BMI32x
Desktop Development 2.1 User manual

BMI32x UserManual

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1 About this user manual

This manual describes the installation and usage of the *Development Desktop 2.1* User Interface (DD2.1); a Windows based PC software application and related embedded firmware/software developed by Bosch Sensortec for demonstration and evaluation of sensors.

1.1 Who should read this manual

This information is intended for users who want to design and implement robust sensor functionality into their applications.

1.2 DD2.1 Overview

DD2.1 is a PC based software used to read, capture, and display sensor data. To display the sensor data of BMI32x on DD2.1, mount the sensor on the Bosch Sensortec application board. This is a universal demonstration environment for Bosch Sensortec sensor products.
Bosch Sensortec sensors are mounted on sensor specific shuttle boards. All sensors shuttle boards have an identical footprint and can be plugged into the application board's shuttle board socket. DD2.1 automatically detects the sensor that has been plugged in and starts the corresponding software application

1.3 About BMI32x

The BMI32x is a highly integrated, low power inertial measurement unit (IMU) that combines precise acceleration and angular rate (gyroscopic) measurement with intelligent on-chip motion-triggered interrupt features.

The technical specifications of the sensor are:

Table 1: Technical specifications

Parameter	**Technical Data**
Digital Resolution	Accelerometer (A): 16-bit Gyroscope (G): 16-bit Temperature: 16 bit
Programmable measurement range & sensitivity	(A): ±2 g, ±4 g, ±8 g, ±16 g (G): ±125 dps, ±250 dps, ±500 dps, ±1000 dps, ±2000 dps , ±4000 dps
Zero-g/Zero-rate offset	(A): ±20 mg (G): ±0.5 dps
Sensitivity Error	(A): ± 0.4% (G): ± 0.4% (with CRT)
Temperature range	-40 ... +85 °C
Output Data Rate (ODR)	(A): 0.78 Hz ... 6.4 kHz (G): 25 Hz ... 6.4 kHz
Digital inputs/outputs	10MHz slave 4x SPI 3xSPI; 2x I2C; 2x digital interrupts
Supply voltage	1.62 ... 3.63 VDD 1.08 ... 3.63 VDDIO
Current consumption	725 µA at full ODR (aliasing-free)

1.4 Sensor Communication:

DD2.1 software supports both SPI and I^2C to communicate with the sensor.

1.5 Graphical display:

DD2.1 UI displays the sensor data and interrupts in different graphical formats.

1.6 Data logging:

DD2.1 offers data logging of the sensor data

2 Getting started

The below sections highlight the procedure to set up connections between the BMI32x, DD2.1, and the PC.

2.1 Upgrading Firmware

2.1.1 For App 2.0 Board:

To upgrade the firmware of DD2.1 to match the current version, follow the steps below:

1. Click **Settings**->**Firmware Upgrade.** The following window appears

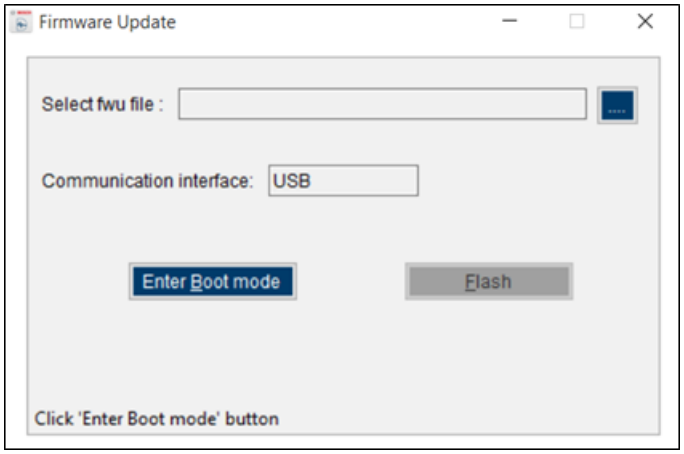


Figure 1 : Firmware upgrade window

2. Click **Enter Boot mode.**

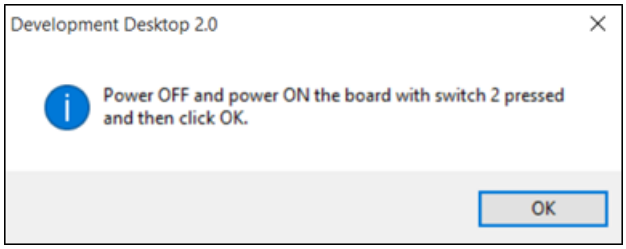


Figure 2 : Application Boot loader

1. Switch off board, and press **Switch 2**.In Application board, all four LEDs will glow simultaneously.
2. Click **OK**.
3. All four LEDs will glow simultaneously.
4. Press **OK**

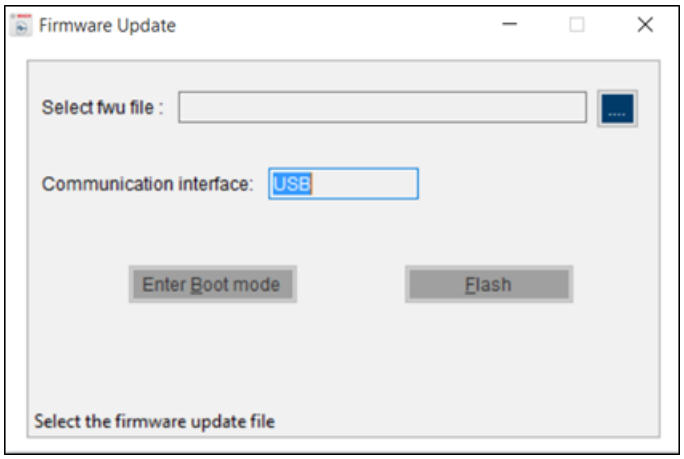


Figure 3 : Boot mode detected

5. Select the default firmware update file (**.fwu2*) from the DD2.1 installation directory in the folder **Firmware**.
6. Click **Flash.**

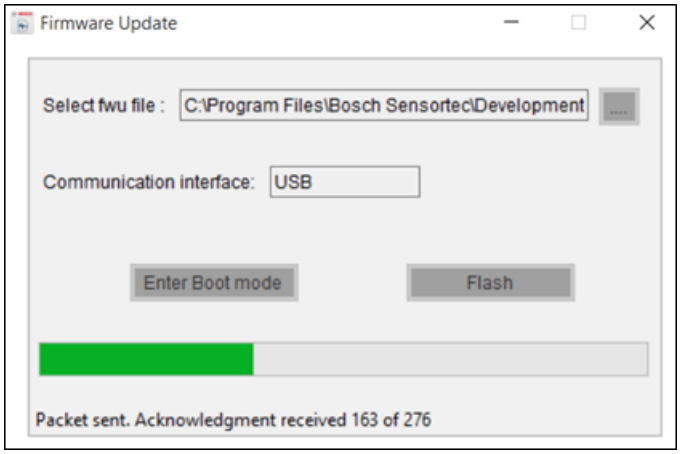


Figure 4 : Firmware upgrade completion

7. Once firmware upgrade is complete, restart the application board, and DD2.1

2.1.2 For App 3.0 Board:

To upgrade the firmware of DD2.1 UI to match the current version, follow the steps below:

1. Click **Menu -> Settings**-> **Firmware Upgrade.** The following window appears:

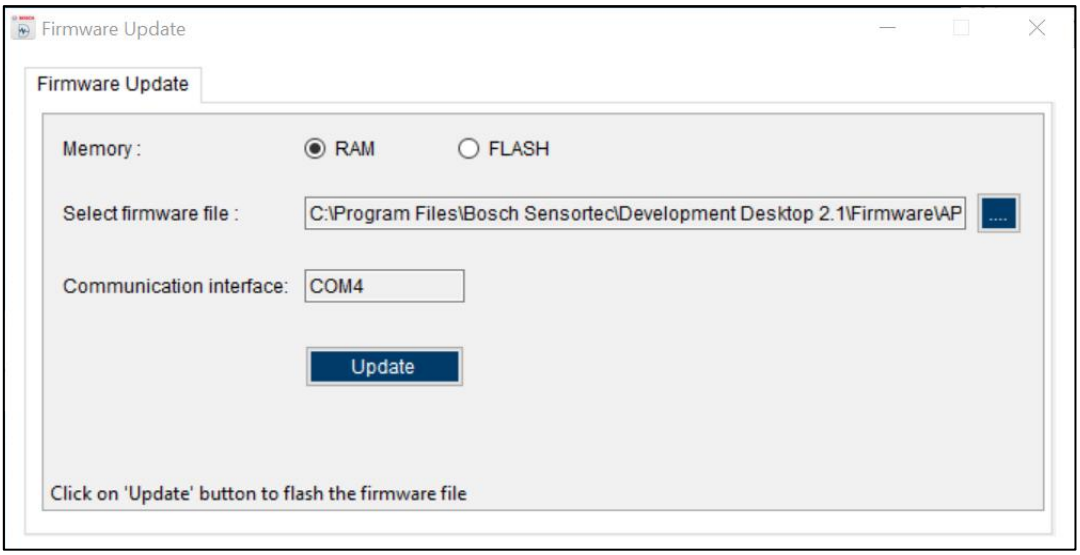


Figure 5 : Firmware upgrade window APP3.0

Default firmware file (**.bin*) will be automatically chosen from the DD2.1 UI installation directory in the folder **Firmware\App3.0**.

