EVAL-ADIS-MCBZ User Guide

FEATURES

- Plug and play rapid evaluation of the ADI MEMS sensor
- Supports the broad range of the ADI MEMS sensor family
- PC-based evaluation software with user friendly graphical interface
- Self contained data capture with battery and SD memory card
- On-board bluetooth low energy (BLE) module

GENERAL DESCRIPTION

This user guide provides an overview of using the EVAL-ADIS-MCBZ, including instructions for the motion capture board (MCB) hardware setup and software functions. The EVAL-ADIS-MCBZ supports a wide array of Analog Devices, Inc., sensor families (ADXL, ADIS, and ADXRS). It easily communicates with sensors and captures data by connecting the hardware to a PC and running the evaluation software. The graphical user interface (UI) of the software allows plotting and storing sensor data for postcapture analysis.

EVALUATION BOARD PHOTOGRAPH

The MCB is shown from the top and angle view in Figure 1 and Figure 2, respectively.

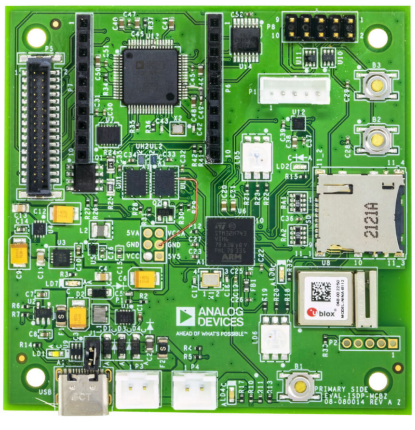

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Figure 1. MCB Photograph (Top)

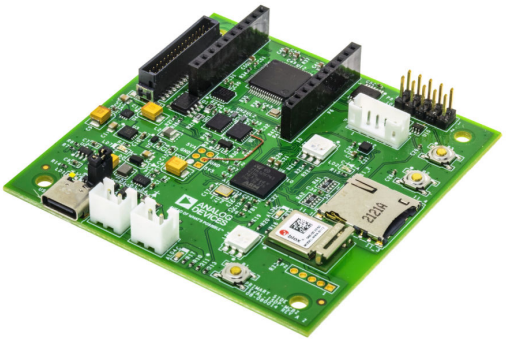

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Figure 2. MCB Photograph (Angle)

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REVISION HISTORY

7/2024—Revision 0: Initial Version

HARDWARE SETUP

The most common hardware setup includes the MCB, USB cable, and the sensor (through the evaluation board (EB) or breakout board (BB)). A battery and SD card can be added to the MCB for saving the data independently from the PC platform. Figure 3 represents the hardware and two different sensors which have different boards (EB and BB). It is important to note that only one sensor can be connected to the MCB at a time, either through the EB or BB sensor connectors.

In Figure 3, the EB and BB interface connectors are located in the upper left side of the MCB. On the MCB silkscreen, P5 identifies the BB interface connector, and P6 and P7 identify the EB interface connector. The EB connector has two 10-pin single-row connectors. For the BB connector, the M55-7003242R from HARWIN was used as a lock connector which has 32 pins with 1.5 mm pitch.

By connecting the sensor to the MCB and the USB cable to the computer, the hardware setup is ready to communicate with the software. The next sections show the software setup and installation.

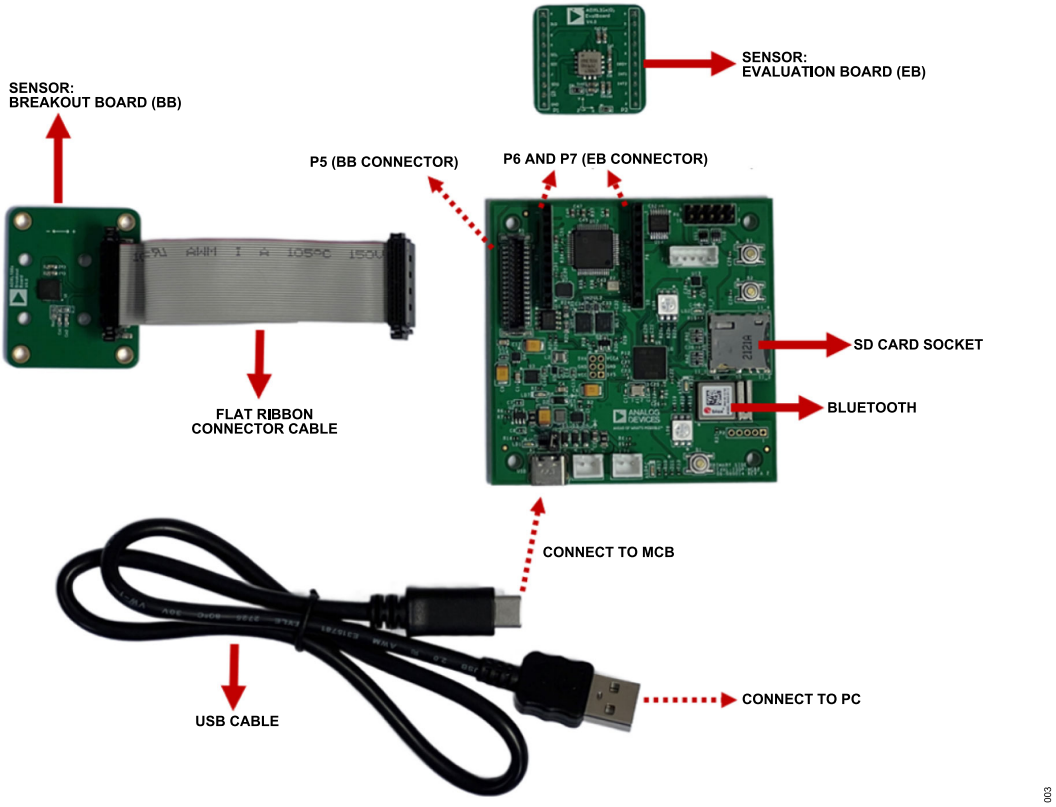

Figure 3. Hardware Setup

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The EVAL-ADIS-MCBZ evaluation software connects sensor to a variety of computing platforms and through an intuitive UI, it provides sensor configuration, data capture, and data analysis functions. See the EVAL-ADIS-MCBZ product page and click **Software** to download the software package into a dedicated folder on the computing platform. Extract the files and then double click **EVAL-ADIS-MCBZ.exe** (see Figure 4) to launch the software, which displays the UI (see Figure 5).

