

Bluetooth® Low Energy IoT Development Kit (B-IDK) Getting Started Guide

INTRODUCTION

This document helps you get started with the Bluetooth Low Energy IoT Development Kit (B-IDK). The B-IDK is a comprehensive node-to-cloud and a modular IoT platform that allows development of various BLE based use cases. Along with the hardware and software, the B-IDK includes a mobile app to interact with sensors and actuators.

The B-IDK features RSL10, Industry's lowest power Bluetooth 5 SoC and comprises of a baseboard (BDK-GEVK) and several sensor and actuator daughter cards. For a complete listing of available daughter cards, please visit <https://www.onsemi.com/B-IDK>. The daughter cards connect to the baseboard, via the two PMOD connectors and/or the Arduino connector to enable various use cases.

Scope

This document covers the hardware setup, software architecture, B-IDK 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.

HARDWARE

- BDK-GEVK – B-IDK Baseboard
- Daughter Cards – Optional
- BDK-DCDC-GEVB – Power Shield For Use With Higher Power Daughter Cards – Optional

Default Configuration

The BDK-GEVK is shipped with the following jumper configuration. As the board supports OBD, there is no need for an external debugger. In case an external debugger is used, connect it to SWD header, J6.

Powering the Board

Multiple options are available to power the BDK-GEVK.

- USB
- Coin Cell (CR2032)
- External AC/DC Adapter plus power shield (BDK-DCDC-GEVB)
- External Supply

When higher power daughter cards (listed below) are attached to the baseboard, external supply either using the power shield or direct is required.

Higher Power Daughter Cards

- D-LED-B-GEVK Dual LED Ballast
- D-STPR-GEVK Dual Stepper Motor Driver
- BLDC-GEVK BLDC Motor Driver



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EVAL BOARD USER'S MANUAL

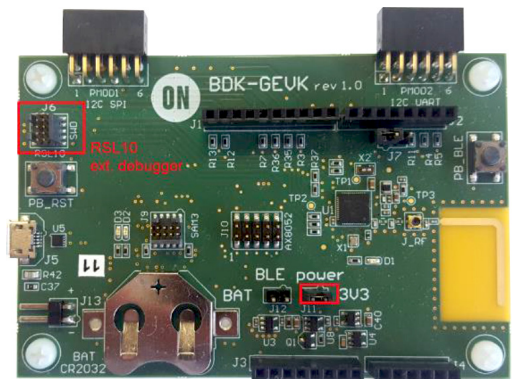
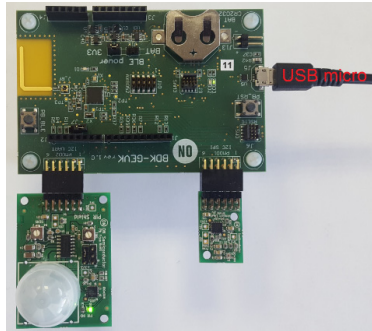


Figure 1. Board Photo

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USB

The B-IDK can be powered via the USB port when the use case doesn't need any higher power daughter cards. An example configuration with the baseboard and a couple of sensor boards is shown below.



Coin Cell

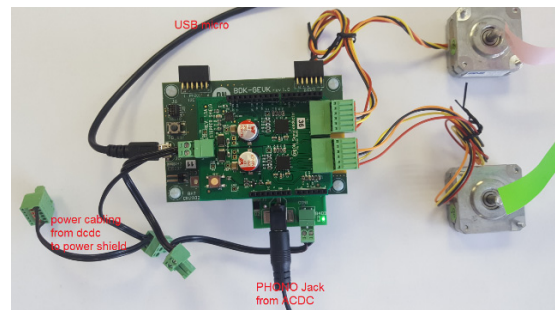
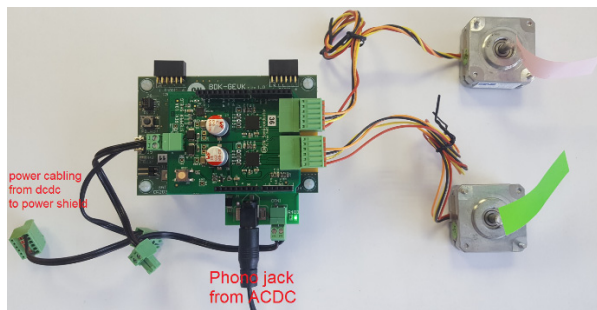
Once the firmware is flashed onto the baseboard, a coin cell (CR2032) may be used to power the system. Similar to USB based power supply, this method of powering is for use cases that don't utilize the higher power daughter cards. The jumper configuration must match the below table to allow for various power modes.

