# **Development Desktop 2.1** User Manual





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BST-VSP-QG000-00

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# **Table of Contents**

1	About this user manual
1.1	Who should read this user manual?
1.2	DD 2.1 Overview
1.3	Sensor Communication
1.4	Graphical display8
1.5	Data logging
1.6	Key Features of DD 2.1
2	Installation9
2.1	System requirements9
2.2	Installing the software9
2.3	Installing App Board USB Drivers
2.4	Uninstalling DD 2.1
2.5	Setting up the board-PC connection15
2.6 2.6.1 2.6.2 2.6.3 2.6.3.1	Startup View
2.6.3.2	Selecting the sensor data/sample representation unit
2.6.3.3	From the Interrupt menu, select the interrupt status lines
2.6.3.4	Selecting color
2.6.3.5	Graph Utilities
3	Key Terms
4	Accelerometer
5	Gyroscope
6	Magnetometer
7	Pressure Sensors
8	Humidity Sensors
9	Altitude Sensors
10	Gas/Air Quality
10.1	Gas resistance
10.2	Indoor Air Quality (IAQ)
11	BHY (Smart) Sensor

11.1	Virtual Sensor in General Settings	. 33
11.2	System in General settings	. 33
11.3	Download the firmware image for BHY	.35
11.4	Register Map	. 37
11.5	System Parameters Map	. 37
11.6	Algorithm Parameters Map	. 38
11.7	Sensor Parameter Map	. 39
11.8	Soft Pass-Through Parameters Map	. 40
11.9	Batching Panel	. 41
12	Temperature Sensors	. 42
13	DD 2.1 GUI common features	. 43
13.1	File	. 43
13.2	Interface selection	
13.2.1	Board communication	
13.3	Sensor Interface	
13.4 13.4.1	Panels Sensor Events and Meta Events	
13.4.2	Reset	. 47
13.4.2.1	PO Reset (Power On Reset)	
13.4.2.2	Soft Reset	
13.4.3 13.4.4	Data Export Memory Map	
13.4.4.1	Binary View	
13.4.4.2	Self-Test View	. 49
13.4.4.3	Register Access	. 50
13.4.4.4	FIFO view	. 51
13.4.4.5	FIFO Streaming	. 52
13.4.4.6	FOC View	. 53
13.4.4.7	G Trigger	. 54
13.4.4.8	CRT (Component Re-Trim)	. 54
13.4.4.9	GBIST (Gyroscope Built-in Self-Test)	. 55
	User Gain update	
13.4.4.11	Interrupts	. 56
	Interrupt View	
	Interrupt Streaming	
	Context Selector/Device initialization	
13.4.4.15	Offset View	. 58
14	Additional GUI Features	. 60
14.1	Roger	. 60

16	References	78
15.2	EEPROM flash on new shuttle board	76
15.1.1.3	Upgrade Firmware	76
15.1.1.2	Update USB Driver	73
15.1 15.1.1 15.1.1.1	How do I know if the Bosch Sensortec board is recognized? How do I list the Bosch Sensortec board under Device Manager? Check the PC-Board Connection	73
15	Troubleshooting Procedure	72
14.6	TDM interface	71
14.5	Out of Range Detection	71
14.4 14.4.1 14.4.2	Head Orientation Steps to Calibrate in BMI290 Steps to Calibrate in BHI360	66
14.3	3D Compass	65
14.2	Shark	64
14.1.1.3	Roger and Pressure	64
14.1.1.2	Roger and Temperature	63
14.1.1 14.1.1.1	Roger and IAQ Roger and Relative Humidity	

# **List of Figures**

Figure 1: Installation setup window	9
Figure 2: License agreement	10
Figure 3: Select destination to save DD 2.1 software	11
Figure 4: Select the Start Menu folder	11
Figure 5: Install DD 2.1	
Figure 6: Installation completion dialog	13
Figure 7: Device driver installation wizard	13
Figure 8: Complete installation wizard	14
Figure 9: DD 2.1 uninstall window	
Figure 10: Connecting the shuttle board onto the APP3.1	15
Figure 11: Connect the board and PC	15
Figure 12: Startup view of BMI270	16
Figure 13: Startup view of BHI260AP Sensor	
Figure 14: Firmware mismatch window	
Figure 15: Firmware upgrade window	18
Figure 16: Firmware upgrade completed	19
Figure 17: VDD/VDDIO option	20
Figure 18: Selecting the data channel	20
Figure 19: Selecting data representation unit (accel, gyro, and mag)	20
Figure 20: Selecting the interrupt status line	21
Figure 21: Selecting color	21
Figure 22: Graph Utilities	22
Figure 23: Filter performance values in BMI270	23
Figure 24: Accelerometer settings	25

Figure 25: Gyroscope settings in IMU sensor	25
Figure 26: Magnetometer settings in the BMM350 sensor	
Figure 27: Pressure Settings	
Figure 28: Sea level pressure and altitude calibration	27
Figure 29: Pressure plotter	
Figure 30: Relative humidity plotter	
Figure 31: Altimeter	29
Figure 32: Altitude plotting in sensor mode	29
Figure 33: Gas resistance plotter in BME680	30
Figure 34: Values captured in BME680 General settings	30
Figure 35: IAQ in BME680	
Figure 36: Mode selection in BME680	
Figure 37: General Settings in the BME68x sensor (sensor mode)	32
Figure 38: Virtual Sensor in BHY(smart) sensors (Read Info & Write Info) tab	
Figure 39: General settings for BHY sensors (smart sensors)	
Figure 40: Firmware download in Progress for BHI260AP	
Figure 41: Firmware downloaded completed for BHI260AP	
Figure 42: Virtual Sensor Plotter for smart sensors in BHI260AP	
Figure 43: Binary View for BHY/smart sensors (BHI260AP)	
Figure 44: Register map view in BHI260AP	
Figure 45: System Parameters Map view in BHI260AP	20
Figure 46: Algorithm Parameter Map view in BHI260AP	
Figure 47: Sensor Parameter Map view in BHI260AP	
Figure 48: Soft Pass-Through Parameters Map view in BHI260AP	40 11
Figure 49: Batching panel from BHI260AP	41
Figure 50: Temperature plotter	
Figure 51: Temperature	42
Figure 52: Communication Interface	
Figure 53: Communication Status	
Figure 54: Sensor Interface selection I2C	
Figure 55: Sensor Interface Selection SPI	
Figure 56 : Panels menu for BHI260AP	
Figure 57: Panels menu for BME680	
Figure 58: Sensor Events and Meta events	
Figure 59: Data Export view	
Figure 60: Memory Map	
Figure 61: Binary View	
Figure 62: Selftest View	49
Figure 63: Selftest View results in BMA530	
Figure 64: Register Access (8 bit)	
Figure 65: Register Access for BMA5xy/BMI3xy	
Figure 66: FIFO View in BMA5xy	
Figure 67: FIFO View in BMI270	
Figure 68: FIFO streaming in BMA5xy	53
Figure 69: Data Streaming in BMA5xy	53
Figure 70: FOC View	54
Figure 71: G Trigger	54
Figure 72: CRT view In BMI270	55
Figure 73: CRT in BMI3xy	55
Figure 74: Gyro BIST	55
Figure 75: User Gain Update	
Figure 76: Accelerometer interrupts	
Figure 77: Interrupt View for BMA530	
Figure 78: Context Selector in BMA530 in General Settings	
Figure 79: Context Selector in BMI323 in General Settings	
Figure 80: Device Initialization in BMI270	
-	

Figure 81: Offset View	
Figure 82: Offset View in BMI3xy	.59
Figure 83: Roger	.60
Figure 84: Roger settings	.61
Figure 85: Bad IAQ in Roger	
Figure 86: Very high relative humidity in Roger	.62
Figure 87: Very high temperature in Roger	
Figure 88: In-range pressure in Roger	
Figure 89: Shark view from BHI360	.65
Figure 90: 3D Compass	
Figure 91: Calibrate popup window	.66
Figure 92: Gyro FOC in progress	
Figure 93: Accel FOC	
Figure 94: Calibration Failed	
Figure 95: Calibration Success	
Figure 96: Configuration Panel in BMI290	
Figure 97: Head orientation calibration	
Figure 98: OOR with external magnetic field	
Figure 99: TDM Feature in BMA550	
Figure 100: Communication Interface dialog	
Figure 101: Showing Hidden Devices	
Figure 102: View Devices by container	.74
Figure 103: Device Manager (when drivers are not installed)	.75
Figure 104: Device Manager (when the correct driver is installed)	.75
Figure 105: Boot-mode detected	.76
Figure 106: EEPROM to be flashed	
Figure 107: EEPROM Failed	
Figure 108: EEPROM Success	
Figure 109: RAM Update	
Figure 110: Output in Configuration Panel	.80

# **List of Tables**

Table 1: Graph utility description	
Table 2: IAQ and Roger's Skin Colour	
Table 3: Relative Humidity and Roger's Skin	
Table 4: Temperature and Roger's Lip Colour	
Table 5: Temperature Range details	

# Acronyms and abbreviations

APP3.X: APP3.0: APP3.1: CRT : DD : EMC : FOC : FIFO : GBIST : HW : IAQ : IMU : I2C : NVM :	Application Board 3.0 and Application Board 3.1 Application Board 3.0 Application Board 3.1 Component Re-Trim Development Desktop Electromagnetic Compatibility Fast Offset Compensation First In First Out Gyro Built In Self-Test Hardware Indoor Air Quality Inertial Measurement Unit Inter-Integrated Circuit Non-Volatile Memory
	-
ODR : OSR :	Output Data Rate Over Sampling Rate
POR :	Power On Reset
SPI :	Serial Peripheral Interface
VDD :	Voltage Drain to Drain
	•
VDDIO :	Voltage Drain to Drain Input Output
VOC :	Volatile Organic Compounds

# 1 About this user manual

This user manual describes the installation and use of the Development Desktop 2.1 Software (DD 2.1), which is a Windows-based PC software application developed by Bosch Sensortec. DD 2.1 can only be used in connection with Bosch Sensortec engineering boards (called Application Boards) and sensor shuttle boards.

### 1.1 Who should read this user manual?

This user manual is intended for users who want to evaluate Bosch Sensortec sensors with the Application Board and shuttle board offered by Bosch Sensortec.

### 1.2 DD 2.1 Overview

Bosch Sensortec sensors are mounted on sensor-specific shuttle boards. All sensor shuttle boards have an identical footprint and can be plugged into the Application Board's shuttle board socket. DD 2.1 is a PC-based software that reads, captures, and displays sensor samples. DD 2.1 automatically detects the sensor plugged in and starts the corresponding software application.

### 1.3 Sensor Communication

DD 2.1 software supports both SPI and I2C to communicate with the sensor.

### 1.4 Graphical display

DD 2.1 displays the sensor samples and interrupts in different graphical formats.

### 1.5 Data logging

DD 2.1 offers logging of the sensor samples in .txt or.csv file formats.

### 1.6 Key Features of DD 2.1

The key features of DD 2.1 are below:

- USB 2.0/USB 3.0 full-speed interface to Bosch Sensortec Application Board.
- Visualize real-time sensor signal and monitoring.
- Sensor data/sample acquisition
- Sensor configuration and register access.
- Interrupt configuration and monitoring
- Firmware upgrade via USB/COM
- On-the-fly change of the SPI/I2C Interface of the sensors

# 2 Installation

The procedure to install DD 2.1 is described in this section.

### 2.1 System requirements

The PC on which DD 2.1 will be installed needs to have the following requirements:

- Operating system: Windows 10 (64-bit)/Windows 11
- Memory: 1 GB
- **Processor**: 1 GHz or higher (Recommended)
- Host controllers: USB 2.0, USB 3.0

### 2.2 Installing the software

Follow the steps below to download and install DD 2.1:

- To download the Development Desktop software from the Bosch Sensortec tools website <u>Bosch</u> <u>Sensortec Development Desktop</u>, users must provide the required fields and agree to the license agreement.
- 2. Users will receive a link via email to download a Zip file which contains the executable.
- 3. Extract the zip file and Double-click the *DevelopmentDesktop21\_VX.X.exe* icon to install.
- 4. Follow the instructions from the Setup Wizard.
- 5. Read the text in the introduction dialog and click **Next**.

🛃 Setup - Development Des	sktop 2.1 – 🗆 🗙
	Welcome to the Development Desktop 2.1 Setup Wizard
	This will install Development Desktop 2.1 version 3.26.3.2 on your computer.
	It is recommended that you close all other applications before continuing.
	Click Next to continue, or Cancel to exit Setup.
	Next > Cancel

Figure 1: Installation setup window

6. From the License Agreement dialog box, read the license agreement and select I accept the agreement only if you agree to the license agreement and Click Next.



Figure 2: License agreement

- 7. By default, DD 2.1 installs in <u>C:\Program Files\Bosch Sensortec\Development Desktop 2.1</u> (Recommended). Click **Browse** to change the destination directory.
- 8. Click Next.
- 9. From the **Select Destination Location** dialog box, select the destination folder to save the DD 2.1.

🔀 Setup - Development Desktop 2.1	_		×	
Select Destination Location Where should Development Desktop 2.1 be installed?				
Setup will install Development Desktop 2.1 into the follo	wing fol	der.		
To continue, click Next. If you would like to select a different fold	der, clic	k Browse.		
C:\Program Files\Bosch Sensortec\Development Desktop 2.1		Browse		
At least 263.2 MB of free disk space is required.				
< Back N	lext >	Ca	incel	

Figure 3: Select destination to save DD 2.1 software

10. Select the folder name for the DD 2.1 shortcuts and click Next.

Setup - Development Desktop 2.1		_	-	×
Select Start Menu Folder Where should Setup place the program's sho	rtcuts?			Ð
Setup will create the program's shortc	uts in the follo	wing Start Me	nu folder.	
To continue, click Next. If you would like to s	select a differer	nt folder, click	Browse.	
Development Desktop 2.1			Browse	
	< Back	Next >	(	Cancel

Figure 4: Select the Start Menu folder

11. From the **Ready to Install** dialog box, click **Install**.

👘 Set	up - Development Desktop 2.1		—		$\times$
	ady to Install Setup is now ready to begin installing Develo computer.	pment Desktop 2.	1 on your	Q	
	Click Install to continue with the installation, change any settings.	or click Back if you	u want to review	v or	
	Destination location: C:\Program Files\Bosch Sensortec\Deve	lopment Desktop :	2.1	^	1
	Start Menu folder: Development Desktop 2.1				
	<			>	
		< Back	Install	Car	icel

Figure 5: Install DD 2.1

12. The Application Board USB drivers will be automatically enabled by default and are recommended to be installed to connect to the Application Board.

