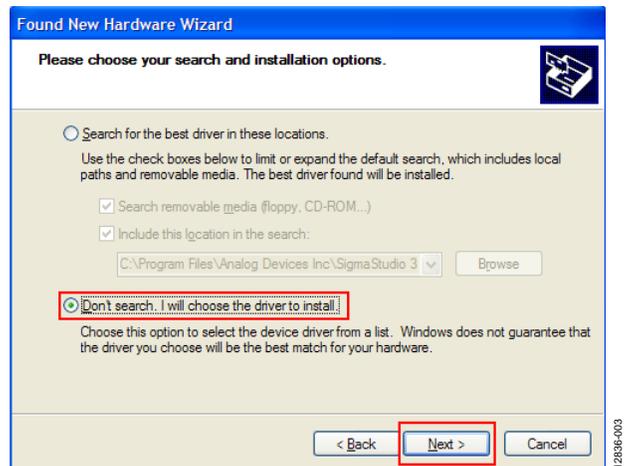


Figure 3. Selection of the Driver to Install

4. Select **ADI Inertial Sensor Evaluation System** from the model list (see Figure 4), and click **Next** to complete the process.

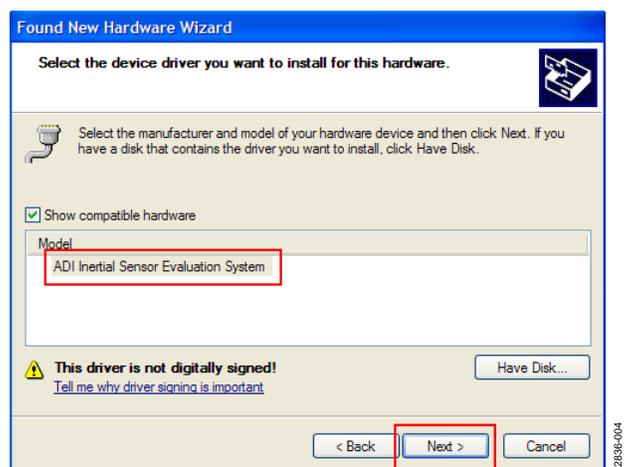


Figure 4. Selection of the ADI Inertial Sensor Evaluation System Drivers

The ISEB is detected automatically in the **Device Manager** as the **ADI Inertial Sensor Evaluation System** 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 **ADXRS290** evaluation GUI, requires that you know the communications port that is assigned to the ISEB. With the ISEB connected 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. Click the **Hardware** tab of the **System Properties** window, as shown in Figure 5.

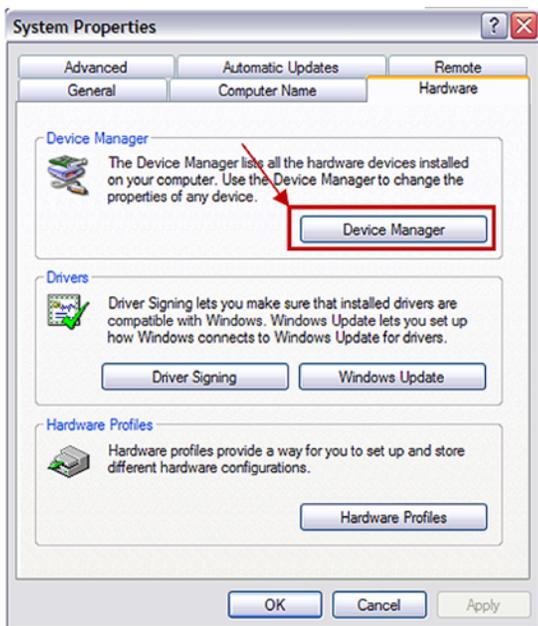


Figure 5. **System Properties**

3. Select **Device Manager** and expand the **Ports (COM & LPT)** menu item as shown in Figure 6. **ADI Inertial Sensor Evaluation System (COM4)** is listed with an assigned COM port number in parenthesis (see Figure 6).

