Technical Document

How to play with BHI360 shuttle board 3.0

Bosch Sensortec

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Table of contents

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.

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.

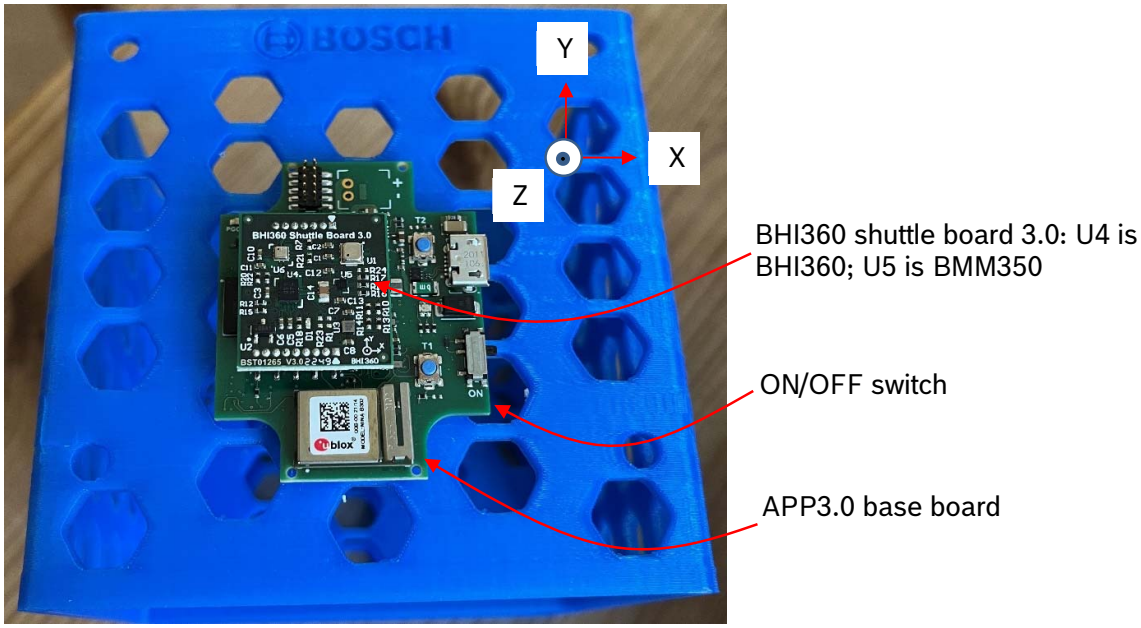


Figure 1 APP3.0 base board and BHI360 shuttle board 3.0

APP3.0 base board can be purchased at https://www.mouser.com/ProductDetail/Bosch-Sensortec/Application-Board-3.0?qs=sGAEpiMZZMuqBwn8WqcFUipNgoezRlc40W78wRsIQAHIB%252BjjvBfvmw%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.

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° <= heading < 360°). 0° = North, 90° = East, 180° = South, 270° = 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° <= pitch <= 180°) with positive values increasing when the Z axis moves towards the Y axis.
- Roll: rotation around the Y axis (-90° <= roll <= 90°) 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. 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.

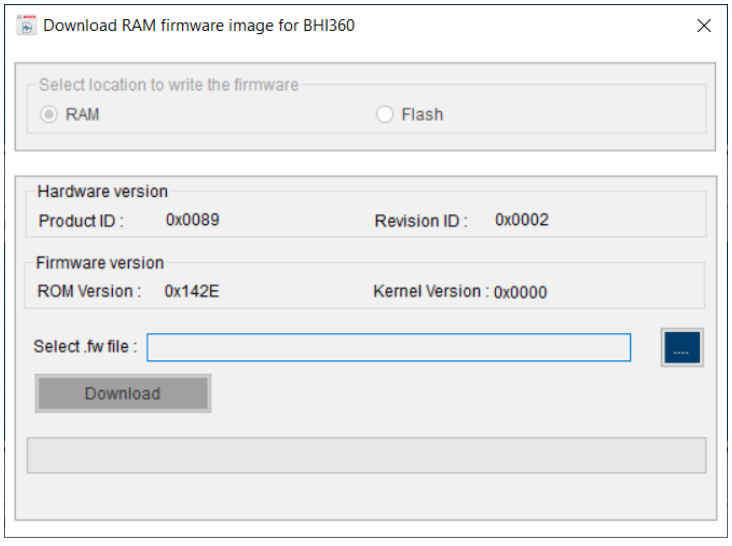


Figure 2 RAM patch download dialog

- 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.