2. Choose RAM or FLASH option to flash the latest recommended firmware file.
3. The file path will get automatically chosen/selected in the select firmware file path textbox. User can also select the firmware as required.
4. Click on **Flash**.
5. DD2.1 recommended firmware is COINES_bridge firmware for App3.0 shuttle board. If the user chose to flash DD firmware, a popup message will be shown. User can still choose the DD firmware and proceed.

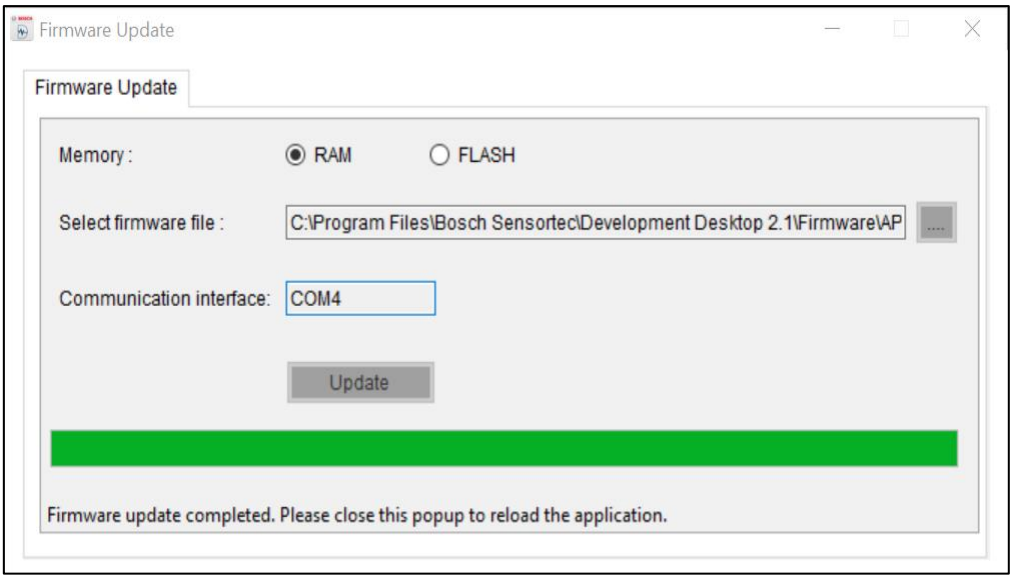


Figure 6 : Firmware upgrade completion for APP3.0

6. Once firmware update is completed, please close the popup and DD 2.1 application will get automatically reloaded.

2.2 Setting Up the board-PC connection

The procedure to connect sensor to PC via USB is as below:

1. Install DD2.1.
2. Insert the shuttle board and application board

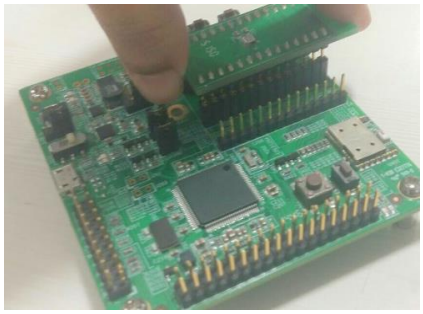


Figure 7 : Insert sensor for APP2.0

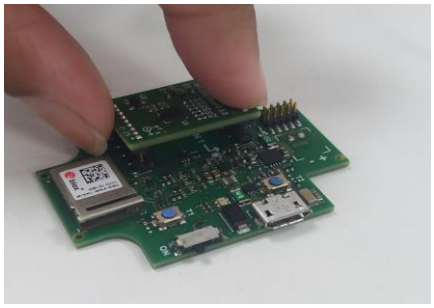


Figure 8 : Insert sensor for APP3.0

3. Connect the board and PC using a USB cable/Bluetooth

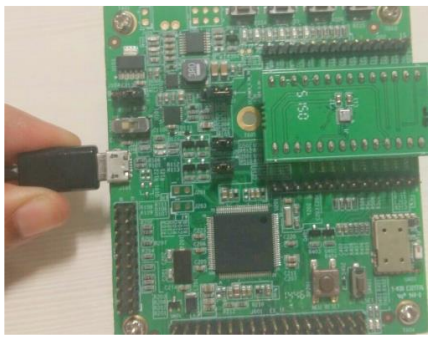


Figure 9 : Connect board and PC for APP2.0

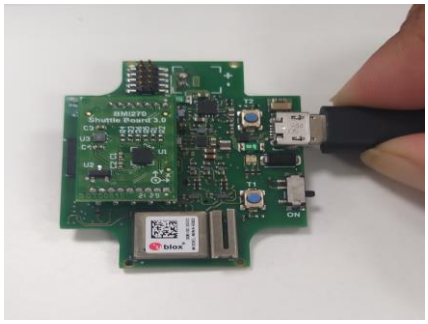


Figure 10 : Connect board and PC for APP3.0

4. Turn the on/off switch **ON**. The LED glows.

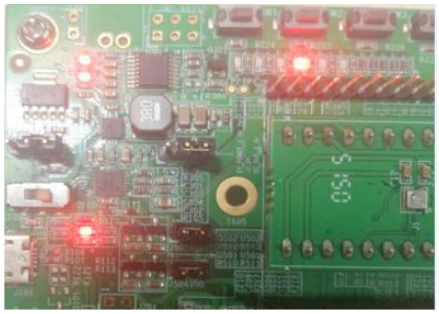


Figure 11 : Connection complete for APP2.0

Figure 12 : Connection complete for APP3.0

2.3 Start-up View

To start the DD2.1 software:

- Click **Start > Programs > Development Desktop 2.1.**

Or

Double click the DD2.1 software icon  on the desktop

The Graphical User Interface (GUI) of the software is as seen below:

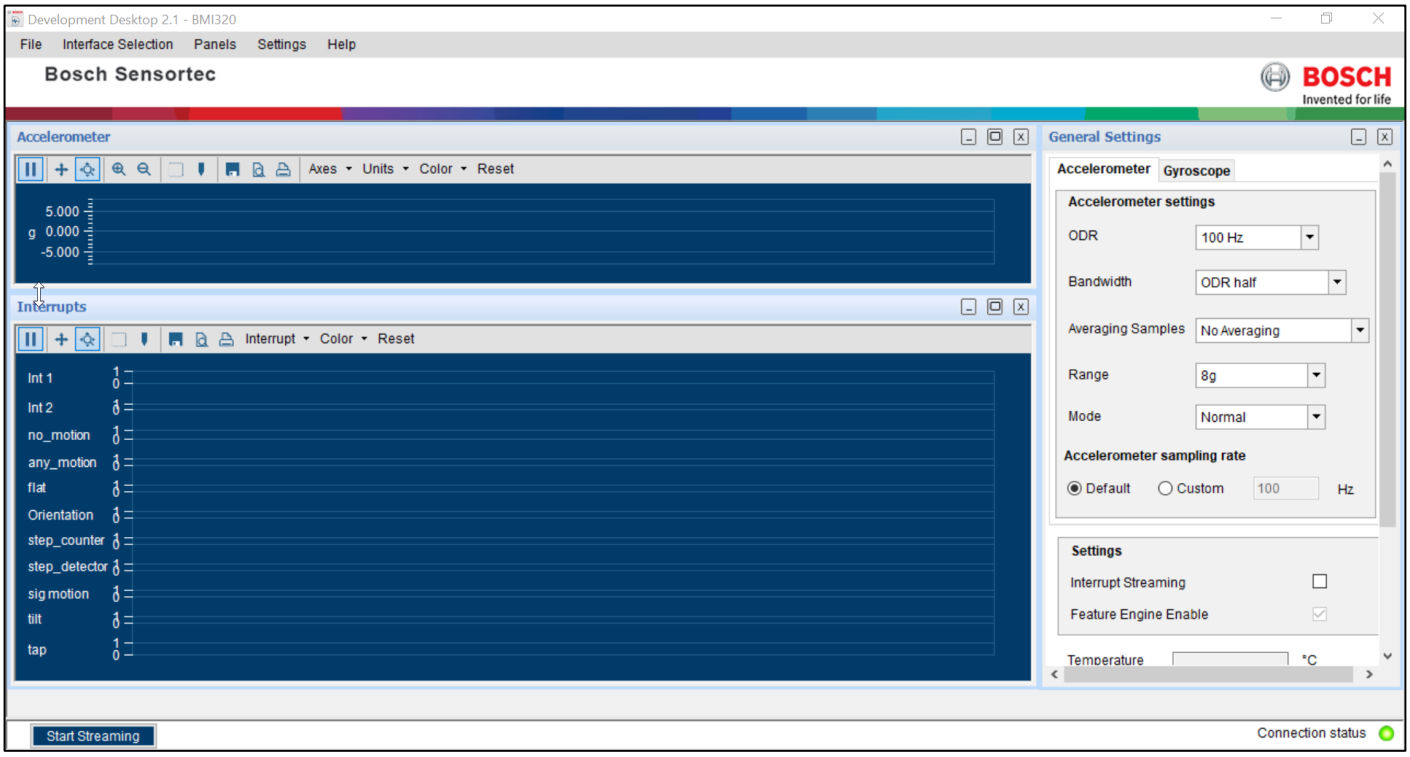


Figure 13 : DD2.1 Startup View

- When the PC and board are connected, the Communication Status glows green as shown below:

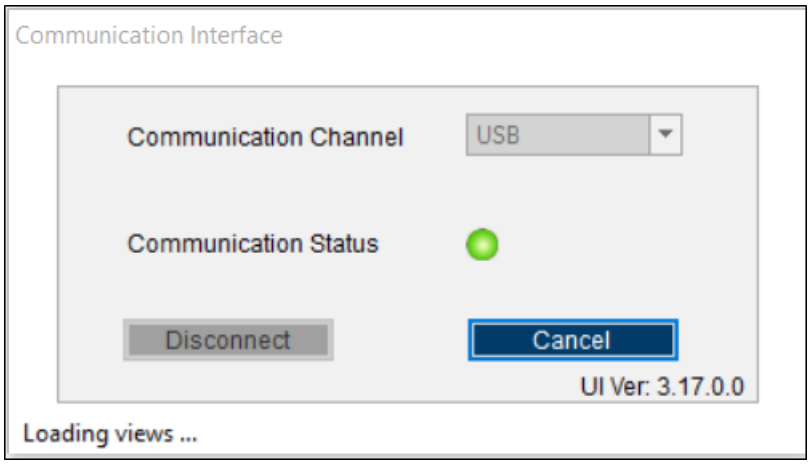
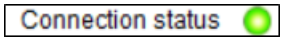


Figure 14 : Communication Status

The communication status is also indicated at the bottom right of the GUI at all times:



- Other menu options include:
  - File
  - Interface Selection
  - Panels
  - Settings
  - Help

3 Working with DD2.1

The **General Settings** panel is present in the right side of the DD2.1 screen. The various general settings available in the BMI32x are discussed in the below sections.

3.1 General Settings

3.1.1 Accelerometer

The accelerometer settings panel is as seen below

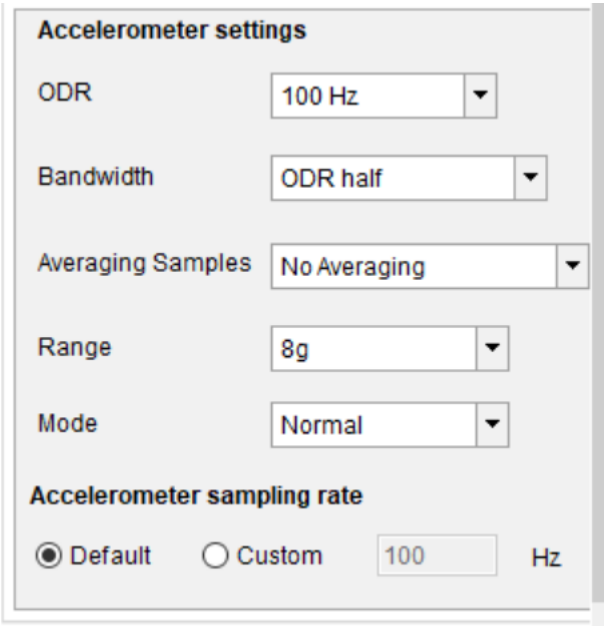


Figure 15 : Accelerometer settings panel

- ODR: To choose the Output Data Rate (ODR), select the relevant values from the drop-down list. The possible ODR values are:
  - 0.78 Hz
  - 1.56 Hz
  - 3.12 Hz
  - 6.25 Hz
  - 12.5 Hz
  - 25 Hz
  - 50 Hz
  - 100 Hz
  - 200 Hz
  - 400 Hz
  - 800 Hz

- 1600 Hz
- 3200 Hz
- 6400 Hz

Note:

1) **The ODR varies based on the power mode selected.**
2) **To view the sensor data at 6.4KHz,the user needs to use either FIFO streaming or Interrupt streaming**
3) **During interrupt streaming, the user needs to put the interrupt latch to latched mode.**

- Bandwidth: The different Bandwidth options are:
  - ODR Half
  - ODR Quarter

- Averaging Samples: For optimized performance, the different averaging samples options available are:
  - No Averaging
  - Average 2samples
  - Average 4samples
  - Average 8samples
  - Average 16samples
  - Average 32samples
  - Average 64samples
  - Average 128samples

- Range: To choose the g-range, select the relevant value from the drop-down list. In all power modes, the g-range values available are:
  - 2g
  - 4g
  - 6g
  - 8g

- Mode: To choose the power mode, select the relevant value from the drop-down list.
  - Disable
  - Ultra-Low power
  - Low power
  - Normal
  - High Performance

- The two sampling rates offered by DD2.1 for the BMI32x are:
  - Default: A pre- defined sampling rate value supported by the sensor.
  - Custom: User-defined sampling rate value. Custom sampling rate can only be a value between 0.78 Hz and 6400 Hz.
- Select relevant value by clicking the radio button next to the options.

Note: When the DD2.1 UI is launched, sampling rate will be at Default. When you wish to input a custom sampling rate, please enter the value next to the corresponding option

3.1.2 Gyroscope

The gyroscope settings panel is as seen below:

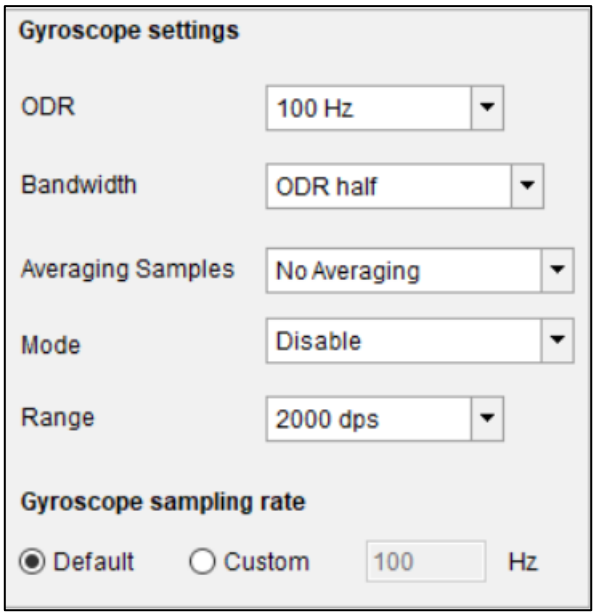


Figure 16 : Gyroscope settings

- ODR: To choose the Output Data Rate (ODR), select the relevant values from the drop-down list. The possible ODR values are:

    - 0.78 Hz
    - 1.56 Hz
    - 3.12 Hz
    - 6.25 Hz
    - 12.5 Hz
    - 25 Hz
    - 50 Hz
    - 100 Hz
    - 200 Hz
    - 400 Hz
    - 800 Hz
    - 1600 Hz
    - 3200Hz
    - 6400 Hz

Note:

1) **The ODR varies based on the power mode selected.**
2) **To view the sensor data at 6.4KHz,the user needs to use either FIFO streaming or Interrupt streaming**
3) **During interrupt streaming, the user needs to put the interrupt latch to latched mode.**

- Bandwidth: The different Bandwidth options are:
    - ODR Half
    - ODR Quarter

- Averaging Samples: For optimized performance, the different averaging samples options available are:

    - No Averaging
    - Average 2samples
    - Average 4samples
    - Average 8samples
    - Average 16samples
    - Average 32samples

- Average 64samples
- Average 128samples

- Range: To choose the g-range, select the relevant value from the drop-down list. In all power modes, the g-range values available are:
  - 4000dps
  - 2000dps
  - 1000dps
  - 500dps
  - 250dps
  - 125dps

- Mode: To choose the power mode, select the relevant value from the drop-down list.
  - Disable
  - Suspend
  - Ultra-Low power
  - Low power
  - Normal
  - High Performance

- The two sampling rates offered by DD2.1 for the BMI32x are:
  - Default: A pre- defined sampling rate value supported by the sensor.
  - Custom: User-defined sampling rate value. Custom sampling rate can only be a value between 0.78 Hz and 6400 Hz.
- Select relevant value by clicking the radio button next to the options.