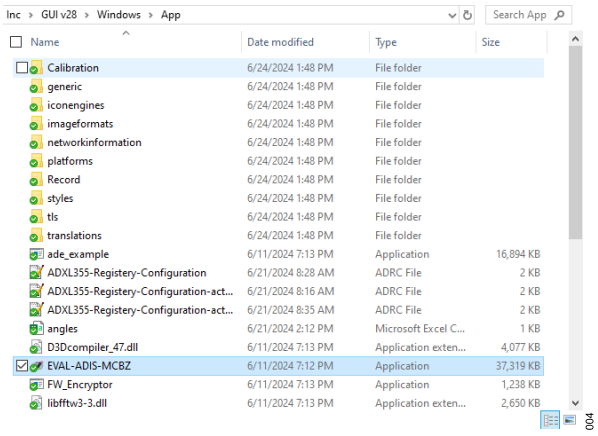

Figure 4. Software Application

UI ELEMENTS

The UI window has several icons or tabs, each offering distinct functionality. See Figure 5 for visual guidance, where each icon is labeled with a corresponding number. They are introduced as follows:

1. Scan COM ports
2. List of available COM ports
3. Connect or disconnect
4. Battery status
5. Inertial sensor sample per second (SenSPS)
6. Magnetometer sample per second
7. View rate: equal or lower than SenSPS
8. Graphs interval length
9. Changing mouse mode: zoom or move
10. Clear callouts: point information
11. Clear charts
12. Help: shortcuts description
13. About: shows supporting sensor families
14. Acceleration graphs unit selector
15. Automatic, full, or manual scale range
16. Enable or disable graphs
17. Sensor family
18. Sensor model
19. Basic configuration panel: for rapid configuration
20. Register map tab: available for digital sensor
21. Record data and interrupts in .csv files
22. SD card tab: records data, downloads recorded files, and formats SD card
23. BLE module panel
24. Current measurement
25. Magnetometer tab
26. Firmware update
27. **Real Time** tab: for data streaming
28. **Full View** tab: buffers all data and shows it in time domain
29. **Data Analysis** tab: buffers all data and shows it in frequency domain
30. **Allan variance** tab: automatically created the root Allan variance of imported time domain data
31. **3D** tab: interactive view of the sensor orientation/motion
32. **Calibration** tab
33. **Load .adr File** tab

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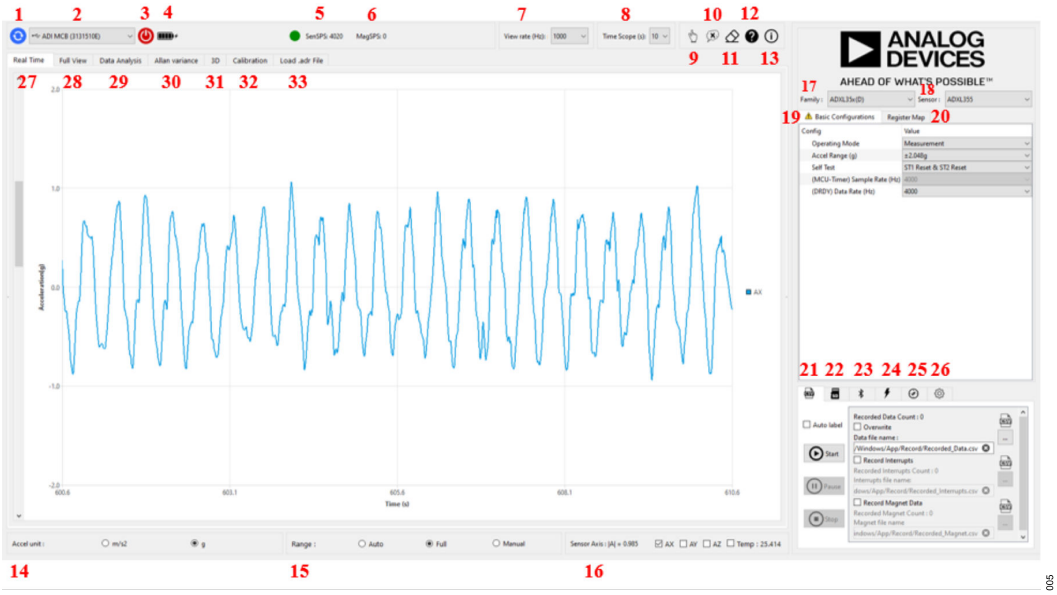

Figure 5. UI Elements

CONNECTING TO THE HARDWARE

Starting from the main screen in the UI, connect to the MCB using the following steps:

1. Click the scan button to search for the available COM ports.
2. Select the desired COM port. If the EVAL-ADIS-MCBZ is connected to the PC, the COM port list is updated and the EVAL-ADIS-MCBZ is shown as **ADI MCB**, followed by eight characters that correspond to the microcontroller serial number.
3. Click the connect button.

After connecting to the MCB, the sensor family and part number show up on the top right tab. Figure 6 shows the sensor connection and recognition icons.

