

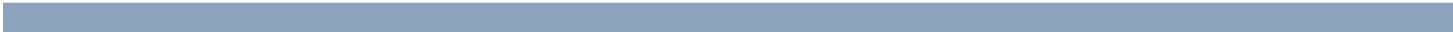
# How to play with BHI360 shuttle board 3.0

Bosch Sensortec



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## 1 Introduction

The BHI360 is the latest intelligent programmable ultra-low power smart sensor. It consists of Bosch Sensortec's 32-bit microcontroller (Fuser2), state-of-the-art 6-axis IMU and a powerful software framework containing pre-installed sensor fusion library BSX4 and other sensor processing software. It is 3 x 2.5 x 0.95mm in size and LGA-20 package so that it is pin-to-pin compatible with existing IMU such as BMI270 and BMI323.

BHI360 is in mass production. Its datasheet is available online at <https://www.bosch-sensortec.com/media/boschsensortec/downloads/datasheets/bst-bhi360-ds000.pdf>. The schematics of BHI360 shuttle board 3.0 is available online at [https://www.bosch-sensortec.com/media/boschsensortec/downloads/shuttle\\_board\\_flyer/application\\_board\\_3\\_1/bst-bhi360-sf000.pdf](https://www.bosch-sensortec.com/media/boschsensortec/downloads/shuttle_board_flyer/application_board_3_1/bst-bhi360-sf000.pdf).

Every time when BHI360 is powered on, the RAM patch with the filename "\*.fw" needs to be downloaded into BHI360. There are a few pre-generated RAM patches available for users to download. With the SDK users can modify the API source code and then generate their own RAM patches. After the RAM patch is downloaded to BHI360 the host processor needs to enable one or multiple virtual sensors, for example 9DoF Orientation virtual sensor with selected output data rate (ODR). Then BHI360 will automatically output sensor fusion results continuously such as Euler angles of pitch/roll/heading.

This document shows instructions on how to play with the BHI360 shuttle board 3.0 to quickly evaluate BHI360.

## 2 Hardware

The hardware includes one APP3.0 base board, one BHI360 shuttle board 3.0 and one micro USB cable as shown in Figure 1.

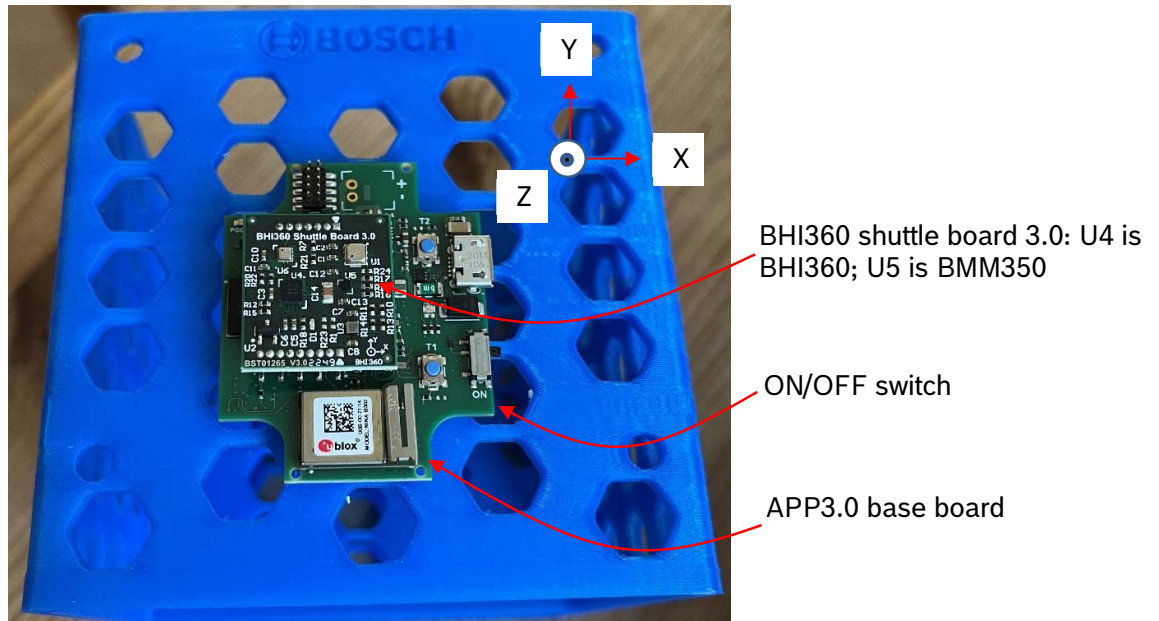


Figure 1 APP3.0 base board and BHI360 shuttle board 3.0

APP3.0 base board can be purchased at <https://www.mouser.com/ProductDetail/Bosch-Sensortec/Application-Board-3.0?qs=sGAEpiMZZMuqBwn8WqcFUipNgoezRlc40W78wRslQAHIB%252BjivBfvmw%3D%3D>.