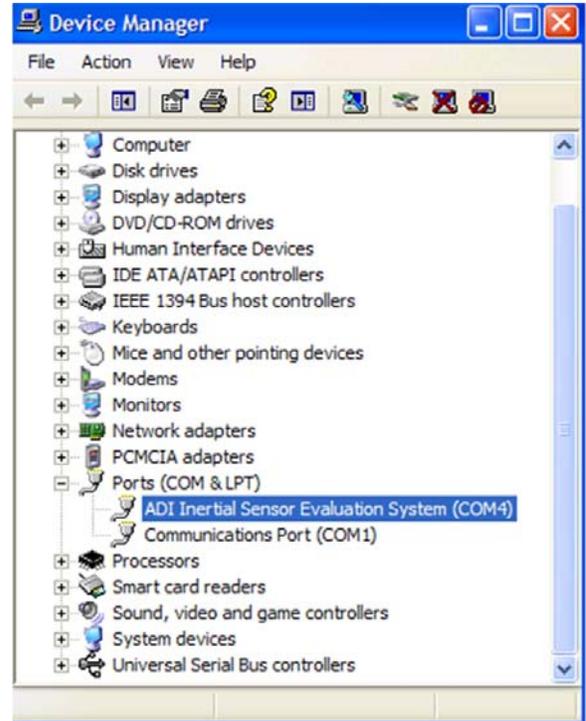


Figure 6. **Device Manager** Showing the COM Port Number

4. Note the COM port number for future use.

Installing the Latest ISEB Firmware

The latest ISEB firmware is found at ftp://ftp.analog.com/pub/iMEMS_Sensor_Eval/. To use the ISEB evaluation hardware, flash the firmware onto the ISEB microcontroller. The **FTP** site contains the firmware itself and the utility that allows you to flash a new version of the firmware onto the ISEB microcontroller.

To flash the firmware onto the ISEB microcontroller, follow these steps:

1. Ensure that the ISEB is disconnected from the satellite board and connected to and detected by the PC. The COM port on which the device is recognized must also be obtained, as mentioned in the COM Port Verification section.
2. Run the **ARMWSD.exe** program (it can be downloaded from any **EVAL-ADXL3xxZ-M.zip**, **EVAL-ADXL3xxZ-MLP.zip**, or **EVAL-ADXRS290Z-M.zip** files at ftp://ftp.analog.com/pub/iMEMS_Sensor_Eval/). The **ARMWSD** dialog box displays information about the downloader, as shown in Figure 7.

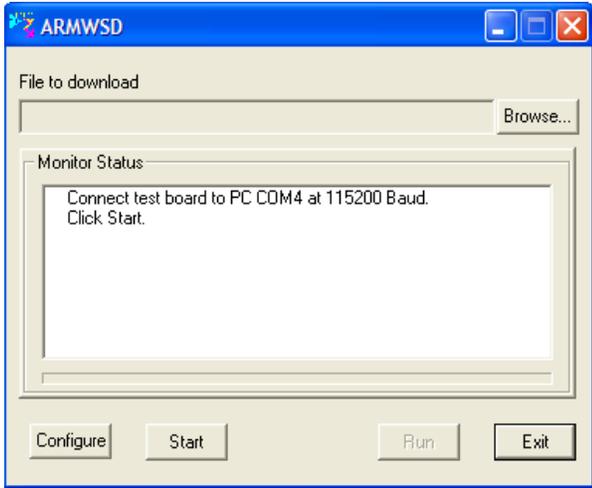


Figure 7. ISEB ARMWSD Firmware Downloader

3. Click **Browse...** and select the `ADI_ISEB_FW_XRS290.hex` file.
4. Click **Configure** to display the box shown in Figure 8.

