# EVBUM2614

# RSL10-SENSE-GEVK (and RSL10-SENSE-DB-GEVK) User Guide

ON Semiconductor®

www.onsemi.com

EVAL BOARD USER'S MANUAL

### Introduction

The RSL10−SENSE−GEVK (and RSL10−SENSE−DB−GEVK) is a comprehensive, compact, node−to−cloud IoT sensor platform that allows development of various Bluetooth Low Energy based use cases. Along with the hardware and software, the RSL10−SENSE−GEVK includes a mobile app to interact with sensors and actuators. The board features RSL10, Industry's lowest power Bluetooth® 5 SoC and several sensors from ON Semiconductor and Bosch. By combining motion, environmental, ambient light sensing with the ultra−low power of the Bluetooth 5 Certified RSL10 and will enable customers to realize a new class of battery powered static, mobile and wearable smart sensors targeting consumer and industrial applications in the IoT.

The overall deep sleep consumption of 20 μA results in a battery life of over 1 year. For further increase in battery life, software configuration wizard allows flexible timing setup as discussed in the following sections.

### Variants

There are two SKUs of the RSL10 Sensor kit. Both variants are pre−loaded with an ultra−low power firmware and include a 3 V CR2032 coin cell and a flexible NFC antenna.

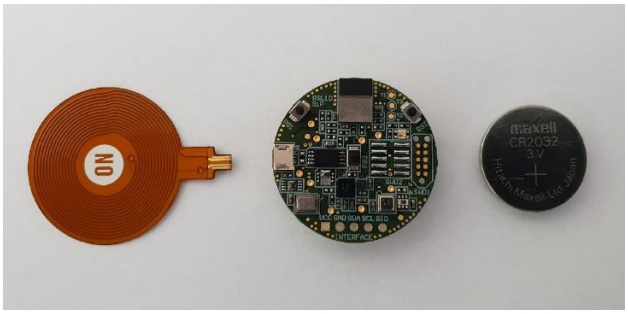

Figure 1.

**RSL10−SENSE−GEVK**: Firmware can be flashed via 10−pin needle adapter (e.g. TC2050 from Tag−Connect) (not included). The 10−pin header for debugger is not populated on the board.

**RSL10−SENSE−DB−GEVK**: The "debug" (−DB) version of the board also includes a low cost Segger debugger J−Link LITE CortexM and a USB cable. Users can directly debug/communicate/flash the firmware over the populated−pin header.

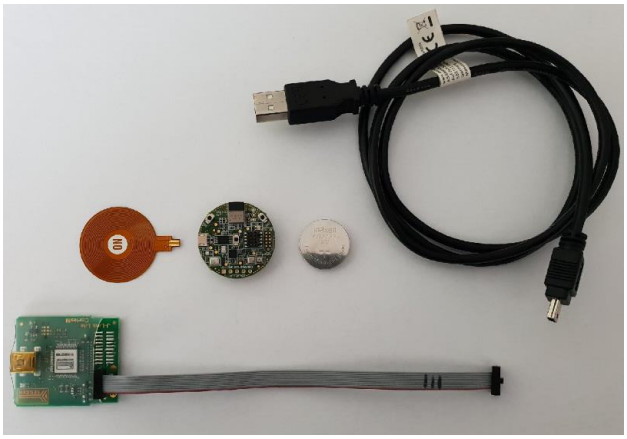

Figure 2.

### Scope

The board starts functioning as soon as the coin cell is in place. This document covers the setup, software architecture, documentation and provides instructions on downloading firmware to the board. The details regarding the mobile app and cloud connectivity are not covered in this document.

### Default Configuration

In addition to the RSL10 SiP (System−in−Package), the following sensors are present on the board.

- NOA1305, ambient Light sensor
- N24RF64, NFC EEPROM
- BME680, environmental sensor (temperature, humidity, pressure, air quality)
- BHI160 + BMM150, 3−axis accelerometer, gyroscope, magnetometer. Together returnabsolute orientation supported in software
- INMP522 −> ultra−low power microphone for audio applications
- User can insert NFC flexible antenna into dedicated connector and bend underneath the battery holder for custom packaging / cases.

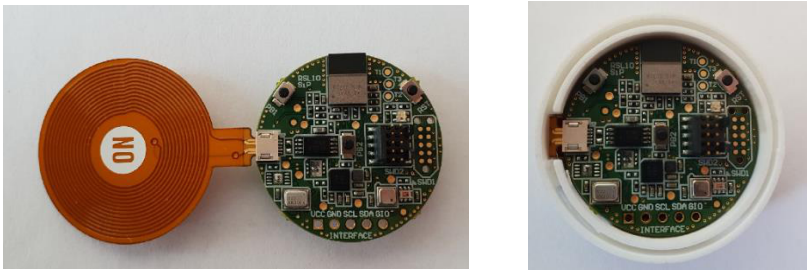

**Figure 3.**

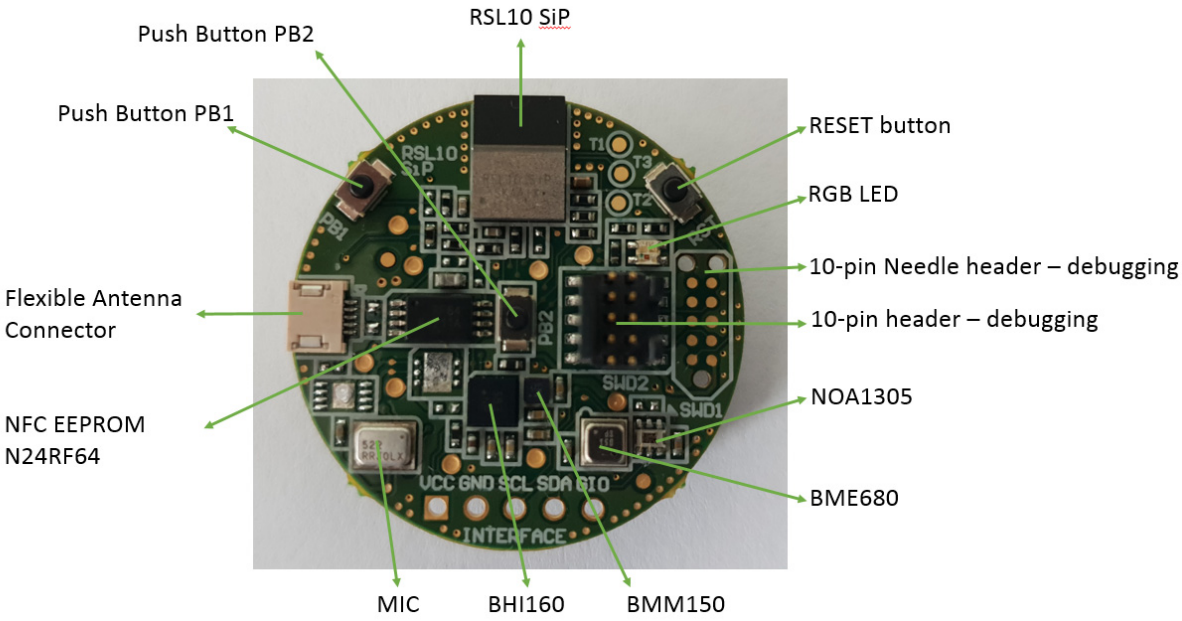


**Figure 4.**

Both kits are shipped with the ultra−low power firmware pre−loaded into the boards.

### Powering the Board

To power RSL10−SENSE−GEVK, one has to insert CR2032 (3 V) battery into battery holder located on the bottom side of the board.

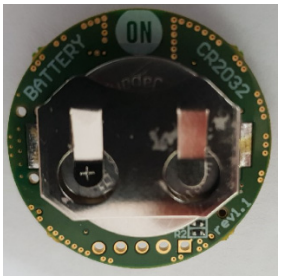


**Figure 5.**

## SOFTWARE

The RSL10−SENSE−GEVK boards are, by default, configured with the ultra−low power firmware. For users that want to download different firmware versions, this section details the involved steps.

### Prerequisities

1. Install 64−bit version of Java from https://www.java.com/en/download/
2. Install J−Link Version 6.32i or later from https://www.segger.com/downloads/jlink (select J−Link software and documentation pack)
3. Download and install "ON Semiconductor IDE Installer" from https://www.onsemi.com/PowerSolutions/product.do?id=RSL10

a.) Download the "RSL10 SDK Getting Started Guide" and RSL10 CMSIS pack under "RSL10 Software Package" from the above site. All of these are highlighted in the picture below. Save the CMSIS pack in a folder, for example, C:\cmsis_packs


**Figure 6.**

4. Download the B−ID CMSIS pack from https://www.onsemi.com/B−IDK and save it in the same folder as the RSL10 CMSIS pack (see 3.a above)
5. CMSIS pack at item 4. is dependent on ARM CMSIS pack as well. Please install ARM CMSIS pack 5.5.1 or higher after download from: https://github.com/ARM−software/CMSIS_5/releases
6. CMSIS pack at item 4. is also dependent on ARM CMSIS – FreeRTOS version 10.2.0 or higher for users exposed to design the code under FreeRTOS with RSL10: https://github.com/ARM−software/CMSIS−FreeRTOS/releases

The next section provides details on importing the downloaded CMSIS packs into the SDK.

### Importing CMSIS Packages

1. Launch the RSL10 ON Semiconductor IDE

NOTE: Please import RSL10 CMSIS pack first as the B−IDK CMSIS pack (step 4 in the Prerequisites section) depends on the RSL10 CMSIS pack (step 3.a) in the Prerequisites section)

2. Refer to Chapter 3 of RSL10 SDK Getting Started Guide (step 3.a) for step−by−step instructions on importing the CMSIS packs.
3. Once all packs are successfully imported, they can be viewed in the CMSIS pack manager perspective as shown below (Figure 7)

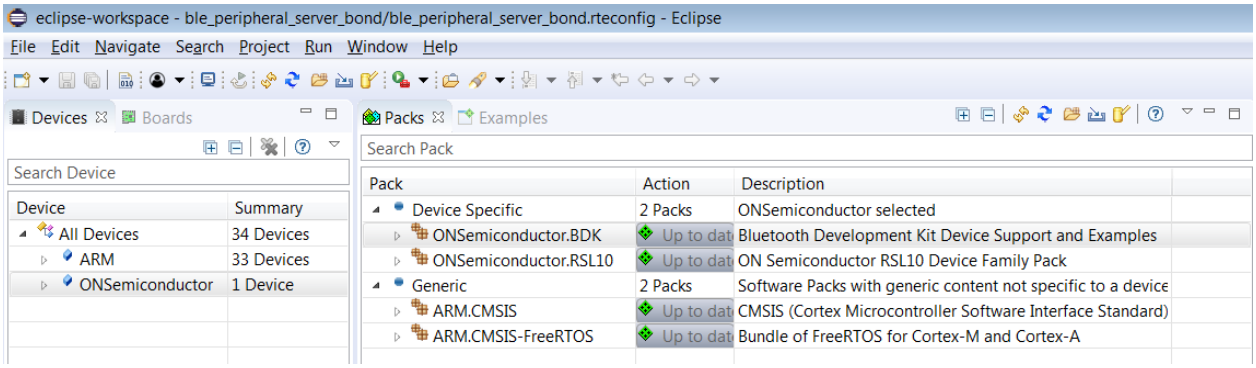


**Figure 7.**

### Compiling and Flashing of Ultra Low Power Firmware

4. Examples related to RSL10−SENSE−GEVK are highlighted in brackets. Choose the example *Custom Service Firmware with Deep Sleep (RSL10−SENSE−GEVK)*