APP3.0 base board schematics is available online at [https://www.bosch-sensortec.com/media/boschsensortec/downloads/software\\_tools/application\\_board\\_3\\_0/app3\\_0\\_schematics.pdf](https://www.bosch-sensortec.com/media/boschsensortec/downloads/software_tools/application_board_3_0/app3_0_schematics.pdf).

BHI360 shuttle board 3.0 can be purchased at <https://www.mouser.com/ProductDetail/Bosch-Sensortec/Shuttle-Board-3.0-BHI360?qs=ulEaXIWI0c%252BcB%2FkhNMvzBA%3D%3D>.

BHI360 X/Y/Z axes are marked in Figure 1. The Euler angle definition from Orientation virtual sensor output is as shown below.

- Heading: rotation around the Z axis ( $0^\circ \leq \text{heading} < 360^\circ$ ).  $0^\circ$  = North,  $90^\circ$  = East,  $180^\circ$  = South,  $270^\circ$  = West. The heading value increases when you rotate around the Z axis clockwise from top view of Figure 1.
- Pitch: rotation around the X axis ( $-180^\circ \leq \text{pitch} \leq 180^\circ$ ) with positive values increasing when the Z axis moves towards the Y axis.
- Roll: rotation around the Y axis ( $-90^\circ \leq \text{roll} \leq 90^\circ$ ) with positive values increasing when the X axis moves toward the Z axis.

### 3 Software

In order to evaluate BHI360 shuttle board 3.0, there are two software available,

- Development Desktop 2.1 (DD2.1) v3.26
- COINES v2.8.8

Their differences are as shown in Table 2.

Table 1 functionalities of these two SW

Functionalities	DD2.1	COINES
Real-time waveforms	Yes	No
Log data into a CSV file	Yes	Yes
Low level programming	No	Yes
Develop and test own algorithm	No	Yes

#### 3.1 DD2.1 SW

DD2.1 SW can be downloaded online at [https://www.bosch-sensortec.com/media/boschsensortec/downloads/development\\_desktop\\_software/v3\\_26/developmentdesktop21\\_v3-26-exe.zip](https://www.bosch-sensortec.com/media/boschsensortec/downloads/development_desktop_software/v3_26/developmentdesktop21_v3-26-exe.zip). After installation users are able to download the RAM patch into BHI360, enable virtual sensors, view real-time results and log results into a CSV file. The instructions are as shown below.

- Connect micro USB cable from APP3.0 base board to PC USB port. Switch on APP3.0 base board.
- Launch DD2.1 SW and DD2.1 will automatically recognize the BHI360 shuttle board. A dialog window will pop up asking users to download the RAM patch as shown in Figure 2.

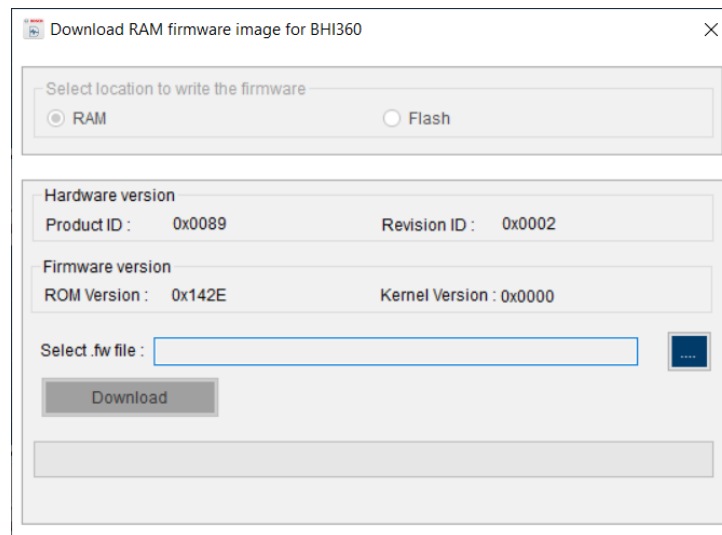


Figure 2 RAM patch download dialog

- Click the “...” button and then select the “Bosch\_Shuttle3\_BHI360\_BMM350C.fw” that is located in the “C:\Program Files\Bosch Sensortec\Development Desktop 2.1\Firmware\BHI360” folder as shown in Figure 3. Click “Open” button.