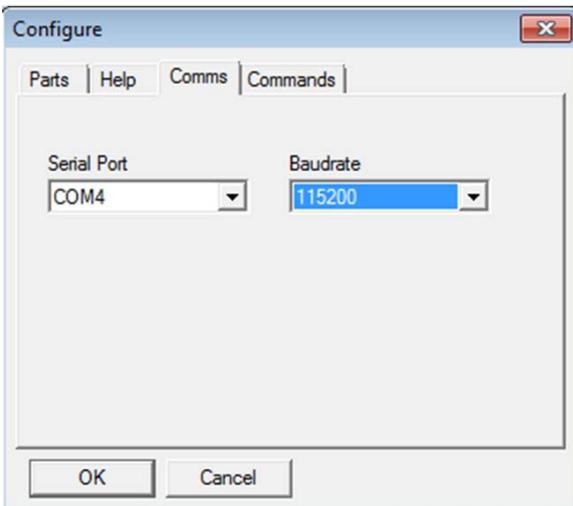


Figure 8. Select the Correct COM Port for the Downloader

The downloader file is configured for the [ADuC7026](#) microcontroller on the ISEB, which can be selected in the **Parts** tab. The other option you may need to change is the COM port. You can select the correct port from the **Serial Port** menu found in the **Comms** tab (see Figure 8). If you cannot download the hexadecimal file correctly, lower the **Baudrate** and try again. Select **Program** and **Verify** at the same time in the **Commands** tab, as shown in Figure 9.

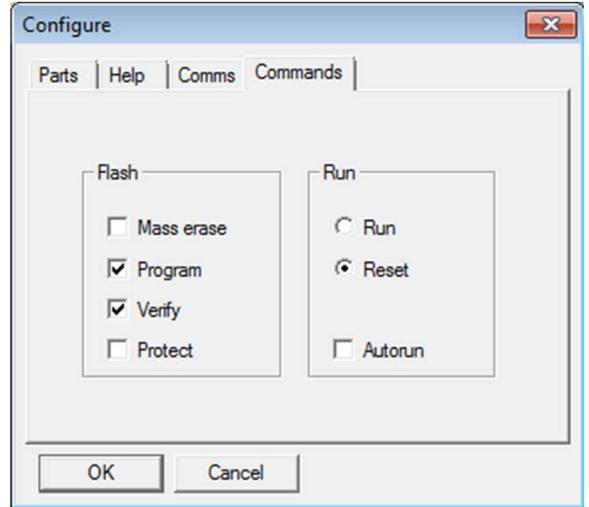


Figure 9. Configuration for the Downloader

When the COM port is selected, click OK to accept the changes and go back to the **ARMWSD** box (shown in Figure 7).

When the ISEB is connected to the PC, the correct firmware is selected automatically, and the downloader is fully configured, but you must follow these steps to flash the firmware:

1. Click **Start** in the **ARMWSD** box (see Figure 7) to initiate the flashing process, and press the two buttons (shown in Figure 10) on the ISEB in the following order to flash the firmware:
 - a. Press and hold down **SW1** (Serial Download).
 - b. With **SW1** held down, press and release **SW2** (Reset).
 - c. Release **SW1**.

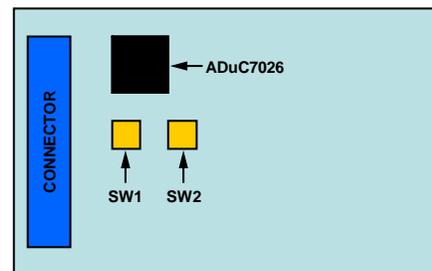


Figure 10. ISEB Switch Locations for Flashing the Microcontroller

The download begins and the downloader automatically verifies it.

2. If the downloading process fails, which is shown in the **Monitor Status** box (see Figure 7), click **Start** to attempt the download again and then press the appropriate switch combination. It may take a few attempts to reprogram the board successfully.
3. After the download has completed, 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 you to obtain a new evaluation GUI. If the firmware found on the [FTP](#) site is used to flash the ISEB microcontroller, 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 the [FTP](#) site.

Installing the ADXRS290 Software Evaluation GUI

The software GUI installation does not include the National Instruments drivers and the run-time engines necessary for proper operation. If there are no such run-time engines in the computer, install them before installing the **ADXRS290** software evaluation GUI. The run-time engine installer is found at ftp://ftp.analog.com/pub/iMEMS_Sensor_Eval/ISEB_Run%20Time%20Engine/.