Table 1. JUMPERS

J11	J12	Usage
IN	X	Programming and Power over USB
X	IN	After programming. Only RSL10 is powered.
IN	IN	After programming. Both RSL 10 and OBD Microcontroller are powered

External AC/DC Adapter Plus Power Shield (BDK-DCDC-GEVB)

For use cases that utilize higher power daughter cards, an external AC/DC power supply (Ex: SMI24-12-V-P6) plus the power shield (BDK-DCDC-GEVB) are needed to power the system. While the 3.3 V supply to the baseboard is provided by the power shield via the Arduino connector, power cables (Green connector) are required between BDK-DCDC-GEVB and the higher power daughter card. For firmware flashing and debugging, the USB cable may be plugged in simultaneously with this mode as shown below.



External Supply

The B-IDK can be powered by an external supply via J13. In this mode, the battery cannot be installed. Jumpers J11 and J12 must be installed.

SOFTWARE

The B-IDK software allows for rapid development of various use cases. This section details the prerequisites and detailed steps in downloading firmware onto the baseboard.

Prerequisites

1. Install 64-bit version of Java from <https://www.java.com/en/download/>
2. Install J-Link Version 6.32f 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



4. Download the B-IDK 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>

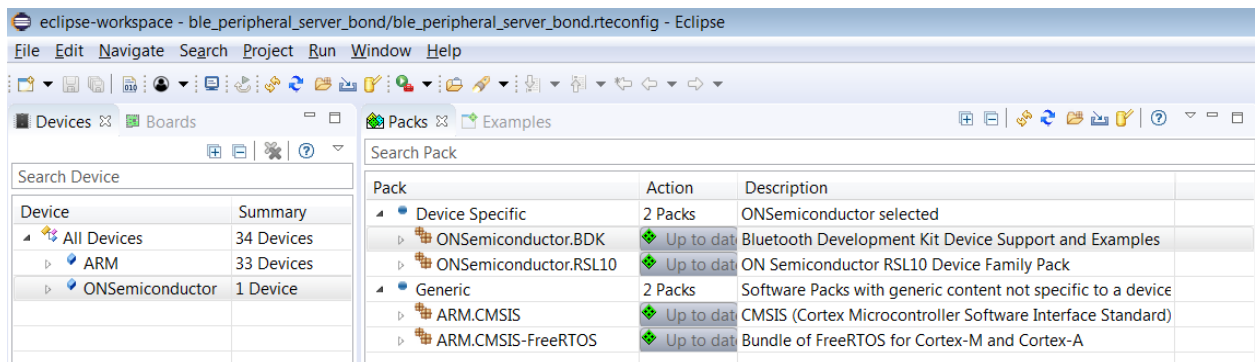
The next section provides details on importing the downloaded CMSIS packs into the SDK.