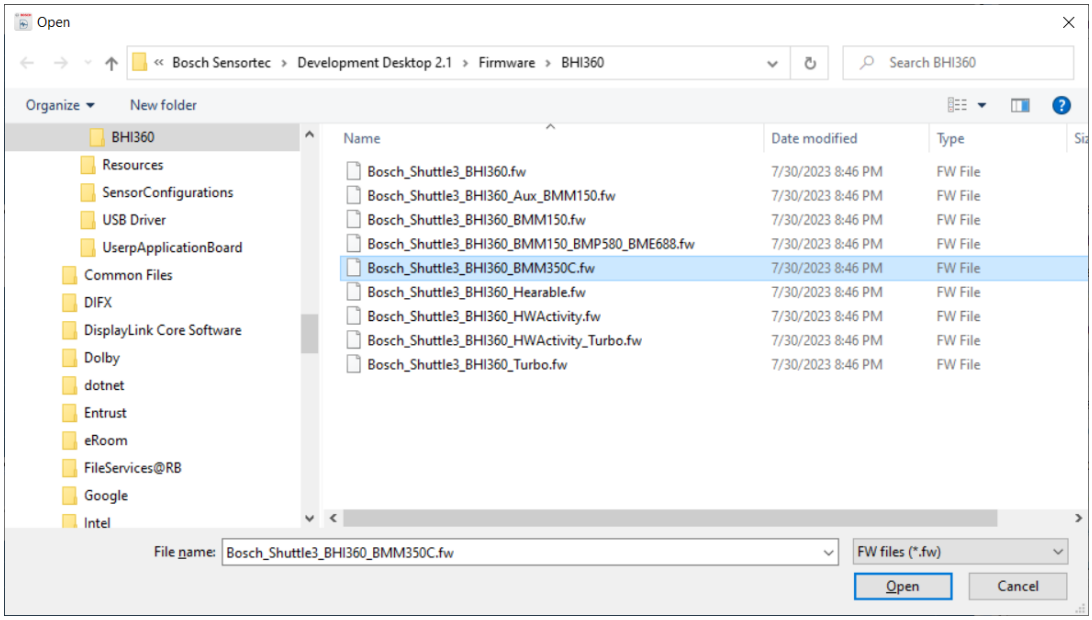


Figure 3 Locate RAM patch

- 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.

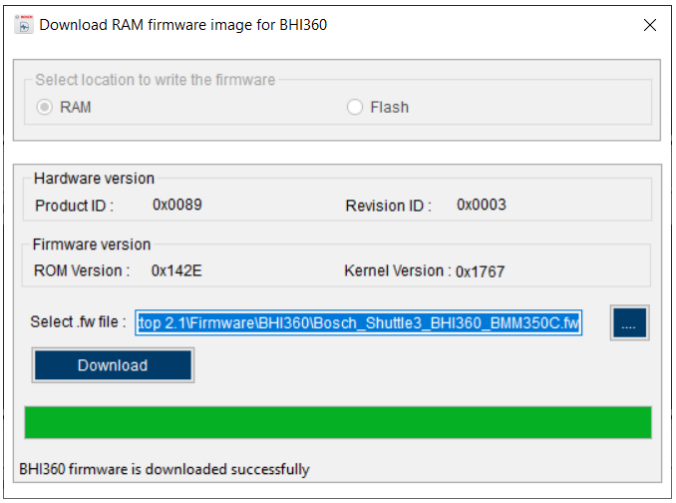


Figure 4 Download RAM patch

- 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.

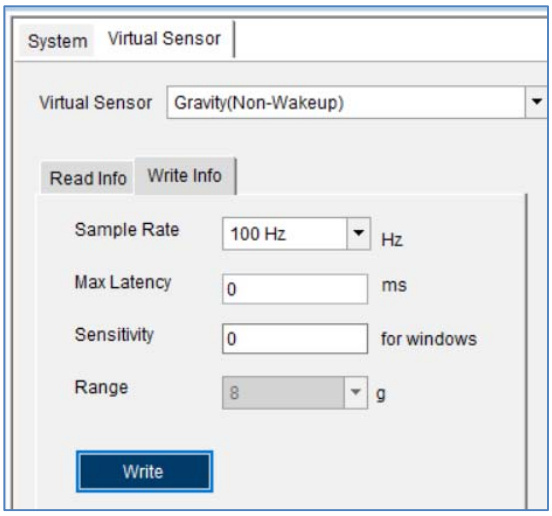


Figure 5 Enable a virtual sensor

- 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.