To run the software GUI installation routine, double-click the **setup.exe** file located in the **/EVAL-ADXRS290-M GUI Installer/** folder. Complete the following steps to install the evaluation software:

1. Choose the destination directory. The installer auto populates the names of the directories in which to store the software GUI and required National Instruments products (see Figure 11). You can change these directories; however, most installations can proceed with the default values.

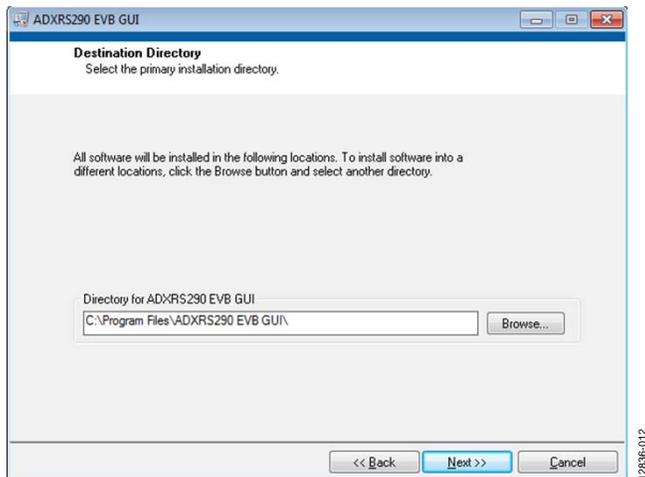


Figure 11. Destination Directory Selection

2. Click **Next**. The National Instruments Software License Agreement is displayed.
3. Read the license agreement, accept it, and click **Next**. The installer lists the required components to install on your PC (see Figure 12).

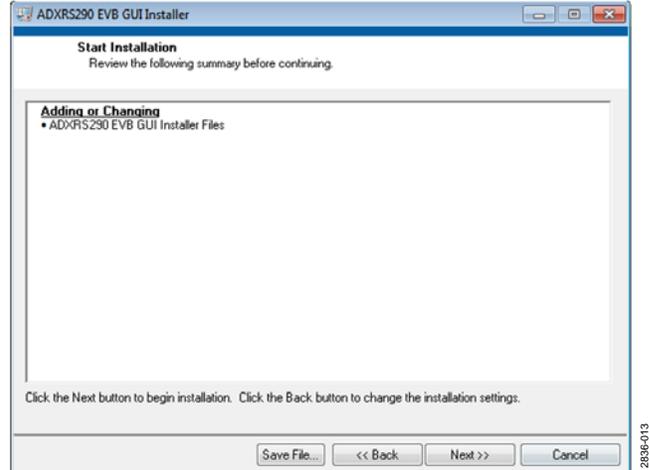


Figure 12. Start Installation (Listing Varies Based on PC Requirements)

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. Figure 13 shows the dialog box that is displayed after the installation is complete.

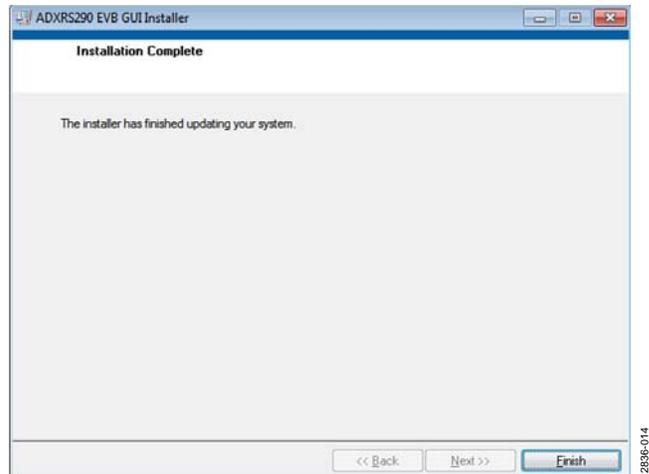


Figure 13. Installation Complete

5. Click **Finish** to complete the installation.

EVALUATION BOARD HARDWARE SETUP PROCEDURES

To configure the hardware, follow these steps:

1. Connect the ISEB to the [ADXRS290](#) satellite board using the 18-inch, 20-pin ribbon cable. This cable is keyed to prevent inserting it backwards and causing damage to the system.
2. Connect the ISEB to the USB A to mini-B cable.
3. 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 [ADXRS290](#) evaluation system is now set up and ready to use.