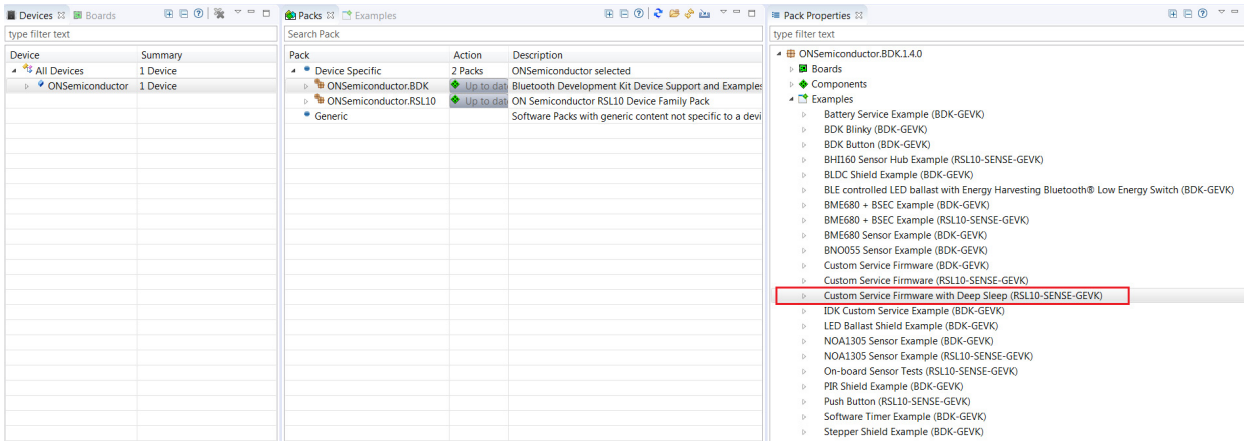


**Figure 8.**

5. Right click and copy the project into workspace

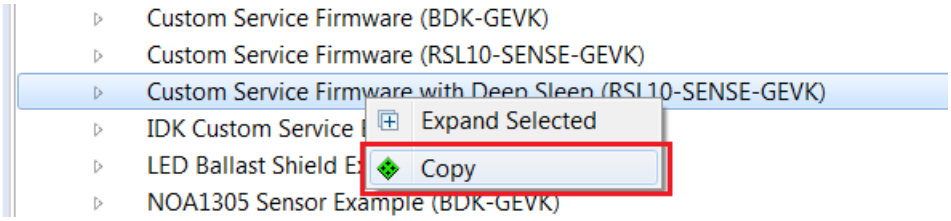


**Figure 9.**

NOTE: Once the example is copied, it can be viewed under Project Explorer. All source files including main are located in the src folder.

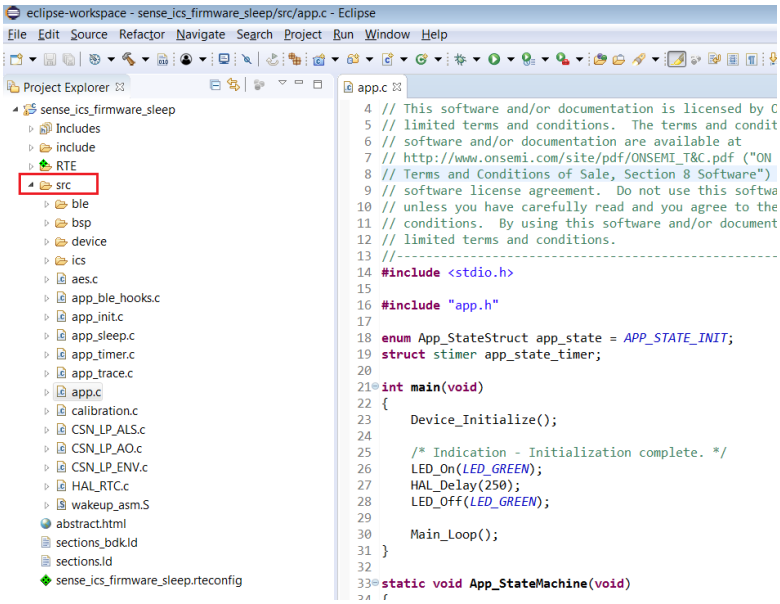


**Figure 10.**

6. Now user has to build the project as this creates binaries to be flashed to RSL10−SENSE−GEVK. For the sensor board, there are two options:
   a.) 1 Debug
   b.) 2 Release – go to hammer icon inside IDE and click Release. Project is automatically build

Debug mode enables user to debug application over serial terminal connected to GPIO pin on expansion connector. It's the option how to fine tune the sleep mode code. RSL10−SENSE−GEVK natively doesn't support serial communication, only RTT over JTAG.

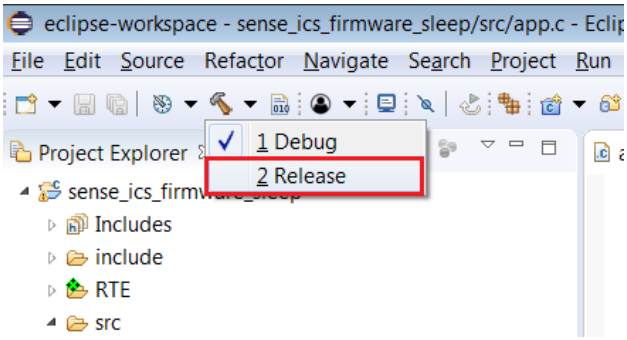


**Figure 11.**

NOTE: If the binaries are not seen, press F5 (refresh)

Alternatively you can build the project: right click on project under Project Explorer –> Build Configurations –> Set Active –> 2 Release

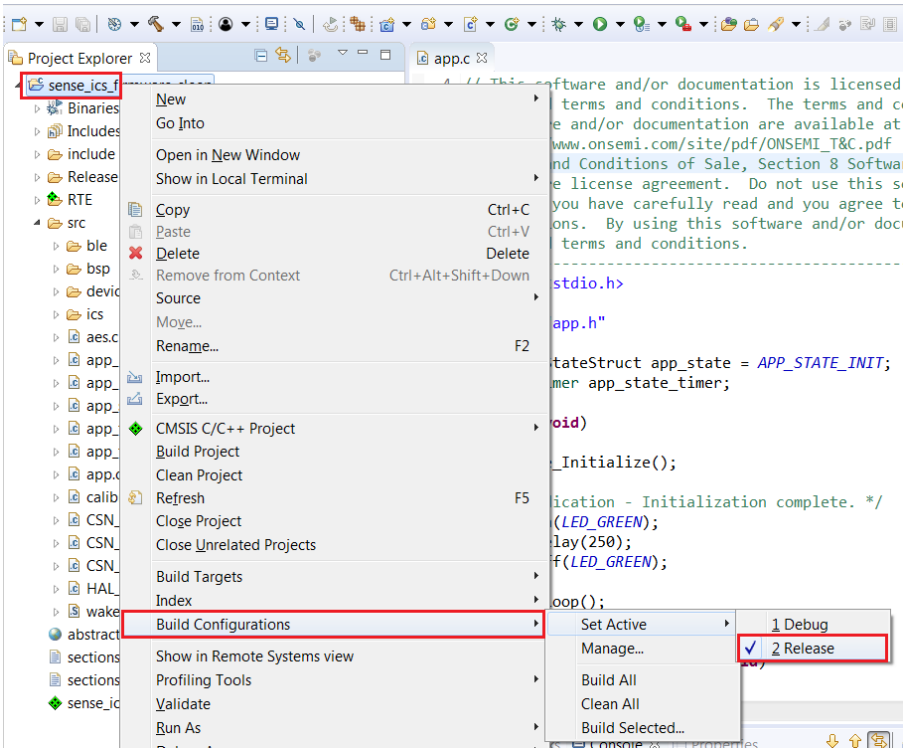


**Figure 12.**

7. Once the build is done, the code is ready to be flashed to the RSL10−SENSE−GEVK.
   a.) Insert the battery into the board. Mandatory step as it creates the voltage reference for SWD logic signals.
   b.) Connect the low cost Debugger (RSL10−SENSE−DB−GEVK version) / 10−pin needle adapter with J−LINK (RSL10−SENSE−GEVK version)

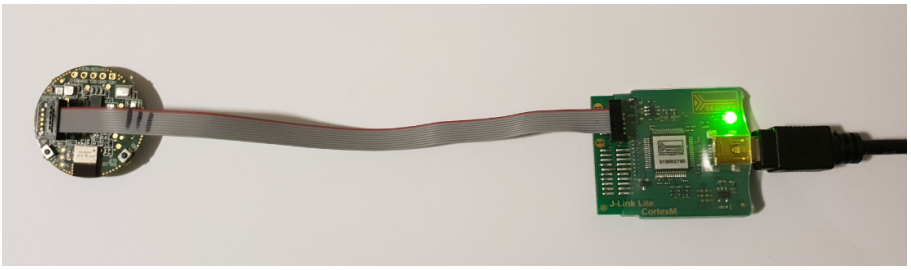

**Figure 13.**

8. Select the project (sense_ics_firmware_sleep), and go to debug configurations as shown below.

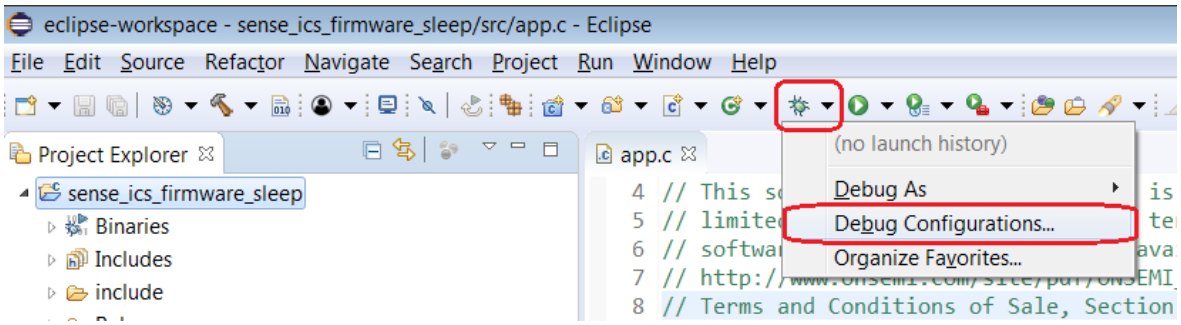


**Figure 14.**

a.) Double click GDB Segger J−Link Debugging to create the debug configuration for the selected example.