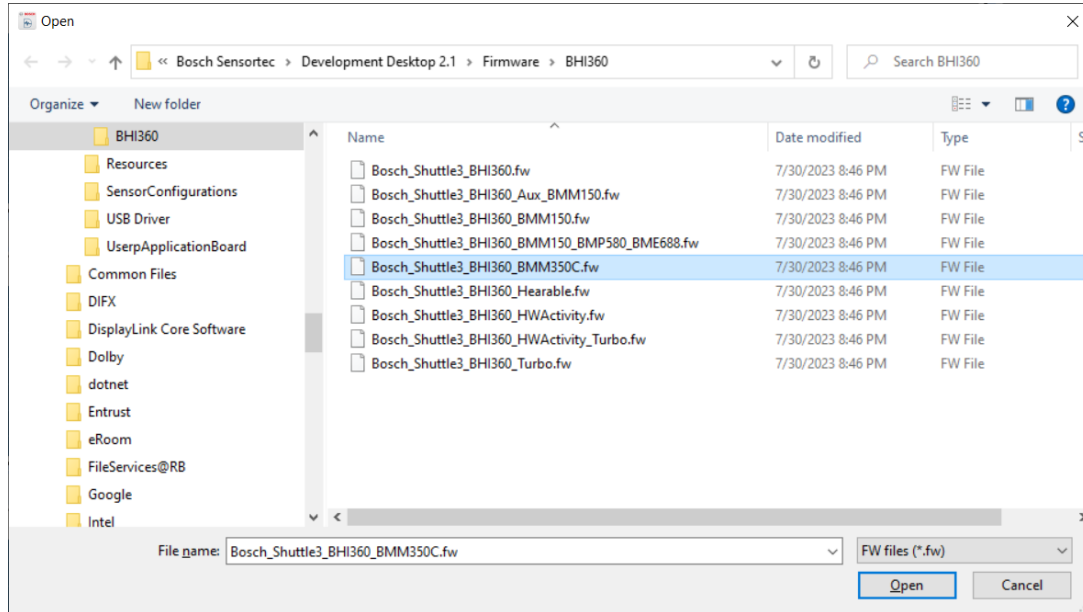


Figure 3 Locate RAM patch

- Click the “Download” button in Figure 2. After a short while users should see the text “BHI360 firmware is downloaded successfully” as shown in Figure 4. Then close this dialog.

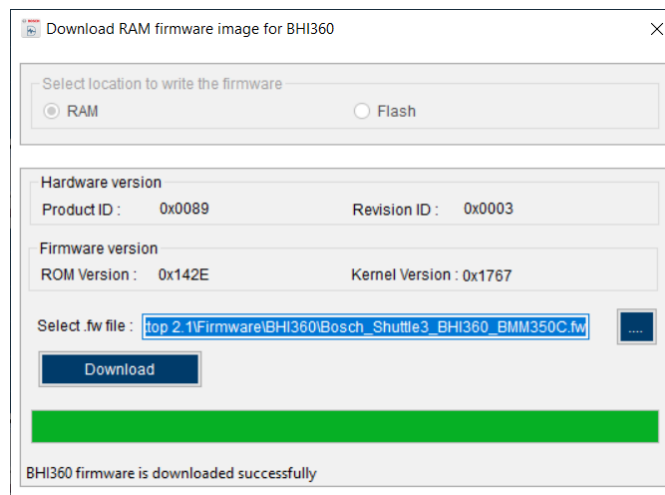


Figure 4 Download RAM patch

- Next step is enable one or multiple virtual sensors by clicking the “Virtual Sensor” tab on the top right corner of DD2.1 SW. For example, from the “Virtual Sensor” dropdown list select “Gravity (Non-Wakeup)” and then click “Write Info” tab. Select 100Hz from the “Sample Rate” dropdown list and then click “Write” button as shown in Figure 5.

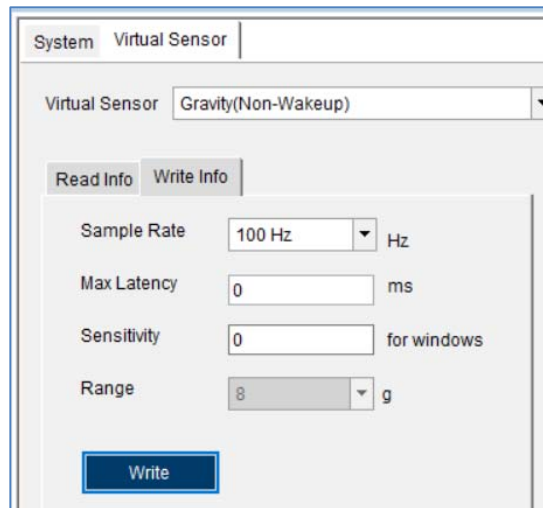


Figure 5 Enable a virtual sensor

- Similarly enable virtual sensor “Linear Acceleration (Non-Wakeup)” and “Orientation (Non-wakeup)” with the same 100Hz sample rate and click the “Write” button each time.