Install App Board USB driver – To install the default driver and display the Bosch Sensortec name on the COM port for APP3.X boards.

To exit the installation completion dialog, click **Finish**.

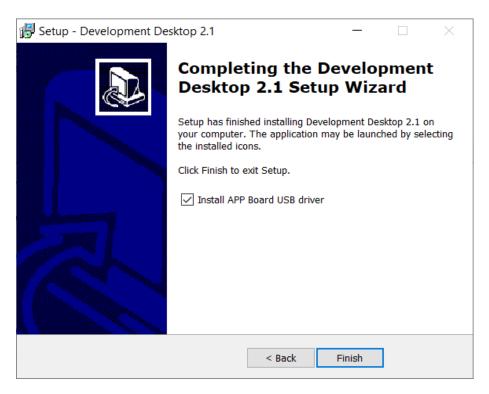


Figure 6: Installation completion dialog

### 2.3 Installing App Board USB Drivers

1. The Device Driver Installation Wizard appears after the DD 2.1 setup Wizard is completed. Click Next to set the completion panel.

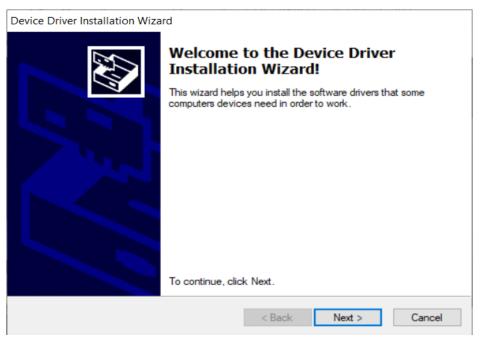


Figure 7: Device driver installation wizard

2. Click on **Finish** to complete the Device Driver installation wizard, which will show the USB/COM port names as Bosch Sensortec GmbH.

Device Driver Installation Wiz	Completing the De Installation Wizard		
	The drivers were successfully in	stalled on this comput	er.
	You can now connect your devi came with instructions, please re		f your device
	Driver Name ✓ Bosch Sensortec GmbH	Status Ready to use	^
	<ul> <li>✓ Bosch Sensortec GmbH</li> <li>✓ Bosch Sensortec GmbH</li> </ul>	Ready to use	~
	< <u>B</u> ack	Finish	Cancel

Figure 8: Complete installation wizard

### 2.4 Uninstalling DD 2.1

The uninstall program removes all the system's DD 2.1 components. It removes the DD 2.1 software files, directories, folders, and registry key items.

Perform the following procedure to uninstall the DD 2.1 software:

- 1. Close DD 2.1.
- 2. Click Start > Development Desktop 2.1 > Uninstall Development Desktop 2.1.
- 3. The uninstaller dialog box appears. Click **Yes**.

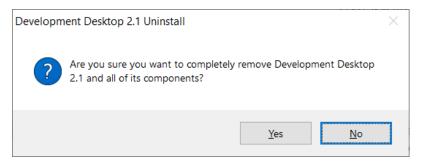


Figure 9: DD 2.1 uninstall window

### 2.5 Setting up the board-PC connection

The user needs to follow this procedure to connect the sensor shuttle board to the PC.

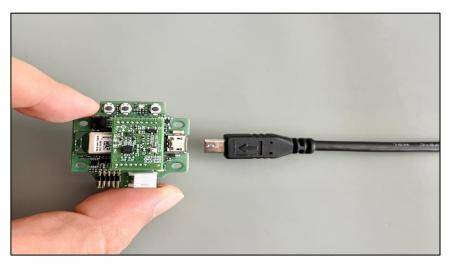


Figure 10: Connecting the shuttle board onto the APP3.1

- 1. Insert the shuttle board onto any Application Board.
- 2. Connect the APP3.X and PC using a Micro USB cable.

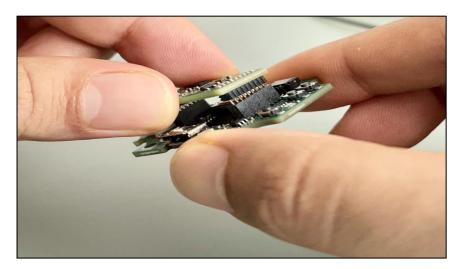


Figure 11: Connect the board and PC

The connection is complete, and the Application Board will be turned ON.

### 2.6 Startup View

To start the DD 2.1 application:

#### 1. Click Start > Programs > Development Desktop 2.1, or

Double-click the DD 2.1 software icon on the **BBOSCH** desktop.

desk

Depending on its features, the DD application's GUI will differ for different sensors. The landing page will be similar for all sensors, as shown below Figure for the BMI270 sensor.

Bosch Sensortec		BOS Invented
olerometer	General Settings	(
🕇 + 🐼 🔍 🖓 🚺 🖡 🖪 🛆 Axes - Units - Color - Reset	Accelerometer Gyro	scope
8.00 1	Accelerometer sett	ings
7 500 -	ODR	100 Hz
6500 m		100112
6 000 🖞	Bandwidth	Normal mode •
5.500 <sup>4</sup> 5.000 <sup>4</sup>		
4500 1	Filter Performance	Performance Optimized
4.000 #	Range	8g 💌
3500 4	Karge	og []
2.500 -	Accelerometer sam	olion rate
2.000 ក្ន		
1500	Default     O	Custom 100 Hz
0,500 -		
0 000 1	Sensor Settings	
-0.500	Interrupt Streaming	
1500 -	Advance Power Save	
-2.000 개	Accelerometer Enable	e 🗵
-2.500		
-3.000 ਵ -3.000 ਵ	Magnetometer Enabl	
-4.000 🗄	Gyroscope Enable	
-4.500 - -5.000 -	Temperature Enable	
-3.00 g -3.00 g 	Device Initialization	
-6.000 -		
4500 T	<ul> <li>Wearable Gesture</li> </ul>	is Recognition
-7.000 - -7.500 -	O Context & Activity R	Recognition
-8.000	<	i cogniseri

Figure 12: Startup view of BMI270

Below Figure shows the landing page for BHY sensors (smart sensors)

Development Desktop 2.1 - BHI260AP			- 0 ×
File Interface Selection Panels Settings Help			
Bosch Sensortec			BOSCH
		_	Invented for life
Accelerometer			General Settings
🔢 + 🐼 🔍 🗨 📕 🖪 🖻 🗎 Axes - Color - Reset Sensor Status	• all		System Virtual Sensor
100.0 -			Plot1
80.0 -	S Download firmware image for BHI260AP	×	Plot2
400 - 200 - 00 -	Select location to write the firmware  RAM		Plot3
			Active Virtual Sensors
Magnetometer	Hardware version           Product ID :         0x0089         Revision ID :         0x0002		Application processor suspended FIFO Watermark
100.0	Firmware version ROM Version : 0x142E Kernel Version : 0x0000		Wakeup Watermark 0  Size bytes Non-Wakeup Watermark 0  Size bytes
600 - 400 -	Select.fw file :		Write
200 - 00 -	Download	_	Physical sensor working status Accelerometer Magnetometer Gyroscope
Gyroscope			Sampling Rate
III + 🐼 🔍 🔍 📕 🕅 🖳 🛆 Axes - Color - Reset Sensor Statu			Range Power Mode
100.0 -	•		Interrupt Enable
80.0 - 60 0 -			
40.0 -			Error Indicator Orientation
20.0 - 0.0 -			Roll Degree Pitch Degree
Start Streaming			Connection status 📀

Figure 13: Startup view of BHI260AP Sensor

Note: The communication status is indicated at the bottom right of the GUI:

Connection status | 🔘

Other menu options include:

- File
- Interface Selection
- Panels
- Settings
- Help

#### 2.6.1 Upgrading the Firmware

The DD 2.1 application requires Bosch Sensortec APP3.X hardware, which should have relevant firmware (COINES Bridge firmware) flashed in it.

By default, the Application Board might have different firmware flashed in it, and each DD application might recommend that the user upgrade to the appropriate supported firmware.

To upgrade the firmware of DD 2.1 to match the current version, follow the steps below:

If the firmware flashed to the Application Board and DD 2.1 is incompatible, an information message will be displayed as shown in below Figure.

- Ignore: To resume with the available firmware in the app board, click Ignore. (Note: The firmware can also be updated from Menu > Settings > Firmware Upgrade).
- **Upgrade**: To flash the required firmware file (which varies based on the installer variant), click **Upgrade**.
- Exit: To close the DD application, click Exit.

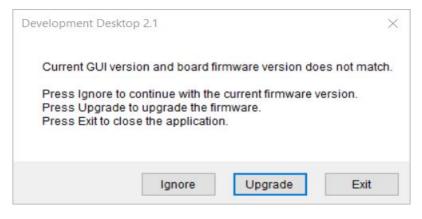


Figure 14: Firmware mismatch window

- 1. From the **Firmware Update** dialog, select the **RAM** or **FLASH** option to flash the latest recommended firmware file.
  - RAM is for temporary flashing of the firmware in the app board, which resets to the old firmware when the app board is reset.
  - FLASH is for permanent flashing of the firmware in the app board, which will be retained even after the app board is reset.
- 2. The file path will be automatically chosen/selected in the **select firmware file** path textbox (Recommended). The user can also select the firmware as required.

Memory :	RAM	⊖ FLASH
Select firmware file :	C:\Program	Files\Bosch Sensortec\Development Desktop 2.1\Firmware\AP
Communication interface	COM4	
	Update	

#### Figure 15: Firmware upgrade window

DD 2.1 recommended firmware is COINES\_bridge\_flash\_firmware/COINES\_bridge\_ram\_firmware for APP3.1. If the user chooses to flash DD firmware, a popup message will be shown that DD firmware (DevelopmentDesktop\_2.1\_Firmware\_v1.9.bin) might not work as expected for all the features, where users still have the option to flash DD firmware.

3. Click **Update**.

**Note**: Default firmware file (\*.bin) will be automatically chosen from the DD 2.1 installation directory in the folder Firmware **App3.1** for APP3.1 & **Firmware App3.0** for APP3.0.

4. Once the firmware update is completed, close the popup, and the DD 2.1 application will automatically reload.

Memory :	RAM	⊖ FLASH
Select firmware file :	C:\Program	Files\Bosch Sensortec\Development Desktop 2.1\Firmware\AP
Communication interface:	COM4	
	Update	

Figure 16: Firmware upgrade completed.

### 2.6.2 VDD/VDDIO

User can change the Voltage Power supply(VDD/VDDIO) to the shuttle board from **Menu** > **Settings** > **VDD/VDDIO** or click **Ctrl+Shift+V.** VDD/VDDIO can be entered in steps of 100mV power supply. This feature is applicable only for APP3.1 Board.

VDD/VDDIO		_		1
Enter VDD value in	the range 1	710mV to	3600m	v
VDD	1800	mV		
Enter VDDIO value	in the range	1080mV	to 1980r	πV

Figure 17: VDD/VDDIO option

### 2.6.3 Changing the graph settings

This section describes the different graph settings options in the application.

2.6.3.1 Selecting the data channel

To select the signals (X, Y, and Z) shown on the graph, perform **Channel Selection**. By default, all channels are displayed. From the **Axes** menu, select the axes to show them or unselect the axes to hide them.

Axe	s 🔹 Units 🝷
~	X axis
~	Y axis
~	Z axis

Figure 18: Selecting the data channel

#### 2.6.3.2 Selecting the sensor data/sample representation unit

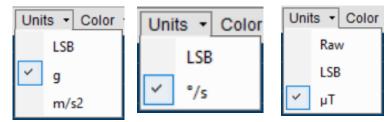


Figure 19: Selecting data representation unit (accel, gyro, and mag)

From the **Units** menu, select any of the units for the connected Sensor. Available units are:

- LSB
- g
- m/s<sup>2</sup>

- Interrupt Color Re Interrupt 1 Interrupt 2 Any\_motion No\_motion Low\_G Single Tap Double Tap Triple Tap VAD Self Wake-up
- 2.6.3.3 From the Interrupt menu, select the interrupt status lines.

Figure 20: Selecting the interrupt status line

The sensor interrupt status lines can be monitored on the plotter by enabling the interrupts from the **Interrupt** menu on the graph. Similarly, based on the individual sensor features, the interrupt status line can be enabled/disabled from the **Interrupt** menu on the plotter.

#### 2.6.3.4 Selecting color

Color - Reset
X axis
Y axis
Z axis
Interrupt 1
Interrupt 2

Figure 21: Selecting color

Different colors are used to distinguish between the three axes' signals in the plotted graph. These colors and the graph's background color can be modified using **Channel Selection**.

#### 2.6.3.5 Graph Utilities

The sensor samples can be analyzed using graph features like Play/Pause, view history, graph speed, Zoom In/Out, zoom specific areas in the graph, and an option to save the snapshot and print. The graph utilities shown in below Figure enhance the user experience.



Figure 22: Graph Utilities

#### Table 1: Graph utility description

	Sensor sample plotting is paused. Click this button to view the sensor samples in the plotter.
Η	Sensor samples are plotted on the graph. Click this button to pause the sensor samples.
+	Scroll the graph to view the history.
*Ç*	Zoom in/out of the X-axis to control the speed of samples plotted
¢	Zoom in
Q	Zoom out
	Zoom in a particular area of the graph
Ψ.	View the X and Y values on the graph.
	Save the current instance of the graph.
a.	Print previews the current instance of the graph.
A	Print the current instance of the graph.