EVALUATION BOARD HARDWARE

The [EVAL-ADXRS290Z-M](#) provides all of the support circuitry required to operate the [ADXRS290](#) in its various modes of configuration. Figure 1 shows typical bench characterization setup used to evaluate the [EVAL-ADXRS290Z-M](#).

First, the [EVAL-ADXRS290Z-M](#) was created to study and evaluate the [ADXRS290](#). You can view and save the real-time output of the [ADXRS290](#) on a PC for algorithm developing, check the noise performance of the [ADXRS290](#), check the power consumption of the [ADXRS290](#) under different work modes, view and save the [ADXRS290](#) temperature drift data, change the power supplies, and check the [ADXRS290](#) performance under a different power supply.

Second, you can use the [EVAL-ADXRS290Z-M](#) for secondary development and to realize different reference designs based on it.

POWER SUPPLIES

Many of the [EVAL-ADXRS290Z-M](#) functions are supported by the USB directly, with no other power supply needed to run the board. There is an on-board dc-to-dc, low dropout (LDO) regulator, and voltage references to adjust the supply for each part on the evaluation board.

JUMPER SETTINGS

Set the jumper settings and 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 to connect the main board to the satellite board.
JP1	Jumper used to select different functions of the SYNC/ASEL pin (Pin 11 of ADXRS290). Connect to GND for default.
JP2	Jumper used to select different functions of the AST pin (Pin 3 of ADXRS290). Connect to GND for default.
JP3	Jumper used to select different functions of the SENS pin (Pin 4 of ADXRS290). Connect to GND for default.

EVALUATION BOARD CIRCUITRY

Gyroscope

The [ADXRS290](#) is a high performance pitch and roll (dual-axis in-plane) angular rate sensor (gyroscope) designed for use in stabilization applications. The [ADXRS290](#) provides an output full-scale range of $\pm 100^\circ/\text{sec}$ with a sensitivity of 200 LSB/ $^\circ/\text{sec}$. Its resonating disk sensor structure enables angular rate measurement about the axes normal to the sides of the package around an in-plane axis. Angular rate data is formatted as 16-bit twos complement and is accessible through a digital serial peripheral interface (SPI). The [ADXRS290](#) exhibits a low noise floor of 0.004 $^\circ/\text{sec}/\sqrt{\text{Hz}}$, and features programmable high-pass and low-pass filters.

Microcontroller

The microcontroller on the [EVAL-ADXRS290Z-M](#) is the [ADuC7026](#). It is a fully integrated, 1 MSPS, 12-bit data acquisition system incorporating high performance, 12-channel analog-to-digital converters (ADCs), a 32-bit MCU, and Flash/EE memory on a single chip. There are also 4-channel 12-bit voltage output digital-to-analog converters (DACs) on the [ADuC7026](#) that control the power supply of the [ADXRS290](#). The development tools, such as the Windows serial downloader, the IAR embedded workbench and ROM monitor, and the Keil uVision3, are available at www.analog.com/aduc7xxx_development_tools.

HOW TO USE THE SOFTWARE FOR TESTING

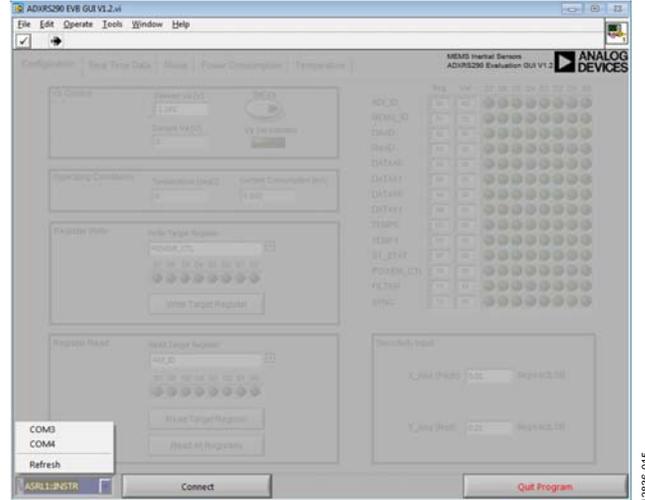


Figure 14. ADXRS290 Evaluation GUI Startup Page

GETTING STARTED

Before running the software evaluation GUI, press the SW2 button to reset the ISEB as is described in the Installing the Latest ISEB Firmware section. This reset removes any errors 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** and to your desktop. To launch the evaluation GUI, click **ADXRS290 EVB GUI**. A window similar to the one shown in Figure 14 displays.