- Click “System” tab on the top right corner of DD2.1 SW and select the above three virtual sensors from Plot1, Plot2 and Plot3 respectively as shown in Figure 6. Then scroll down and click the “Refresh” button. Users will see green circle next to “Interrupt Enable” when clicking each tab of “Accelerometer”, “Magnetometer” and “Gyroscope”. This means that each physical sensor is active and 9DoF sensor fusion is ready to go.

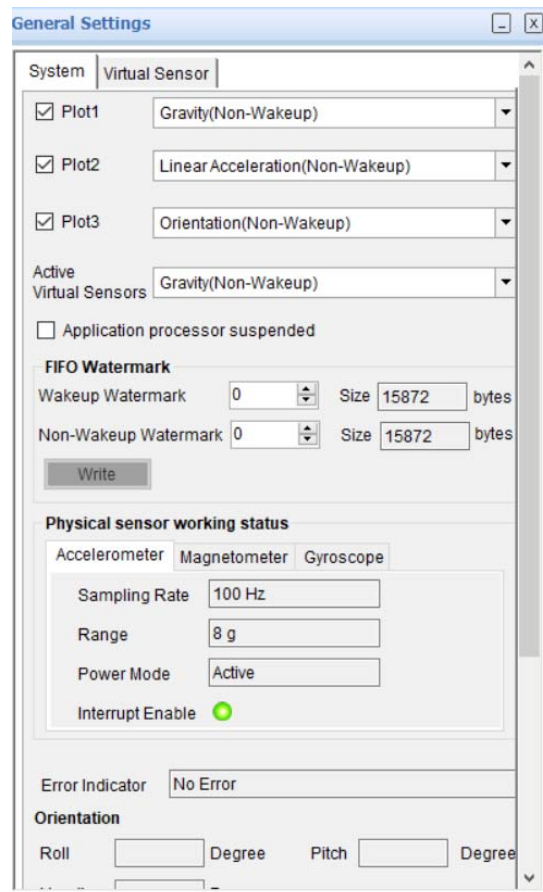


Figure 6 Prepare to plot

- Now click “Start Streaming” button on the bottom left to see the waveforms in real-time by rotating the APP3.0 base board with BHI360 shuttle board plugged in. When moving on a flat surface back and forth, linear acceleration is changing in Plot2, while gravity vector in Plot1 remains the same as shown in Figure 7.



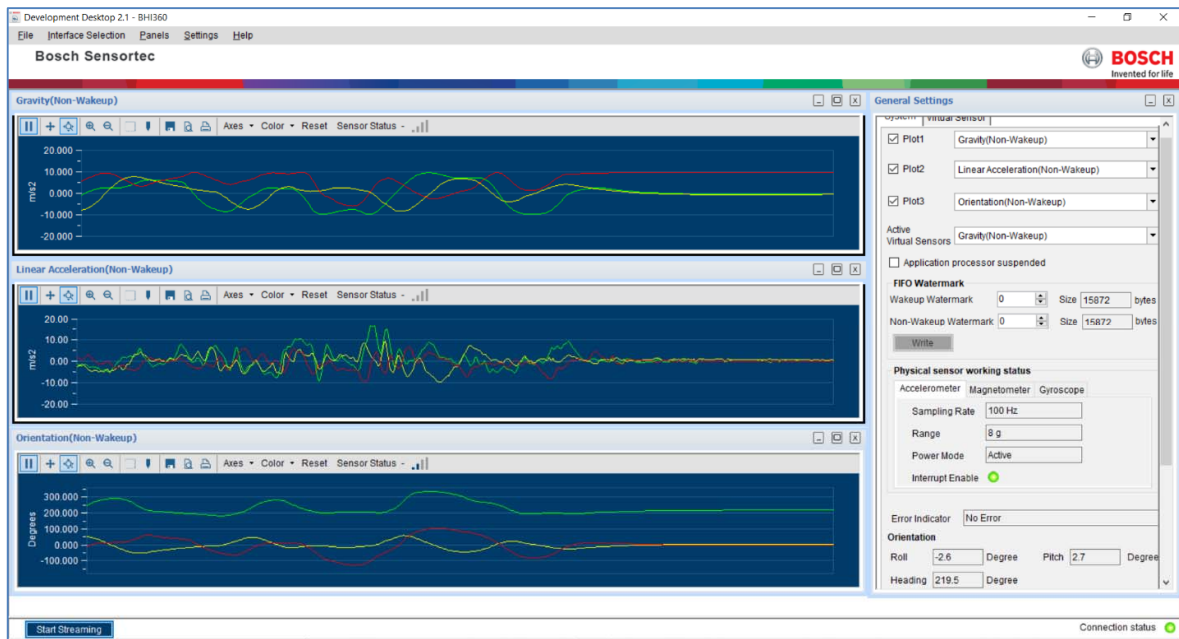


Figure 7 BHI360 virtual sensors' waveforms

- Click “Panels -> Data Export” a dialog window will pop up as shown in Figure 8. The enabled virtual sensors' results can be saved into a CSV file. Users can click “EnableLogging” button and then click “Start Streaming” button.