Importing CMSIS Packages

1. Launch the RSL10 SDK ON Semiconductor IDE

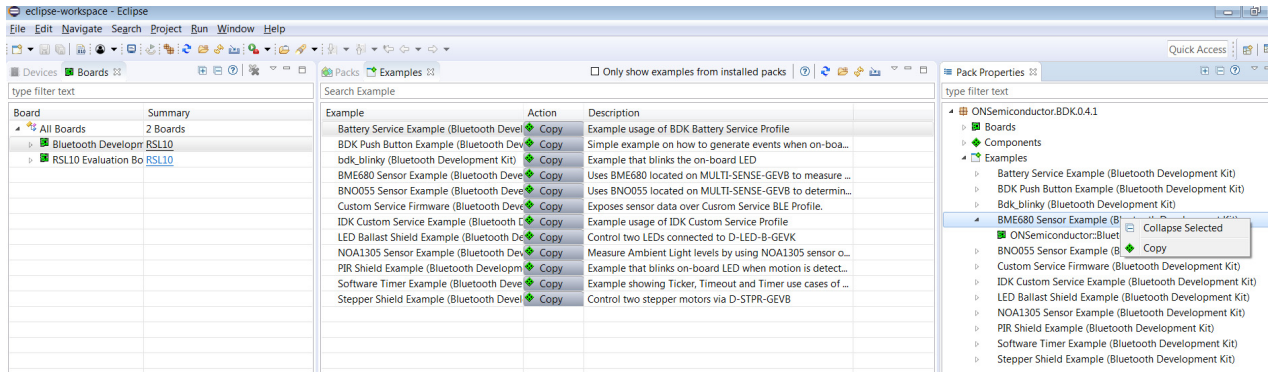
NOTE: Please import RSL10 CMSIS pack first as the B-IDK CMSIS pack (step 4 in the Prerequisites section) depends on the RSL10.

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.