Note: When the DD2.1 UI is launched, sampling rate will be at Default. When you wish to input a custom sampling rate, please enter the value next to the corresponding option

3.1.3 Sensor Settings

The sensor settings panel is as seen below:

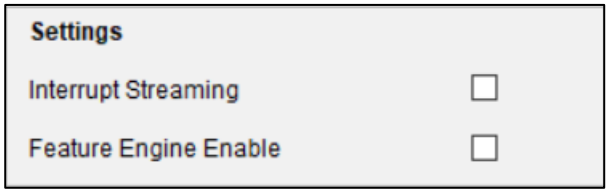


Figure 17 : Sensor settings

- Interrupt Streaming: In Interrupt, data is streamed as and when data ready interrupt of Accelerometer and Gyroscope is 1. When ODR more than 3.2KHz is selected, then the user needs to put the interrupt latch to latched mode.
- Feature Engine Enable: Enables or disables feature engine. A Soft-reset is required to re-enable the feature engine.

3.1.4 Temperature

While data streaming in the plotter, the real time temperature is updated in the given box as shown below:

Figure 18 : Temperature

3.1.5 Reset

- To reset all values to its default  state, click

- When reset, the following values are reset to their default value as seen below:
- Accelerometer
- ODR – 100 Hz
- Bandwidth – ODR Half
- Averaging Samples – No Averaging
- Range – 8g
- Mode - Disable
- Accelerometer sampling rate – Default
- Gyroscope
- ODR – 100 Hz
- Bandwidth – ODR Half
- Averaging Samples – No Averaging
- Range – 2000dps
- Mode - Disable
- Gyroscope sampling rate – Default

3.1.6 PO Reset

To reset sensor values to default state, click 

3.2 Interface Selection

Interface Selection has two menu options as seen:

3.2.1 Board Communication

- To check communication between board and DD2.1, go to **Menu -> Interface Selection -> Board Communication**, or click **Ctrl+Shift+B.**

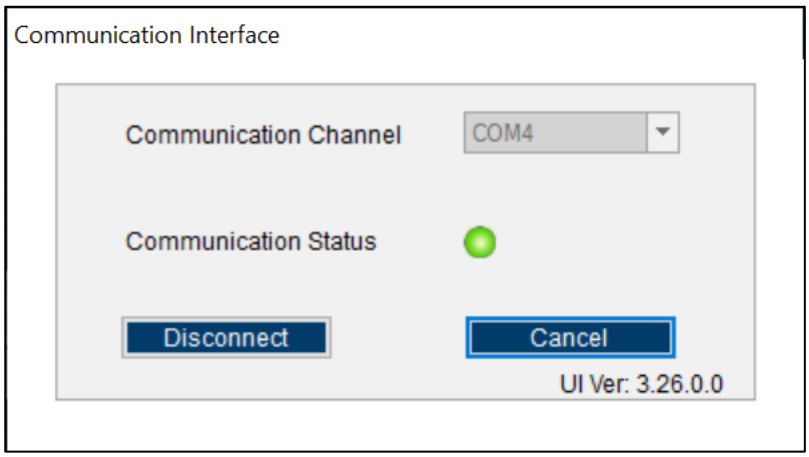


Figure 19 : Communication Status green

- If the board and application are connected, **Communication Status** will be green as seen:

- Click **Disconnect** to break the communication.
- Click **Cancel** to exit the window.
- If the board and application are not connected, the **Communication Status** will be red as seen

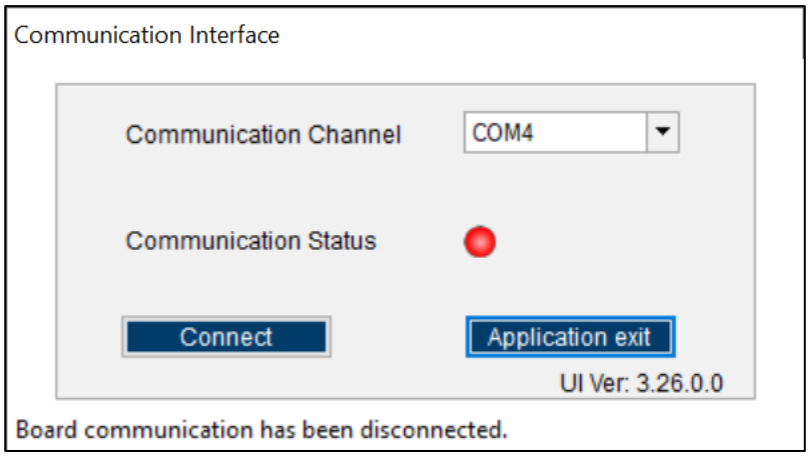


Figure 20 : Communication status red

- Click **Connect** to establish connection.
- Click **Application exit** to close DD2.1

3.2.2 Sensor Interface

To select between the two available interfaces (SPI and I^2C), go to **Menu -> Interface Selection -> Sensor Interface**, or click **Ctrl+Shift+I.** The following window appears

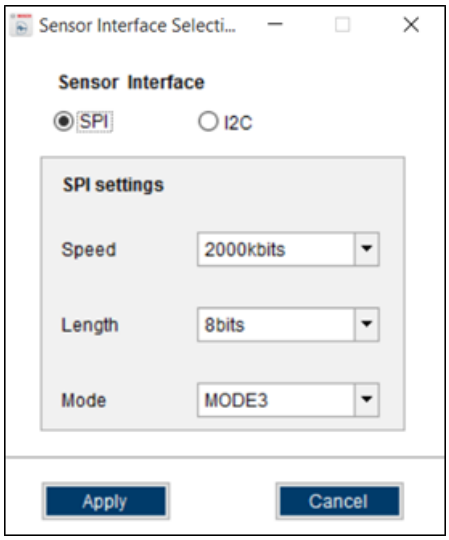


Figure 21 : Sensor settings SPI

Note: By default, the sensor interface is in SPI.

- Select the relevant **SPI Address. SPI speed and SPI Mode.**

- Click **Apply**.
- To select **I²C,** click the appropriate radio button. The following window appears.

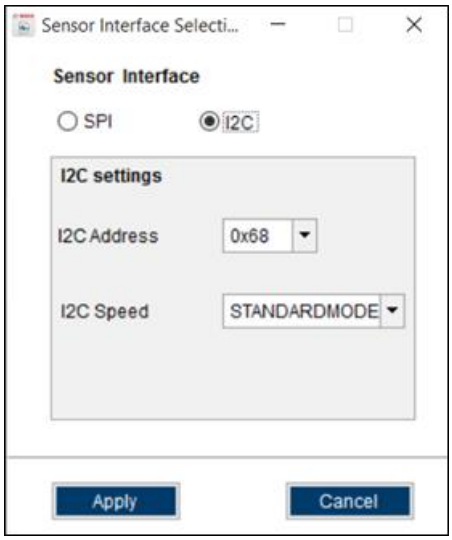


Figure 22 : I2C sensor interface settings

- Select the relevant **I²C Address** and **I²C speed.**
- Click **Apply**.