Data Export
— □ ×

Virtual Sensor	Wakeup	Non Wakeup
Accelerometer Passthrough	NA	<input type="checkbox"/>
Accelerometer Uncalibrated	<input type="checkbox"/>	<input type="checkbox"/>
Accelerometer Corrected	<input type="checkbox"/>	<input type="checkbox"/>
Accelerometer Offset	NA	<input type="checkbox"/>
Gyroscope Passthrough	NA	<input type="checkbox"/>
Gyroscope Uncalibrated	<input type="checkbox"/>	<input type="checkbox"/>
Gyroscope Corrected	<input type="checkbox"/>	<input type="checkbox"/>
Gyroscope Offset	NA	<input type="checkbox"/>
Magnetometer Passthrough	NA	<input type="checkbox"/>
Magnetometer Uncalibrated	<input type="checkbox"/>	<input type="checkbox"/>
Magnetometer Corrected	<input type="checkbox"/>	<input type="checkbox"/>
Magnetometer Offset	NA	<input type="checkbox"/>
Gravity	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Linear Acceleration	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Rotation Vector	<input type="checkbox"/>	<input type="checkbox"/>
Game Rotation Vector	<input type="checkbox"/>	<input type="checkbox"/>
Geomagnetic Rotation Vector	<input type="checkbox"/>	<input type="checkbox"/>
Orientation	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Virtual Sensor	Wakeup	Non Wakeup
Temperature	<input type="checkbox"/>	<input type="checkbox"/>
Pressure	<input type="checkbox"/>	<input type="checkbox"/>
Humidity	<input type="checkbox"/>	<input type="checkbox"/>
Gas	<input type="checkbox"/>	<input type="checkbox"/>
Step Detector	<input type="checkbox"/>	<input type="checkbox"/>
Step Counter	<input type="checkbox"/>	<input type="checkbox"/>
Multi Tap Detector	NA	<input type="checkbox"/>
Activity	<input type="checkbox"/>	NA
Wrist Wear	<input type="checkbox"/>	NA
Wrist Gesture	<input type="checkbox"/>	NA
No Motion	<input type="checkbox"/>	NA
Any Motion	<input type="checkbox"/>	NA
SensorTime	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Metaevents	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Select Destination

Append 
Overwrite

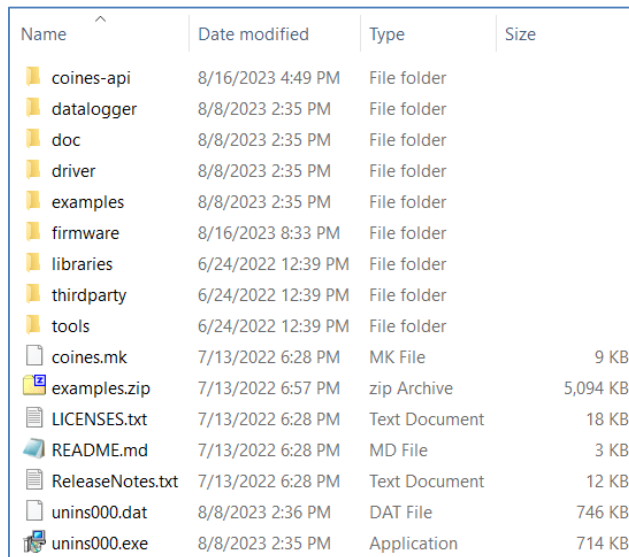
Enable Logging

Figure 8 Log data into a CSV file

### 3.2 COINES SW

COINES v2.8.8 SW can be downloaded online at [https://www.bosch-sensortec.com/media/boschsensortec/downloads/software/communication\\_with\\_inertial\\_and\\_environmental\\_sensors\\_coines/v2\\_8/coines\\_external\\_v2-8\\_rc\\_installer.zip](https://www.bosch-sensortec.com/media/boschsensortec/downloads/software/communication_with_inertial_and_environmental_sensors_coines/v2_8/coines_external_v2-8_rc_installer.zip). Users can unzip this file and then double click “COINES\_External\_V2.8\_RC.exe” to install the COINES SW. After installation users are able to find the folder C:/Windows/COINES/v2.8.8 as shown in Figure 9.