## 3 Key Terms

Below are some of the key terms used in this user manual.

ODR stands for "Output Data Rate" in the context of sensors. It refers to the rate at which a sensor provides samples or measurements as output. ODR specifies how often the sensor updates and reports its readings, typically in measurements per second (e.g., Hertz - Hz). Some of the sensors will have the ODR as "Sample Rate".

In an accelerometer or gyroscope, an ODR of 100 Hz means the sensor provides 100 samples per second, and each data point represents the sensor's measurements at that moment in time. Adjusting the ODR can impact the sensor's power consumption, data accuracy, and the number of samples it generates, making it an important setting when using sensors in various applications.

 Bandwidth refers to the range of frequencies of motion or vibration the sensor can effectively detect. It affects the sensor's ability to accurately capture high-frequency or rapid changes in motion.

- Power Mode in sensors refers to different operating states or configurations that determine the sensor's power consumption and performance characteristics. These modes are used to optimize the sensor's behaviour based on the specific requirements of an application. Power modes supported in Bosch Sensortec sensors are below:
  - Low-Power mode is designed for minimal power consumption. It allows the sensor to operate with reduced power usage while sacrificing some performance features. This mode is often used when extended battery life or energy efficiency is a priority.
  - **Normal mode** has the sensor operate with a balance between power consumption and performance. This mode provides adequate sensitivity and accuracy for many common applications without excessive power drain.
  - **High-Performance mode** maximizes the sensor's data accuracy and output frequency capabilities. It's typically used when precise measurements or rapid data updates are essential, even if it means higher power usage.
  - **Suspend mode** is the lowest power state, often used when the sensor must be on standby but maintain its configuration. Power consumption is minimized in this mode, and the sensor can quickly return to an active state when required.
  - **Sleep mode** puts the sensor in a sleep state such that no measurements are performed, and there is minimal power consumption. A sensor usually starts in sleep mode after the power-up sequence.
  - Non-stop mode applies only to the BMP580 sensor, where repetitive measurements can be done without duty cycling.
  - **Forced mode** also allows triggering new measurements at any rate, depending on the sensor feature. In force mode, the sensor will wake up from sleep mode, read the data, and return to sleep mode.

The BMM350 sensor has two flavors: "Forced Mode" and "Forced Mode Fast." It is possible to switch to Forced Mode from Suspend Mode only.

• **Filter Performance** refers to the effectiveness of the filters or signal processing techniques employed to remove unwanted noise, interference, or artifacts from the sensor's raw data. The term "filter" can refer to hardware (analog or digital filters) and software-based algorithms used to enhance the quality and accuracy of the sensor's output.

Filter Performance	Performance Optimized
	Power Optimized
	Performance Optimized

Figure 23: Filter performance values in BMI270

If the user selects any **Filter Performance** option, such as **Power Optimized** or **Performance Optimized**, the sensor's other configurations, bandwidth, range, and ODR will be changed accordingly without user intervention.

Filter performance is crucial in various sensor applications, such as accelerometers, gyroscopes, and environmental sensors, as it helps do the following:

- **Reduces noise**: Filters can eliminate random or unwanted variations in the sensor data, making detecting meaningful patterns or changes in the measured parameter easier.
- **Improves accuracy**: By minimizing interference and noise, filter performance can enhance the precision and reliability of sensor measurements.
- **Enhances data interpretation**: Clear and filtered data allow for better analysis and interpretation, aiding in decision-making and problem-solving.
- Range refers to the sensor's measurement range or dynamic range. It specifies the minimum and maximum values that the sensor can accurately measure. The range is typically expressed in physical units (e.g., g/meters per second square/LSB for accelerometer and degrees per second for gyroscope). It determines the span of values within which the sensor can provide reliable and accurate measurements.
  - Accelerometer Range: If an accelerometer has a range of ±2 g (g represents the acceleration due to gravity), it can accurately measure accelerations ranging from -2 g to +2 g. Accelerations outside this range may result in distorted or clipped data.
  - **Gyroscope Range**: A gyroscope with a range of ±2000 degrees per second can provide accurate measurements of angular rates within the range of -2000 degrees per second to +2000 degrees per second.

# 4 Accelerometer

Bosch Sensortec has specifically designed the 3-axis accelerometer family for low-power applications optimized for devices such as smartphones and wearables. Accelerometers measure the change of linear motion by applying the sensing principle of capacitive detection.

- By default, the accelerometer plotter will be enabled and visible in the master view. To toggle the accelerometer plotter, select Menu > Panels > Accelerometer or click Ctrl+A.
- From the **general settings** tab, select **Accelerometer** (refer below Figure) to modify the accelerometer settings.

Page 25 | 81

#### Bosch Sensortec | Development Desktop User Manual

Accelerometer		
Accelerometer settings		
ODR	100 Hz 🔻	
Bandwidth	Normal mode 🔻	
Filter Performance	Performance Optimized 💌	
Range	4g 💌	
Accelerometer sampling rate		
● Default ○ C	ustom 100 Hz	

Figure 24: Accelerometer settings

# 5 Gyroscope

Gyroscopes are motion sensors that detect and measure an object's angular motion and orientation. Sensors with gyroscope features often share common settings such as power modes, Output Data Rate (ODR), bandwidth, filter performance, and range.

- In some cases, the gyroscope plotter is hidden by default. To toggle the Gyroscope plotter, navigate to Menu -> Panels -> Gyroscope, or click Ctrl+Alt+G.
- From the **general settings** tab, select **Gyroscope** to modify the gyroscope settings (refer below Figure).

Accelerometer Gyro	scope	
Gyroscope settings		
ODR	100 Hz 💌	
Bandwidth	ODR half	
Averaging Samples	No Averaging 👻	
Mode	Normal	
Range	2000 dps 🔻	
Gyroscope sampling rate		
● Default ○ Cu	stom 100 Hz	

Figure 25: Gyroscope settings in IMU sensor

### 6 Magnetometer

The magnetometer is a small, robust triaxial sensor measuring the terrestrial magnetic field at low power for heading calculation. It accurately measures orientation in relation to the Earth's magnetic field.

- The magnetometer plotter will be visible by default in some cases. To toggle the magnetometer plotter, select Menu > Panels > Magnetometer or click Ctrl+M.
- From the general settings tab, select Magnetometer to modify the magnetometer settings (refer below Figure)
- Data will be displayed only in the Forced Mode, as shown in below Figure.

neral Settings			
Magnetometer Set	tings		
Data Output Rate	12.5 Hz		
Power mode	Forced	Mode 🔻	
Averaging Samples	Average	e 2samples 🔻	
Note : Configuration set as per appropria			
Enable X axis			
Enable Y axis			
Enable Z axis			
х	Y	Z	
60.722	17.0332	23.7826	
Units uT 🔻	Force	Measurement	
		2	•

Figure 26: Magnetometer settings in the BMM350 sensor

### 7 Pressure Sensors

Bosch Sensortec low-power barometric pressure sensors stabilize the altitude and enable accurate indoor navigation and outdoor activities. Set different Oversampling Rates (OSR), and samples will be collected accordingly.

Calibration for sea level pressure is done by entering the reference sea level pressure, which only applies to the BMP58x sensor.

In some cases, the pressure plotter will be visible by default.

 From the general settings tab, select Pressure settings to modify the pressure settings (refer below Figure).

Absolute altitude	378.13	meter -
Sea level pressure	1013.25	hPa 🔻
Absolute pressure	968.648	hPa 🔻
Absolute temperature	30.18	°C ▼
UID	149494493042218	]
PO Reset		

Figure 27: Pressure Settings

Absolute altitude	378.13	meter -
Sea level pressure	1013.25	hPa 🔻
Absolute pressure	968.648	hPa 🔻
Absolute temperature	30.18	•C •
UID	149494493042218	]
PO Reset		

Figure 28: Sea level pressure and altitude calibration

Pressure	- O ×
🔢 + 🐼 🔍 🔍 📕 🖪 🛆 Color - Units - Reset Plotter mode - Interrupts -	
385.0 -	
384.0	
383.0 -	
bj 382.0 - e 381.0 -	
eg 380.0	
± 3/90 - ≺ 378.0 -	
377.0 -	
376.0 – 375.0 –	

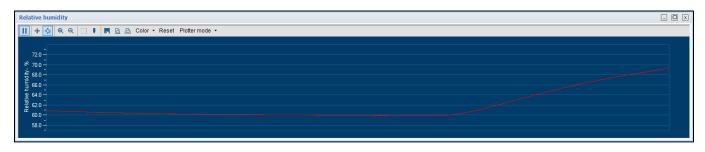
Figure 29: Pressure plotter

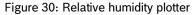
# 8 Humidity Sensors

Bosch Sensortec humidity sensors combine high linearity and high accuracy sensors and are perfectly feasible for low current consumption, long-term stability, and high EMC robustness. The humidity sensors offer an extremely fast response time, supporting performance requirements for emerging applications such as context awareness and high accuracy over a wide temperature range for environmental sensors.

A GUI named **Roger** is created to represent the humidity better, which can be referred to here.

- In some cases, the humidity plotter is visible by default. To toggle the humidity plotter, select Menu
   > Panels > Relative Humidity or click Ctrl+H.
- Humidity samples can be viewed in the plotter (refer below Figure), and the general settings will display the run-time value in a textbox, represented in %.





# 9 Altitude Sensors

Bosch Sensortec altitude sensors utilize barometric pressure changes to calculate relative altitude. The sensor provides accurate altitude readings by measuring changes in atmospheric pressure. View the readings in the Altimeter panel.

Altitude data can be viewed in the plotter as shown in below Figure, and it can also be viewed in a circular gauge by enabling it from **Panels** > **Altimeter** or clicking **Ctrl +Shift + D**.



Figure 31: Altimeter

In some cases, the altitude plotter will be visible by default (refer below Figure). To toggle the altitude plotter, select **Menu > Panels > Altitude** or click **Ctrl+P**.

Altitude	- O X
🔟 + 🐼 🔍 🔍 📕 🖻 🛆 Color - Units - Reset Plotter mode -	
4200 100 100 100 100 100 100 100	

Figure 32: Altitude plotting in sensor mode

# **10 Gas/Air Quality**

### 10.1 Gas resistance

Bosch Sensortec gas sensors are highly integrated four-in-one environmental sensors combining barometric pressure, ambient temperature, relative humidity, and gas measurement in one small package. Consider the following:

- Gas resistance range values will be different for the BME680 and BME688 sensors.
- Gas resistance can be viewed in the plotter, as shown in below Figure, and the general settings display the run-time value in a textbox.

The gas resistance plotter can be toggled by navigating to Menu > Panels > Gas or click Ctrl+Alt+G.

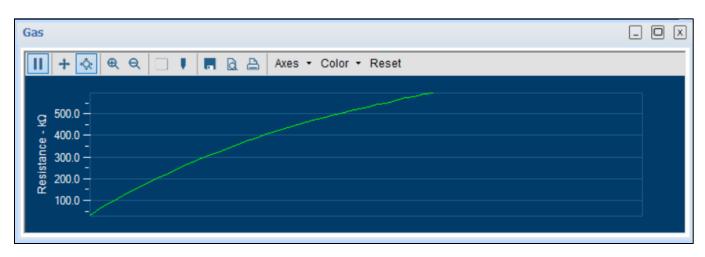


Figure 33: Gas resistance plotter in BME680

Absolute altitude	385.98	meter 💌
Sea level pressure	1013.25	hPa 🔽
Absolute pressure	967.7386	mmHg PSI
Absolute temperature	35.45	°C ▼
Relative humidity	61.85	%
Gas resistance	981.752	kΩ
PO Reset		

Figure 34: Values captured in BME680 General settings.

Select the **Sea level pressure** drop-down menu to select the unit for reading the sample (**hPa**, **mmHg**, or **PSI**).

### 10.2 Indoor Air Quality (IAQ)

Indoor Air Quality (IAQ) is an index used to measure the air quality inside closed environments to estimate the well-being of the occupants. The absolute IAQ values indicate the presence of volatile organic compounds.

- In some cases, the IAQ plotter is visible by default. To toggle the gas plotter, select Menu > Panels > IAQ or click Ctrl+I.
- View IAQ in the plotter as shown in below Figure, and a circular gauge is displayed in the General Settings for the BME680 sensor.

IAQ is calculated based on the BSEC algorithm. It's displayed in the circular gauge plotter in **General Settings** > **Measurement Settings** and shows values based on the air quality range. By default, the BME680 sensor has BSEC mode, which users can modify from **Panels** > **Mode selection settings**.

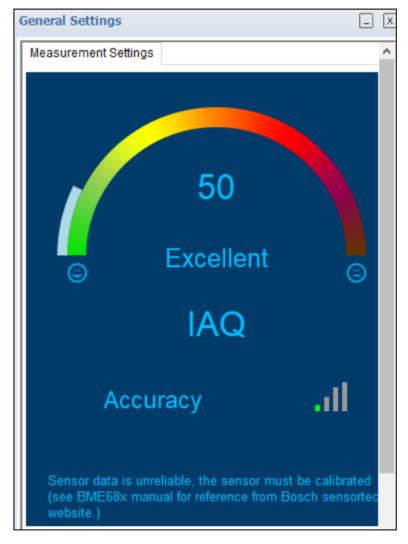


Figure 35: IAQ in BME680

There are two modes available in the **Mode Selection settings** dialog (refer below Figure):

• **Sensor Mode**: Raw samples from the connected virtual sensor are plotted directly. When switched to sensor mode, the **General Settings** dialog for the BME680 sensor has its sensor feature configuration, as shown in below Figures.

**BSEC Mode**: Raw samples are fed into the BSEC library, which processes input signals from the sensor and produces the required output, such as IAQ, Humidity, and Accuracy status.

The BME680 sensor in BSEC mode receives the samples based on the sampling mode chosen.