Note: Interface Selection is disabled when the sensor is streaming data

3.3 Panels

The different panels available in the BMI32x sensors are discussed in the below sections:

3.3.1 Configuration

To view the **Configuration** settings panel, go to **Menu ->Panels -> Configuration**. The following window appears:

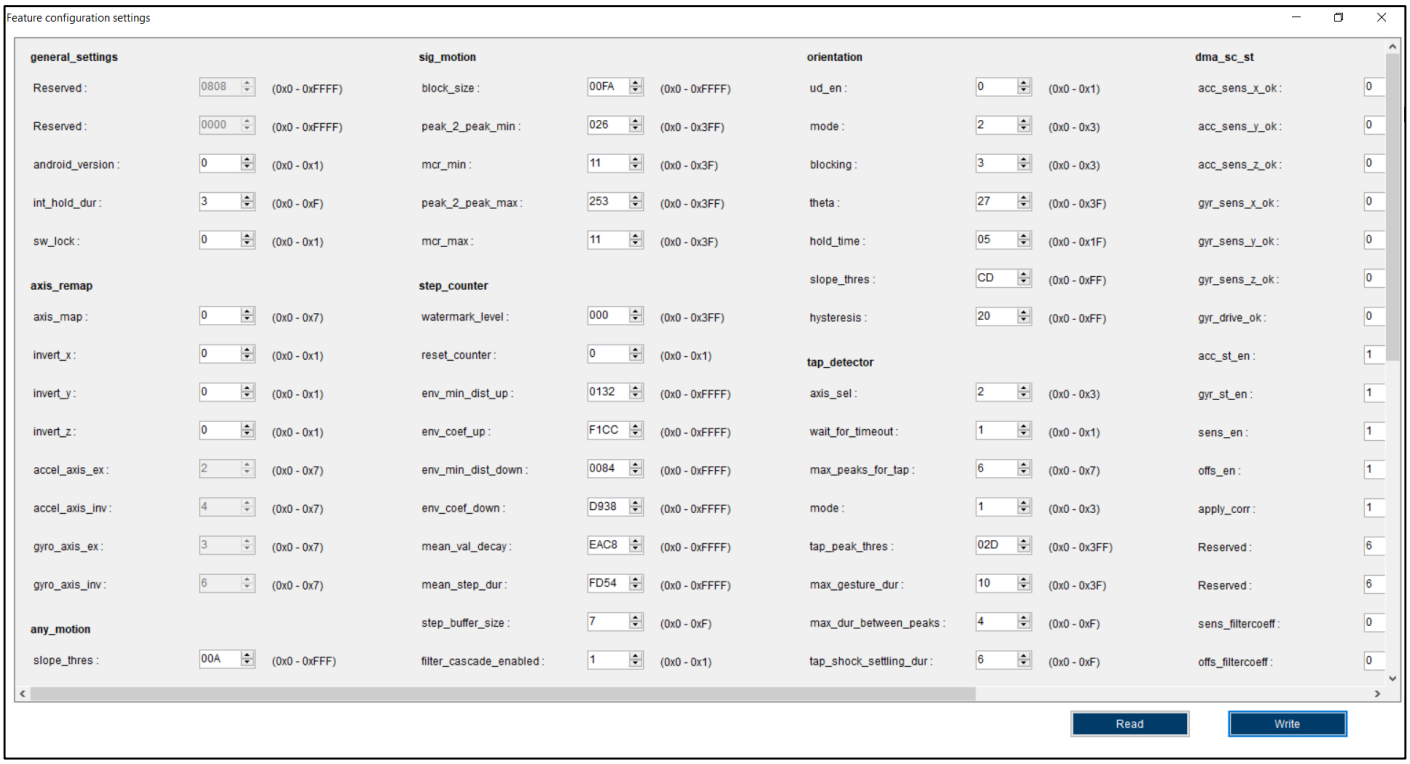


Figure 23 : Configuration settings

- The **Configuration** settings panel is used for feature interrupts configuration.
- To enable any interrupt, follow the below steps
- Enable the interrupts in register 0x10 register
- Write value 1 in 0x14 register.
- Enable the Int 1 and Int2 Configurations in 0x38
- Map the interrupts to the HW line in the register 0x3A (or) 0x3B.
- Then start the streaming.
- The interrupt will be plotted in the DD2.1 plotter.

Using the above procedure, some of the interrupts in BMI32x which can be enabled and verified using DD2.1 are as seen below:

- Any motion
- No motion
- Orientation
- Flat
- Sig motion
- Step counter/detector
- Tilt
- Tap (Single tap/Double tap and triple tap)

3.3.2 Accelerometer

To view the real-time accelerometer data in the plotter, go to **Menu -> Panels -> Accelerometer**, or click **Ctrl+A**.

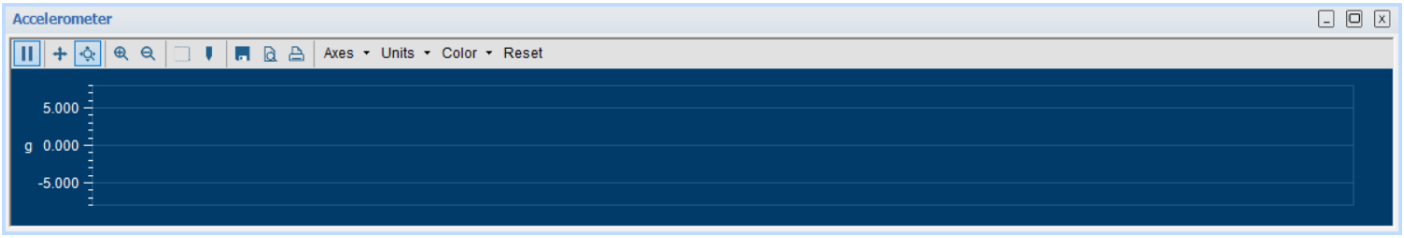


Figure 24 : Accelerometer Plotter

3.3.3 Gyroscope

To view the real-time gyroscope data in the plotter, go to **Menu -> Panels -> Gyroscope**, or click Ctrl+Alt+G.

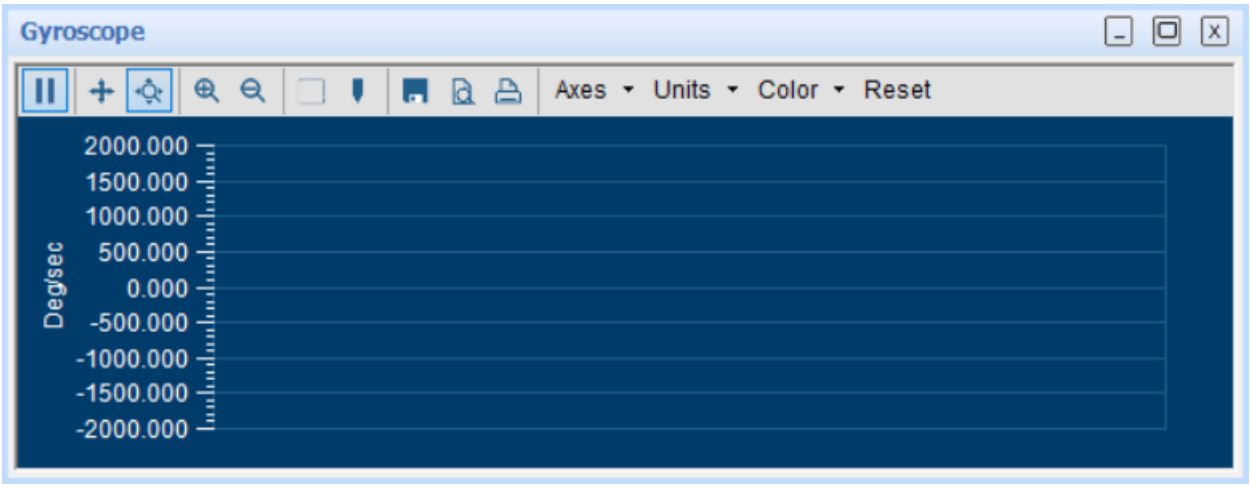


Figure 25 : Gyroscope plotter

3.3.4 Memory Map

To view **Memory Map** options, go to **Menu -> Panels -> Memory Map**. A drop-down appears as seen below

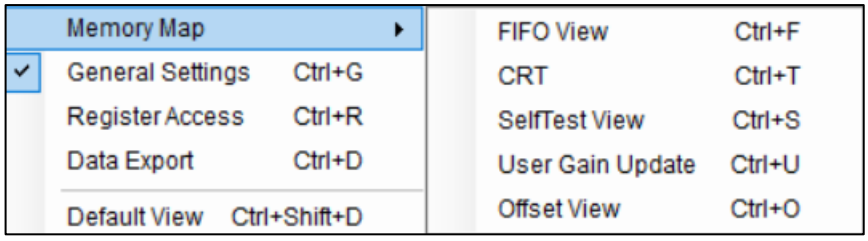


Figure 26 : Memory Map

3.3.4.1 Offset View

To set offset values for BMI32x, go to **Menu -> Panels -> Memory Map -> Offset View**, or click **Ctrl+O**. The following window appears

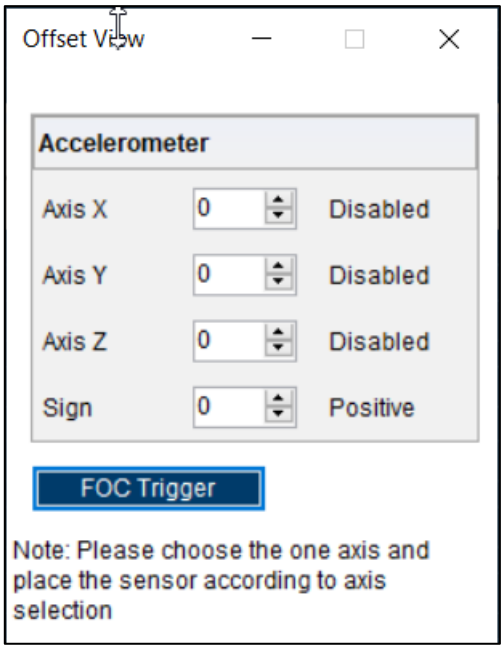


Figure 27 : Offset View

Offset view is used to allow the user to provide user defined offset values in which the sensor data is compensated.