COINES (“COmmunication with INertial and Environmental Sensors”) provides a low-level interface to APP3.0 board and each sensor shuttle board 3.0. Users can access MEMS sensors through a C interface. COINES can be used with the SensorAPI of the sensor. The SensorAPI is available at <https://github.com/BoschSensortec>. Source code of sample applications and SensorAPI are provided with the COINES library as a package. Users can modify, compile and run the sample applications.



Name	Date modified	Type	Size
coines-api	8/16/2023 4:49 PM	File folder	
datalogger	8/8/2023 2:35 PM	File folder	
doc	8/8/2023 2:35 PM	File folder	
driver	8/8/2023 2:35 PM	File folder	
examples	8/8/2023 2:35 PM	File folder	
firmware	8/16/2023 8:33 PM	File folder	
libraries	6/24/2022 12:39 PM	File folder	
thirdparty	6/24/2022 12:39 PM	File folder	
tools	6/24/2022 12:39 PM	File folder	
coines.mk	7/13/2022 6:28 PM	MK File	9 KB
examples.zip	7/13/2022 6:57 PM	zip Archive	5,094 KB
LICENSES.txt	7/13/2022 6:28 PM	Text Document	18 KB
README.md	7/13/2022 6:28 PM	MD File	3 KB
ReleaseNotes.txt	7/13/2022 6:28 PM	Text Document	12 KB
unins000.dat	8/8/2023 2:36 PM	DAT File	746 KB
unins000.exe	8/8/2023 2:35 PM	Application	714 KB

Figure 9 COINES folder

The subfolder of “examples” contains subfolders of each sensor that have C source code for evaluation.

One example of using COINES together with the APP3.0 base board and BHI360 shuttle board 3.0 is as shown below.

- Go to <https://github.com/jmeubank/tdm-gcc/releases/download/v10.3.0-tdm64-2/tdm64-gcc-10.3.0-2.exe> to download TDM-GCC compiler version 10.3.0 and then install it on PC.
- Go to folder C:\COINES\v2.8.8\examples\bhy2\examples\euler in Windows File Explorer. Then press and hold “Shift” key on the keyboard and then right click the mouse. Select “Open PowerShell window here” as shown in Figure 10.