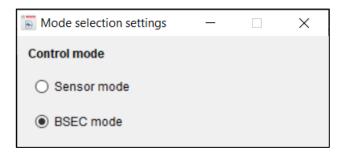


Figure 36: Mode selection in BME680

General Settings		_	X	G	eneral S	ettings		6	. x
Measurement Settings Profile	Settings		^		Measure	ement Settings	Profile Settings		^
Control Settings				Numbe	er of Conversions	b_conv = 0b0011)			
Humidity oversampling	OSx1 ▼				Index		Wait Time	Resistance	
Pressure oversampling	OSx2 ▼				muex	Temperature [°C]	[ms]	heat X	
Temperature oversampling	OS x 1 💌				0	200	100	82	
Mode	Sequential 🔻				1	250	152	95	
Run Gas					2	400	200	134	
Run Gas					3	0	0	0	
Force Measurement					4	0	0	0	
Configuration Settings					5	0	0	0	
Wake up period	0.59 ms 💌				6	0	0	0	
IIR filter coefficient	0 -				7	0	0	0	
					8	0	0	0	
Gas wait Shared time	0 ms				9	0	0	0	
Sampling Rate									
Default 8.8 Hz	O Custom 1 Hz	>			W	rite			

Figure 37: General Settings in the BME68x sensor (sensor mode)

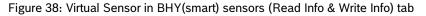
### 11 BHY (Smart) Sensor

### 11.1 Virtual Sensor in General Settings

Configure and view the virtual sensor parameter information for BHY (smart) sensors by selecting **General Settings**, where the user can configure and view the virtual sensor parameter information.

- From the **Read Info** tab, users can view the virtual sensor parameter details.
- From the **Write Info** tab, users can choose the virtual sensor and the Sample Rate (By default, 100Hz is selected and user must click on **Write** button to configure the sensor).

General Settings		[	. X	]	Ger	neral Settings		_ X
System Virtual Sense	pr		Â		s	ystem Virtual	Sensor	^
Virtual Sensor Step	Detector(Wakeup)	•	·			Virtual Sensor	Accelerometer Passthrough(Non-Wakeu	(q)
Read Info Write In	fo					Read Info W	rite Info	
SensorType	94					Sample Ra	te 100 Hz 🔻 Hz	
DriverID	230					Max Latency	y 0 ms	
DriverVersion	1					Sensitivity	0 for windows	
Power	0					Range	8 <b>v</b> g	
Max Range	1					Write		
Resolution	16							
Max Rate	1							
FIFO Reserved	0							
FIFO Max	9728	₽						
Event size	1							
Min Rate	1							
Deed	1							
Read								



### 11.2 System in General settings

Users can choose different plotters to view in the plotter and other options like updating the FIFO watermark level, disabling interrupt and general settings page.

All active virtual sensors will be listed from **General Settings** > **Virtual Sensor** > **Active Virtual Sensor** field.

System Virtual Sensor				
Plot1 Orientation(Non-Wakeup)				
Plot2 Rotation Vector(Non-Wakeup)				
Plot3 Accelerometer Passthrough(Non-Wakeup) 🔻				
Active Virtual Sensors Accelerometer Passthrough(Non-Wakeup)				
Application processor suspended				
FIFO Watermark				
Wakeup Watermark 0 🗘 Size 9728 bytes				
Non-Wakeup Watermark 0 Size 9728 bytes				
Write				
Physical sensor working status				
Accelerometer Magnetometer Gyroscope				
Sampling Rate 100 Hz				
Range 8 g				
Power Mode Active				
Interrupt Enable 🔘				
Error Indicator No Error				
Orientation				
Roll -77.9 Degree Pitch -178.6 Degree				
Heading 79.6 Degree				
Disable Interrupt Reset System Refresh				

Figure 39: General settings for BHY sensors (smart sensors)

#### 11.3 Download the firmware image for BHY

For smart sensors, users can download and flash the virtual sensors and view the sensor samples in the plotter. This firmware will be flashed in the shuttle board's microcontroller, and the corresponding virtual sensor is listed in the **General Settings**.

- 1. In **the Download firmware image for "sensor name"** dialog, go to the **Select the firmware (.fw)** field and select the appropriate file. Then, click **Download** to flash the firmware file in it. A confirmation message appears indicating the progress of the firmware download (see
- 2. Select one of two options: RAM or Flash
  - RAM: Firmware will be flashed in RAM location
  - Flash: Firmware will be flashed in Flash location

Once the firmware is flashed, the application will show a confirmation message, as shown in below Figure.

Download firmware image for BHI26	0AP	
Select location to write the firmware -		
⊚ RAM	) Flash	
Hardware version		
Product ID : 0x0089	Revision ID : 0x0002	
Firmware version		
ROM Version : 0x142E	Kernel Version : 0x0000	
	Kernel Version : 0x0000	
rmware download is in progress		

#### Figure 40: Firmware download in Progress for BHI260AP

Select location	to write the firmware	1	
RAM		) Flash	
Hardware versi	on		
Product ID :	0x0089	Revision ID : 0x0003	
Firmware versio	on		
ROM Version :	0x142E	Kernel Version : 0x1767	
Select .fw file : Downloa		APP30_SHUTTLE_BHI260_aux_BMM150.fw	

Figure 41: Firmware downloaded completed for BHI260AP

3. From **General Settings**, the user can choose the required virtual sensors and view the samples in the plotter, as shown in below Figure.

Development Desktop 2.1 - BHI260AP	- 0 ×
Elle Interface Selection Panels Settings Help Bosch Sensortec	BOSCH
	Invented for life
Accelerometer Uncalibrated (Non-Wakeup)	General Settings
III + ⊗        •	Plot3 Magnetometer Uncalibrated(Non-Wakeup)     Active     Vritual Sensors Accelerometer Uncalibrated(Non-Wakeup)     Active     Vritual Sensors Accelerometer Uncalibrated(Non-Wakeup)     FIFO Watermark     D     Size 9728 bytes     Non-Wakeup Watermark     O     Size 9728 bytes     Write
III +	Physical sensor working status       Accelerometer     Magnetometer       Gyroscope       Sampling Rate     100 Hz       Range     8 g       Power Mode     Active       Interrupt Enable     Interrupt Enable
Magnetometer Uncalibrated (Non-Wakeup)	Error Indicator No Error
11     + ⊗     €     ⊕     □     ■     ■     Ares • Color • Reset Sensor Status •1]       200.00     -     -     -     -     -       100.00     -     -     -     -       -     100.00     -     -     -       -     200.00     -     -     -	Orientation Roll Degree Pitch Degree Heading Degree Disable interrupt Reset System Refresh
Stop Streaming	Connection status 🧿

Figure 42: Virtual Sensor Plotter for smart sensors in BHI260AP

#### **Binary View in smart sensors (BHY)**

**Panels** > **Binary View** (refer below Figure) displays the mapping feature/functionalities where the user can view the register info and grouping of parameters.

Panels Settings Help			
	Download firmware image for BHI260AP	Ctrl+F	
>	General Settings	Ctrl+G	
	Register Access	Ctrl+R	
	Binary View	•	Register Map
Sen 3D ( Sha Hea	Batching Panel	Ctrl+B	System Parameters Map Algorithm Parameters Map
	SensorEvents and MetaEvents	Ctrl+M	
	3D Compass	Ctrl+C	Sensor Parameters Map
	Shark	Ctrl+H	Soft Pass-Through Parameters Map
	Head Orientation	Ctrl+O	
	Data Export	Ctrl+D	
	Default View Ctrl+	-Shift+D	

Figure 43: Binary View for BHY/smart sensors (BHI260AP)

Each mapping functionality is described in detail below.

#### 11.4 Register Map

The **Register Map** view dialog displays the list of register addresses and their values in decimal, Hex, and binary. It's only used for read operations. Click **Read** to view the Register Map (refer below Figure).

Address	value(decimal)	value(Hex)	value(binary)	^
0x07	68	0x44	01000100	
0x08	0	0x00	0000000	
0x09	0	0x00	0000000	
0x0A	0	0x00	00000000	
0x0B	0	0x00	00000000	
0x0C	0	0x00	00000000	
0x0D	0	0x00	00000000	
0x0E	0	0x00	00000000	
0x0F	0	0x00	00000000	
0x10	0	0x00	00000000	
0x11	0	0x00	00000000	
0x12	0	0x00	00000000	
0x13	0	0x00	00000000	
0x14	0	0x00	0000000	
0x15	0	0x00	00000000	
0x16	0	0x00	0000000	
0x17	3	0x03	00000011	
0x18	211	0xD3	11010011	
0x19	188	0xBC	10111100	
0x1A	19	0x13	00010011	
0x1B	11	0x0B	00001011	
0x1C	137	0x89	10001001	
0x1D	3	0x03	00000011	
0x1E	46	0x2E	00101110	

Figure 44: Register map view in BHI260AP

#### 11.5 System Parameters Map

The **System Parameters Map** dialog (refer below Figure) displays the parameter values (per the datasheet).

- 1. To select the system parameter to view its values, open the **System Parameter Map** dialog.
- 2. From the Param Selection section:
  - a. In the **Starting Param Number** field, select the parameter to start the value range.
  - b. In the **Ending Param Number** field, select the parameter to end the value range.
  - c. To update the parameter settings with your starting and ending selections, click **Update**.

**Note**: Only three parameters are displayed on the landing page by default.

Param Selection -				
Starting Param N	lumber 101 🖨 End	ling Param Number	103 🖨 Update	
Parameter No	Parameter value(decimal)	Parameter value(Hex)	Parameter value(binary)	^
101	42	0x2A	00101010	
	170	0xAA	10101010	
	130	0x82	10000010	
	202	0xCA	11001010	
	48	0x30	00110000	
	0	0x00	0000000	
	0	0x00	0000000	
	0	0x00	0000000	
102	42	0x2A	00101010	
	170	0xAA	10101010	
	130	0x82	10000010	
	202	0xCA	11001010	
	48	0x30	00110000	
	0	0x00	0000000	
	0	0x00	0000000	
	0	0x00	0000000	
103	0	0x00	0000000	
	0	0x00	0000000	
	0	0x00	0000000	
	0	0x00	0000000	
	0	0x00	0000000	
	38	0x26	00100110	

Figure 45: System Parameters Map view in BHI260AP

### 11.6 Algorithm Parameters Map

The **Algorithm Parameters Map** dialog (refer below Figure) displays the parameter values (per the datasheet).

- 1. To select the algorithm parameters map view, open the Algorithm Parameters Map dialog.
- 2. From the **Param Selection** section:
  - a. In the **Starting Param Number** field, select the parameter to start the value range.
  - b. In the Ending Param Number field, select the parameter to end the value range.
  - c. To update the parameter settings with your starting and ending selections, click **Update.**

Note: Only one parameter will be displayed on the landing page by default.

Page 39 | 81

Param Selection -				
Starting Param N	lumber 201 🖨 End	ling Param Number	203 🖨 Update	
Parameter No	Parameter value(decimal)	Parameter value(Hex)	Parameter value(binary)	^
201	0	0x00	00000000	
	64	0x40	01000000	
	72	0x48	01001000	
	0	0x00	0000000	
	1	0x01	0000001	
	82	0x52	01010010	
	0	0x00	0000000	
	4	0x04	00000100	
	127	0x7F	0111111	
	48	0x30	00110000	
	1	0x01	0000001	
	64	0x40	01000000	
	4	0x04	00000100	
	0	0x00	0000000	
	111	0x6F	01101111	
	0	0x00	0000000	
	0	0x00	0000000	
	0	0x00	20000000	
	255	0xFF	1111111	
	0	0x00	0000000	
	0	0x00	0000000	
	0	0x00	0000000	

Figure 46: Algorithm Parameter Map view in BHI260AP

#### 11.7 Sensor Parameter Map

The **Sensor Parameters Map** dialog (refer below Figure) displays the parameter values (per the datasheet).

- 1. To select the algorithm parameters map view, open the Sensor Parameters Map dialog.
- 2. From the **Param Selection** section:
  - a. In the **Starting Param Number** field, select the parameter to start the value range.
  - b. In the **Ending Param Number** field, select the parameter to end the value range.
  - c. To update the parameter settings with your starting and ending selections, click **Update.**

Note: Only one parameter will be displayed on the landing page by default.

Param Selection -				
Starting Param N	lumber  301 🖨 🛛 End	ding Param Number	303 🖨 Update	
Parameter No	Parameter value(decimal)	Parameter value(Hex)	Parameter value(binary)	^
301	1	0x01	0000001	
	205	0xCD	11001101	
	1	0x01	0000001	
	1	0x01	0000001	
	16	0x10	00010000	
	0	0x00	0000000	
	16	0x10	00010000	
	0	0x00	0000000	
	0	0x00	0000000	
	0	0x00	0000000	
	200	0xC8	11001000	
	67	0x43	01000011	
	0	0x00	0000000	
	0	0x00	00000000	
	0	0x00	0000000	
	0	0x00	0000000	
	109	0x6D	01101101	
	5	0x05	00000101	
	0	0x00	0000000	
	0	0x00	0000000	
	7	0x07	00000111	
	0	0x00	00000000	~

Figure 47: Sensor Parameter Map view in BHI260AP

### 11.8 Soft Pass-Through Parameters Map

The **Soft Pass-Through Parameter Map** dialog displays the sensor interface and interface settings in which the user can do the following from the Mode Settings section:

- input the Start address.
- input the add delay.
- choose the transfer type as Burst/Normal
- Select the direction as **Read/Write**

The user can view the selections in Hex format in the **Register Data (He**x) field. Users can also write the required values in the **Write Data** field by clicking **Write**.

Users can view the success/failure messages at the bottom of the dialog (refer below Figure).