Note: In BMI32x, Fast Offset Compensation can be enabled for Accelerometer.

- To evaluate offset for Accelerometer, follow the below steps:
  - Choose the axis for which offset is to be verified
  - Then choose the sign (1 – Negative. 0 – Positive)of the Axis.
  - The trigger the FOC
  - The user needs to choose atleast one axis for FOC to happen

3.3.4.2 FIFO View

To launch the FIFO view settings panel, go to **Menu -> Panels -> Memory Map -> FIFO View**, or click **Ctrl+F**. The following window appears:

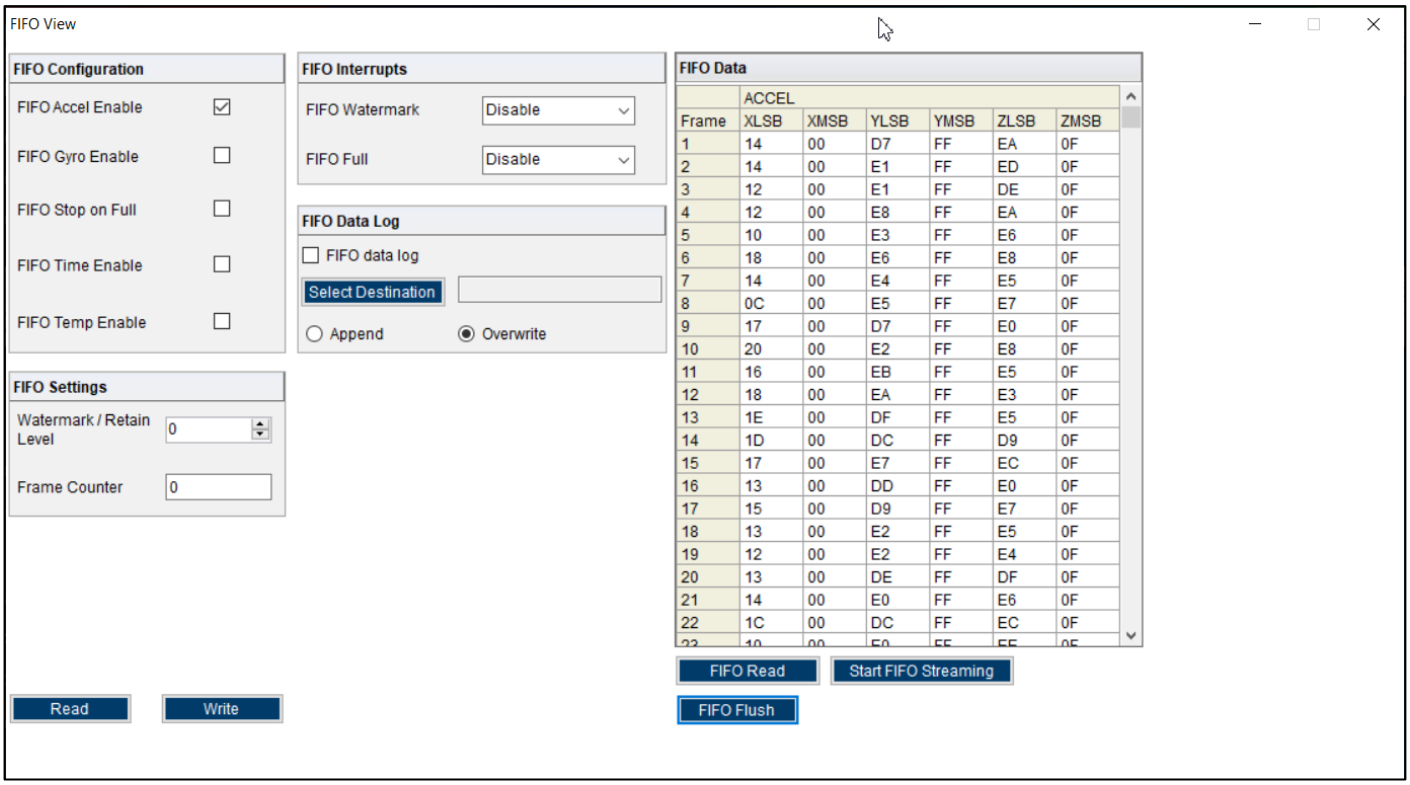


Figure 28 : FIFO View

- To enable data streaming with **FIFO view**, follow the steps below:
- As per requirement, enable the accelerometer, gyroscope or both.
- Click **Write** to write the values into the sensor.
- Click **FIFO Read**.
  - This will display the FIFO data in the data grid.
- Click **Start FIFO Streaming** to stream FIFO data in the accelerometer panel and in the gyroscope panel as well.
- Click **FIFO Data Log** to store data plotted/read during FIFO streaming/reading.
- Click FIFO Flush to clear the FIFO memory.

3.3.4.3 CRT

To View the UI for CRT, go to **Menu -> Panels -> Memory Map -> FIFO View**, or click **Ctrl+T**

CRT:

- The component retrim feature is to retrim the gyroscope's sensitivity

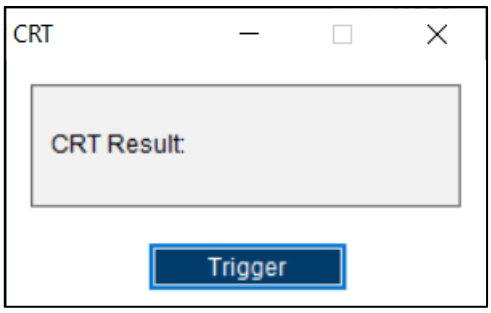


Figure 29 : CRT view

- During this process, the gyroscope is not useable for generating rate data
- Once the user clicks the Trigger button, then the CRT process gets started and the result gets Updated (either PASS or FAIL).

3.3.5 General Settings

To view the General Settings panel, go to **Menu -> Panels -> General Settings,** or click **Ctrl+G.**

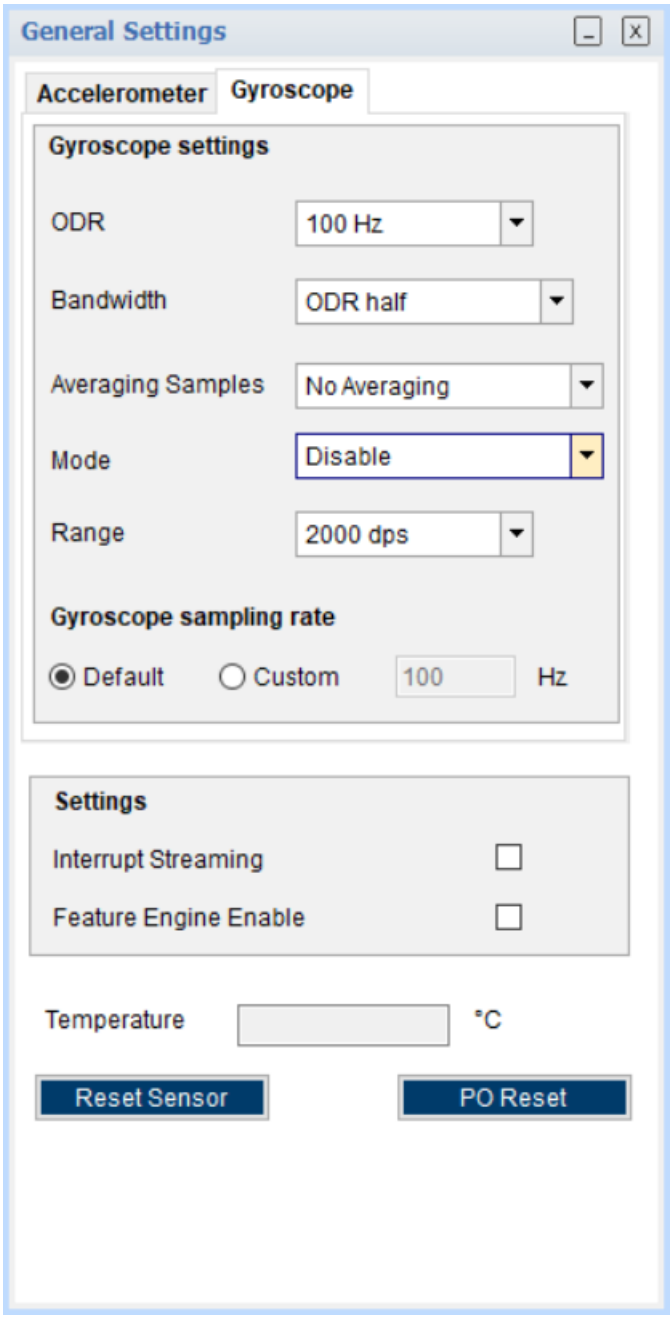


Figure 30 : General Setting

- The General settings contain the Accelerometer and Gyroscope configuration

3.3.6 Register Access

To go to Register Access, go to **Menu -> Panels -> Register Access**, or click **Ctrl+R.**
The following window appears