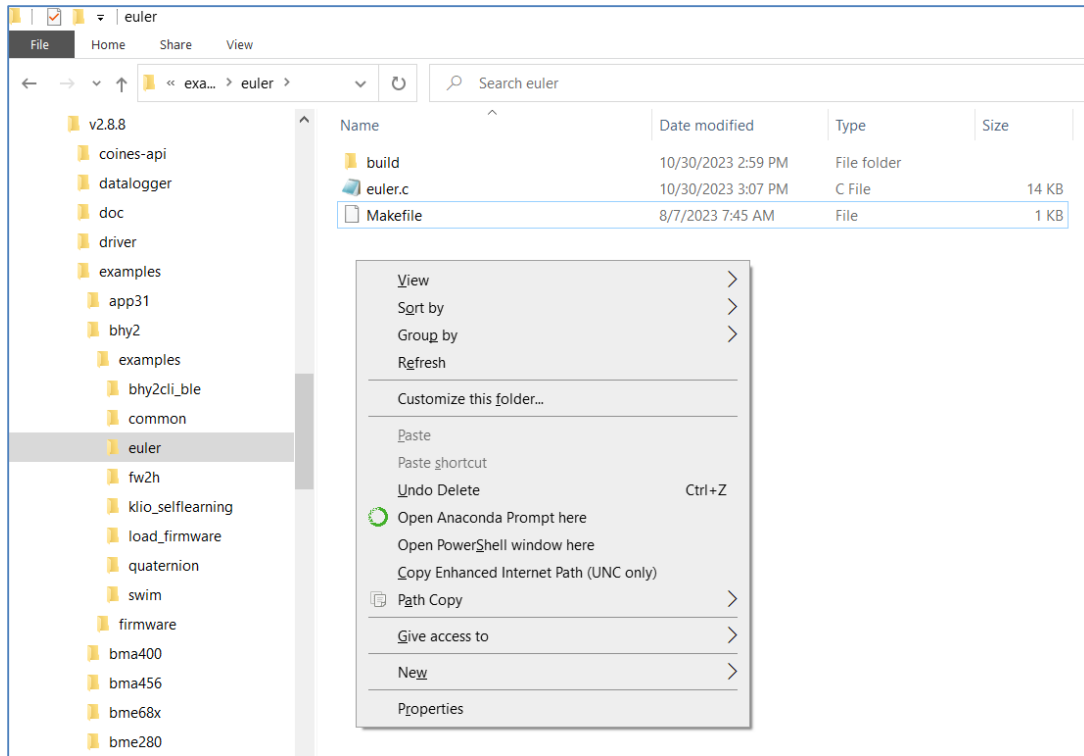
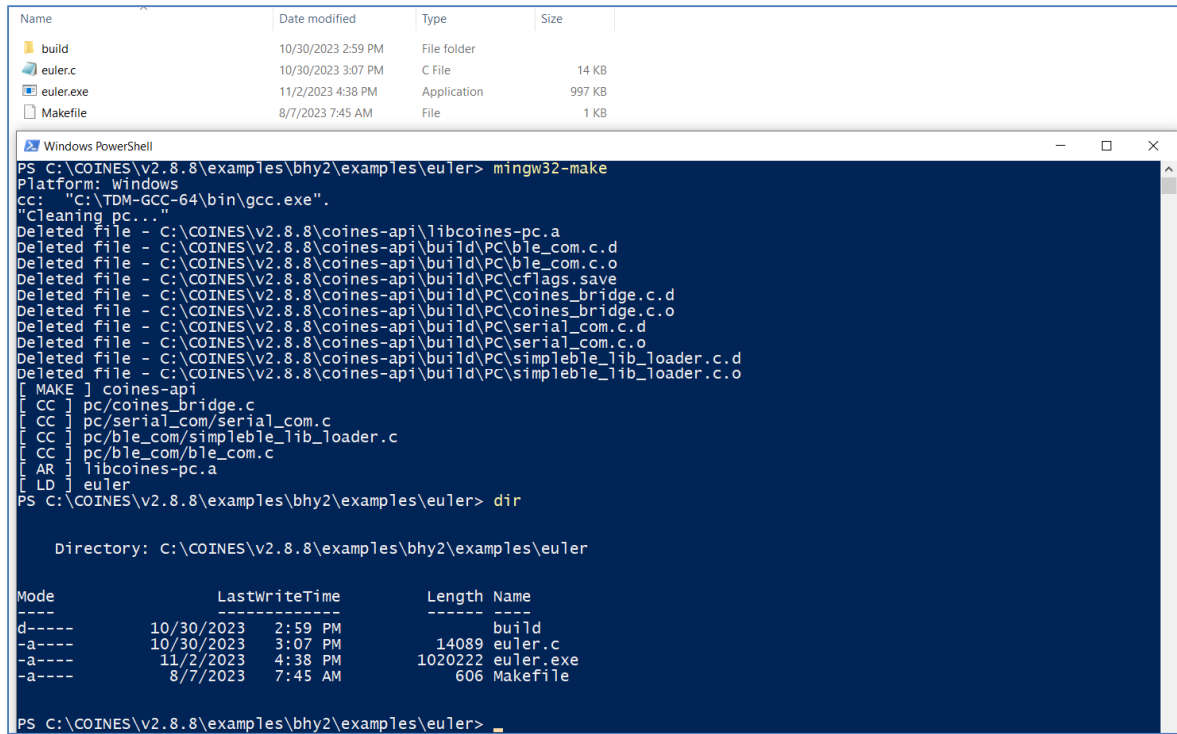


Figure 10 COINES example folder

- Type mingw32-make in the command window and press Enter key. The exe file is generated as shown in Figure 11.



```

Name                               Date modified      Type               Size
--
build                               10/30/2023 2:59 PM File folder
euler.c                             10/30/2023 3:07 PM C File             14 KB
euler.exe                           11/2/2023 4:38 PM Application        997 KB
Makefile                             8/7/2023 7:45 AM File               1 KB

Windows PowerShell
PS C:\COINES\v2.8.8\examples\bhy2\examples\euler> mingw32-make
Platform: windows
cc: "C:\TDM-GCC-64\bin\gcc.exe".
"Cleaning pc..."
Deleted file - C:\COINES\v2.8.8\coins-api\libcoins-pc.a
Deleted file - C:\COINES\v2.8.8\coins-api\build\PC\ble_com.c.d
Deleted file - C:\COINES\v2.8.8\coins-api\build\PC\ble_com.c.o
Deleted file - C:\COINES\v2.8.8\coins-api\build\PC\cf_flags.save
Deleted file - C:\COINES\v2.8.8\coins-api\build\PC\coins_bridge.c.d
Deleted file - C:\COINES\v2.8.8\coins-api\build\PC\coins_bridge.c.o
Deleted file - C:\COINES\v2.8.8\coins-api\build\PC\serial_com.c.d
Deleted file - C:\COINES\v2.8.8\coins-api\build\PC\serial_com.c.o
Deleted file - C:\COINES\v2.8.8\coins-api\build\PC\simpleble_lib_loader.c.d
Deleted file - C:\COINES\v2.8.8\coins-api\build\PC\simpleble_lib_loader.c.o
[ MAKE ] coins-api
[ CC ] pc/coins_bridge.c
[ CC ] pc/serial_com/serial_com.c
[ CC ] pc/ble_com/simpleble_lib_loader.c
[ CC ] pc/ble_com/ble_com.c
[ AR ] libcoins-pc.a
[ LD ] euler
PS C:\COINES\v2.8.8\examples\bhy2\examples\euler> dir

Directory: C:\COINES\v2.8.8\examples\bhy2\examples\euler

Mode                LastWriteTime         Length Name
----                -
d-----          10/30/2023   2:59 PM             build
-a----          10/30/2023   3:07 PM           14089 euler.c
-a----          11/2/2023    4:38 PM          1020222 euler.exe
-a----           8/7/2023    7:45 AM             606 Makefile
PS C:\COINES\v2.8.8\examples\bhy2\examples\euler>
  