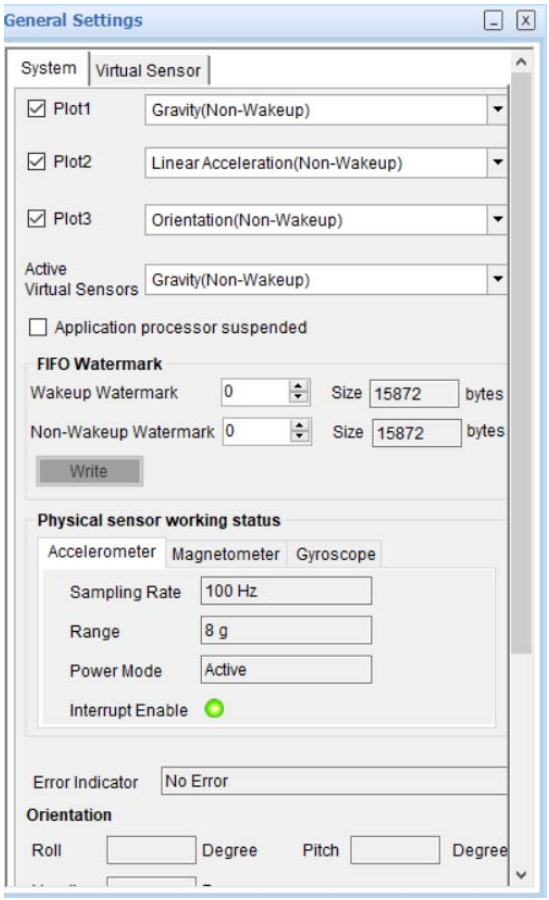


Figure 6 Prepare to plot

- 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.

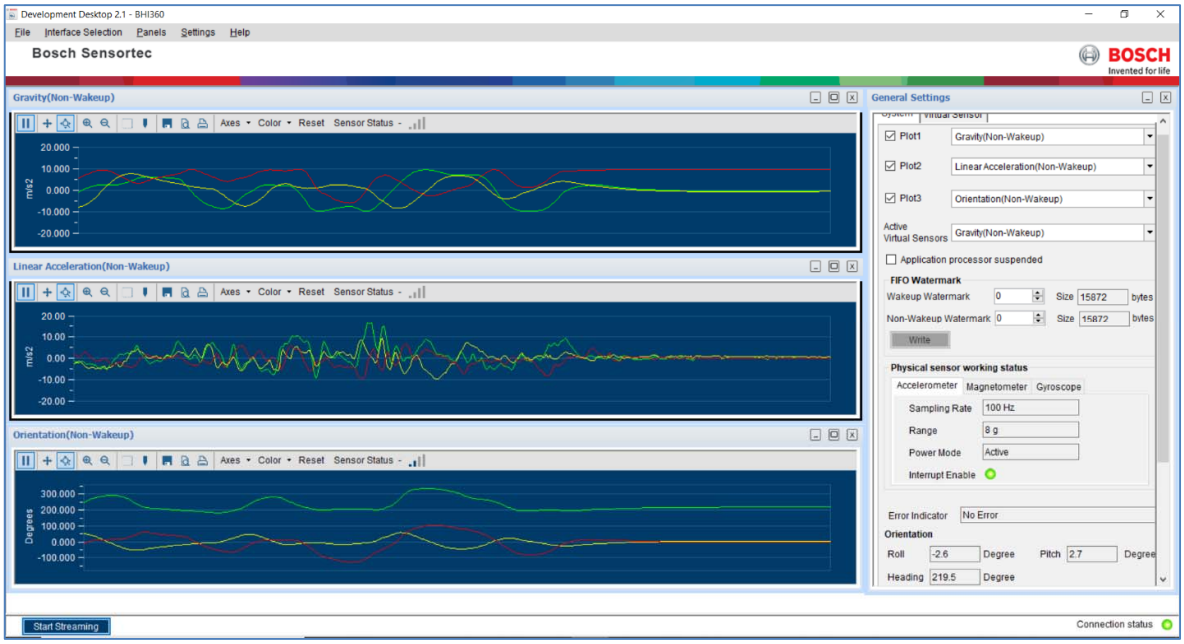


Figure 7 BHI360 virtual sensors' waveforms

- 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.