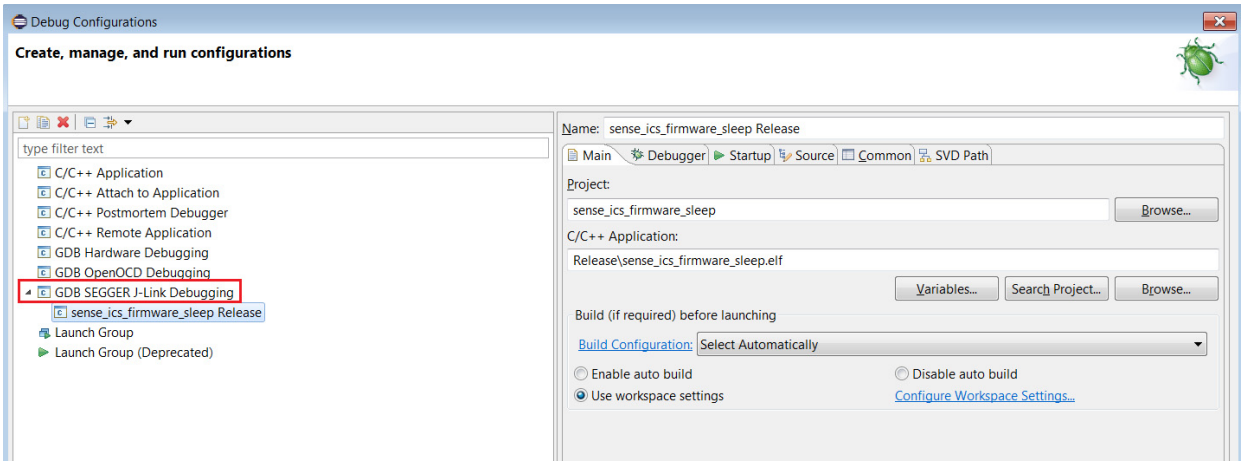


**Figure 15.**

NOTE: The debug configuration for the selected example is automatically saved and there's no need to re−create it. Make sure you have the Release version of binary (.elf). Click on Search Project and Qualifier returns *Release* in the path. For debugging purposes you can build and switch Debug version as discussed in step 12 a/b.

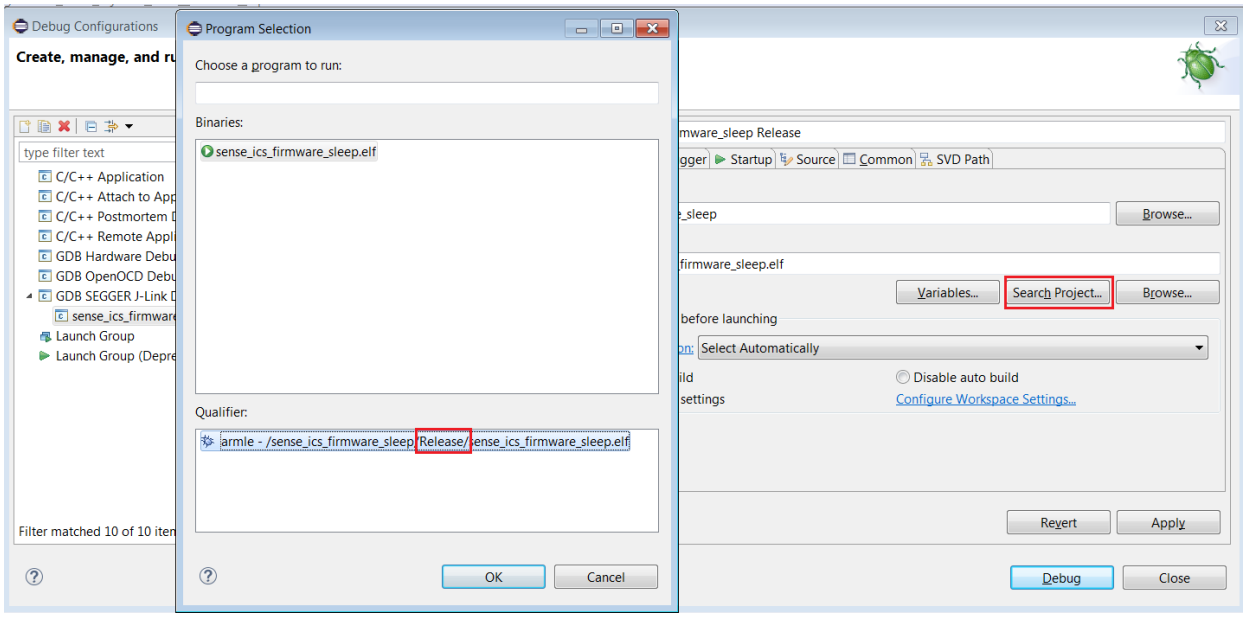


**Figure 16.**

b.) On the Debugger tab, set RSL10 as the device name.
Click Debug.

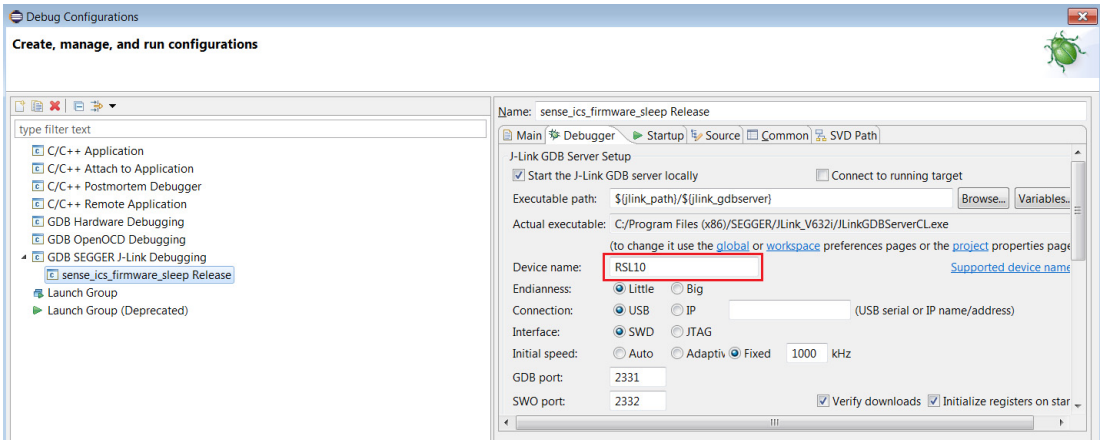


**Figure 17.**

9. For application debugging, confirm perspective switch by clicking Yes.

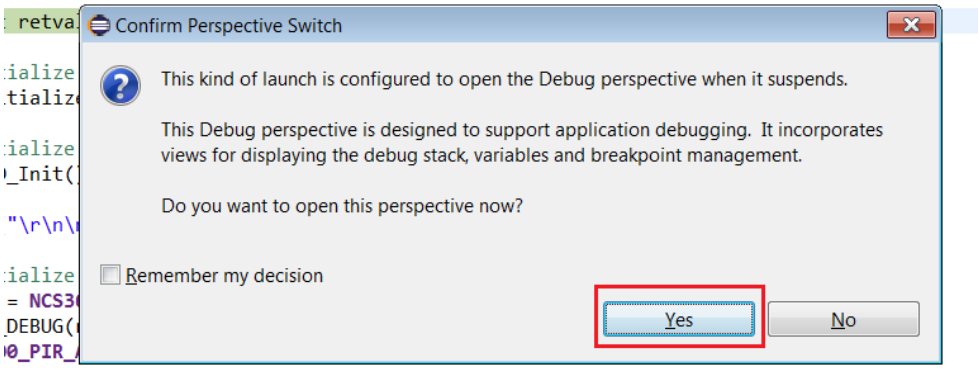


**Figure 18.**

10. The debug session is now launched. Click Resume (F8) to start the target CPU. Green LED briefly flashes. By default, in Release version is no Logging option and terminal doesn't return useful data. By terminating the session, user closes connection with DBG server.