Page **41 | 81** 

😸 Soft Pass-Through	Parameter Map							_		×
Mode Settings			Interface	e Settings						
Sensor Interface	SIF1 -		I2C	I2C Clock Rate	400	<ul> <li>Khz</li> </ul>	Address (	hex) 0	<b>•</b>	
Delay Control Delay Value	No ▼ 0 ÷ [x	50us delay]	⊖ SPI	SPI	40			0.510.0		
Start Address (hex)	0			Clock Rate Mode	10 4 wire	<ul> <li>Mhz</li> </ul>	CS Pin CPOL	GPIO0	<b>•</b>	
No of Bytes (dec)	1			CS Level	Low	•	СРНА	1	Ŧ	
Transfer Type Direction	Burst			LSB First	No	¥				
Register Data (hex)				141-14-	Data					
Read Data : 0x00				Write	e Data :					-
			ß							
	Clear	Rea	d					Wr	ite	
Data transfer is comple	ted successfully.									

Figure 48: Soft Pass-Through Parameters Map view in BHI260AP

### 11.9 Batching Panel

The **Batching Panel** dialog allows the virtual sensors to be written simultaneously by modifying the sampling range and Latency. The ODR/Sampling Rate configuration done on the virtual Sensor in general settings will also be updated in the batching panel section.

🚡 Batching Panel		_		×
Virtual Sensor	Accelerometer Passthro	ugh(Nor	n-Wakeup	) ~
Sampling Rate	25 Hz $\vee$ Hz			
Max Latency	2 ms			
			Write	

Figure 49: Batching panel from BHI260AP

# **12 Temperature Sensors**

DD 2.1 offers a temperature plotter for a sensor that supports temperature. The temperature plotter is visible by default in some cases. To open the temperature plotter, select **Menu > Panels > Temperature**, or click **Ctrl+T**.

From the **Temperature** dialog, users can view the temperature in \*C/Fahrenheit/Kelvin, which can be modified from the **Units** menu drop-down menu.

Temperature samples can be viewed in the Temperature plotter, as shown in below Figure.

Temperature	- O ×
🔢 🕂 🐟 🔍 🗐 🖡 🖻 🖶 Color 🕶 Units 🕶 Reset	
35.0 34.0 32.0 30.0 30.0 22.0 22.0 27.0 25.0	

Figure 50: Temperature plotter

In the DD 2.1 **General Setting**s, select **Temperature** to open the Temperature dialog that displays the runtime value in the Temperature field, as in below Figure.

Temperature	29.88	°C



г

# **13 DD 2.1 GUI common features**

DD 2.1 has a distinct user interface for adjusting sensor functionalities. The following sections of the user manual outline the shared features accessible for all the sensors.

### 13.1 File

The File menu includes the Exit option to close DD 2.1.

### 13.2 Interface selection

The Interface Selection menu offers two options, each briefly explained below.

### 13.2.1 Board communication

You can choose the communication mode between the board and PC to establish a USB or COM interface. Follow these steps to change the communication Interface:

 Click Interface Selection -> Board communication. The Communication Interface dialog opens. The Communication Channel displays the current mode of communication. The connection is active if the Communication Status is green (refer below Figure).

Communication Interface	
Communication Channel	сомз - СС
Communication Status	•
Connect	Application exit
	10.000
No response from the board.	

Figure 52: Communication Interface

- 2. To change the interface, click **Disconnect**. The **Communication Status** turns red (refer below Figure).
- 3. To select the desired interface, click the **Communication Channel** drop-down field. The **Communication Status** turns green, indicating the connection is established.

	Communication Channel	соме - СЭ
	Communication Status	•
1	Connect	Application exit
		UI Ver: 1.3.0.1

Figure 53: Communication Status

### 13.3 Sensor Interface

The **Sensor Interface Selection** dialog specifies the communication protocol for the sensor interface. Bosch Sensortec provides SPI and I2C protocols to read or write data/samples from the sensor. The interfaces are completely configurable, where some sensors, like BMA5xy, will be loaded by default in the I2C interface, and others might not be supported by the SPI interface (BMM350).

To configure the I2C interface for the connected sensor (refer below Figure):

- 1. Open the Sensor Interface Selection dialog.
- 2. From the **Sensor Interface** section, select **I2C**.
- 3. From the I2C settings section, select the I2C address by clicking the I2C Address drop-down field.
- 4. Select the I2C speed by clicking the I2C Speed drop-down field.
- 5. Click **Apply**.

Sensor Interface Se	🕞 Sensor Interface Selec — 🗌 🗙				
Sensor Interface	•				
⊖ SPI	I2C				
I2C settings					
I2C Address	0x18 🔻				
I2C Speed					
Apply	Cancel				

Figure 54: Sensor Interface selection I2C

- 6. Open the Sensor Interface Selection dialog.
- 7. From the Sensor Interface section, select SPI.
- 8. From the **SPI settings** section, select the SPI speed by clicking the **Speed** drop-down field.
- 9. Select the SPI length by selecting the length from the Length drop-down field.
- 10. Select the SPI mode by selecting the mode from the **Mode** drop-down field.
- 11. Click Apply.

To configure the SPI interface for the connected sensor (refer below Figure):

🚡 Sensor Interface Selec — 🗌 🗙				
Sensor Interface	e			
SPI	O 12C			
SPI settings				
Speed	2000kbits 🔻			
Length	8bits 💌			
Mode	MODE3			
Apply	Cancel			

Figure 55: Sensor Interface Selection SPI

### 13.4 Panels

The **Panels** menu lists different sensor options and provides a way to configure the sensor and view the results. Refer below figures for examples of the **Panels** menu.

Par	nels	Settings	Help	
	Dov	vnload firmw	are image for BHI260	AP Ctrl+F
~	Gen	neral Settings	3	Ctrl+G
	Reg	gister Access		Ctrl+R
	Bina	ary View		•
	Bate	ching Panel		Ctrl+B
	Sen	isorEvents a	nd MetaEvents	Ctrl+M
	3D (	Compass		Ctrl+C
	Sha	ark		Ctrl+H
	Hea	ad Orientation	n	Ctrl+O
	Data	a Export		Ctrl+D
	Def	ault View		Ctrl+Shift+D

Figure 56 : Panels menu for BHI260AP

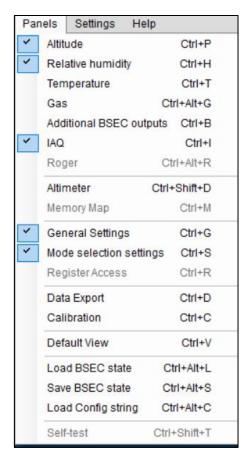


Figure 57: Panels menu for BME680

#### 13.4.1 Sensor Events and Meta Events

The **Sensor Events and Meta Events** dialog is used to view the interrupts triggered, which have been configured in the virtual sensor. Users can also view the activity status (still/walk/run etc.) in the grid. Users can toggle the events and interrupts from this view and do a read/write based on the functionality. It also provides a timestamp in micro-seconds, along with the Meta event type.

interrupts			MetaEvent Name	Event enable	Interrupt enable	TimeStamp 12118	Meta Event Type 10	Meta Event Name Initialized	Byte 1 103	Byte 2 23	
Sensor	Status		Flush Complete			12118	10	Initialized	103	23	
Significant Motion	•		Sample Rate Changed			5861494	12	FIFO Overflow	255	255	
			Sample Rate Changed			36508374 36508374	3	Power Mode Changed Sample Rate Changed	63 63	7	
Step Detector	•		Power Mode Changed			36508374	3	Power Mode Changed	67	7	
Tilt Detector	0		Error			36508374 38613313	2 12	Sample Rate Changed FIFO Overflow	67 255	1 255	
Wake Gesture	•		Algorithm Events			38960068 40289261	12 6	FIFO Overflow Sensor Status	136 43	23	
Glance Gesture	0		Sensor Status	Ø							
Pick Up Gesture	•		Reserved								
Step Counter			Reserved								
			Reserved								
			Reserved		Ē						
Timestamp	Activity	Status	Sensor Error								
00 10 56 480	SNI	Start	SensorError	U	L						
00:10:55:473	Tift	End	The second second second								
00:10:54:466	Titt	Start	FIFD Overflow	R	U						
00:10.51:445	Till	End									
00.10.50.438	Till	Start	Dynamic Range Changed								
00.10.49.431	Titt	End									
00.10.48.424	Titt	Start	FIFO Watermark								
00.10.48.424	Tift	End	-								
00.10.48.424	Run	End	Reserved								
00:10:44:395	Till	Start		0.22							
00.10.42.382	Run	Start	Initialized	P							
00.10.36:338	Run	End		-	-						
00:10:32:311	Run	Start	Transfer Cause								
00:10:30:295	Till	End									
00:10:29:288	Tift	Start	Sensor Framework								
00:10:28:281	TIR	End		-							
00:10:27:274	Titt	Start	Reset								
00:10:24:252	Still	End									
00:09:22:817	SBI	Start									

Figure 58: Sensor Events and Meta events

### 13.4.2 Reset

#### 13.4.2.1 PO Reset (Power On Reset)

During Power On Reset (POR), the voltages VDD/VDDIO are ramped to their respective target values. After reaching the target supply voltages, all registers are accessible after a delay of 450 us. After every POR or soft reset, the IMU remains in suspend mode. To prepare the device for operation, it must be initialized.

#### 13.4.2.2 Soft Reset

A soft reset can be initiated at any time by writing the command soft reset (0xB6) to register CMD. The soft reset performs a fundamental reset to the device, mainly equivalent to a power cycle. Following a delay, all user configuration settings are overwritten with their default state (setting stored in the NVM) wherever applicable.

### 13.4.3 Data Export

The DD application allows the export of the sensor samples to .txt or .csv file format using the **Data Export** dialog under **Panels** menu.

By default, the application will suggest saving the file in the Documents folder, but the user can choose any other location.

Users can follow the procedure below to export the data:

- 1. From the Panels menu, click Data Export (or) ALT + D.
- 2. Select the required data to be exported.
- 3. Click **Select Destination** to save the log file (supported formats are .txt and .csv only).
- 4. Select Append/Overwrite.
- 5. Click Start Logging.

Data Export		- 🗆 X
🗹 Temp - Raw	🗹 Temp - °C	
Accelerometer		
⊠ ×	V Y	<b>∠</b> Z
✓ m/s2	☑ g	
✓ Interrupts	Sensor Tim	e
Select Destination	C:\Users\uoq1	cob\Documents\da
○ Append	Overwrite	
	Stop Logging	

Figure 59: Data Export view

### 13.4.4 Memory Map

The **Memory Map** option under the **Panels** menu allows the user to choose sensor-supported features like Binary view, Interrupt view, Self-Test view, CRT, User Gain Update, etc.

The different options within Memory Map are described in the sections below

Par	nels Settings Heip		
~	Accelerometer Ctrl+A		
~	Accel Interrupts Alt+A		
	MemoryMap	•	Binary View Ctrl+B
~	General Settings Ctrl+G		Interrupt View Ctrl+I
	Register Access Ctrl+R		FIFO View Ctrl+F
	Data Export Ctrl+D		SelfTest View Ctrl+S
	Default View Ctrl+Shift+D		

Figure 60: Memory Map

#### 13.4.4.1 Binary View

To view the data in binary format, navigate to **Menu -> Panels -> Memory Map -> Binary View**, or click **Ctrl+B**. The **Binary View** dialog appears.

From the **Binary View** dialog, the user can read or write values into multiple registers in one view.

To read or write values from the **Binary View** dialog, use the following procedure:

1. Enter the value in the box alongside the register name.

2. As per requirement, click **Read/Write** 

an 1001050 an 6000050 an 6000050 an 6000050 an 6000050 an 6000050	0 00 00	09h 11h	10101001 00000000 00000000			000000000		03h 08h 13h	00000000	00 0		00000000	00 101	05h	00000000	00 101	05h	00000000 00 0	07h	00000000	00  0	
on 0000000 in 0000000 on 0000000	0 00 0	11h	00000000						-	00 4	0Ch	00000000	100.0									
in (0000000 m (0000000	0 00 00		hannen	00 (\$)	12h	00000000	00 4						100 141	ODh	00000001	01 01	0Eh	00000000	OFh	00000000	00 0	
an (0000000	_	19h	44444444				- CO CO CO	1.30	00000000	00 101	14h	00000000	00 0	15h	00000006	00 (0)	16h	00000000 00 00	17h	00000000	00 0	
	0 00 0		00000000	00 10	1Ah	01001001	49 4	18h	00000000	00	1Ch	00000000	00 101	1Dh	00000000	00  \$	tEh	00000000 00 00	1Fh	00000000	00	
sh 0000000	- I fee con	21h	00000000	00 (4)	22h	00000000	00 00	23h	00000000	00 (4)	24h	00100010	22	25h	00000000	00 101	26h	00000000	27h	00000000	00 0	
a protection and	0 00 0	29h	00000000	00 0	24h	00000000	00  0	28h	00000000	00 0	2Ch	00000000	00 0	2Dh	00000000	00 (0)	2Eh	00000000	2Fh	00000000	00 0	
n [0000000	0 00 41	3th	00000000	00 0	32h	00000000	00 4	33h	00000000	00 4	34h	00000000	00 🔤	35h	00000000	00  0	36h	00000000	37h	00000000	00 0	
an 0000000	0 00 4	39h	00000000	00 (4)	34h	00000000	00 (4)	38h	00000000	00 (0)	3Ch	00000000	00 (0)	3Dh	00000000	00 (4)	3Eh	00000000	3Fh	00000000	00 101	
n 0000000	0 00 0	41h	00000000	00 4	4211	00000000	00 4	43h	00000000	00 44	44h	00000000	00 0	45h	00000000	00 0	45n	00000000 00 00	47h	00000000	00 0	
In 0000000	00 00	49h	00000000	00 (0)	44h	00000000	00 (0)	48h	00000000	00 101	4Ch	00000000	00 0	4Dh	00000000	00 (0)	4Eh	00000000	4Fh	00000000	00 0	
on 0000000	0 00 0	51h	00000000	00 (4)	52h	00000000	00 0	53h	00000000	00 (0)	54h	00000000	00 0	55h	00000000	00 (0)	56h	00000000	57h	00000000	00 101	
ah 00000110	0 06 0	59n	00000001	01 01	54h	00101101	20 0	58h	01111011	78 0	5Ch	11010100	D4 0	5Dh	01000100	44 0	5Eh	00000001 01 0	5Fh	00111011	38 0	
on 01111010	7A  0	61h	11011011	08.4	62h	01111011	78 0	63h	00111111	3F  4-	64h	01101100	6C 0	65h	11001101	CD(0)	66h	00100111 27 4	67h	00011001	19 0	
3h 10010110	0 96 0	69h	10100000	A0 (\$)	6Ah	11000011	C3  0	68h	00001110	06 101	6Ch	00001100	0C 4	6Dh	00111100	3C   0	6Eh	11110000 F0 @	6Fh	00000000	00 0	
h 11110311	F7 4	71h	00000000	00 (4)	72h	00000000	00 (4)	73h	00000000	00 101	74h	00000000	00 101	75h	00000000	00 (0)	76h	00000000 00 00	77h	00000000	00 00	
sh 0000000	00 (0)	795	00000000	00 (0)	7Ab	00000000	00 (0)	78h	00000000	00 (0)	7Ch	00000000	00 0	7Dh	00000000	00  0	7Eh	00000000 00 00	7Fh	00000000	00 0	

Figure 61: Binary View

#### 13.4.4.2 Self-Test View

To conduct a self-test of the three axes in an Accelerometer, navigate to **Menu > Panels > Memory Map > SelfTest View**, or click **Ctrl+S**. The **Self-test** dialog opens as shown in below Figure.