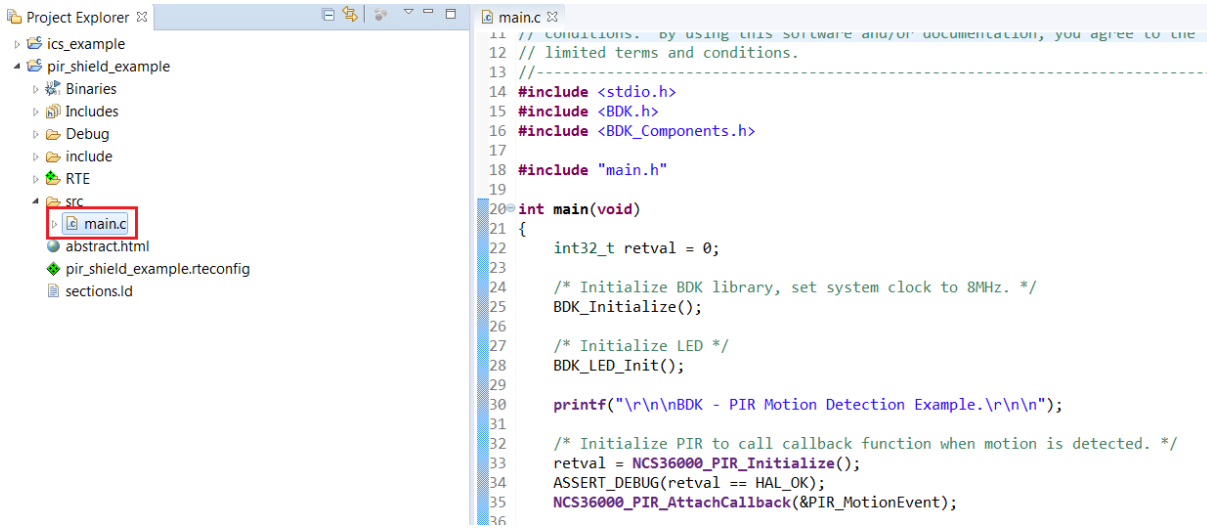


Compiling and Flashing

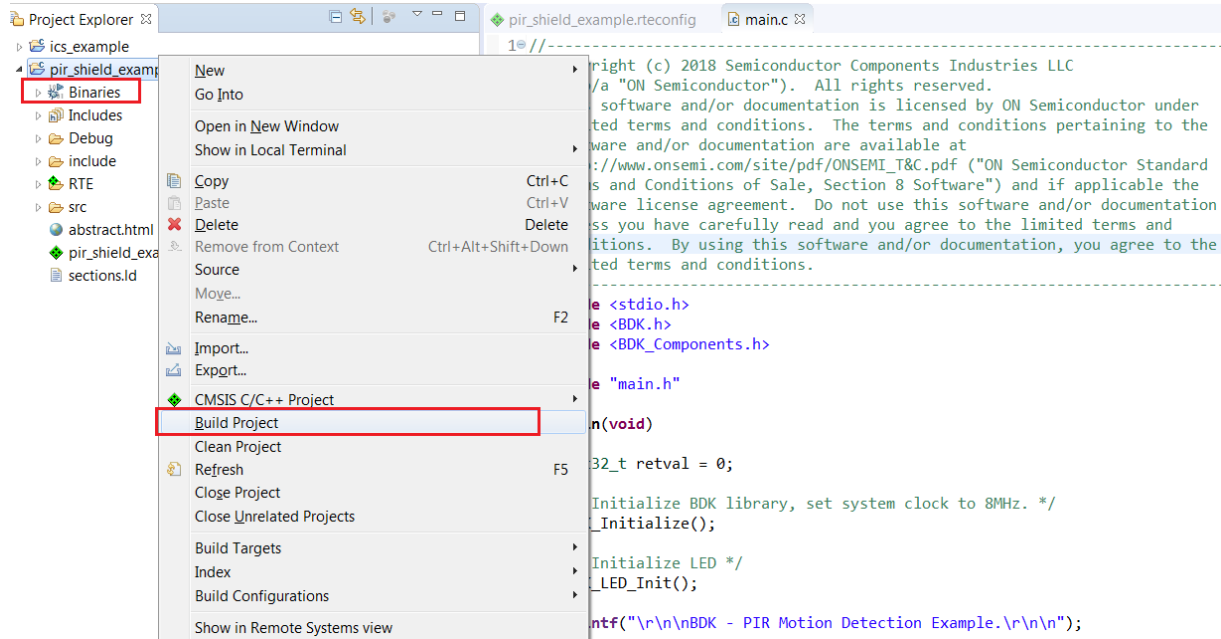
1. Choose an example (for example, pr_shield_example) to flash by copying it to the workspace.