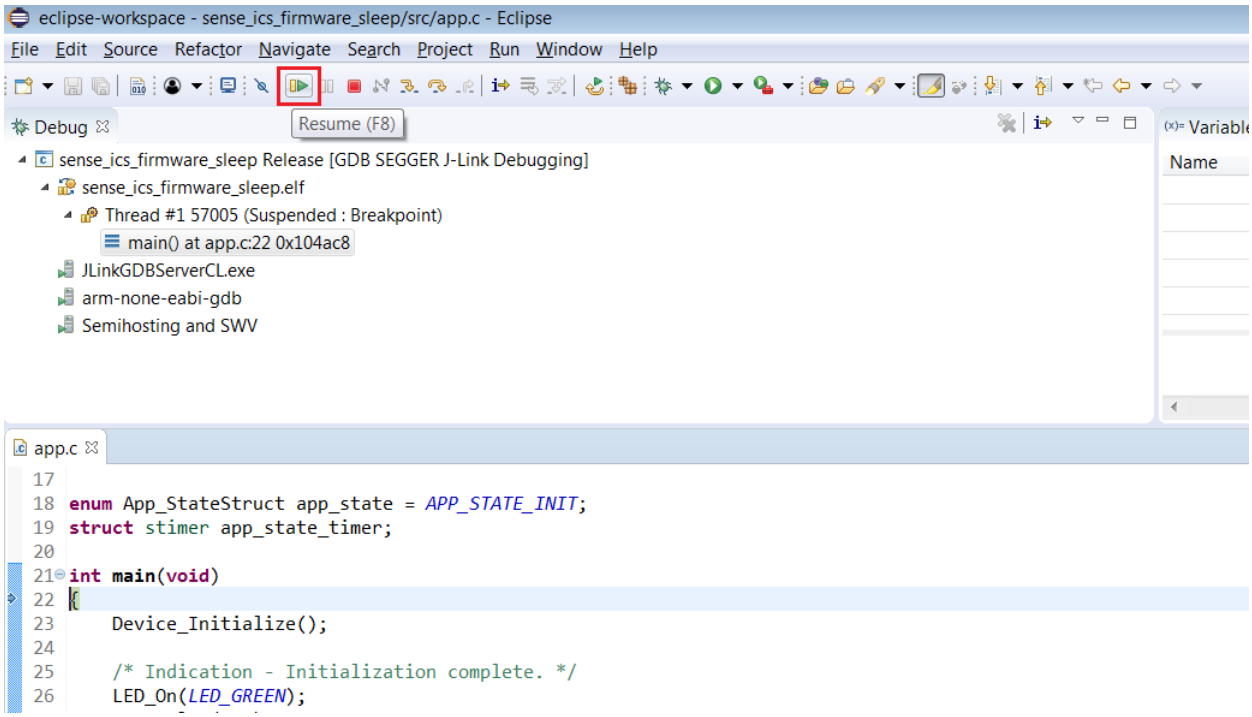


**Figure 19.**

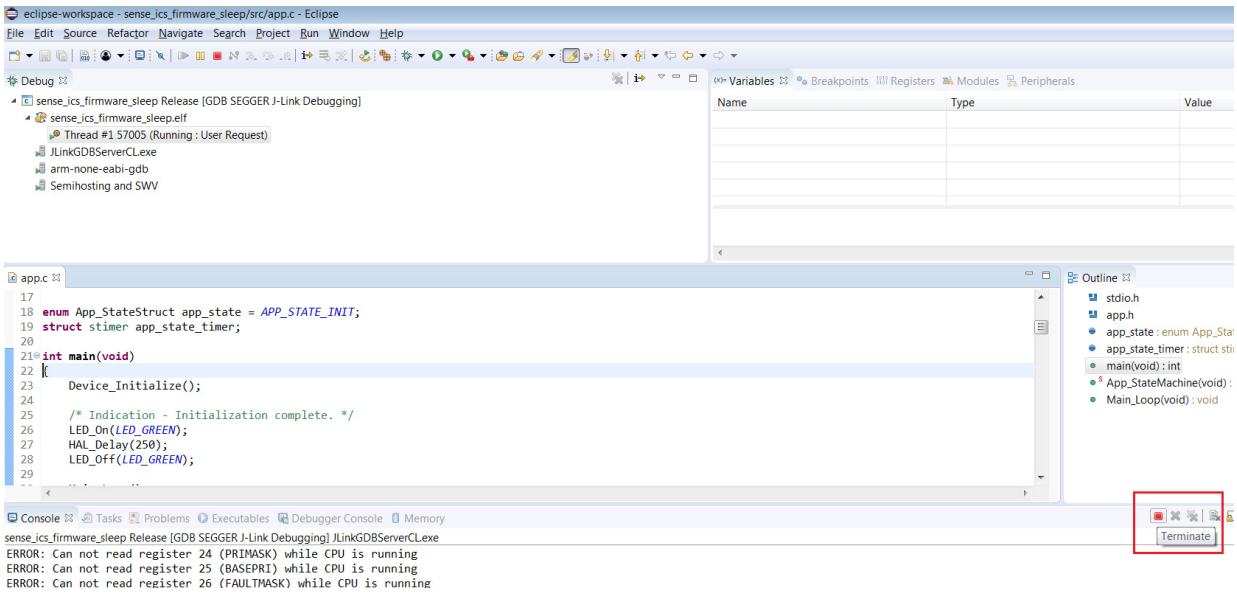


**Figure 20.**

11. Disconnect debugger, download and open the mobile app available under store (Android and iOS). App name is *RSL10 Sense and Control* ( www.onsemi.com/b−idk )

IMPORTANT NOTE:

When the board is flashed, Green LED shortly blinks. Board starts BLE advertising only and is visible on the mobile app. When connection with mobile app is not made for next 60s (by default), blue LED blinks and RSL10−SENSE−GEVK goes into deep sleep mode. You can resume operation by holding button PB1 for >1s. Green LED blinks and process repeats. See below the state diagram.

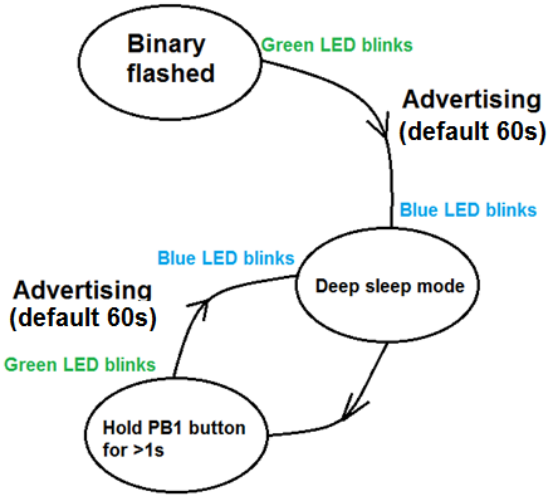


**Figure 21.**

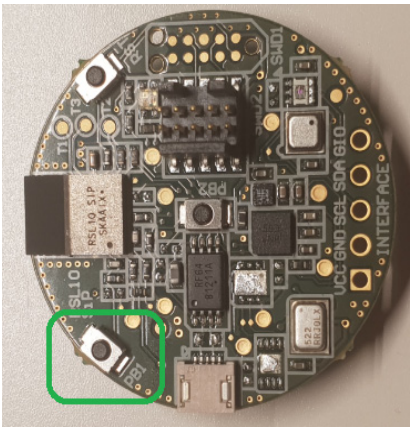

**Figure 22.**

12. User is exposed to set various parameters that have impact on battery longevity. Three main parameters can be configured in CMSIS:
    a.) BLE Advertising Interval (Default 1000 ms)
    b.) Advertising stop Timeout (Default 60 s)
    c.) Wake−up Button Check Interval (Default 1500 ms)

To get into the CMSIS Configuration Wizard, right click on RTE_app_config.h and open CMSIS Configuration Wizard. Change parameters, save the project and build it starting from step 12.

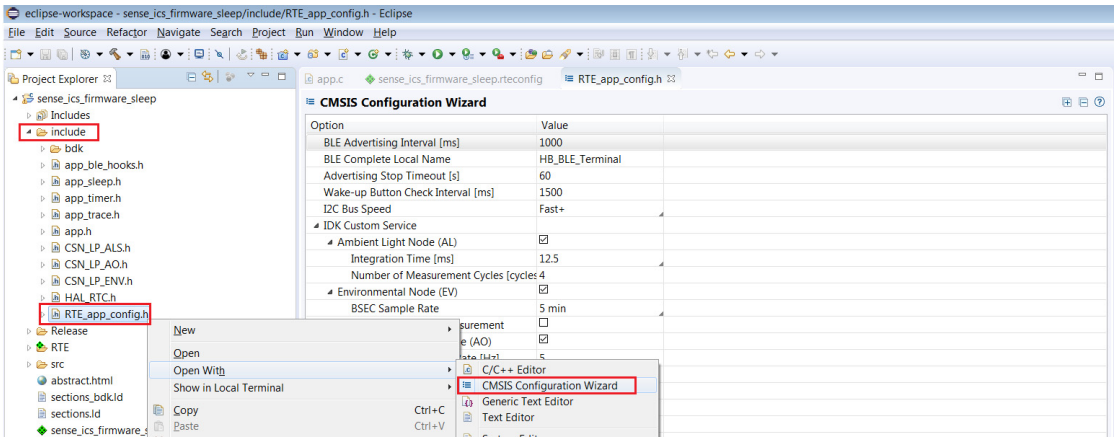


**Figure 23.**

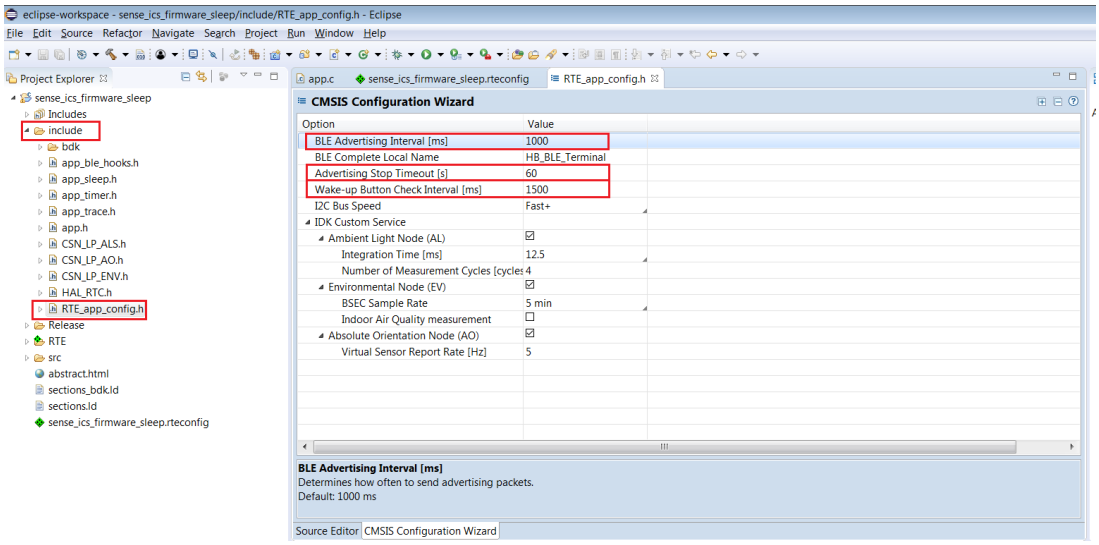


**Figure 24.**

### Mobile App Usage

13. Within the *Advertising Stop Timeout* interval, board is visible on the app screen. RSL10−SENSE−GEVK is advertising only over BLE. When multiple boards (sensor nodes) are present, each has unique MAC address and user selects the desired one –> HB_BLE_Terminal.

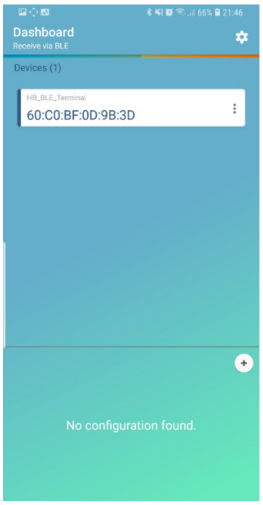


**Figure 25.**

14. When the appropriate board is selected, one can choose what sensor data to observe. Below are depicted all supported sensors and quantities taken. More simultaneous sensors in place equals more power required.

    RSL10−SENSE−GEVK supports also cloud connectivity via the same mobile app that functions as a gateway.

NOTE: Air quality is not supported in this low power mode example due to heating element and consequent need for higher power consumption. However it's available under *BME680 + BSEC example* or *Custom Service Firmware* in CMSIS.

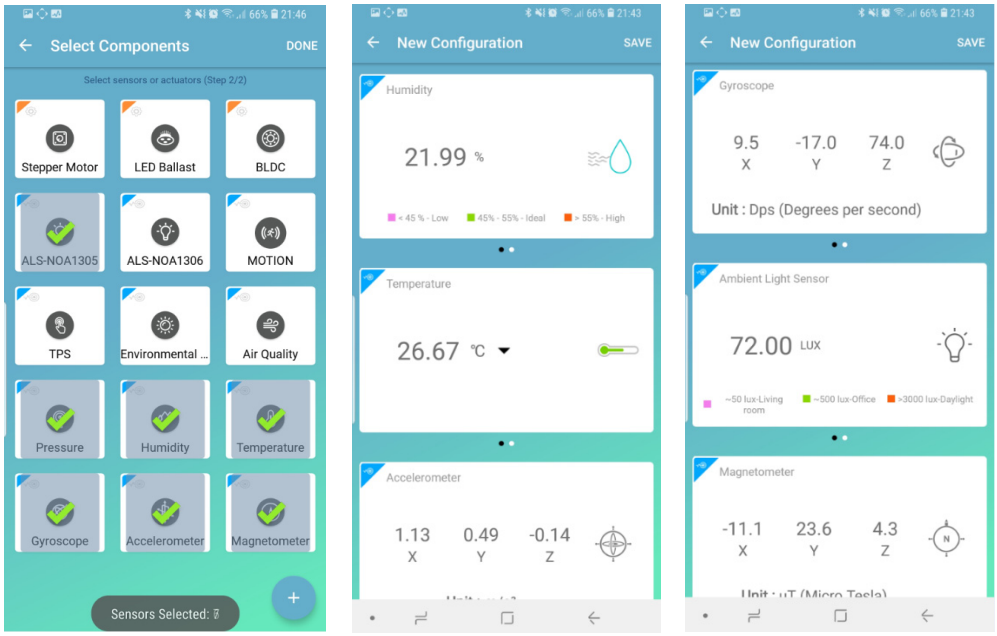


**Figure 26.**

### Ultra−low Power Firmware Modes

15. The following are the low power features of above described firmware:

- BDK libraries adapted for use with deep sleep mode of RSL10.
- HAL library for RTC and RTC based low power timer.
- Low power IDK Custom Service nodes for:
  a.) ALS (NOA1305)
  b.) Environmental sensing (BME680 + BSEC software)
  c.) Absolute Orientation (BHI160 + BMM150)
- Automatic on demand sensor activation.
- Automatically stops BLE advertising if no connection is made.
- BLE advertising can be restarted by holding push button (PB1).
- Configurable using RTE configuration header.