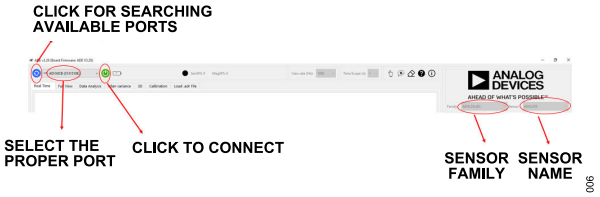

Figure 6. Hardware Detection

When the system recognizes the sensor, the **Register Map** and **Basic Configurations** tabs fill with the corresponding sensor configuration options. Both tabs are on the right side of the UI. Figure 7 shows the settings in the **Basic Configurations** and **Register Map** tabs.

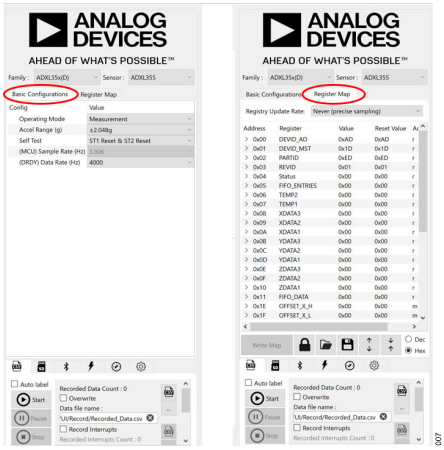

Figure 7. Basic Configurations vs. Register Map

Once initial configurations are completed, for certain sensors within the same family that lack a specified register for precise model detection, select the part number through the sensor combo box located on the top right side of the UI. Incorrect configuration of the sensor model may result in data being displayed on the graphs with incorrect scaling.

UI TABS

The UI provides an environment for visualizing and analyzing sensor data which consists of five tabs labeled **Real Time**, **Full View**, **Data Analysis**, **Allan variance**, **3D**, and **Load .adr File**. The first three ones and the **3D** tab are dedicated to online COM port data from the MCB. The next sections explain each tab and its feature in detail.

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Sensor Operational Mode

Once the sensor connects and powers up, it enters **Standby** mode by default. To start data capturing or analysis, select the desired operational mode from the **Operating Mode** dropdown list in the **Basic Configurations** tab. Figure 8 shows the different operational modes for two different sensors (the ADXL355 and the ADXL382).

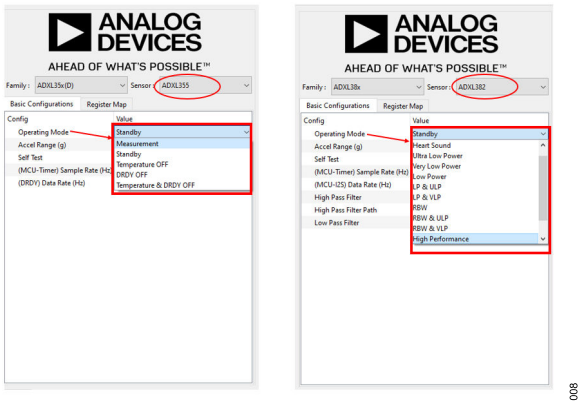

Figure 8. Operation Mode

Real Time Tab

Click the **Real Time** tab to capture and display data in the UI once the sensor is in **Measurement** mode. Click **View rate** to select the sample rate for the display, and click **Time Scope** to establish the length of the time record to display in the UI. The sample rate (**View rate** setting) may need adjustment, based on the bandwidth of the computing platform. Figure 9 shows the **View rate** and **Time Scope** tabs and their different values for ADXL355.

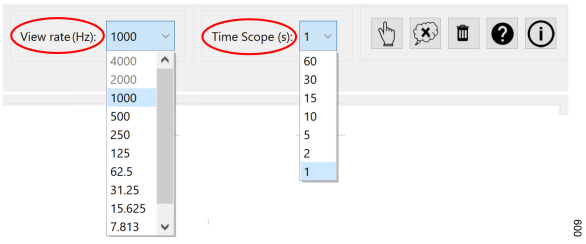

Figure 9. Real Time

Full View Tab

Use this tab to capture acceleration data (in all axes), temperature, and interrupt pin status over time. Select the buffering type according to preference. The following three buffering methods are:

- **Manual buffering**: click **Start Buffering** to begin data capture. Click **Stop and Draw Charts** to stop capturing and display the data for the specified time duration.
- **Single buffering**: define the buffering time, then click **Start Buffering** to capture data for that duration. The system stops automatically after the set time.
- **Periodic buffering**: select this option to repeat single buffering periodically.

Figure 10 shows the buffering options.

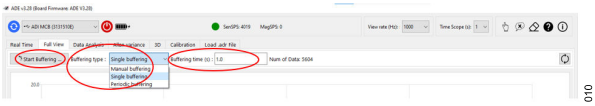

Figure 10. Full View

Figure 11 shows an example of **Single buffering** for the buffering time of 5 seconds. The acceleration in x-, y-, and z-axis and the interrupt (data ready in this case) are shown in Figure 11.

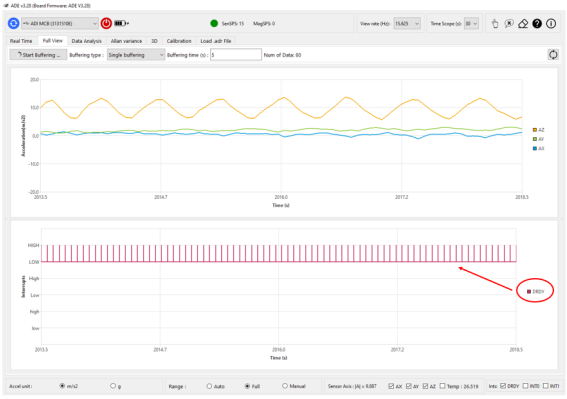

Figure 11. Interrupts

The **View rate** and **Time Scope** boxes do not apply to this tab. The buffering time is controlled using the three buffering options.