At this point, the functionality of the GUI completely deactivates. Before testing any devices, associate the software GUI with the previously installed hardware through the COM port. See the **PC Device Manager** area under the **Ports (COM & LPT)** submenu to determine which COM port is assigned to the Analog Devices inertial sensor evaluation system (see Figure 6).

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 use. The following sections describe the purpose of each tab of the GUI. You can exit the GUI at any time; click **Quit Program**, which is located in the lower right corner of the startup window.

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 no longer function properly. Additionally, if for any reason the ISEB and the software evaluation GUI do not appear to be properly communicating, perform the following reset routine:

1. Click **Quit Program** or select **File > Exit** to close the software GUI.
2. When the software GUI is closed, press the reset button (SW2) to reset the ISEB.
3. Restart the software GUI.

CONFIGURATION TAB

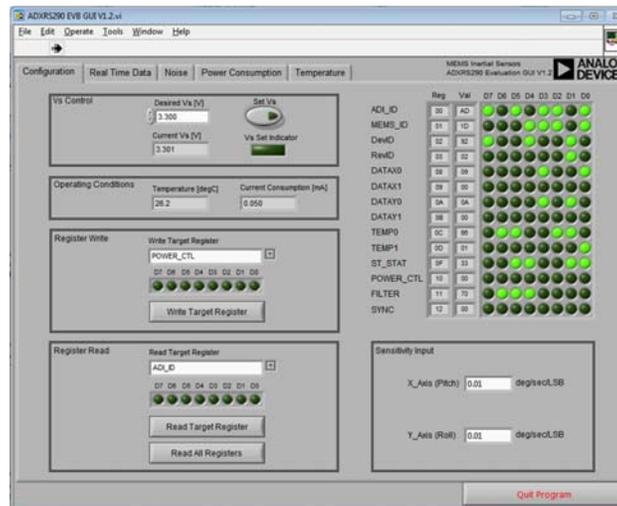


Figure 15. Configuration Tab

The **Configuration** tab allows you to set the operating conditions for the **ADXRS290**, as well as to read to/write from the contents of the memory map. Figure 15 shows the **Configuration** tab after the COM port verification step has been completed. The following actions are available in the **Configuration** tab: **Vs Control**, **Operating Conditions**, **Register Write**, **Register Read**, and **Sensitivity Input**.

The **Vs Control** section sets the supply voltage of the **ADXRS290**. The default value is 3.3 V. When you click the **Set Vs** button, the ISEB applies the desired supply voltage and then reads back the **ADXRS290** operating voltage, operating temperature, and current consumption. These values are then displayed in the **Operation Conditions** box.

To write a value to a register, select the register from the **Write Target Register** menu within the **Register Write** box and select 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 **ADXRS290**. Note that the D7 through D0 indicators under the **Register Write** section 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 the **Register Read** box refresh to reflect the target register content.

To perform a read back of the entire **ADXRS290** memory map, click the **Read All Registers** button. This action updates all register values and indicators on the right side of the window.