16. Environmental Sensing Node (BME680 + BSEC software):

- Provides two sample rates (every 3 seconds or every 5 minutes). By default, due to reduced power consumption, environmental sensors updates each 5 minutes.
- Option to disable IAQ measurement to save power.
- Long term average power consumption:
  a.) Outputs: Indoor Air Quality, Compensated Temperature, Compensated Humidity, Pressure
    i. Low Power mode – 900 μA (3 s sample rate),
    ii. Ultra−low power mode – 90 μA (5 min sample rate)
  b.) Outputs: Compensated Temperature, Compensated Humidity, Pressure
    i. < 5.2 μA (1 s sample rate)
- Gas sensor uses too much power and is not suitable for CR2032 battery powered systems. By default, this feature is disabled in ultra−low power firmware

17. Ambient Light Node (NOA1305):

- Sensor is activated only when ambient light value is requested by peer device.
- Power consumption depends on number of requests received from peer device.
  a.) ~80 μA current draw when sensor is active
- Sensor remains active for 4 measurement cycles (integration times) to stabilize sensor output.
- Integration time and number of cycles are configurable from RTE header.

18. BLE Connection Interval – Possible Power savings:

- BLE allows devices to negotiate connection parameter, most notably **Slave Connection Interval**
  a.) BLE communication always occurs at every connection interval even if the devices do not have anything to exchange (just send empty packets).
  b.) Configurable from 1.25 ms up to 4000 ms.
  c.) Bigger Slave Connection Interval −> Less energy consumed by HB.
  d.) Master (phone) has complete control over used connection interval.
- Android allows only 3 specific interval configurations:
  i. High (11.25 – 15 ms), Balanced (30 – 50 ms), Low Power (100 – 125 ms)
- All Android apps do not allow to set connection interval and always force balanced mode.

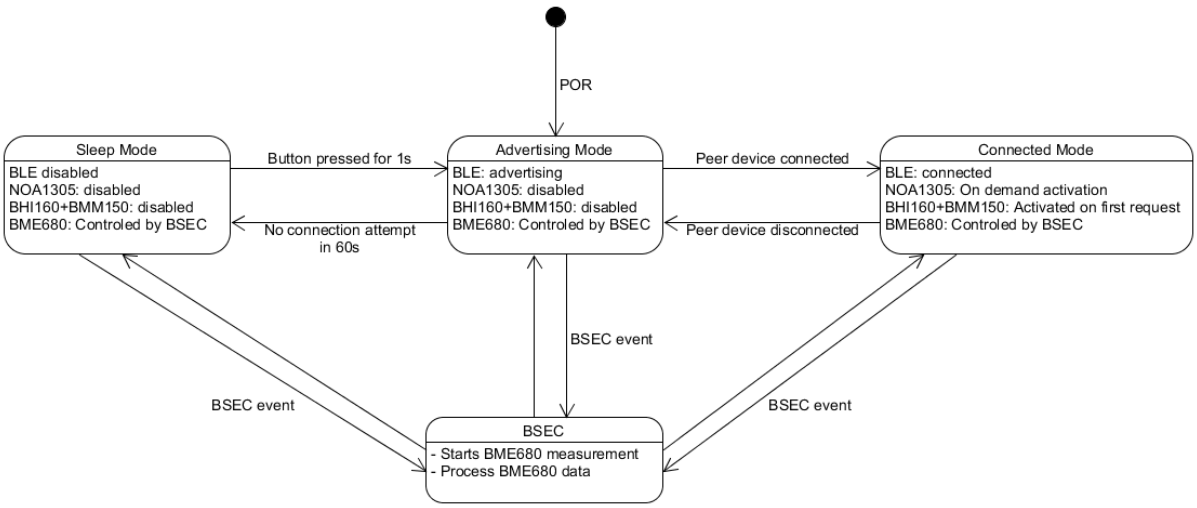


**Figure 27.**

19. Short term power consumption (100s interval):

- Deep Sleep mode:
  a.) 1.5 s periodic button check
  b.) Consumption: 18.7 uA @ 3 V
- Advertising mode:
  c.) 1 Hz BLE advertising interval
  d.) Consumption: 24.5 uA @ 3 V
- Connected mode:
  e.) Full operation connected to RSL10 Sense & Control:
    i. ALS: 1 s measurement & report rate
    ii. Absolute Orientation: 12.5 Hz measure rate, 1 s report rate
    iii. Environmental data (IAQ disabled): 5 min. measure rate, 3 s report rate
  f.) Consumption: ~3000 uA @ 3 V

20. Low power firmware – block diagram. The diagram in Figure 27 depicts detailed high level operation of ultra−low power firmware.

### Compiling and Flashing of the Rest Examples Attached to RSL10−SENSE

In this section user is guided on how to flash software for all remaining examples in the CMSIS pack. The procedure is similar as for Ultra−Low power FW. Let's pick up *On−board Sensor Tests* that enables microphone functionality and returns sensors data into console.

21. Right click and copy the project into workspace

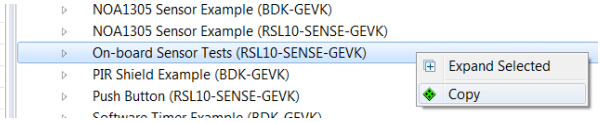


**Figure 28.**

22. Right click on the project and build it

NOTE: If the binaries are not seen, press F5 (refresh)

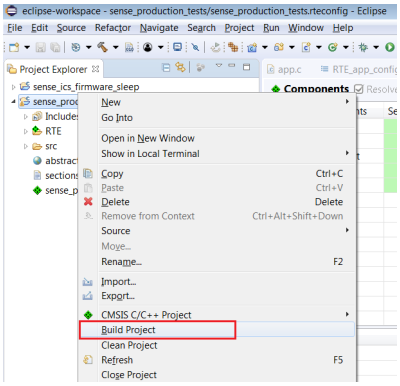


**Figure 29.**

23. Once the project is build, go to Debug configurations, double click on GDB SEGGER J−Link Debugging that automatically creates Session and import binaries ready to be flashed. Click on Debug button.

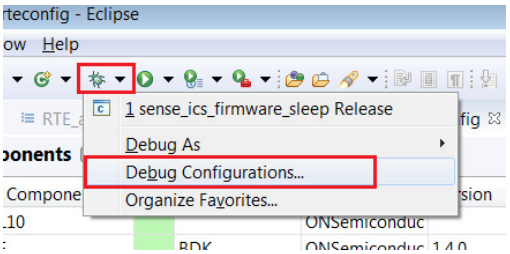


**Figure 30.**

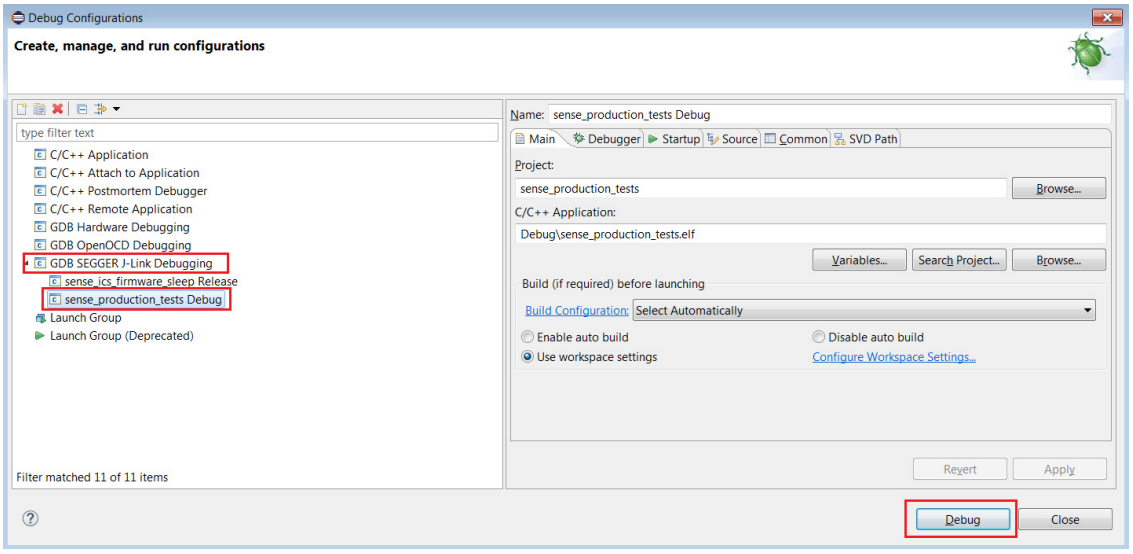


**Figure 31.**

24. When the debug session is launched, click on Resume button (F8).

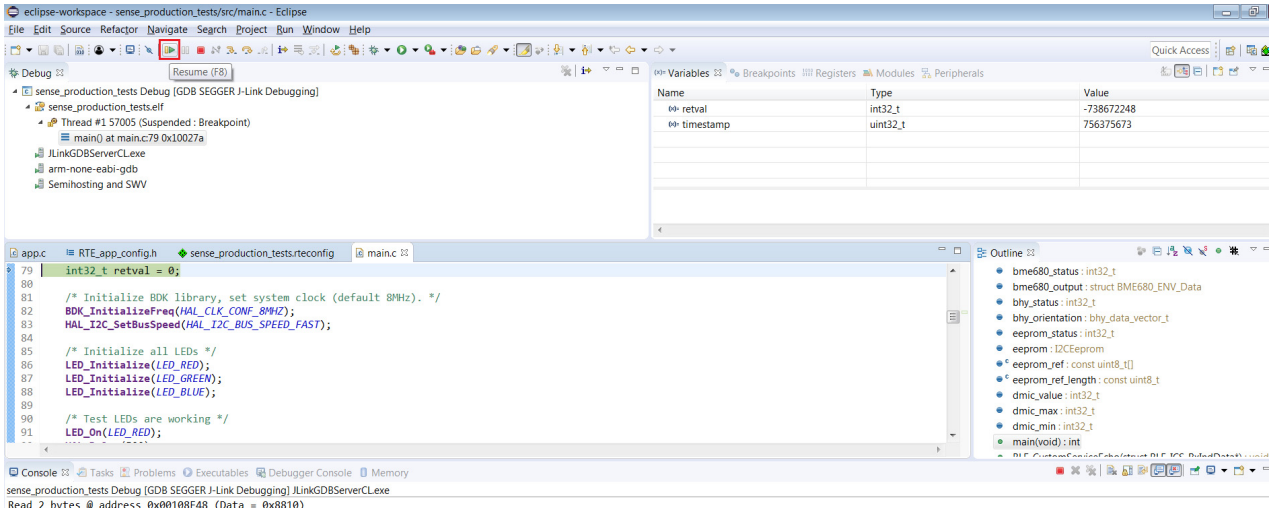


**Figure 32.**

## Logging/Debugging

This is the next step after launching the session. For logging/debugging the downloaded Firmware, either J−Link RTT or Eclipse Console may be used. This section provides instructions for both.