Data Analysis Tab

To explore the captured data in the frequency domain, click the **Data Analysis** tab. It uses the fast Fourier transform (FFT) algorithm for frequency analysis. Data can be buffered with the three methods discussed in the Full View Tab section. Select between **FFT** and **PSD** modes using the corresponding radio buttons on the UI. The square root of the PSD is shown in the **PSD** tab. Figure 12 shows the **Data Analysis** tab for a sample case, displaying a frequency of 200 Hz for acceleration in the z direction.

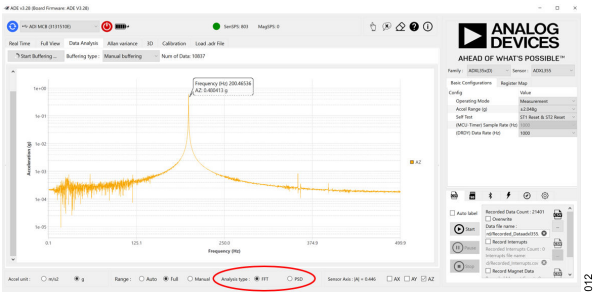

Figure 12. Data Analysis

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Allan Variance Tab

The **Allan variance** tab generates root Allan variance plots by loading prerecorded time domain data in .csv format.

Figure 13 shows an example of a root Allan variance curve obtained for the ADXL357 accelerometer. Notice that the velocity random walk (**VRW**) and bias instability (**BI**) are computed from the loaded data set as well, and displayed as an array formatted as X-axis, Y-axis, and Z-axis. Similarly, for gyroscopes, the angle random walk and BI are computed.

Figure 13. ADXL357 Root Allan Variance

3D Tab

Click the **3D** tab to display a three-dimensional cube representing the sensor position within the XYZ (Cartesian) coordinate system, showing changes over time. Real-time values for acceleration and rotation are also visible in this tab, providing immediate feedback on the sensor orientation and movement.

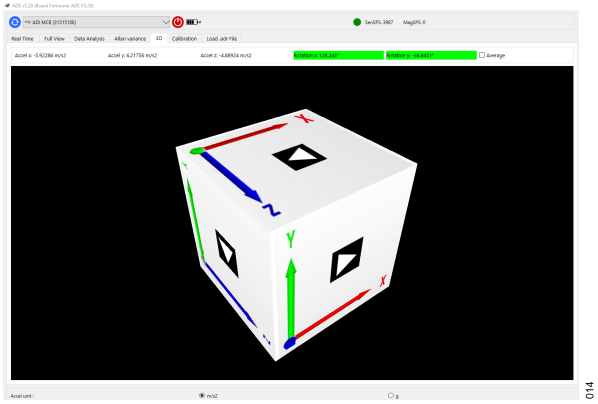

Figure 14. 3D Tab

Calibration Tab

This tab allows a quick and easy way to perform offset and sensitivity calibration for accelerometers and inertial measurement units (IMUs) by leveraging the acceleration of gravity. Follow these steps for the calibration procedure:

1. Enter the local latitude, longitude, altitude, and heading of the location where the calibration is performed. This serves to fine tune the calibration to the local gravity field.

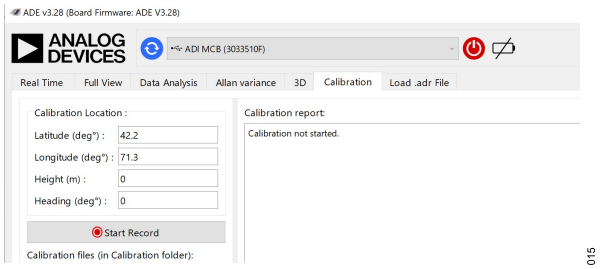

Figure 15. Entering the Local Coordinates for the Calibration Procedure

2. Click the **Start Record** button.
3. Position the EVAL-ADIS-MCBZ board in different directions so that at least a positive and negative reading on each axis is recorded. For a 3-axial accelerometer, it is recommended, at least, to position the board so that each axis reads approximately +1g and −1g. Figure 16 shows three sample directions for the +1g acceleration along three different axes. The more positions are recorded, the more accurate the calibration is. Make sure to hold each position for at least three seconds for the calibration algorithm to work properly.

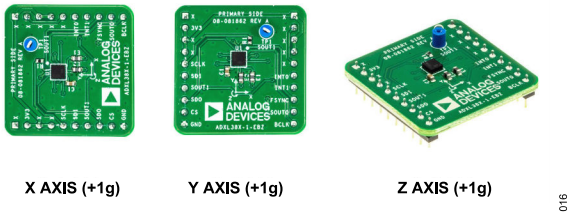

Figure 16. Sample Direction

4. Stop the recording. A .csv file with the naming convention **SensorName_CRD_year-month-day_hour-minute-second** is created, as shown in Figure 17, where the sensor connected is the ADXL359. This file contains the time domain data from start to finish of the recording.

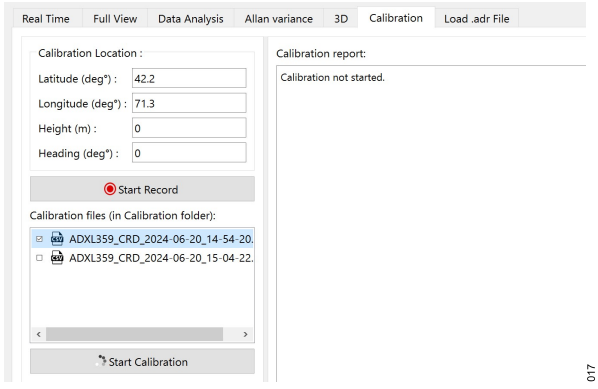

Figure 17. Calibration File Example

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5. Notice that the **Calibration files** text box can contain multiple calibration files. Select the appropriate file and click **Start Calibration**. The following two types of calibration files are created (see Figure 18):
   a. A .bin file that is used to load the calibration coefficients into the EVAL-ADIS-MCBZ board and apply all necessary compensations.
   b. A .txt file that contains a report of the calibration results. The calibration report is displayed on the right hand side of the UI, intermediately after the calibration is completed.