S	Selftest	—	$\times$
	X-Axis Data	0	LSB
	Y-Axis Data	0	LSB
	Z-Axis Data	0	LSB
		Trigger	

Figure 62: Selftest View

Click **Trigger**. The self-test results are displayed in the same dialog as show in below Figure.

Page 50 | 81

Bosch Sensortec | Development Desktop User Manual

Selftest	_	×
X-Axis Data	21322	LSB
Y-Axis Data	20255	LSB
Z-Axis Data	9488	LSB
	Trigger	
Selftest succes	s	

Figure 63: Selftest View results in BMA530

#### 13.4.4.3 Register Access

The **Register Access** dialog reads or writes values into a register.

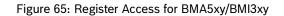
To view and configure the **Register Access** dialog, use the following procedure:

 Select Menu > Panels > Register Access or click Ctrl+R. The Register Access dialog opens (refer below Figures).

Register Access				_		$\times$
	Address [h]	00 😫				
Data Data Bits	Data [h]	00 🗣	0000000			
Bit 7 Bit	6 🗌 Bit 5 🗌	Bit 4 🗌 B	it 3 🗌 Bit 2	🗌 Bit 1	B	lit O
	Read		Write			

Figure 64: Register Access (8 bit)

Register Access				_		$\times$
Normal Read/Write	Burst Read/Write	[	Data			
Address [h] 00	Address [h]	00 😫				^
Data [h] 0000 🔄 000000000000000	No of Words [h]	01 😫				
Read Write						>
	Read	Vrite			Clear	



- 2. Enter the register address in Address [h].
- 3. Enter the value you wish to read/ write in Data [h].
- 4. Choose the specific data bits for reading or writing the data.
- 5. Click on **Read/Write** to communicate with the sensor.

#### 13.4.4.4 FIFO view

In FIFO configuration, enable FIFO, X, Y, Z, or a combination of these three axes to do a Read operation.

If the sensor time needs to be included in the logs, choose **Sensor Time** from the drop-down menu. This can be done in either of two ways:

- o "Dedicated Frame" The sensor time is added to the data after a certain number of packets.
- o **"Each Frame"** The sensor time is added to each entry in the data grid.

The user has the option to specify the watermark level. The watermark level is set by default, which will vary depending on the sensor feature.

For FIFO data logging, choose the desired file folders under "**Select Destination**" and check the "FIFO data log" box to enable it. The logs can be either appended or overwritten, and the user can make this choice through the radio buttons.

- Click Start FIFO Streaming to stream FIFO.
- Click **FIFO Flush** to clear the FIFO memory.

Click **FIFO Read** after enabling all settings, and data will be populated in the grid. The FIFO view is displayed in below Figure.

#### Page 52 | 81

FIFO View	Ş							-	×
FIFO Configuration	on		FIFO Control		FIFO Da	ta			
FIFO Enable			FIFO RST Enable		Frame	Header	Accel XLSB	XMSB	YLSB
X Enable			FIFO Frame Sync						
Y Enable			FIFO Sottingo						
Z Enable			FIFO Settings Watermark / Retain Level	1024					
Compression Enable			Fifo fill Level	0					
Full Interrupt	0	UnMapped	FIFO Data Log						
WaterMark Interrupt	0	UnMapped	Select Destination						
Sensor time	Dedicated Frame $ \smallsetminus $			Overwrite .ogging					
Read	nded to set Watermark le	Write	level, to get the Waterma	rk Interrunt	FIF	O Read	·		
<	nueu to set Watermark le	ver iowel utait illi	rever, to get the waterina	ik interrupt.					)

Figure 66: FIFO View in BMA5xy

FIFO Configuration		FIFO Interrupts			FIFO Da	ta										
FIFO Accel Enable							GYRO						ACCEL			
The Oracler Enable		FIFO Tag Int1			Frame	Header	XLSB	XMSB	YLSB	YMSB	ZLSB	ZMSB	XLSB	XMSB	YLSB	Y
FIFO Mag Enable					1	40										
					2	8C	01	00	FE	FF	00	00	59	F8	BF	F
FIFO Gyro Enable		FIFO Tag Int2			3	88	02	00	FD	FF	FF	FF				_
					4	8C	FF	FF	FF	FF	FE	FF	52	F8	C5	F
FIFO Stop on Full					5	88	FF	FF	FD	FF	00	00				_
FIFO Stop of Full	<u> </u>	FIFO Watermark	Int1	Int2	6	8C	00	00	FF	FF	02	00	54	F8	C2	F
	_	The Watermark			7	88	FF	FF	FD	FF	00	00				_
FIFO Time Enable					8	8C	FE	FF	FE	FF	FE	FF	50	F8	BF	F
					9	88	00	00	FF	FF	00	00				_
FIFO Frame		FIFO Full	Int1	✓ Int2	10	8C	FF	FF	FE	FF	FF	FF	4E	F8	BF	F
Header Enable					11	88	00	00	00	00	FD	FF				_
					12	8C	FF	FF	00	00	00	00	52	F8	C1	F
FIFO Settings		Gyro Downsampling	g Configuration	1	13	88	00	00	FE	FF	01	00				_
					14	8C	00	00	00	00	FF	FF	57	F8	BA	F
Watermark / Retain	512 🗘	FIFO Downsamplin	a 0	<b>÷</b>	15	88	FF	FF	00	00	00	00				_
Level			-		16	8C	FF	FF	FD	FF	01	00	53	F8	BD	F
					17	88	FE	FF	FD	FF	FD	FF				_
Frame Counter	2019	FIFO Filter Data	1 = Filt	ered 🔻	18	8C	FF	FF	FF	FF	00	00	51	F8	BC	F
					19	88	FF	FF	FD	FF	00	00				_
					20	8C	01	00	00	00	02	00	51	F8	C0	F
Accel Downsampling	Configuration	FIFO Data Log			21	88	01	00	02	00	00	00				_
		-			22	8C	FF	FF	FC	FF	01	00	56	F8	C1	F
FIFO 0	<b>\$</b>	Select Destination			23	88	FE	FF	00	00	02	00				_
Downsampling	•				24	8C	00	00	00	00	00	00	52	F8	BD	F
		Append	Overwrite	e	25	88	01	00	FE	FF	03	00				_
FIFO Filter Data	= Filtered 💌		Start Logging		26	80	01	00	FF	FF	01	00	1E	FS	RR	F
D'alla	- mored	`	Start Logging		EIE	) Read	S	tart FIFO	Streamin	g						
Read	Write				FIFO	Flush										
<											_					>

Figure 67: FIFO View in BMI270

#### 13.4.4.5 FIFO Streaming

The FIFO streaming feature enables FIFO streaming based on input parameters such as Output Data Rate (ODR), Range, and Sensor Time until a specified watermark level is determined by the FIFO buffer size.

From the **FIFO Streaming View** dialog, the data in the FIFO queue is plotted until it reaches the designated watermark level.

If Stop on full is selected, the streaming will halt once the designated watermark is reached.

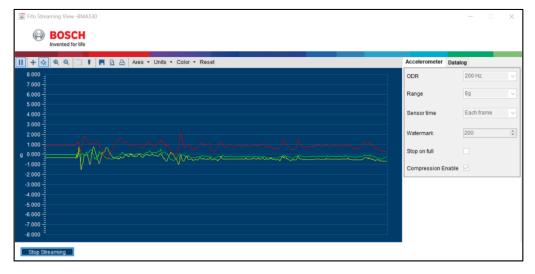


Figure 68: FIFO streaming in BMA5xy

FIFO streaming samples can be logged by selecting the destination (By default, it will prompt to save in the Documents Folder) and clicking **Start Logging** (refer below Figure)

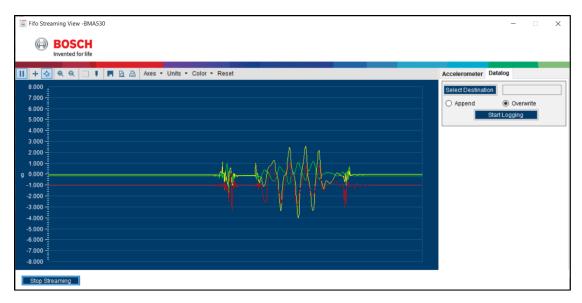


Figure 69: Data Streaming in BMA5xy

Note: FIFO Streaming applies to BHY/BMI3xy/BMA456/BMA400/BMI270 sensors.

#### 13.4.4.6 FOC View

The **FOC View** provides details on the offset compensation of the accelerometer and can be controlled by this view.

To launch this feature, select the **Panels** menu in the main menu and then select **Memory Map** > **FOC View** or **Ctrl + O** as a shortcut.

Fast-offset compensation must be executed only when the device is still and one axis is parallel to the gravitation vector. This axis can be either aligned with the gravitational vector or in the opposite direction.

FOC View	- 🗆 X
Accelerometer	
FOC Axis	Z-positive axis $\ \lor$
Filter Coefficient	0
FOC Trigger	
ast offset compens	sation is completed

Figure 70: FOC View

#### 13.4.4.7 G Trigger

G Trigger comprises two features. To view the G Trigger feature, select from the menu **Panels > Memory Map > G Trigger** or click **Ctrl + T.** 

	Memory Map	۲	Binary View	Ctrl+B
~	General Settings	Ctrl+G	Offset View	Ctrl+O
	Register Access	Ctrl+R	FIFO View	Ctrl+F
	Data Export	Ctrl+D	Interrupt View	Alt+Shift+I
	Default View	Ctrl+Shift+D	G Trigger	Ctrl+T

Figure 71: G Trigger

13.4.4.8 CRT (Component Re-Trim)

The **Component Re-trim** feature re-trims the gyroscope's sensitivity. During this process, the gyroscope is not usable for generating the rate of the samples.

Page 55 | 81

Bosch Sensortec | Development Desktop User Manual

🚡 G Trigger	-	×
CRT	⊖ Gyro BIST	
CRT Resul	t: SUCCESS	
Trigge	er	

Figure 72: CRT view In BMI270

0	CRT	_		×
	CRT Result:	SUCC	ESS	
	Sensitivity		Offset	
		Trigger		

Figure 73: CRT in BMI3xy

#### 13.4.4.9 GBIST (Gyroscope Built-in Self-Test)

The gyroscope's built-in self-test can be used to determine whether the relative deviation in quadrature is measured within a specific range.

🕞 G Trigger	-	-		×
	Gyro E	IST		
Gyro Self Tes	stAxes:	1		
Gyro Self Te	st X Axis:	1		
Gyro Self Tes	st Y Axis:	1		
Gyro Self Tes	st Z Axis:	1		
Gyro Self Te:	st Result:	SU	CCES	3
Trigger				

Figure 74: Gyro BIST

#### 13.4.4.10 User Gain update

The **User Gain update** feature is used to amplify the signal. For example, when the accelerometer is operated at a specific ODR, the sensor must use the gain data and offset values from the DMR register space to correct the accel data using these factors.

To view the User Gain update feature, from the main menu, select Panels -> Memory Map -> User Gain Update or press Ctrl + U.

For filtered data, the ASIC always applies gain and offset correction. The operation result is updated once the gain values are updated, as shown in below Figure.

User Ga	ain Update	_	×
	Gain Update Result:	Success	
	User Gain	Update	

Figure 75: User Gain Update

**Note**: The host must switch off advanced power save mode for the Gyro User Gain update.

#### 13.4.4.11 Interrupts

The **Interrupts** feature shows the real-time interrupt status of sensors (refer below Figure). The round LEDs show the sensor interrupt status, and the circle LEDs show the interrupt pin status. A green LED shows the interrupt occurrence.

To view the Interrupt dialog, from the main menu, select Panels > Accel Interrupts or Alt + A.

Interrupts	- 🗆 X
Generic Interrupt 2	<ul> <li>FIFO Watermark</li> <li>FIFO Full</li> <li>Generic Interrupt 1</li> <li>Generic Interrupt 3</li> <li>Step_detector</li> <li>Step_counter</li> <li>Tilt</li> <li>Orientation</li> <li>FOC</li> <li>MCU_Err</li> <li>HW Int1</li> </ul>

#### Figure 76: Accelerometer interrupts

#### 13.4.4.12 Interrupt View

The Interrupt View feature enables and assigns interrupts to Interrupt 1 and Interrupt 2 hardware lines. The user can modify the interrupt configuration for each of the interrupt lines. Once changes are made, click **Write** to save the values to the respective registers. To confirm that the values have been successfully written to the registers, click **Read**.

Open the Interrupt View	<pre>dialog from Panels :</pre>	> Memory map >	Interrupt View.