*Using J−Link RTT*

25. After step 30 is done, open J−Link RTT viewer 6.32i (should be installed when J−Link software package was installed per Step 2)
26. Select USB / Existing session and click OK. As the debugger is in operation, easiest way is to utilize Existing Session.

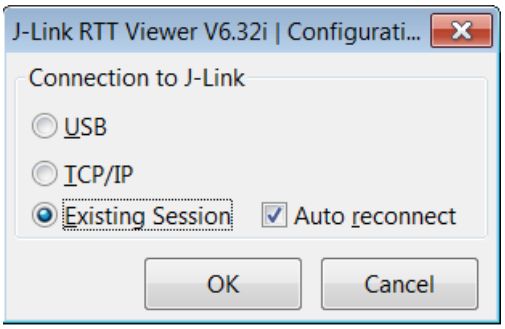


**Figure 33.**

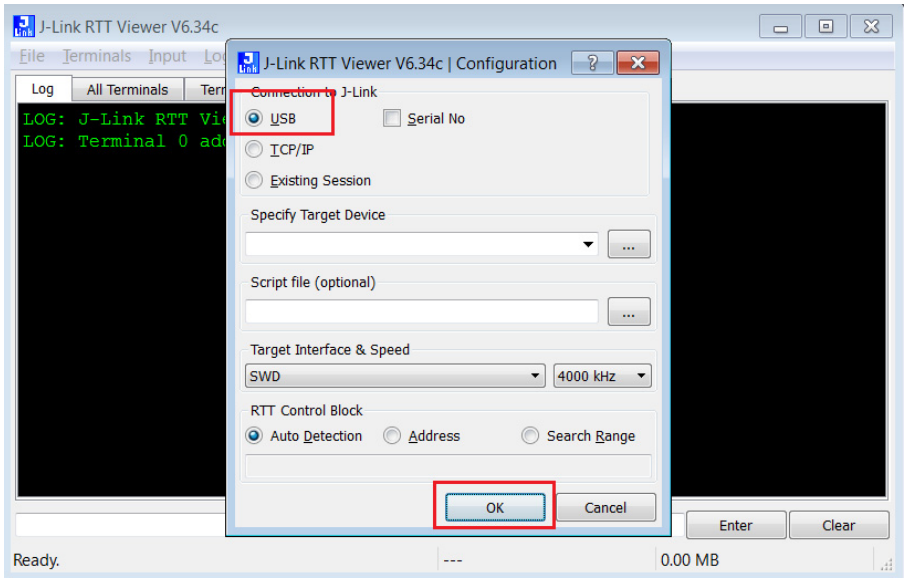


**Figure 34.**

27. RTT prompts you to select the appropriate microcontroller. Select RSL10 and click OK. The serial terminal is ready to use and the events from RSL10 can be observed by clicking the All Terminals Window.

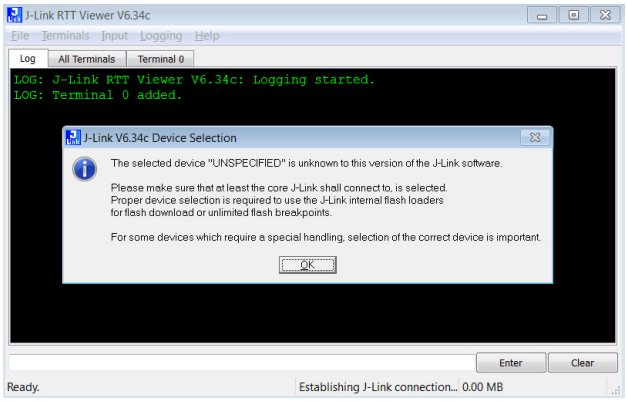


**Figure 35.**

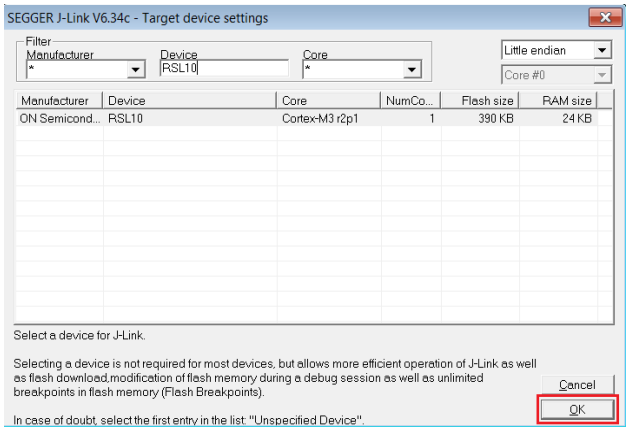


**Figure 36.**

28. Console returns the actual values from all sensors assembled on the board

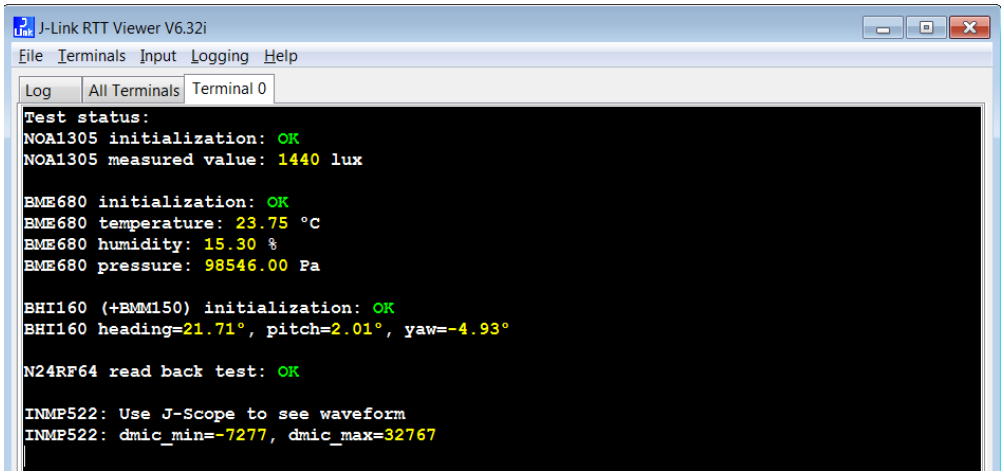


**Figure 37.**

*Using Eclipse RTT Console*

29. Click the Open a Terminal Icon

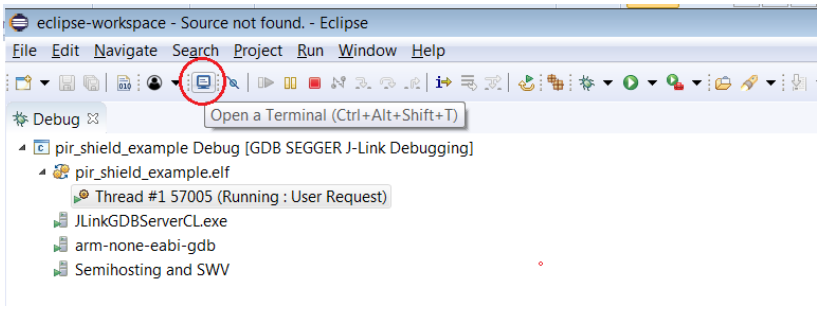


**Figure 38.**

30. Enter the values shown below and launch the session. The incoming events are printed on the terminal window.

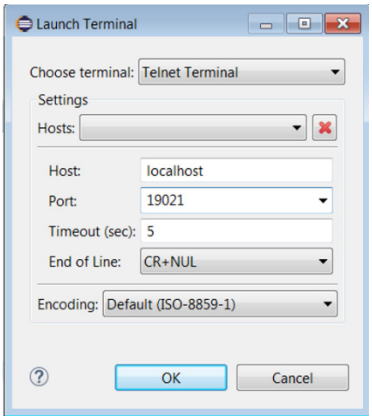


**Figure 39.**

31. Terminal window returns the same data format as using the J−LINK RTT viewer.

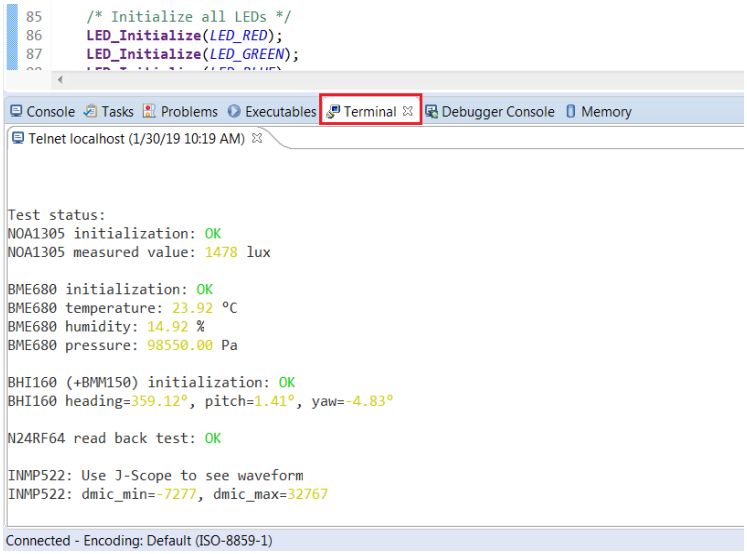


**Figure 40.**

*Using J−scope for MIC data visualization*

32. Launch Segger J−Scope and click on New project

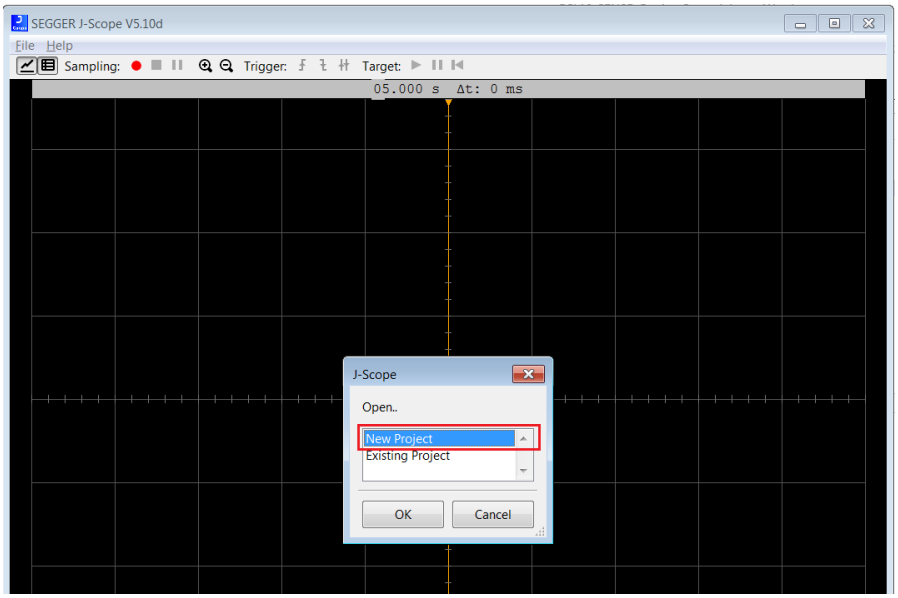


**Figure 41.**

33. When your Eclipse debug session is launched, use existing Session (alternatively you use USB), set Sample rate every 10us and load elf. file (binary) that is located under Eclipse−workspace and Debug folder.