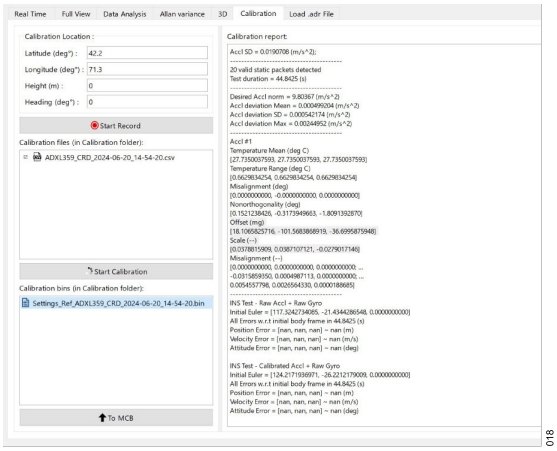

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Figure 18. Calibration Results

6. Select the desired .bin file in the **Calibration bins** text box and click the **To MCB** button to upload the calibration coefficients to the EVAL-ADIS-MCBZ board. A pop-up window with the message **Calibration file uploaded on the MCB** is displayed if the operation is successful. Also, notice that the target icon is shown solid black (see Figure 19), which indicates that the calibration coefficients are being applied on the raw data.

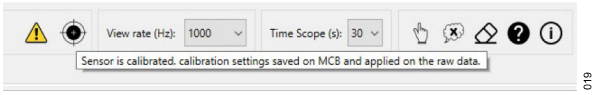

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Figure 19. Upload Calibration File

Figure 20 shows the ADXL359 output before and after the calibration is applied.

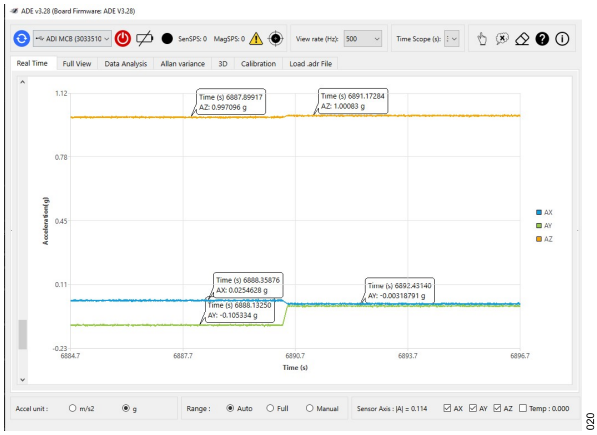

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Figure 20. Before and After Calibration Example

Load .adr File Tab

Click the **Load .adr file** icon in the **Load .adr File** tab to open a window for file selection (previous recordings in .adr format). Alternatively, drag and drop .adr files directly into the UI for automatic opening. After selecting the desired .adr file, specify the sensor model in the toolbar. The UI then draws the input chart or saves it as a .csv file directly. If the **Draw Charts** option is selected, a new tab appears with a dedicated toolbar (including units, range, and axis settings) independent of the **Full View** tab.

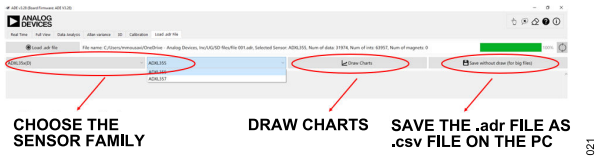

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Figure 21. Load .adr File

SHARED COMMAND

This section introduces the commands, toolbar, and tools shared across all tabs within the UI. These include graph manipulation tools, mouse functionality, and keyboard options that enhance the representation and analysis of plots. Modify parameters such as axis units, zoom level, and movement for precise control and customization of the data visualization experience.

Graph Options

In tabs displaying graphs of data, customize how data appears. Figure 22 shows a sample case at **Full View** tab for an accelerometer data (ADXL355). The first plot illustrates acceleration vs. time, with time units displayed in seconds and acceleration units configurable as either m/s^2 or g by clicking the corresponding radio button, as indicated in the bottom left of the UI (**Accel unit**). The second and third plots exhibit interrupts and temperature plotted over time.

Click the checkboxes at the bottom right of the UI to enable or disable the graphs for acceleration or interrupts data, as shown

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in Figure 22. All graphs and tools, such as radio buttons and checkboxes, adjust dynamically based on the connected sensor.

Adjust axis ranges on each plot by selecting the desired **Range** box at the bottom of the plots window. This option enables plots to display full, manual, or autoadjusted ranges.