REAL TIME DATA TAB

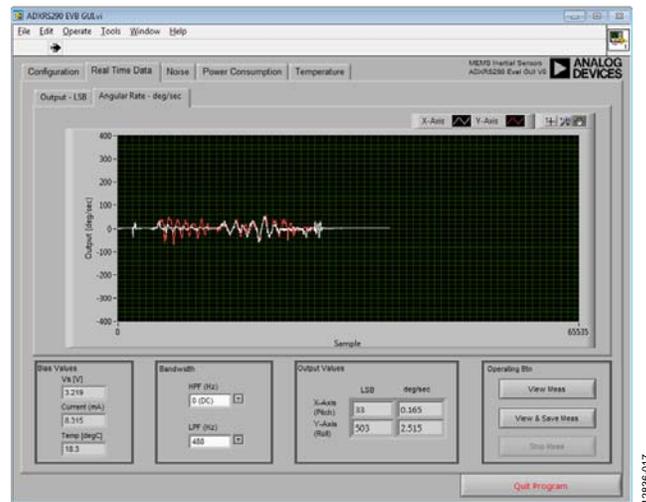


Figure 16. Real Time Data Tab

The **Real Time Data** tab configures the inertial sensor evaluation system and the **ADXRS290** for real-time angular velocity monitoring. This tab contains an oscilloscope-like interface that shows the output of the gyroscope and allows you to adjust the relevant parameters, such as high-pass filter and low-pass filter (see Figure 16).

After configuration is complete, click the **View Meas** button to begin real-time measurement. To prevent software conflicts, many of the options and tabs gray out or disappear until you click the **Stop Meas** button. The gyroscope output data then begins to flow across the screen.

The **View & Save Meas** button performs the same basic function as the **View Meas** button; however, it allows you to continuously stream the data to 11 text files, which is useful for recording the response of the device even during long term events. The first text file is named and located by you, the other 10 text files are named based on the first text file and are located in the same folder.

For example, if you name the first text file **ADXRS290Test.txt** in the pop-up dialog box and save it on your desktop, the other 10 text files, which are named **ADXRS290Test_1.txt**, **ADXRS290Test_2.txt**, ... **ADXRS290Test_10.txt**, are built automatically on your desktop. When **ADXRS290Test.txt** saves the 64k samples, the next 64k sample sets are stored in the files **ADXRS290Test_1.txt** through **ADXRS290Test_9.txt**. In the last file, **ADXRS290Test_10.txt**, the data is saved continuously even if its size is bigger than the 64k samples. If you test the sensor in short time, and the samples are smaller than 64k, the files without any data automatically delete when you click the **Stop Meas** button.

Each text file created contains a header with the date, the time, and the X and Y axes angular velocity data (in degree/second), which are aligned in tab-delimited columns.

NOISE TAB

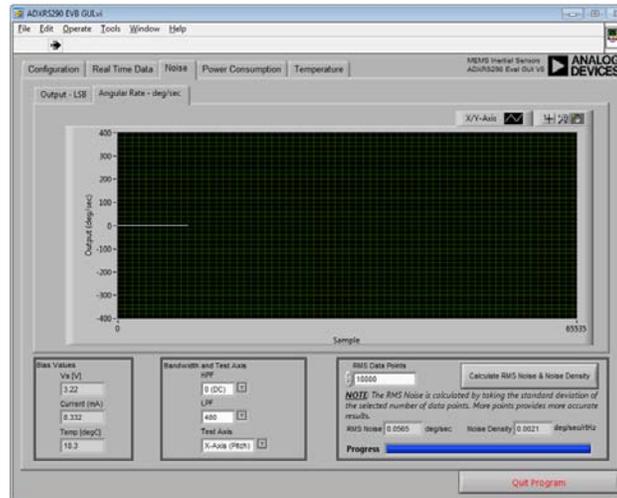


Figure 17. Noise Tab

The **Noise** tab configures the [ADXRS290](#) for real-time angular velocity monitoring and noise calculation. This tab contains an oscilloscope-like interface that shows the output of the gyroscope and allows you to adjust the relevant parameters, such high-pass filter, low-pass filter, and tested axis for real-time show and noise calculation (see Figure 17).

After configuration, click the **Calculate RMS Noise & Noise Density** button to begin noise calculation. To prevent software conflicts, many of the options and tabs are grayed out or disappear until the system finishes the noise calculation.

Ensure that the evaluation board is in a vibration free environment when you test the noise performance. Any vibration on the evaluation board may cause the fault noise result.

Calculate the **RMS Noise** by taking the standard deviation of the selected number of data points. More points provide more accurate results, and you also need to wait for a longer time to get the noise performance. The number of default points is 10,000.