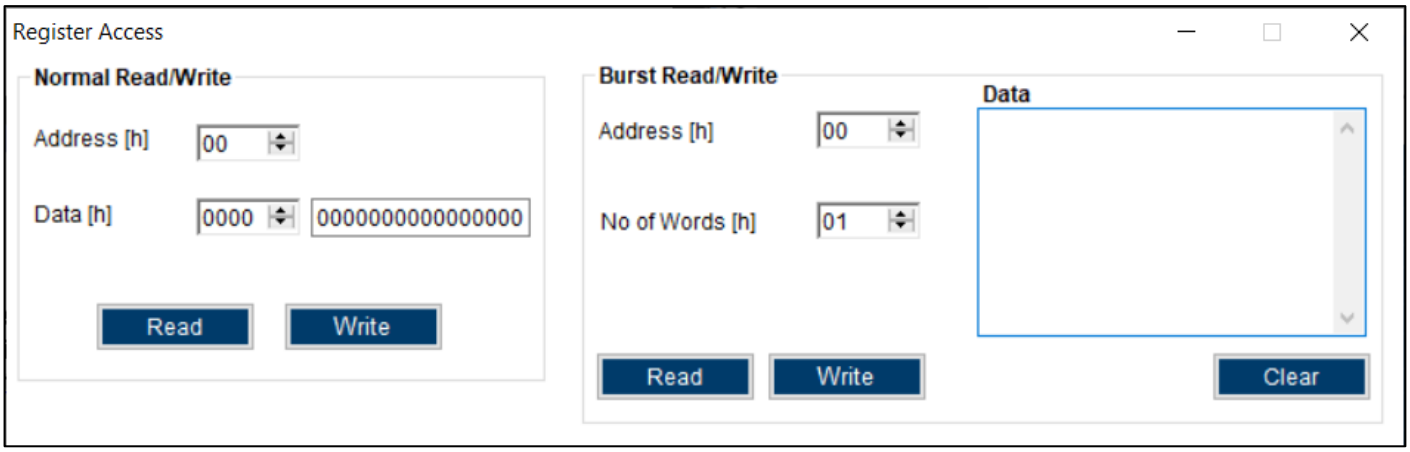


Figure 31 : Register access

Register Access is used to read or write values into a register. To implement this, follow the below steps:

- Enter the hexadecimal register address in **Address [h]**.
- Enter the hexadecimal data you wish to read/ write in **Data [h]**.
- click **Read/Write**

Burst Read/Write:

- Enter the hexadecimal register address in **Address [h]**.
- Enter the No. Of Words to read or write.
- Once the user clicks the read button, then the values are displayed in the data list box.
- Once the user clicks the write button, then the values will be written in the register.

3.3.7 Data Export

- To save the output values plotted by DD2.1, go to **Menu -> Panels -> Data Export**, or click Ctrl**+D.**
- By default, the data values are logged into a text (*.txt*) file in the destination folder of DD2.1
- The steps to follow data logging are as seen:
- Go to **Menu -> Panels-> Data Export**, or click **Ctrl + D.** The following window is displayed

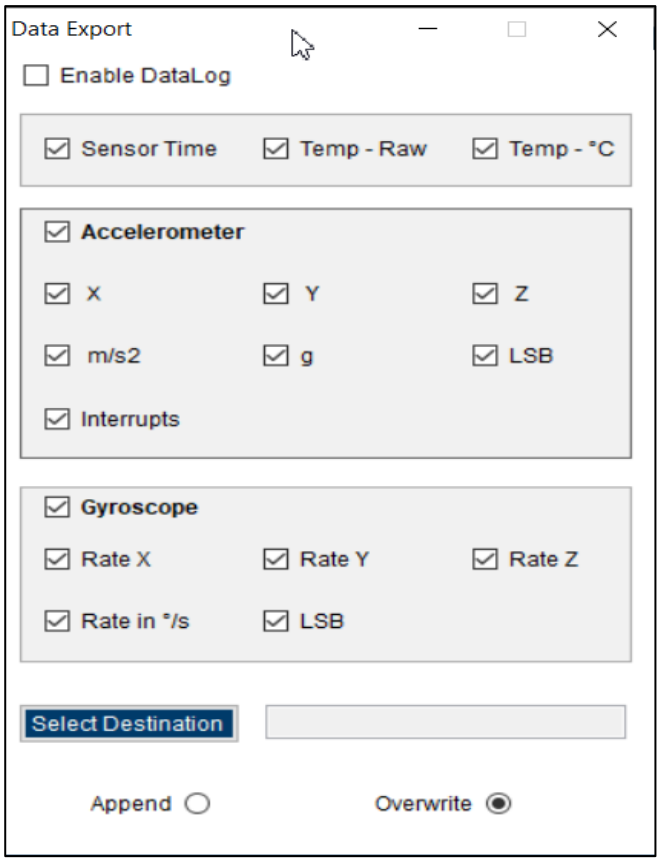


Figure 32 : Data export

1. Check the checkbox **Enable Data Log.**
2. Click **Select Destination**, and select required destination folder

Note: The data log will be stored in the destination folder selected by you.

1. To log new data into the selected file, click **Append.**
   Or
   To erase old data from the selected file and log new data in its place, click **Overwrite.**
2. Click **Start streaming** button to plot the sensor data in the plotter.
3. Click Stop streaming to end the plotting of the sensor data.

The output of the sensor data is saved in the desired destination path

3.3.8 Self-Test View

To view the self-test, go to Panels->Memory Map->SelfTest or Click Ctrl + S

- Accelerometer:
  - The self-test of accelerometer checks whether the accelerometer sensor is in Working condition or not.
  - By clicking on the Self-Test button , the self-test is triggered for all the axes of the accelerometer and then the self-test result is displayed.

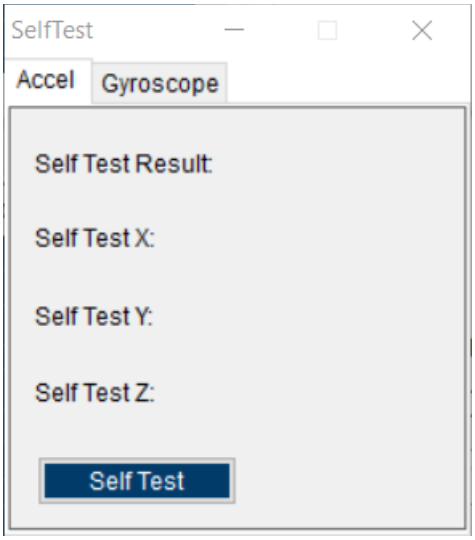


Figure 33 : SelfTest View (Accelerometer)

- Gyroscope
- The self-test of gyroscope checks whether the gyroscope sensor is in Working condition or not.
- By clicking on the Self Test button , the self-test is triggered for all the axes of the accelerometer and then the self-test result is displayed.

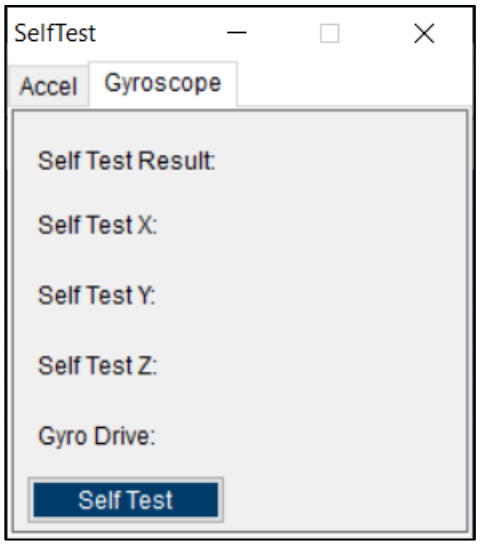


Figure 34 : SelfTest Gyroscope

3.3.9 User gain update:

To view the User gain update UI, **Menu** -> **Panels** -> **Memory Map** -> **User gain Update** or press **Ctrl + U**.