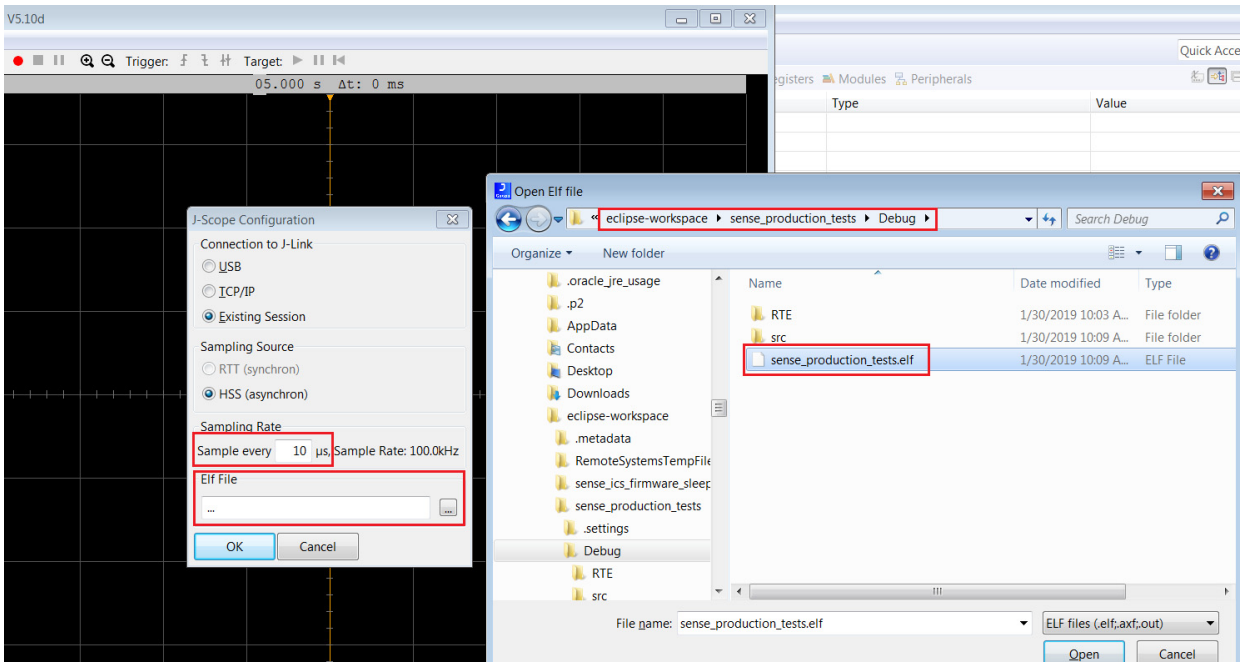


**Figure 42.**

34. J−Scope symbol section opens. Check dmic_value box and hit OK button.

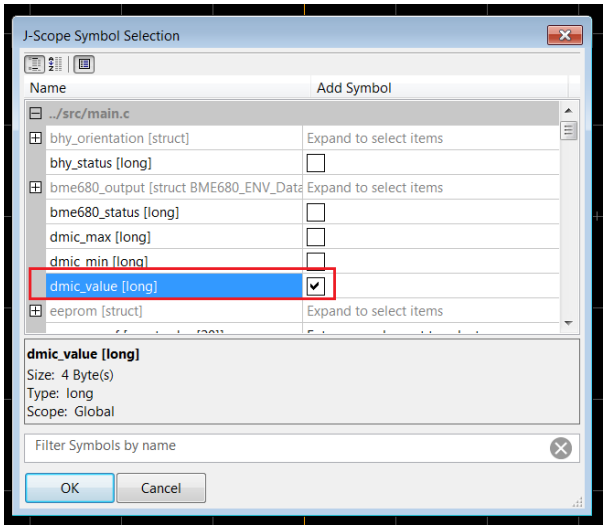


**Figure 43.**

35. Visualization of the audio is started when Red Sampling button is pushed (or F5.)


**Figure 44.**

### Configuration Setup

System settings can be configured directly from within the CMSIS pack. Each example is equipped with basic system configuration that covers three main categories. These are accessible in the RTE/BDK folder within the project. Each system configuration starts with “RTE_”. As shown below, opening the RTE_... header files using the CMSIS configuration wizard (right click on the header file), displays the configuration table. Various application specific parameters can be set. This allows pre−configuration of RSL10 without the need for explicit programming.

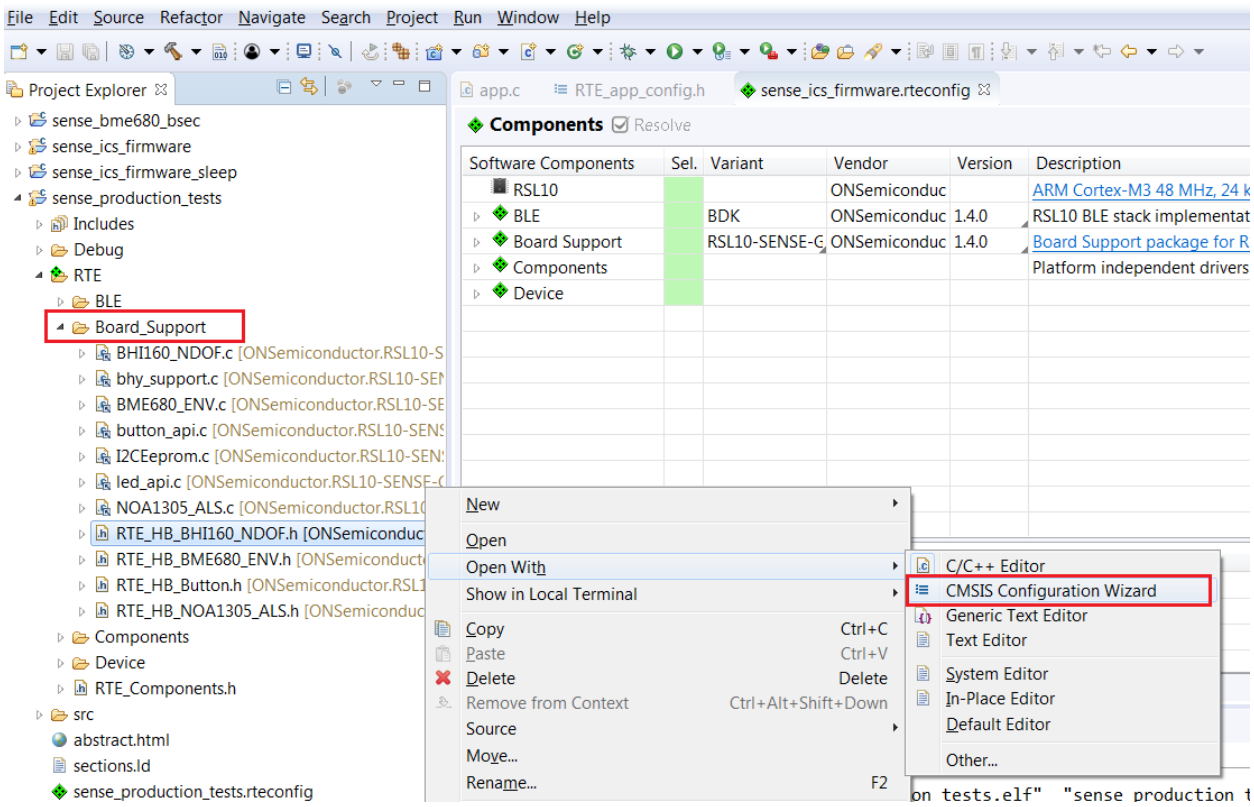


**Figure 45.**

A brief description on the header files is given in the wizard for various sensors.

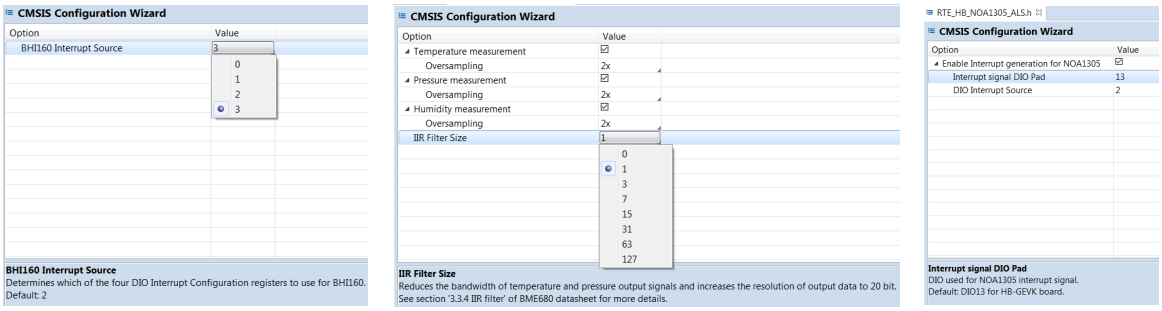


**Figure 46.**

## DOCUMENTATION

Detailed documentation of all functions, code, APIs, HALs is part of the CMSIS package. Every use case (for a particular daughter card, service, etc.) copied into the workspace has its own manual with key description in the abstract.html page. URL Information and orderable part numbers are also provided as shown below.

### *.rteconfig

The *.rteconfig file lists the software components within the CMSIS pack. To access the components, double click *.rteconfig file. Extensive help is provided under the description tab.