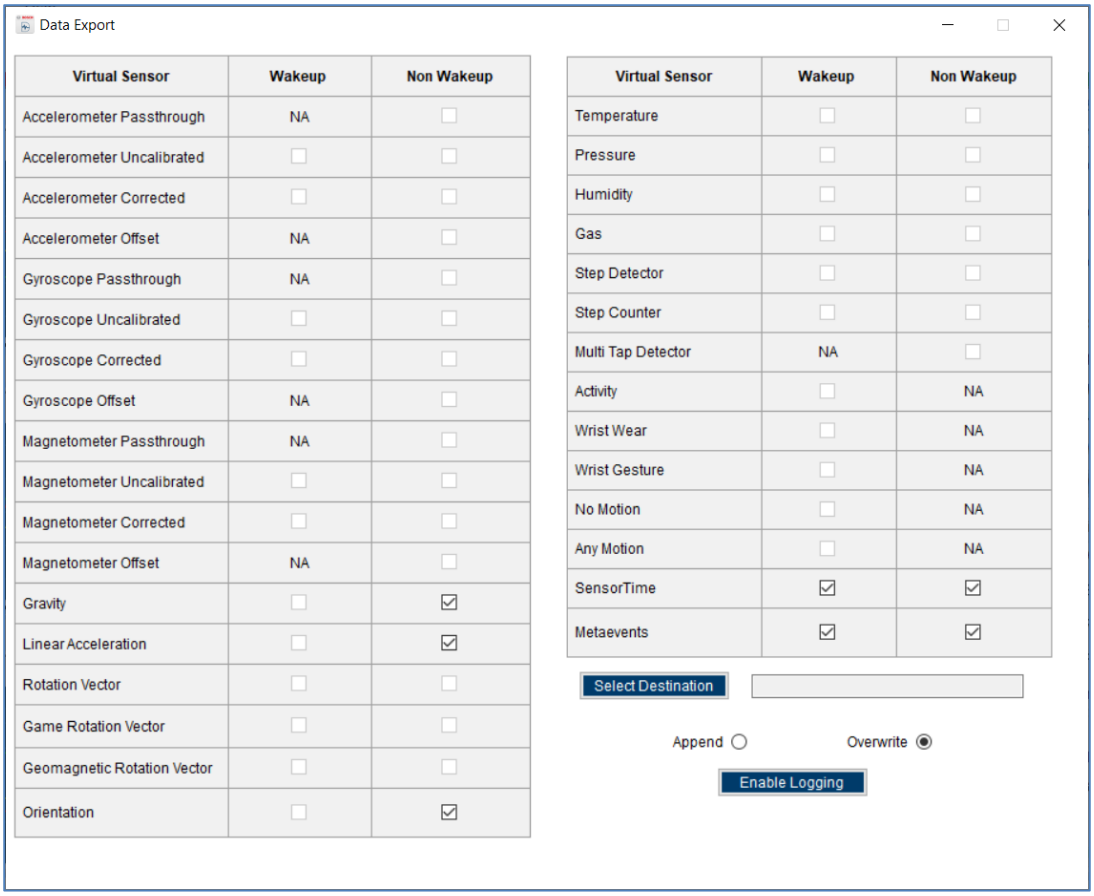
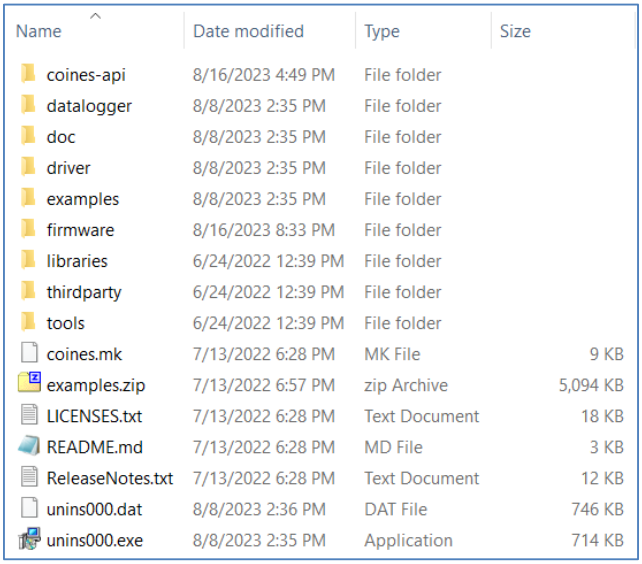


Figure 8 Log data into a CSV file

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. 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.