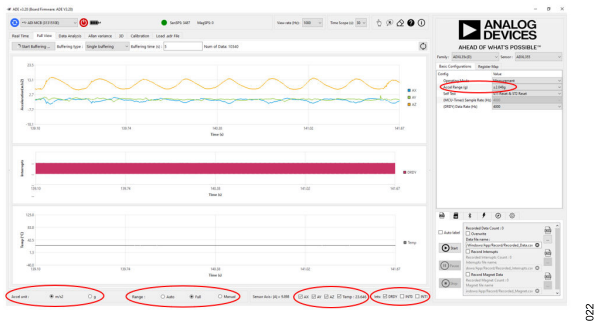

Figure 22. Graph Options

Mouse Modes and Options

The mouse operates in two modes on graphs: **Zoom** and **Move**. Toggle between these modes using the arrow and hand icons located at the top right of the UI. In **Zoom** mode (indicated by the arrow icon), click and drag to define a zoom area with a blue bounding rectangle on the graph. In **Move** mode (indicated by the hand icon), scroll through the graph by holding down the left mouse button and moving the mouse. In either mode, right clicking the graph provides options as follows:

- **Reset**: resets the view to the original view.
- **Save**: saves a PNG file from the current viewed graph.
- **Move/Zoom**: switches between mouse modes.
- **Zoom In**: zooms in the graph.
- **Zoom Out**: zooms out the graph.
- **Enlarge**: enlarges the height of the plot in a multiple plot page.
- **Shrink**: shrinks the height of the plot in a multiple plot page.
- **Disable**: removes the plots from the page.

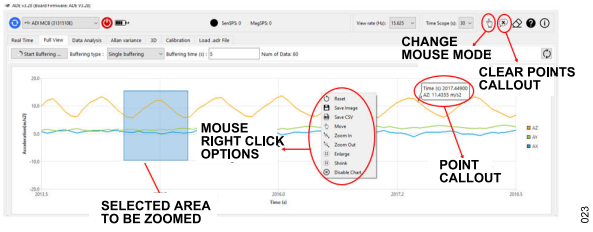

Figure 23. Mouse Options

When the mouse moves over a data series on the graph, information about each point is displayed. A callout appears at the location of the mouse cursor, showing the corresponding x and y dimensions of the data point. Double clicking a point saves the callout, and all callouts can be cleared using the button at the top of the UI. Figure 23 illustrates the mouse options.

Shortcuts

Shortcuts include keyboard and mouse actions, accessible by clicking the question mark icon at the top right of the UI. Figure 24 shows this icon and the pop-up window detailing the keyboard and mouse shortcuts.

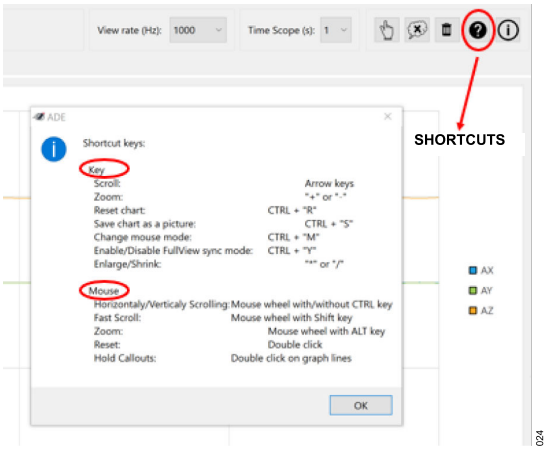

Figure 24. Shortcuts

SENSOR CONFIGURATION

Configure the sensor using either the **Basic Configurations** or **Register Map** tab. In the **Register Map** tab, customize and modify registers to meet specific requirements for desired application. The **Basic Configurations** tab provides a streamlined interface with fewer options for modification. Detailed explanations of each tab follow in the subsequent sections.

Basic Configuration

In the **Basic Configurations** tab, access options to select the **Operating Mode**, **Accel Range**, **Self Test**, and **Data Ready Rate**. Customize these settings according to specific requirements from the provided options. Figure 25 shows the available configurations for each setting.

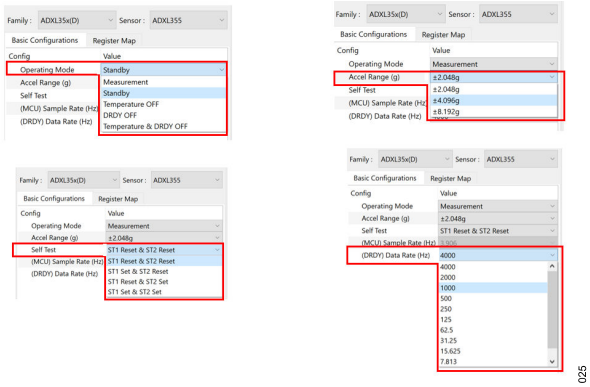

Figure 25. Basic Configuration

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Register Map

The **Register Map** tab displays a tree view of the digital sensor register map. This map includes detailed information such as register address, name, bit values, reset value, and access type (read, write, or both).

Display register and reset values in either hexadecimal or decimal format by selecting the desired option in the bottom right corner of the tab, and enter register values in either format; the UI automatically detects them. Additionally, update the **Register Map** with a selectable **Registry Update Rate**.

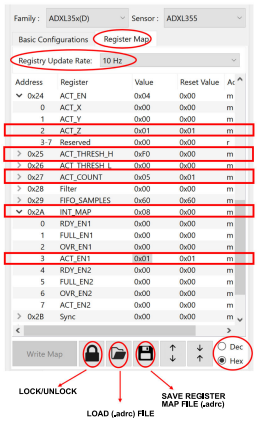

Figure 26. Register Map

To change sensor register values based on the desired application, modify the register values as follows:

1. Click the lock button to halt register map updates.
2. Double click the value of the corresponding register to edit it.
3. Click **Write Map**.

Note that changes to the registers are applied, and the current register value displays after adjusting the **Registry Update Rate** from **Never** to the desired rate.

To discard changes, click the unlock button. Additionally, save the current registry and load it for future use. Sensor register map configuration files are saved in .adrc format and can be loaded by dragging and dropping the corresponding file.

Figure 26 shows the register map tree along with its options and a sample configuration for activity detection for ADXL355 utilizing the ACT_EN, ACT_THRESH_H, ACT_COUNT, and INT_MAP registers. For further insights into activity detection and the corresponding registers, refer to the ADXL355 data sheet.