- The user gain update is to update the gain values of gyroscope.
- Once the gain values are updated, the result of the operation is updated in this UI.

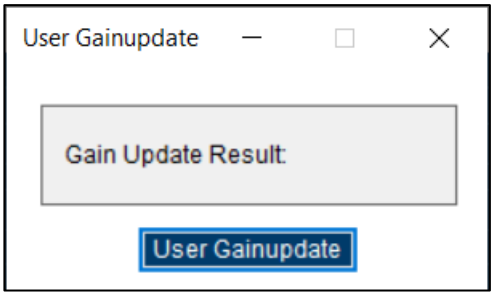


Figure 35 : User gain update

3.3.10 Default View

- To view the **Default View,** go to **Menu -> Panels -> Default View,** or click **Ctrl+Shift+D.**
- The DD2.1 will revert to its default GUI view.
- The panels available in this view are:
- Accelerometer Panel
- Interrupts Panel
- General Settings Panel

Note: The Magnetometer and Gyroscope panels will only be visible if Magnetometer Enable and Gyroscope Enable has been checked in the General Settings panel

4 General Troubleshooting

Follow below guidelines while working with DD2.1:

- Ensure that the shuttle board (with a valid sensor) is seated properly in the application board.
- Ensure that the PC-board connection is properly established.
- When switching on/ off DD2.1, close and restart DD2.1.
- Ensure that at least one channel is selected.

Follow these steps to check the USB connection:

- Click **My Computer -> Manage** -> **Computer Management.**
- Go to **System Tools** -> **Device Manager**
- Click on BST board and check for the USB connection.

Sometimes, data transfer between PC and application board does not work despite the USB device being properly enumerated in the Device Manager.
This could be because the application board is older or that the USB PID and VID have been used with that computer before. In this case, Windows is unable to install the required drivers automatically.
Follow these steps to check the USB connection:

1. Right-click on the USB-device corresponding to your application board (if you are not sure which device corresponds to your application Board, unplug all other USB devices like keyboard and mouse temporarily).

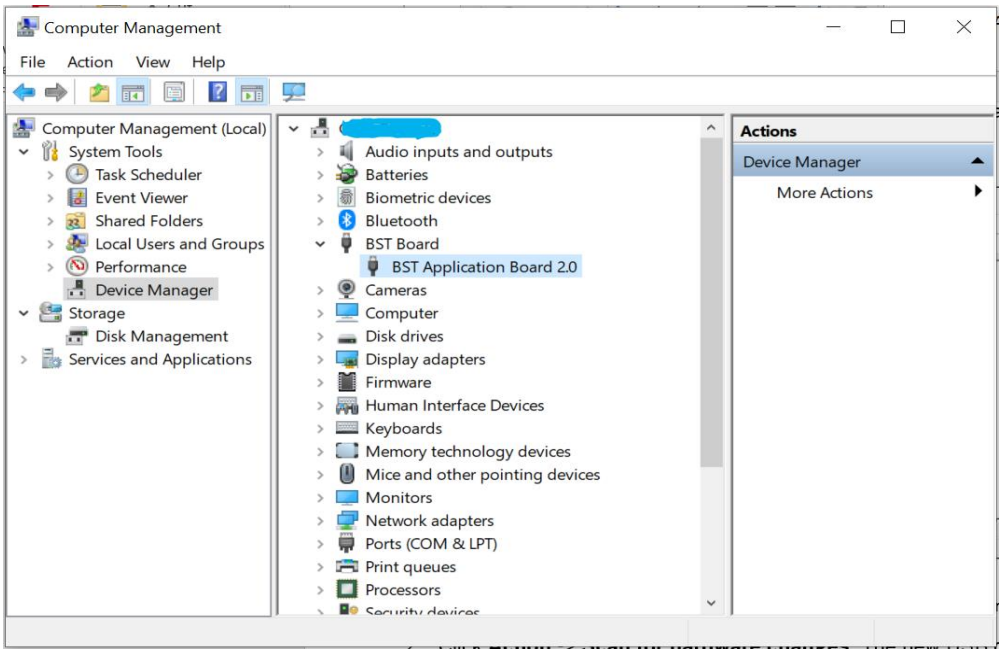


Figure 36 : Selecting USB device

2. Click **Action** -> **Scan for hardware changes**. The new USB driver is installed automatically. Thereafter, the device communication will function properly.

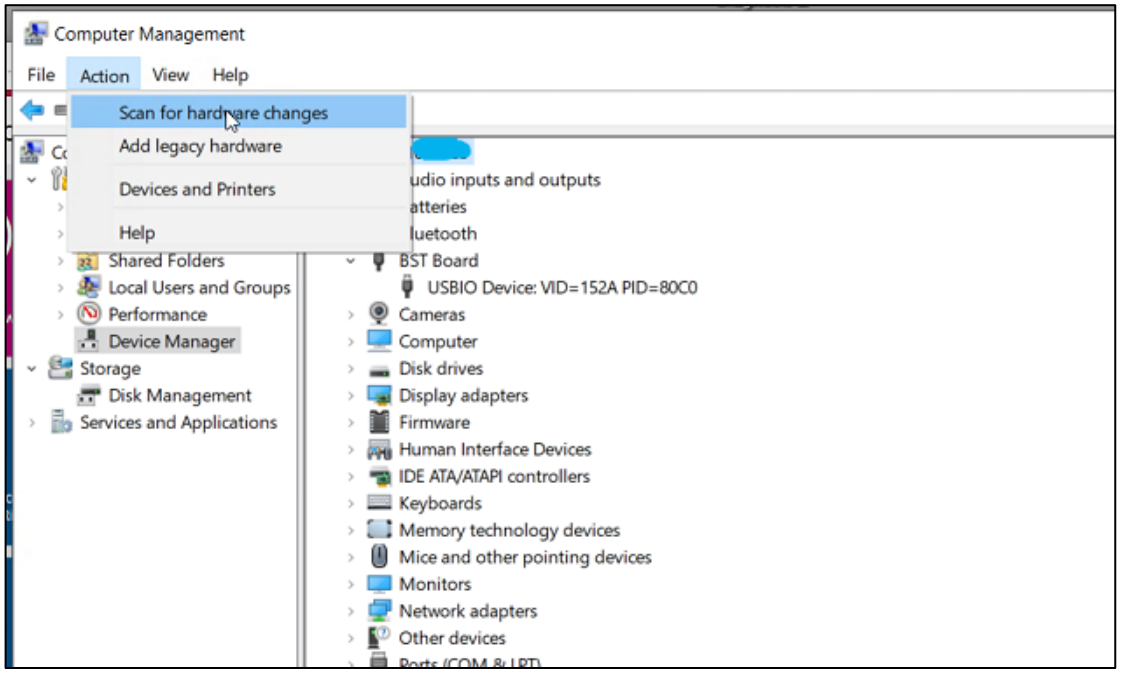


Figure 37 : USB driver Installation

The following table lists some of the possible faults that you might encounter and the troubleshooting method

Table 2: Possible Scenarios

Condition	Possible cause	Solution
If **Communication Status** remains grey red after checking the **Start** Button.	Application Board is turned off.	**Power on** the application Board and restart the DD2.1 application. If the board is powered by rechargeable battery, ensure that the battery is charged.
Unable to locate the data logged file.	Destination path not properly defined.	Locate the file in the setup path of Development Desktop**.**
Error message **Please connect application Board** is displayed.	Application Board is not connected properly.	Ensure that the PC is connected with the application Board properly. If the board is powered by rechargeable battery, ensure that the battery is charged.
Error message **Please connect Shuttle Board** is displayed.	Shuttle Board is not fixed properly.	Ensure that the Shuttle Board is correctly fixed in the Development Board.
Error message **Please select a path or file for logging** is displayed.	Destination path for saving the logged data is not defined.	Select the **Data Export** option in the file menu and specify the destination path.
Error message **Please select File from File Menu → Data Export option to proceed** is displayed.	Destination path not selected.	In the file menu, select the **Data Export** option and select the destination path.
Error message **Please Connect Valid Sensor** is displayed.	Wrong sensor fixed on the application Board.	Ensure that correct sensor is fixed on the application Board.
Graph for x, y, z channel not plotted.	Channel x, y, z not checked.	Ensure that x, y, z channels are checked.

5 Legal disclaimers

5.1 Engineering samples

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5.3 Application examples and hints

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6 Document history and modifications

Table 3: Revision History

Rev. No	Chapter	Description of modification/changes	Date
1.0		Document creation	21 Aug 2020
1.1		Updated DD application version	7 April 2023

Bosch Sensortec GmbH
Gerhard-Kindler-Straße 9
72770 Reutlingen / Germany

contact@bosch-sensortec.com
www.bosch-sensortec.com

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