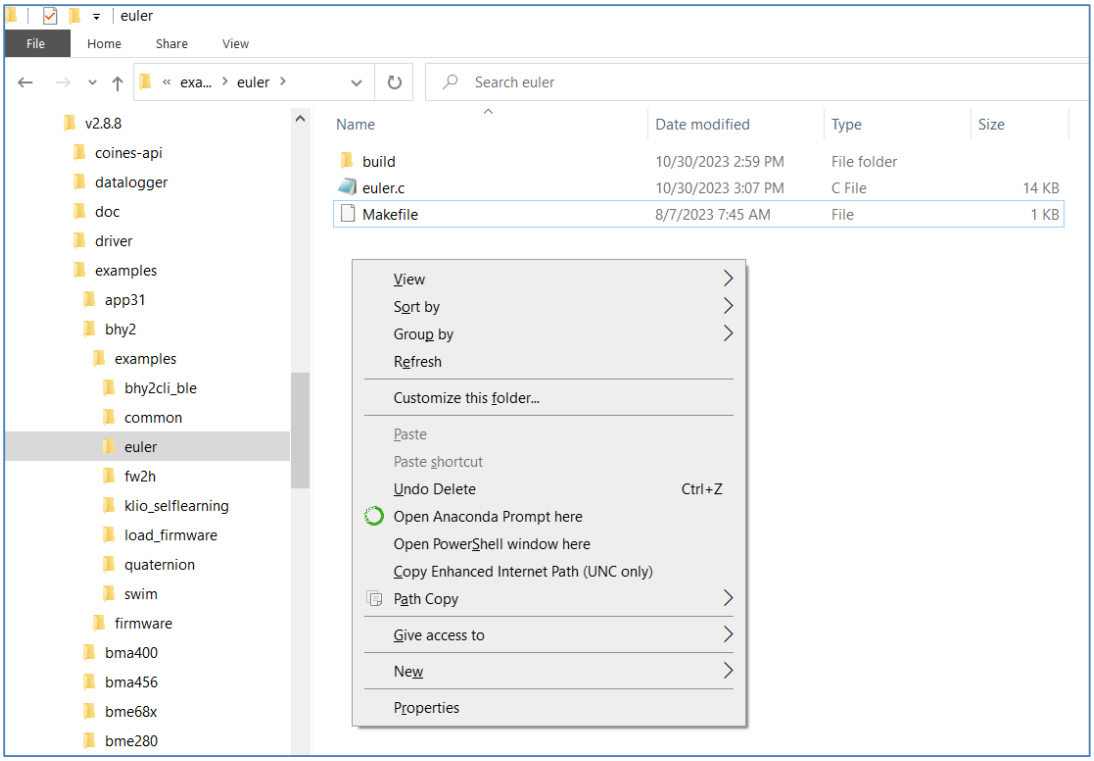


Figure 10 COINES example folder

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

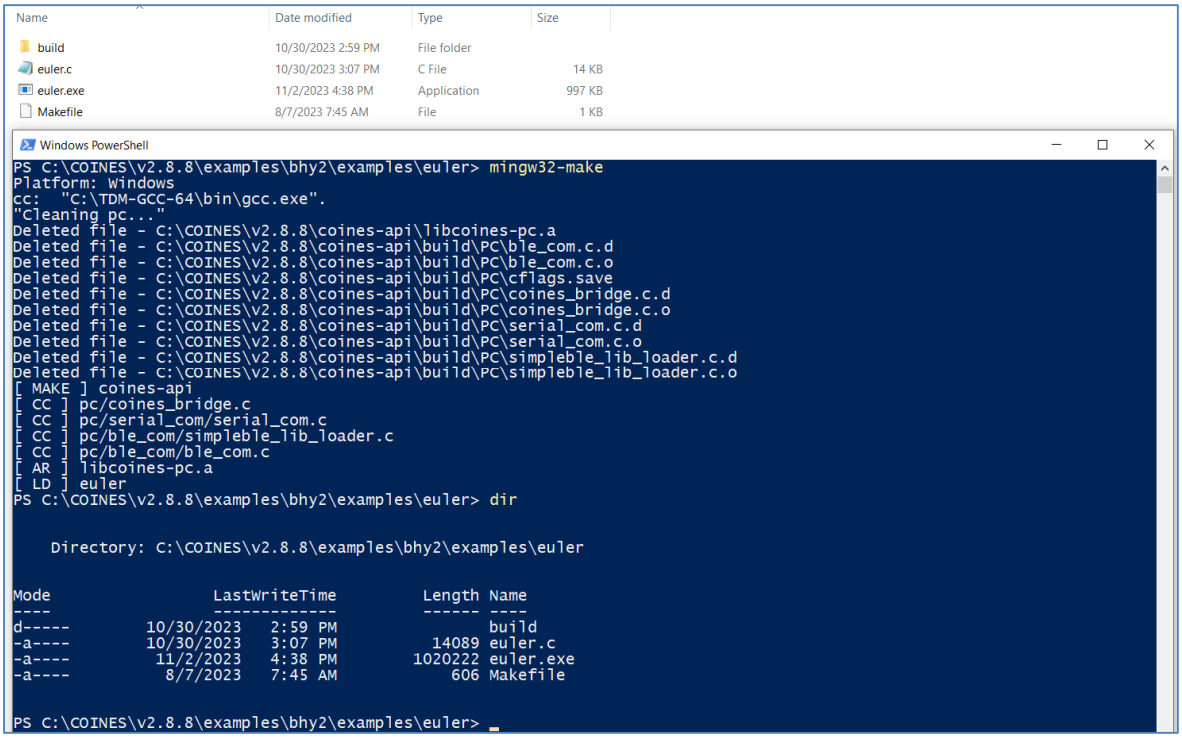


Figure 11 COINES compiling to EXE file

- 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.