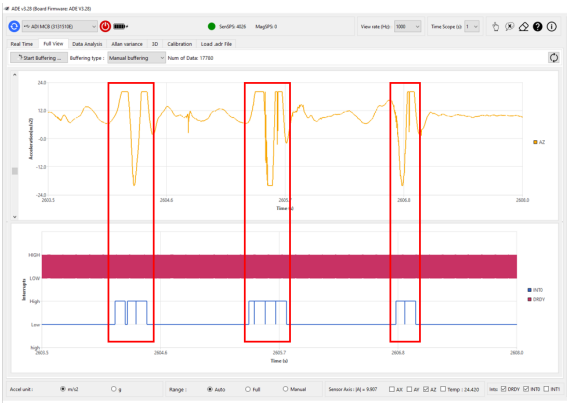

Figure 27. Activity Detection Example

Figure 27 shows the buffered data for the configured register map for activity detection. It displays instances of activity detected when the acceleration in the z-axis exceeds the threshold defined in the ACT_THRESH_H register for a specified number of occurrences defined in the ACT_COUNT register.

RECORD DATA

In addition to capturing visual data and saving graphs in .png format (using the mouse right click option), tabulated data vs. time can also be recorded on the PC or SD card.

Data Recording on PC

Save data in .csv format directly onto the PC. Access recording options through the tab at the bottom right of the UI. Click the **CSV** icon to display the save option and specify a file name. Select the **Auto label** box to automatically generate a name based on the sensor name, date, and time. Use the **Overwrite** option to replace data in an existing file. Record interrupts and magnetometer data by checking their respective boxes.

The **Start**, **Pause**, and **Stop** buttons offer flexibility to initiate, pause, and terminate data recording as needed. During data recording, the **Recorded Data Count** indicator displays the number of recorded data points, providing real-time monitoring of the recording progress. Figure 28 shows the PC recording tab.

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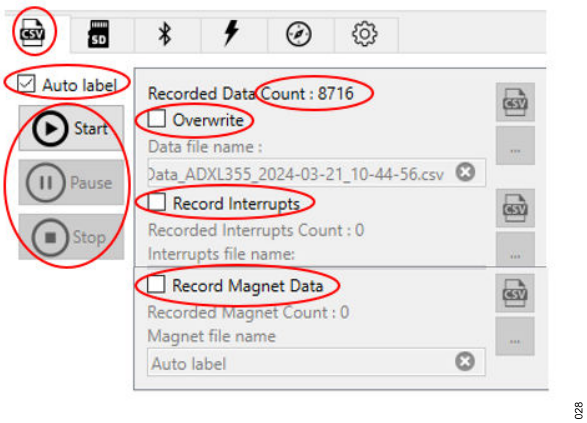

Figure 28. Data Recording on PC

SD Card

Save data on the SD card by selecting the **SD** tab located in the bottom right corner of the UI. Upon connecting the SD card to the MCB, the status **SD card detected.** is displayed. This status also indicates the number of files stored on the card and its remaining memory capacity. To commence data capture, click the start button. To pause or stop data capture, utilize the pause and stop buttons, respectively. When the data capturing stopped, a window appears displaying a report detailing the recorded file, including its name and the number of samples recorded. The SD card functionality also includes options to refresh or format the card, accessible through icons situated on the right side of the **SD** card tab. It is essential to note that SD cards must be formatted before initial use. To save captured data on the PC, use the download icon to save it as a .adr file. See Figure 29 for visual representation of the icons associated with SD card functions.

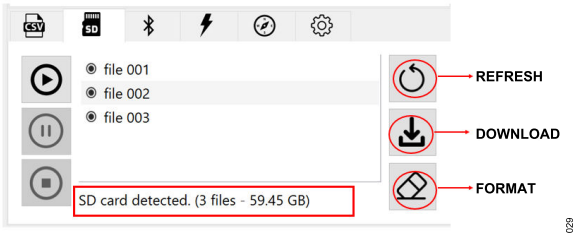

Figure 29. SD Card

BLUETOOTH

The MCB features bluetooth low energy (BLE) for wireless communication. Click the BLE tab in the bottom right corner of the UI to activate BLE mode and search for devices. Figure 30 shows this functionality.

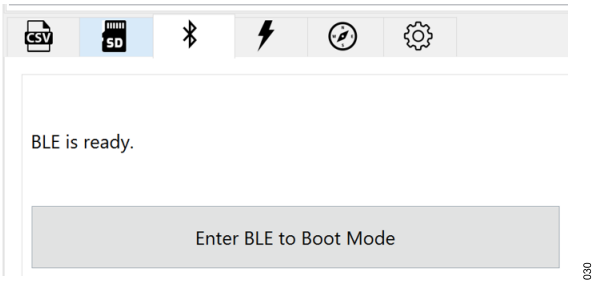

Figure 30. BLE

CURRENT MEASUREMENT

The evaluation system includes the capability to measure sensors currents. Enable current sensing by selecting the **Enable current sensing** option for real-time monitoring with ±20% accuracy. For more accurate results, enable **Precise Measurement**. In **Automatic** mode, the current unit is microamps (µA). Selecting the **Manual** option allows choosing between milliamps (mA) and microamps (µA).

Figure 31 shows the current measurements tab. It is important to note that for analog sensors, it is recommended to disable current sensing due to its potential effect on analog supply.