POWER CONSUMPTION TAB

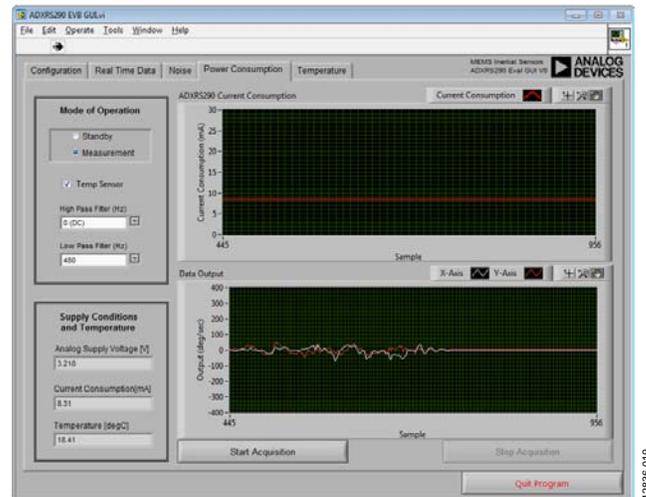


Figure 18. Power Consumption Tab

The **Power Consumption** tab contains two oscilloscope-like interfaces that show the output of the two axes of the gyroscope and power consumption of the [ADXRS290](#) at the same time (see Figure 18).

Click the **Start Acquisition** button to begin the real-time measurement of the two axes of the gyroscope and power

consumption. To prevent software conflicts, many of the option tabs are grayed out or disappear until you click the **Stop Acquisition** button. The gyroscope output data and [ADXRS290](#) power consumption data flow across the screen.

TEMPERATURE TAB

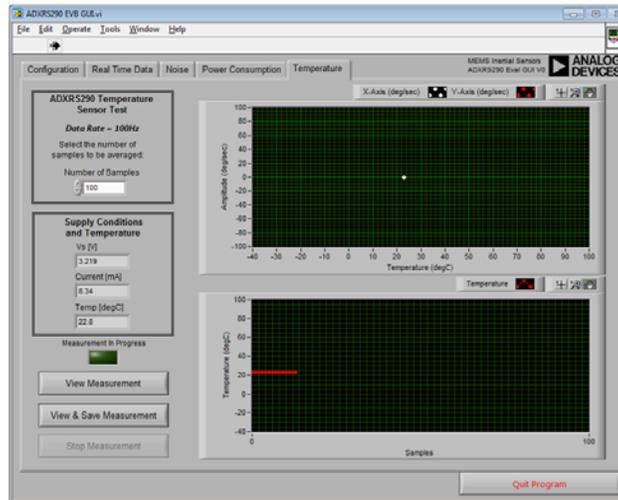


Figure 19. **Temperature Tab**

The **Temperature** tab, as shown in Figure 19, is designed to facilitate temperature testing of the [ADXRS290](#). This tab determines the device offset stability with respect to temperature. An [ADT7301](#) temperature sensor is included on the satellite board for accurate temperature measurement of the environment near the [ADXRS290](#) device.

For this tab, the sampling data rate is fixed to 100 Hz, with the effective data rate observed by the user determined by the **Number of Samples** box. The default number of samples is set to 100, resulting in an effective data rate of 1 Hz, and an effective bandwidth of 0.5 Hz. Low data rates are desirable for temperature testing because offset stability vs. temperature is a predominantly dc behavior. The operation for **View Measurement**, **View & Save Measurement**, and **Stop Measurement** is the same as described in the Real Time Data Tab section.

To avoid measurement error, use the following precautions:

- Keep the temperature sweep ramp rate low ($<2^{\circ}\text{C}/\text{minute}$) to avoid false temperature hysteresis. The physical separation of the [ADT7301](#) and the [ADXRS290](#) results in a temperature differential because each device takes longer to reach equilibrium with the temperature of the environmental chamber. Reducing the temperature ramp rate helps to minimize this effect.
- Ensure that the device does not move during the temperature sweep. Any motion induced during the temperature sweep results in erroneous data samples.

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.