```

Figure 11 COINES compiling to EXE file

- Type `.\euler.exe` in the command window and press Enter key. The RAM patch will be downloaded to BHI360 shuttle board. Then COINES displays Euler angles continuously as shown in Figure 12.

```
Windows PowerShell
PS C:\COINES\v2.8.8\examples\bhy2\examples\euler> .\euler.exe
Host Interface : SPI
Error configuring to SPI.
[COINES Error] SPI configuration failed
BHI260/BHA260 found. Product ID read 89
Host interrupt control
  Wake up FIFO enabled.
  Non wake up FIFO enabled.
  Status FIFO disabled.
  Debugging disabled.
  Fault enabled.
  Interrupt is active high.
  Interrupt is level triggered.
  Interrupt pin drive is push-pull.
Loading firmware into RAM.
Booting from RAM.
Boot successful. Kernel version 5991.
[META EVENT WAKE UP] Firmware initialized. Firmware version 5991
[META EVENT WAKE UP] Firmware initialized. Firmware version 5991
Enable Orientation wake up at 100.00Hz.
[META EVENT WAKE UP] Power mode changed for sensor id 44
[META EVENT WAKE UP] Sample rate changed for sensor id 44
SID: 44; T: 1.009187500; h: 0.000000, p: -0.065918, r: -2.230225; acc: 2
[META EVENT WAKE UP] Accuracy for sensor id 44 changed to 0
SID: 44; T: 1.019218750; h: 0.000000, p: -0.065918, r: -2.230225; acc: 0
SID: 44; T: 1.029250000; h: 0.010986, p: -0.054932, r: -2.230225; acc: 0
SID: 44; T: 1.039265625; h: 0.010986, p: -0.054932, r: -2.230225; acc: 0
SID: 44; T: 1.049296875; h: 0.021973, p: -0.054932, r: -2.230225; acc: 0
SID: 44; T: 1.059312500; h: 0.021973, p: -0.043945, r: -2.230225; acc: 0
SID: 44; T: 1.069343750; h: 0.021973, p: -0.043945, r: -2.230225; acc: 0
SID: 44; T: 1.079375000; h: 0.032959, p: -0.032959, r: -2.230225; acc: 0
SID: 44; T: 1.089390625; h: 0.032959, p: -0.032959, r: -2.230225; acc: 0
SID: 44; T: 1.099421875; h: 0.032959, p: -0.021973, r: -2.230225; acc: 0
SID: 44; T: 1.109437500; h: 0.032959, p: -0.021973, r: -2.230225; acc: 0
SID: 44; T: 1.119468750; h: 0.043945, p: -0.010986, r: -2.230225; acc: 0
SID: 44; T: 1.129484375; h: 0.043945, p: -0.010986, r: -2.230225; acc: 0
SID: 44; T: 1.139515625; h: 0.043945, p: -0.010986, r: -2.230225; acc: 0
```

Figure 8 COINES example results

- Users can modify “euler.c” file with Notepad++ SW for example and compile it again for further evaluation.

## 4 Legal disclaimer

### 4.1 Engineering samples

Engineering Samples are marked with an asterisk (\*) or (e) or (E). Samples may vary from the valid technical specifications of the product series contained in this data sheet. They are therefore not intended or fit for resale to third parties or for use in end products. Their sole purpose is internal client testing. The testing of an engineering sample may in no way replace the testing of a product series. Bosch Sensortec assumes no liability for the use of engineering samples. The Purchaser shall indemnify Bosch Sensortec from all claims arising from the use of engineering samples.

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## 5 Document history and modification

Rev. No	Chapter	Description of modification/changes	Date
1.0		Document creation	November 2 <sup>nd</sup> , 2023

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