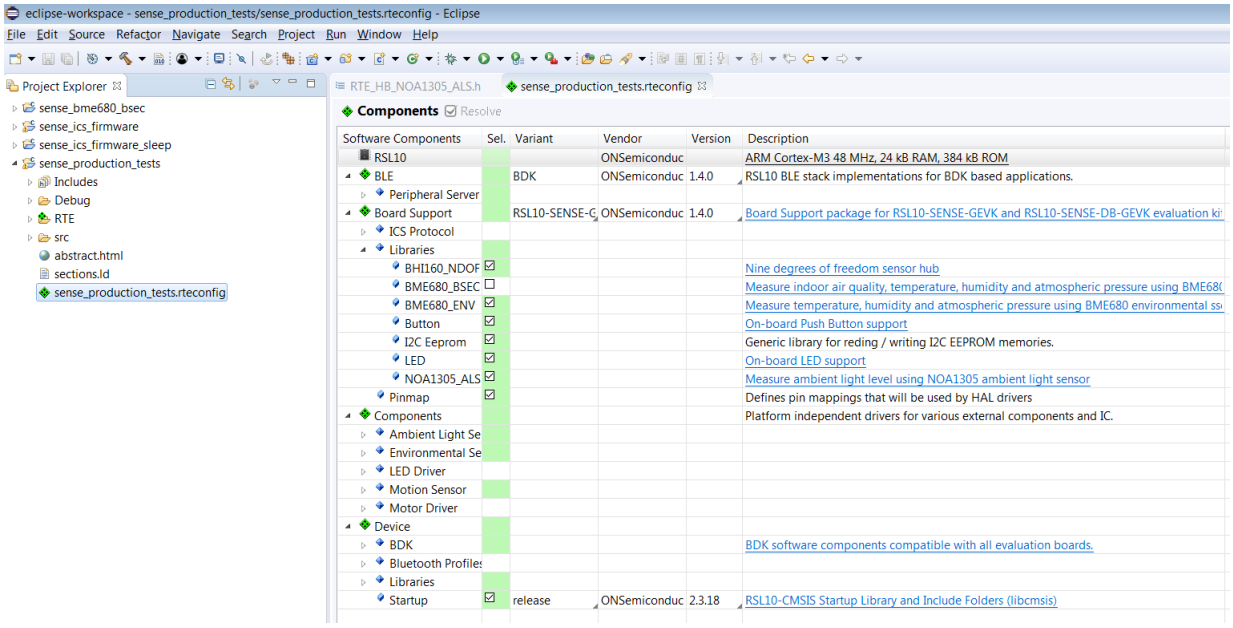


**Figure 47.**

*Main Help Page*

The main help page is accessible via Device/BDK, visible for all use cases in *.rteconfig file. It's further divided into various modules as shown below.

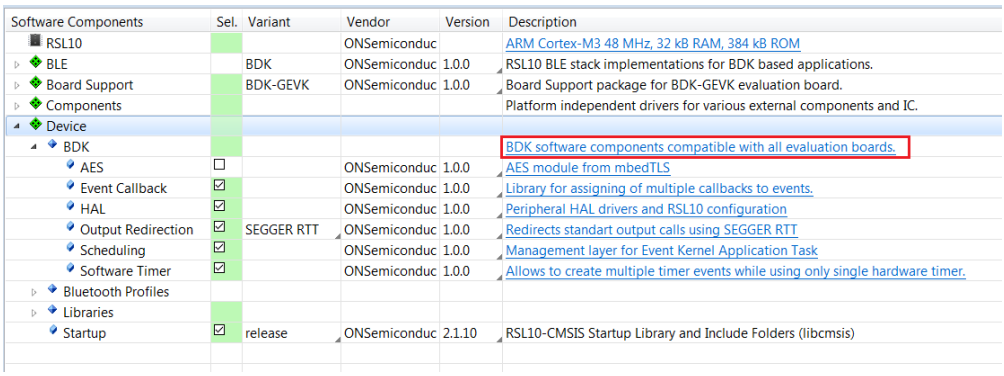


**Figure 48.**

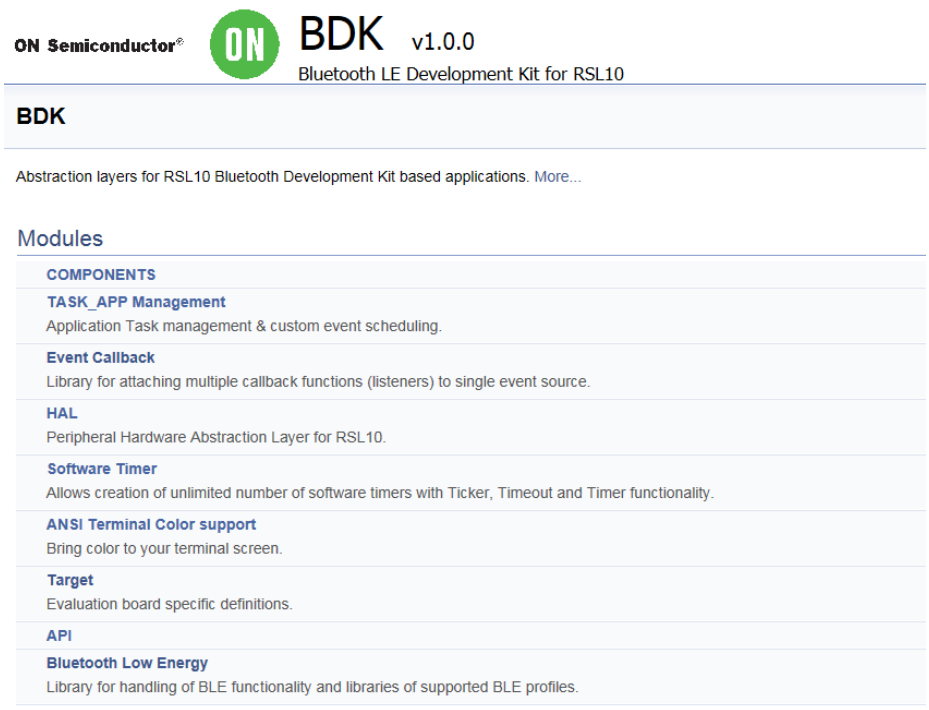


**Figure 49.**

Sub−sections may be expanded for further information (Ex: HAL interfaces shown below)

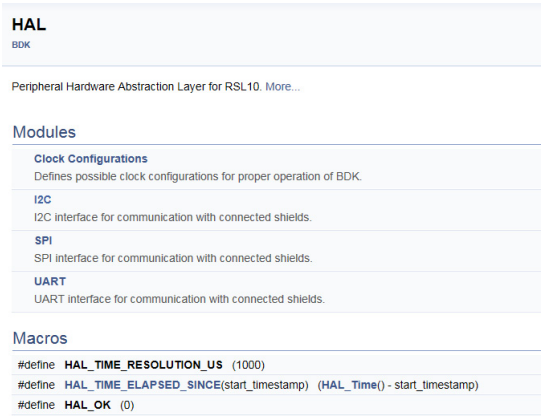


**Figure 50.**

CMSIS also provides software timers and applications task manager abstraction layers to enable management of specific tasks and timing within the event kernel.

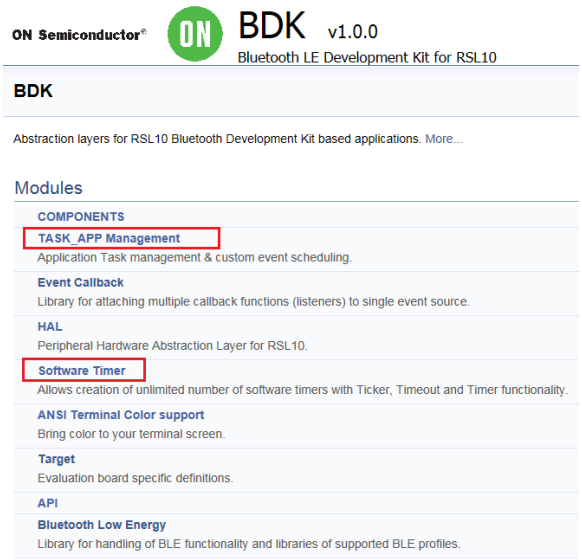


**Figure 51.**

Every example attached to the RSL10−SENSE−GEVK is equipped with addl. help under *abstract.html*

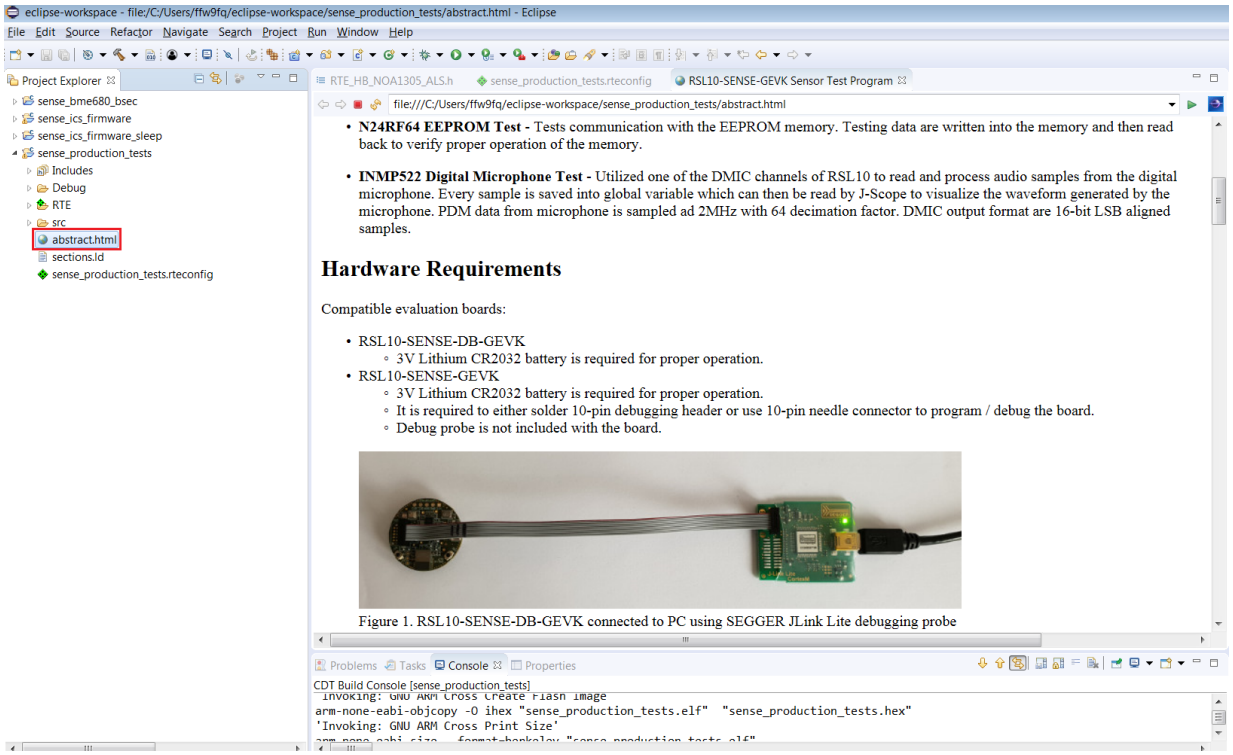


**Figure 52.**

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