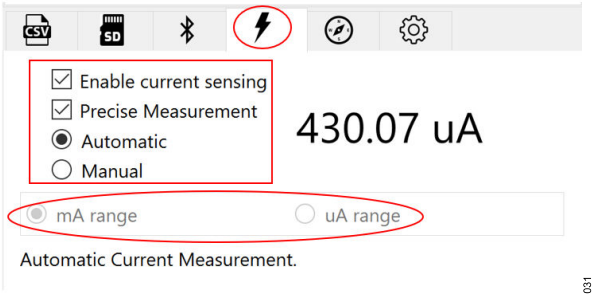

Figure 31. Current Measurement

MCB MAGNET

The MCB has an on-board magnetometer. Activate the magnetic field sensor in the MCB magnet tab by checking the **Enable Magnet Sensor** option. Customize various parameters such as range, data rate, self test functionality, and temperature enablement within the tab. This flexibility allows tailoring of the magnetic field sensor operation to specific needs and application requirements. Figure 32 shows the MCB magnet sensor tab.

EVALUATION SOFTWARE

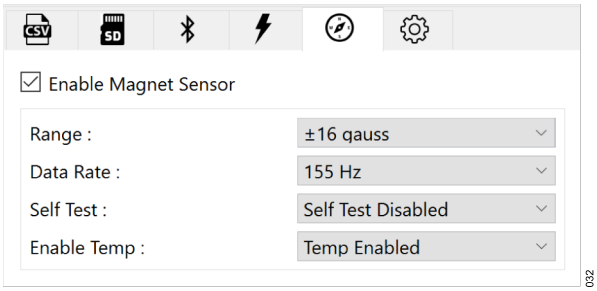

Figure 32. MCB Magnet Tab

FIRMWARE UPDATE

To upload a new version of firmware, click the update firmware tab. This feature facilitates updates of the MCB firmware to the latest version, ensuring compatibility with new features, improvements, and bug fixes.

To initiate the firmware update process, follow these steps within the update MCB firmware tab:

1. On the update MCB firmware tab, click the **Put MCB to Boot Mode** button to transition the MCB from normal mode to boot mode (see Figure 33).

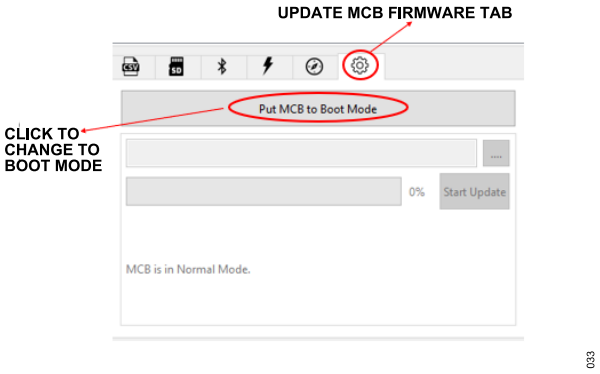

Figure 33. Change to Boot Mode

2. Wait until the MCB restarts and blinks white slowly then follow the on-screen instructions to reconnect to the MCB (see Figure 34). It is crucial to perform the disconnect and connect process. Otherwise, the update may not proceed correctly.

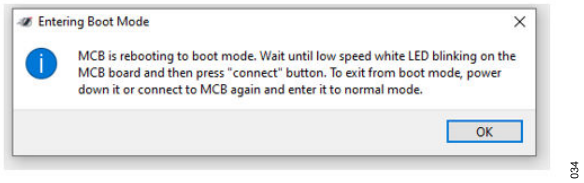

Figure 34. Reconnect the MCB

3. Once the MCB has entered boot mode, the corresponding buttons for firmware upload become active. Select the new firmware file by addressing it or dragging and dropping it into the designated area (see Figure 35).

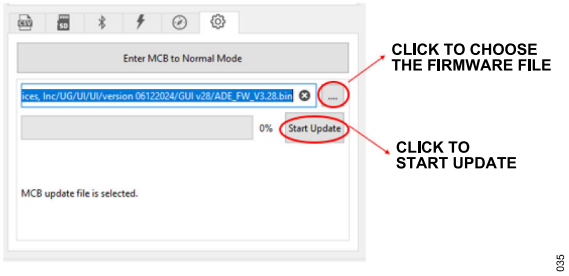

Figure 35. Upload the Firmware File

4. Click **Start Update** to initiate the firmware update process. Figure 36 shows the updating process (top image) and completion status (bottom image).

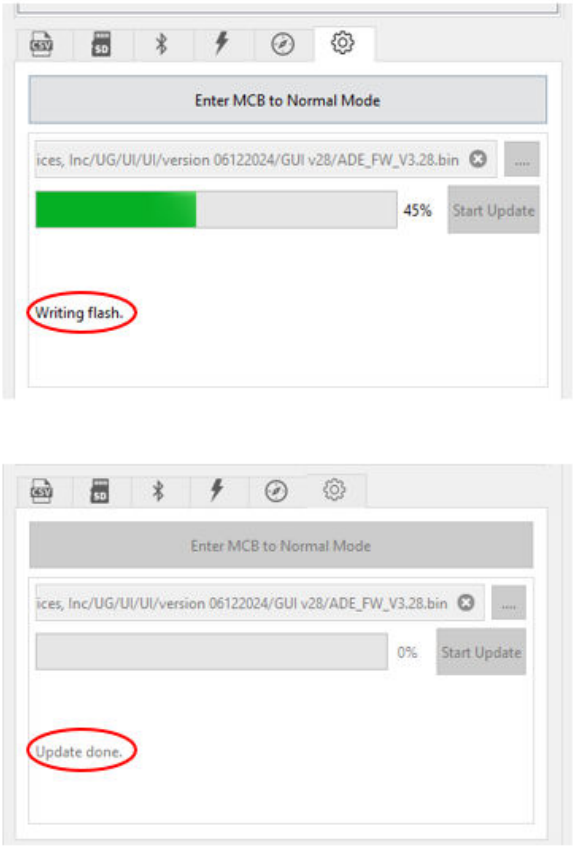

Figure 36. Firmware Updating

If corruption occurs during the update process, reset the MCB with the reset button and manually enter boot mode.

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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