Interrupt View						- 🗆	$\times$
INT1 Configu	ration	Interrupt Mapping and E	Enabling				
Int Mode	1 🗧 Latched	Interrupt Mapping			Interrupt Enab	ling	
		Data ready	0 ≑	UnMapped	Generic Interr	upt 1 🗌	
Level	1 🔶 Active high	Generic Interrupt 1	0 🜲	UnMapped	Generic Intern	upt 2 🗹	
Behaviour	0 🜩 Push-pull	Generic Interrupt 2	2 🖨	Int2	Generic Interr	upt 3 🗌	
		Generic Interrupt 3 Step_detector	0 ÷	UnMapped Int2	Step_Enable	$\checkmark$	
INT2 Configur	ration	Step_counter	2 🗘	Int2	Significant_m	otion 🗹	
Int Mode	1 🖨 Latched	Significant_motion	2 🜲	Int2	Tilt	$\checkmark$	
Level	1 🜩 Active high	Tilt	2 🔹	Int2	Orientation	$\checkmark$	
Dahariana	0 🔶 Push-pull	Orientation	0	UnMapped	FOC		
Behaviour	0 🜩 Push-pull	FOC	0 ≑	UnMapped			
Read	Write	MCU Error	0	UnMapped			
Note : During	interrupt streaming only able	e to map the data ready i	interrupt to	hardware inter	rupt pin 1		

Figure 77: Interrupt View for BMA530

#### 13.4.4.13 Interrupt Streaming

Interrupt streaming is the sensor data based on the hardware interrupt.

#### 13.4.4.14 Context Selector/Device initialization

The Context Selector is a feature that allows users to customize and optimize their interaction with the Sensor based on specific preferences and needs. This feature enables the sensor to adapt its functionality and behavior according to two distinct contexts: Wearable and Smartphone.

**Wearable:** Select this mode when using the sensor in conjunction with wearable technology such as smartwatches or other portable devices. In this mode, the sensor optimizes its output to seamlessly integrate with and complement your wearable technology, offering convenient, hands-free operation.

**Hearable:** Select this mode if you are using hearable variants of sensors or for testing the hearable properties of sensors. Once the user is switched to this mode, the configuration settings of the sensor will be changed to hearable configurations.

**Smartphone:** This mode is ideal for users using mobile phones or smartphones to engage with the sensor. The sensor will adjust its settings to align with smartphone interfaces, enabling seamless connectivity and compatibility with various smartphone functionalities.

Selectors are represented in different ways as per their use case and features for different sensors in DD 2.1. For example, in BMI270, BMI323, and BMA530, context selectors are named as shown in below Figures.

Context Selector		
O Wearable	Smart Phone	

Figure 78: Context Selector in BMA530 in General Settings

Context Selector	
Wearable	⊖ Hearable
○ Smart Phone	

Figure 79: Context Selector in BMI323 in General Settings

Device Initialization
Wearable Gestures Recognition
O Context & Activity Recognition
O Maximum FIFO

Figure 80: Device Initialization in BMI270

#### 13.4.4.15 Offset View

The offset refers to an inherent bias or error in the sensor readings when no actual motion or acceleration occurs. This offset can occur due to factors such as manufacturing imperfections, environmental conditions, or sensor calibration issues.

The offset represents a deviation from the true zero level for accelerometers when the sensor is supposed to measure zero acceleration. This offset could result from gravitational effects or mechanical variations in the sensor, causing it to output a non-zero value even when it's at rest.

For gyroscopes, the offset signifies a bias in the angular rate measurement when there is no rotation. It means the sensor might detect a non-zero rotation rate even if it's perfectly still. This offset can stem from imperfections in the sensor's construction or the electronics involved in its measurement.

Calibration processes are often used to minimize or eliminate these offsets. During calibration, these biases are identified and compensated for, allowing the sensor readings to be more accurate by adjusting the output data to reflect true zero values when there is no motion or rotation.

- 1. To enable the offset, select the box before the sensor name.
- 2. Set the offset for X, Y, Z axes in the input box before the respective columns.

0	ffset View		_		$\times$	
[	Acceleromet	er				
	Axis X	1	-	Enabled		
	Axis Y	0	-	Disable	d	
	Axis Z	0	-	Disable	d	
	Sign	0	<b>•</b>	Positive		
[	FOC Trig	ger				
Fa	Fast offset compensation is successful					

Figure 81: Offset View

Offset View	_		$\times$
Offset Enable			
Accelerometer	Gyro	scope 🛛	2
Fast Offset Enable			
Gyroscope			
Accel Offset Registers			
Offset X	10	<b>÷</b>	
OlisetX	10	•	
Offset Y	0	-	
Offset Z	15	-	
Gyro Offset Registers			
Offset X	45	<b>•</b>	
Offset Y	0	-	
Offset Z	45	-	
Read	V	Vrite	

Figure 82: Offset View in BMI3xy

# **14 Additional GUI Features**

DD 2.1 provides additional features so users can view the samples in 3D representation specific to some sensors like BME68x and BHI360.

#### 14.1 Roger

Roger is a panel that demonstrates the changes in different environmental parameters by modifying the features of an image of a boy (Roger). To view this panel, select to **Panels > Roger** or click **Ctrl+Alt+R**.

**Note:** Roger is available only in BSEC mode and specific to BME68x.

Some common features of Roger include the following:

- When ambient environmental parameters change, the image of Roger or his background will change.
- The panel settings can be customized per geographical region to demonstrate changes more accurately.

The real-time pressure, temperature, humidity, and IAQ values are displayed in the top left corner of the panel, as shown in below Figure.



Figure 83: Roger

The different parameters that are captured and displayed by Roger are the following:

- IAQ
- Relative humidity
- Temperature
- Pressure

To change the parameter settings or view the existing settings from Roger, click the **Settings** lcon at the top right of the Roger panel. The settings dialog opens with existing settings, as shown in below Figure.

Page 60 | 81

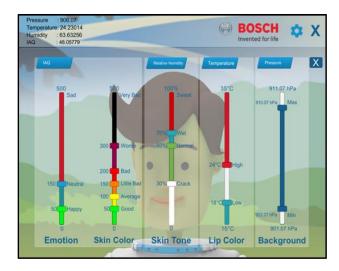


Figure 84: Roger settings

### 14.1.1 Roger and IAQ

Roger's emotion and skin color changes indicate the changes in IAQ. Keeping the settings in the changes in IAQ are reflected in the **Emotion** setting as follows

#### Table 2: IAQ and Roger's Skin Colour

Range	0-50	50-100	100-150	150-200	200-300	300-500
Name	Good	Average	A Little Bad	Bad	Worse	Very Bad
Color						
IAQ	The IAQ is good, and Roger's skin is of natural color.	The IAQ is average, and Roger's skin color changes to yellow.	The IAQ is a little bad, and Roger's skin color changes to orange.	The IAQ is bad, and Roger's skin color changes to red.	The IAQ is worsening, and Roger's skin color changes to dark purple.	The IAQ is very bad, and Roger's skin color changes to black.

Roger's emotion and skin color based on bad IAQ is shown in below Figure.



Figure 85: Bad IAQ in Roger

### 14.1.1.1 Roger and Relative Humidity

The changes in relative humidity are indicated by the changes in **Roger's** skin tone. Below Figure shows Roger's skin tone in very high relative humidity.



Figure 86: Very high relative humidity in Roger

The settings of relative humidity are reflected in Table 3.

Range	0%-30%	30%-60%	60%-70%	70%-100%
Name	Crack	Normal	Wet	Sweat
Color				
Relative	The relative	The relative	The relative	The relative
Humidity	humidity is very low, and Roger's skin is cracked.	humidity is at the optimum level, Roger's skin is normal.	humidity is a little high, and Roger's skin is wet.	humidity is very high, and Roger is sweating.

Table 3: Relative Humidity and Roger's Skin

#### 14.1.1.2 Roger and Temperature

The changes in relative humidity are indicated by the changes in Roger's lip color.

Keeping the Roger settings, the temperature changes are shown in Table 4.

#### Table 4: Temperature and Roger's Lip Colour

Range	0°C-18°C	18℃-24℃	24℃-35℃
Name Color	Low	High	Very High
Temperature	The temperature is very low, and there is no change in lip color.	The temperature is optimum, and there is no change in lip color.	The temperature is very high, and Roger's lip color is red.

**Note:** DD 2.1 in Roger has only a temperature ranging from 0°C to 35°C.

Roger's lip color is shown at a very high temperature in below Figure.



Figure 87: Very high temperature in Roger

#### 14.1.1.3 Roger and Pressure

The change in background in the Roger panel indicates the changes in pressure. Keeping the Roger settings, the changes in pressure are shown in Table 5.

Table 5: Temperature Range details

Range	902.07hPa – 910.07 hPa	901.07 hPa-902.06 hPa and 910.08 hPa- 911.07 hPa
Name Color Temperature	Min-Max The pressure is within the user- defined range, and the background remains unchanged.	Outside the user-defined range When the pressure is between 901.07 hPa and 902.05 hPa, the image background image moves downwards. When the pressure is between 910.08 hPa and 911.07 hPa, the image background image moves upwards.

Note: DD 2.1 in Roger only measures pressure ranging from 901.07 hPa to 911.07 hPa.

The Roger panel's background at in-range pressure (between 902.07 hPa and 910.07 hPa) is shown in below Figure.



Figure 88: In-range pressure in Roger

### 14.2 Shark

DD 2.1 offers a Shark panel for virtual sensors, which will show the orientation of the Sensor on the 3D model of a shark.

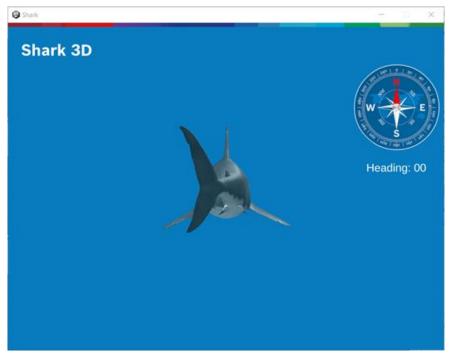


Figure 89: Shark view from BHI360

### 14.3 3D Compass

The 3D Compass is a panel that shows the orientation of App board for the XY axis when the board is connected. The orientation and rotation data are also displayed in the GUI.

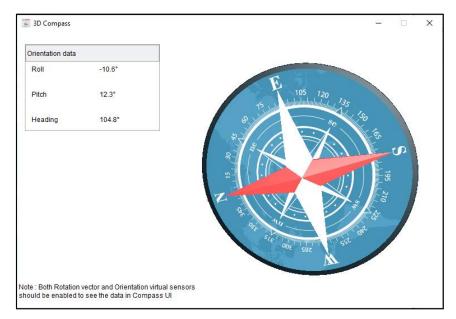


Figure 90: 3D Compass

### 14.4 Head Orientation

DD 2.1 offers a head orientation panel for virtual sensors implementing fusion (please refer to below Figure 96).

14.4.1 Steps to Calibrate in BMI290

- 1. User must do the calibration in BMI290 before launching the Head Orientation to achieve high accuracy. DD application will prompt the user to calibrate the sensor, by default.
- If the user connects the shuttle board with APP3.X for the first time, click on Calibrate Now button.
- If the user has done the calibration already (same shuttle board with same APP3.X board), click on Skip and Proceed button.

Note: It is always recommended to calibrate the sensor to achieve high accuracy.



Figure 91: Calibrate popup window

2. Once Calibrate Now is chosen, the Accel FOC will be triggered followed by Gyro FOC, by default as shown in below Figures.

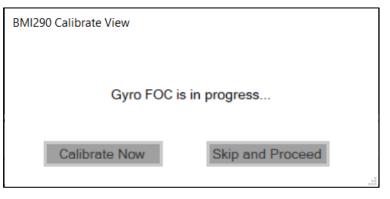


Figure 92: Gyro FOC in progress



Figure 93: Accel FOC

3. User shouldn't move the APP3.X board and should be kept stable on a flat surface. If the user moves the board during the CRT & FOC, the calibration will be failed, and user must re-do the calibration.

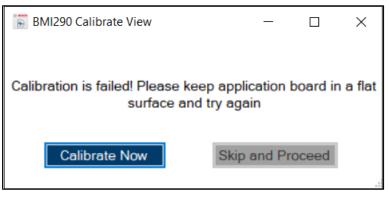


Figure 94: Calibration Failed

4. Once the Calibration is success, user shall close this popup and navigate to Configuration panel.

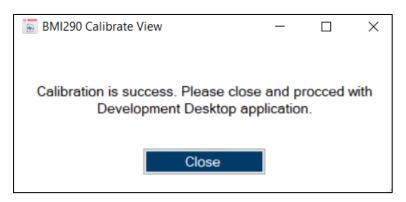


Figure 95: Calibration Success

For BMI290, DD application offers users the choice to calibrate the HMC by updating values in the configuration panel or by clicking on the calibrate button in Head Orientation panel.

• With configuration Panel: User must navigate to Panels → Configuration Panel and update the values as mentioned in the below table.