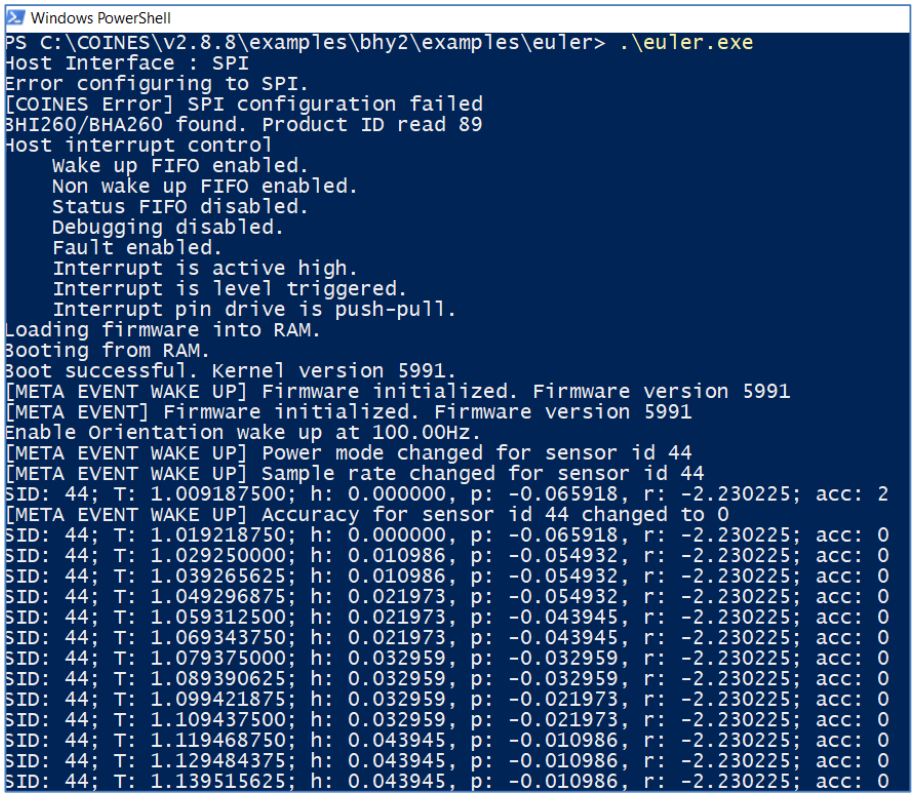


Figure 8 COINES example results

- 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 2nd, 2023

Bosch Sensortec GmbH
Gerhard-Kindler-Strasse 8
72770 Reutlingen / Germany

Contact@bosch-sensortec.com
www.bosch-sensortec.com