Feature configuration settings	Value	Description
Head_orientation_config: Hmc_mode	2	<ul> <li>0 denotes that the calibration is failed or yet to start.</li> <li>1 denotes calibration has started (Need to keep the head Idle to calculate the position)</li> <li>2 denotes calibration is in progress and user must nod the head to get the orientation data (data to calculate based on the algo)</li> <li>3 denotes calibration is done successfully.</li> </ul>
Head_orientation_config: Calib_trigger	1	To trigger the calibration.
Any_motion: enable	1	To enable the Head Orientation for any motion.
Hmc_correction_quarternion_input	Hex format	User can update any values based on the calibration done previously or based on the orientation.

mu_fusion_quaternion	_out	head_orientation_config		hmc_correction_quater	nion_input	hmc_correction_quater	ion_ou
vector_x_lsb :	2F01 (0x0 - 0xFFFF)	head_orientation_enable :	1 (0x0 - 0x1)	vector_x_Isb :	2F01 (0x0 - 0xFFFF)	vector_x_lsb:	
vector_x_msb:	B2C0  \$ (0x0 - 0xFFFF)	hmc_mode :	2 🔹 (0x0 - 0x3)	vector_x_msb :	B2C0 (0x0 - 0xFFFF)	vector_x_msb :	
vector_y_lsb:	2F00 0x0 - 0xFFFF)	calib_trigger :	0 🔹 (0x0 - 0x1)	vector_y_lsb:	2F00 (0x0 - 0xFFFF)	vector_y_lsb :	
rector_y_msb:	2E00 \$ (0x0 - 0xFFFF)	hmc_calib_out_status :	0 ‡ (0x0 - 0x3)	vector_y_msb :	2E00 🗘 (0x0 - 0xFFFF)	vector_y_msb:	
ector_z_lsb:	4093 ‡ (0x0 - 0xFFFF)	Reserved_1:	2F00 🔹 (0x0 - 0xFFFF)	vector_z_Isb :	4093 文 (0x0 - 0xFFFF)	vector_z_lsb:	
ector_z_msb:	4094 0x0 - 0xFFFF)	Reserved_2:	2E00 文 (0x0 - 0xFFFF)	vector_z_msb :	4094 文 (0x0 - 0xFFFF)	vector_z_msb :	
scalar_w_lsb :	9100 0 (0x0 - 0xFFFF)	Reserved_3:	4093 🔹 (0x0 - 0xFFFF)	scalar_w_lsb:	9100 文 (0x0 - 0xFFFF)	scalar_w_lsb:	
scalar_w_msb :	2F01 ‡ (0x0 - 0xFFFF)	Reserved_4:	4094 文 (0x0 - 0xFFFF)	scalar_w_msb:	2F01 🔹 (0x0 - 0xFFFF)	scalar_w_msb:	
		Reserved_5:	9100 🔄 (0x0 - 0xFFFF)				
		Reserved_6 :	2F01 (0x0 - 0xFFFF)				
		l⊋					

Figure 96: Configuration Panel in BMI290

• With Head Orientation panel: The user can calibrate the model by clicking Calibrate from the Head Orientation panel.

During the calibration, the coordinates are reset and mapped to the position of the Application Board. The head orientation GUI holds Euler and Quaternion values from the sensor data based on the head orientation, which is calculated and displayed in the UI.

After keeping the sensor stable for a few minutes, click **Calibrate**, and once the calibration is complete, the status is displayed on the left side of the **Head Orientation** panel.

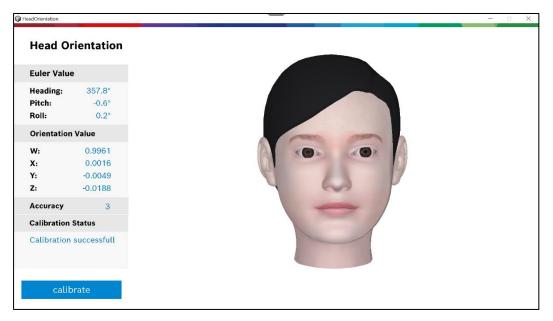


Figure 97: Head orientation calibration

## 14.4.2 Steps to Calibrate in BHI360

For BHI360, user must do the calibration by clicking on the calibrate button in Head Orientation panel.

# 14.5 Out of Range Detection

Out of Range Detection (refer below Figure) detects the magnetic field whenever it is more than 2400 micro-Tesla ( $\mu$ T). It will get automatically restored if it is back to the normal range of less than 2000.



Figure 98: OOR with external magnetic field

### 14.6 TDM interface

TDM is an interface which is specific to BMA550 along with I2C, where user can view the data, log the data in both .wav format and .csv format. It is specific for hearables.

TDM Data View	- 🗆 X
BOSCH Invented for life	
🔢 🕂 🛠 🔍 🗉 🖡 🖻 🗁 Axes - Units - Color - Reset	Configuration Datalog
4 000 <sup>4</sup> 3 500 <sup>4</sup>	Power Mode Low Power Mode 🗸
3.000 =	
2.500	
1.500 - 1.000 -	
0.500 = g 0.000 =	
-0.500	
-1.500	
-2 500	
-3.500 - -4.000 -	
Stop Streaming	

Figure 99: TDM Feature in BMA550

# **15 Troubleshooting Procedure**

After installing DD 2.1, the user may encounter connection issues, such as an error during the initialization of the App Board. This section highlights the potential causes of these situations and their solutions.

 Connect the Bosch Sensortec board and DD 2.1 via COM. When the PC does not recognize the Bosch Sensortec board, the connection is not established. Below Figure shows the message that is displayed.

		соме - С
	Communication Channel	COM6 C2
1	Communication Status	•
1	Connect	Application exit
		UI Ver. 1.3.6.1

Figure 100: Communication Interface dialog

**Note**: If the Bosch Sensortec board is not recognized in the USB port, update the Boot loader with the latest version to be functional.

For APP board 3.0, kindly refer this <u>section</u>. For APP board 3.1, kindly refer this <u>section</u>.

In most troubleshooting cases, the resolution ensures that the device manager recognizes the App Board.

### 15.1 How do I know if the Bosch Sensortec board is recognized?

- 1. Open Computer Management by right clicking on **My Computer > Manage**.
- 2. In Computer Management, navigate to **System Tools** > **Device Manager**.
- 3. From Device Manager, locate the Bosch Sensortec board the list.

OR

- 1. Search for "Device Manager" in MS Windows search.
- 2. From Device Manager, locate the Bosch Sensortec board in the list.

### 15.1.1 How do I list the Bosch Sensortec board under Device Manager?

15.1.1.1 Check the PC-Board Connection

Plug out and plug in the USB cable (from both the computer and board) and restart the board. When the connection is established, all LEDs glow simultaneously.

15.1.1.2 Update USB Driver

Uninstall the old USB drivers:

- 1. Open the Device Manager.
- 2. Select View > Show hidden devices.

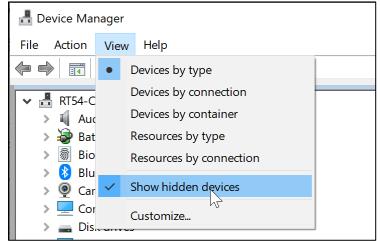


Figure 101: Showing Hidden Devices

- 击 Device Manager Action View Help File 84 Devices by type Devices by connection RT54-C Devices by container 4-P Resources by type • 4-P APF Resources by connection APF Show hidden devices APF APF Customize... APF
- 3. From the Device Driver, to view devices by container, select View > Devices by container.

Figure 102: View Devices by container

- 4. If the board is connected, uninstall all the drivers for the board, whether connected or hidden.
- 5. Reinstall the driver.
- 6. Reconnect the board.

The USB driver can be updated either manually or automatically.

#### **Automatic Update**

- 1. Reinstall the application.
- 2. Check if the Bosch Sensortec board is recognized (in the Device Manager)
- 3. If the board is still not recognized, switch the board off and on.

#### **Manual Update**

The firmware can be updated using two methods.

Method 1:

- 1. Connect the Application board and turn it on.
- 2. Download the COINES-SDK from the Bosch Sensortec website here
- 3. Extract the and install the COINES-SDK.
- 4. Navigate to the COINES-SDK folder from the installation path, open the firmware folder, and then the APP3.X folder according to the appropriate Application Board connected.
- 5. Double-click the batch file **update\_coines\_bridge\_ram\_fw.bat/update\_coines\_bridge\_flash\_fw.bat** to execute it.

Method 2:

1. Open Computer Management by right clicking on **My Computer > Manage**.

🖆 De	evice	Manager	-	$\times$
File	Actio	on View Help		
(= =)				
~ ~				
× 🛔	со	B-C-009V8		^
>	1	Audio inputs and outputs		
>		Batteries		
>	翁	Biometric devices		
>	8	Bluetooth		
>	٢	Cameras		
>	_	Computer		
>	_	Disk drives		
>	-	Display adapters		
>	$\sim$	Firmware		
>	AND I	Human Interface Devices		
>	2000 g	Keyboards		
>		Memory technology devices		
>	0	Mice and other pointing devices		
>		Monitors		
>		Network adapters		
~	Ŵ	Ports (COM & LPT)		
		USB Serial Device (COM6)		
>		Print queues		
>		Processors		
>		Proximity devices		- 1
>	<b>1</b>	Security devices		
>	4-	Sensors		
>		Software components		
>		Software devices		

Figure 103: Device Manager (when drivers are not installed)

- 2. In Computer Management, select **System Tools** > **Device Manager**.
- 3. Right-click on the Bosch Sensortec Application Board > Update Driver Software > Browse My Computer for Driver Software > C:\Program Files\Bosch Sensortec\Development Desktop 2.1\USB Driver > Next.
- 4. After the driver installation, click **Next**.
- 5. Check if the Bosch Sensortec board is recognized (in the Device Manager).

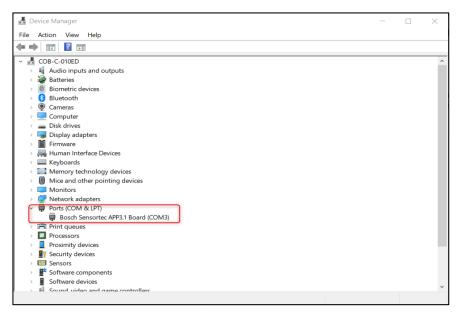


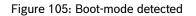
Figure 104: Device Manager (when the correct driver is installed)

#### 15.1.1.3 Upgrade Firmware

For APP3.0, when the firmware file is absent, the LED next to the T1 switch is Blue. To upgrade the firmware on all boards, use the following procedure:

1. Keep T2 pressed, power off, and on the board. A prompt (refer below Figure) indicates that Boot mode is detected.





- 2. Click OK.
- 3. Click Settings > Firmware Upgrade.
- 4. Select the firmware to install and install it in RAM or FLASH.
- 5. Click **Update**.
- 6. Restart the board and DD 2.1.

### 15.2 EEPROM flash on new shuttle board

When a user receives a new shuttle board to be connected to a fresh APP3.X board, it is recommended to flash the EEPROM content on the shuttle board.

To flash the EEPROM content, a batch file needs to be executed to align the shuttle board pins with the mapping of the APP3.X board. This batch file also used to retrieve the Shuttle Name and Shuttle ID from the sensor shuttle board.

If the user has not flashed the EEPROM content, DD application will not recognize the shuttle board and will prompt the message as shown in the below Figure.

Interface Selection Panels Settings Help		
Bosch Sensortec		BOSC Invented for
	Development Desktop 2.1 X	
	Current version of Development Desktop 2.1	
	does not support the connected sensor. Kindly ensure EEPROM content is flashed.	
	Ok	
Start Streaming		Connection statu

Figure 106: EEPROM to be flashed

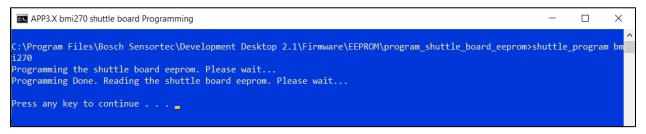
If the user encounters the above-mentioned prompt in the DD application, it is recommended to close the application and navigate to the DD installation path (C:\Program Files\Bosch Sensortec\Development Desktop 2.1\Firmware\EEPROM\program\_shuttle\_board\_eeprom). Here, the user can locate the executable file relevant to the shuttle board that needs to be flashed (example: bmi270\_shuttle\_program.bat).

Once the batch file is executed & the application is launched, an error message will be received as mentioned in below screenshot.



#### Figure 107: EEPROM Failed

User would get a success message as shown in below Figure, if the batch executed is successful.





# **16 References**

The table below links the datasheets for the main sensors supported in DD 2.1.

Sensor	Sensor Datasheet
BMA400	<u>BMA400</u>
BMA456	<u>BMA456</u>
BMI270	<u>BMI270</u>
BMI323	<u>BMI323</u>
BMP390	<u>BMP390</u>
BMP581	<u>BMP581</u>
BMP585	<u>BMP585</u>
BMM150	<u>BMM150</u>
BMM350	<u>BMM350</u>
BME280	<u>BME280</u>
BME680	<u>BME680</u>
BME688	<u>BME688</u>
BHI360	<u>BHI360</u>
BHI260AP	BHI260AP
BMP388	<u>BMP388</u>
BMP280	<u>BMP280</u>
BMP384	<u>BMP384</u>
BNO055	<u>BNO055</u>

# Appendix A. Ram Patch Update

Users can use the **Ram Update** dialog to update the .tbin file for the BMI2xy sensor.

Steps for updating the RAM for the BMI270 sensor:

- 1. Go to the DD installation folder and open the Development Desktop 2.1.exe.config file in Notepad.
- 2. Edit line 12 with the content "<add key="**EnableRAMUpload**" value="false"/>" and change the value to "true". The dialog is enabled in DD and is visible under the **Panels** menu.
- 3. Launch the DD 2.1 application. Go to RAM Patch in the **Panels** menu. The **Ram Update** dialog appears.
- 5. From the **RAM image file** field, select the RAM file.
- 6. From the Image config file field, select the encrypted configuration file.
- 7. Click Upload.
- 8. When the upload is complete, verify it from **Panels** > **Configuration**.

Under output, there will be a field called "message". If the value is 1, it indicates the upload is successful. Otherwise, it is unsuccessful.

RAM Update	_	-	$\times$
RAM image file :	C:\Program Files\Bosch Sensortec\Developme	ent Desktor	
Image config file :	C:\Program Files\Bosch Sensortec\Developme	ent Desktor	
Upload			
Selected file is	igram FilesiBosch SensorfectDevelopment		

Figure 109: RAM Update

output		
byte_0:	00	(0x0 - 0xFF)
byte_1 :	00	(0x0 - 0xFF)
wr_gest_out:	0	(0x0 - 0x7)
act_out:	3	(0x0 - 0x3)
message :	1	(0x0 - 0xF)
Reserved :	0	(0x0 - 0x1)
axes_remap_error :	0	(0x0 - 0x1)
odr_50hz_error :	0	(0x0 - 0x1)
Reserved :	0 🜲	(0x0 - 0x1)

Figure 110: Output in Configuration Panel

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