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

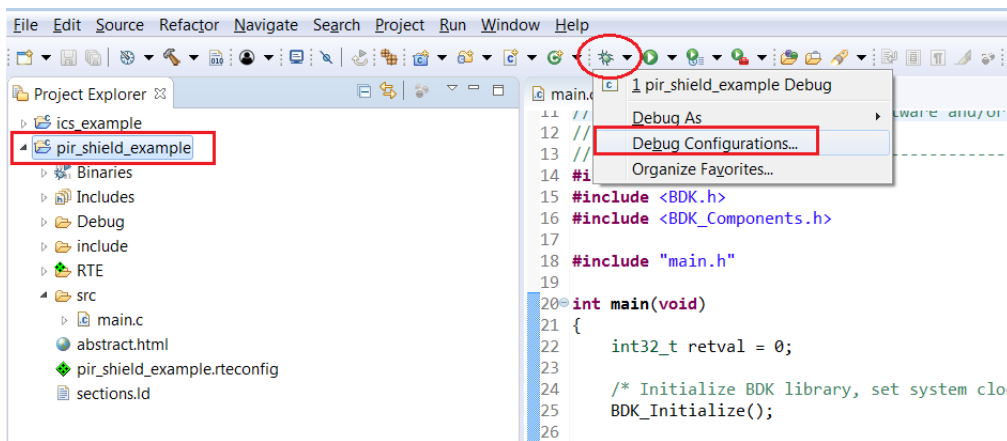


2. Right click and build the project. This creates binaries to be flashed to BDK–GEVK.

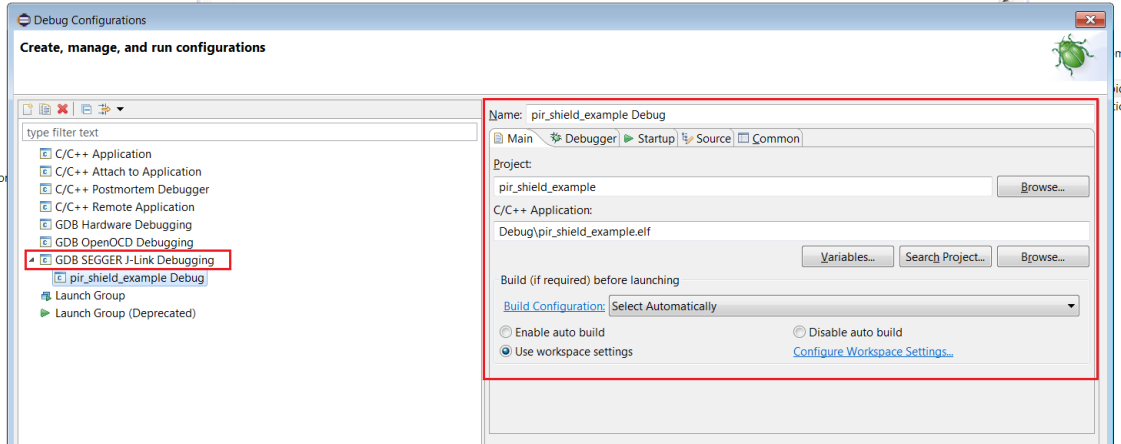


NOTE: If the binaries are not seen, press F5 (refresh).

3. Once the build is done, the code is ready to be flashed to the BDK–GEVK. Select the project (pir_shield_example), and go to the debug configurations as shown below.

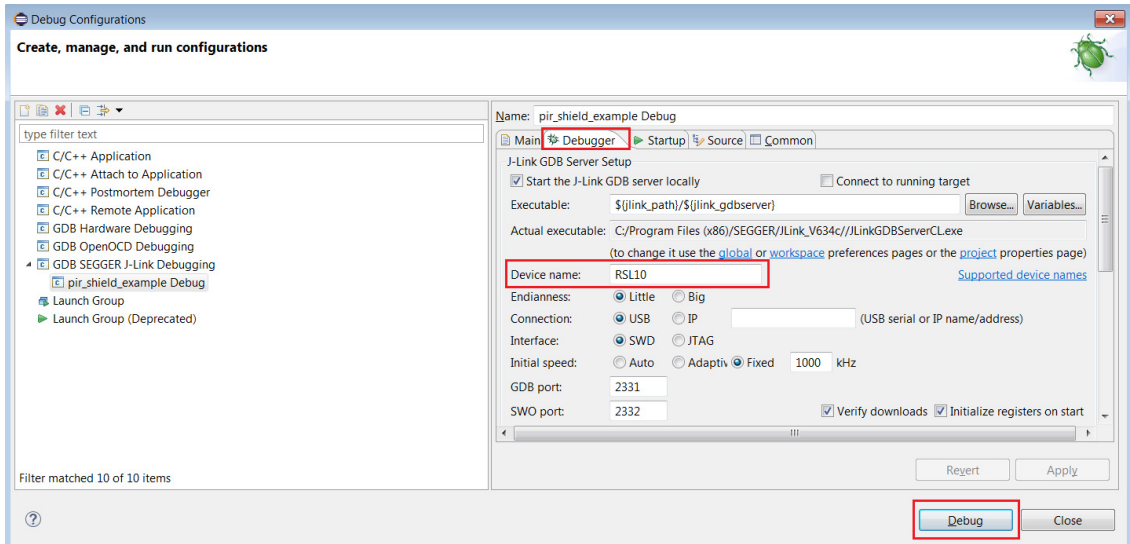


4. Double click **GDB Segger J-Link Debugging** to create the debug configuration for the selected example.

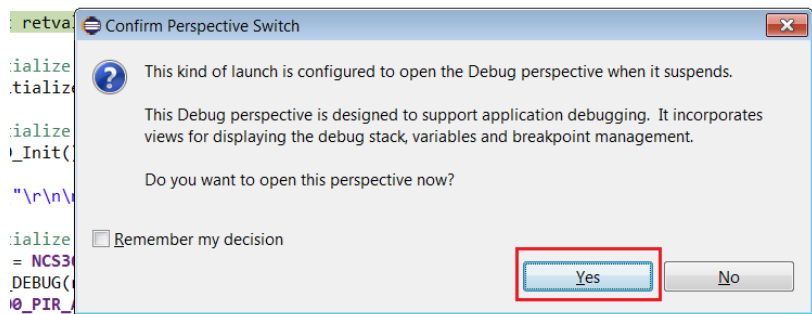


NOTE: The debug configuration for the selected example is automatically saved and there's no need to re-create it.

5. On the **Debugger** tab, set RSL10 as the device name. Click **Debug** to launch the code.



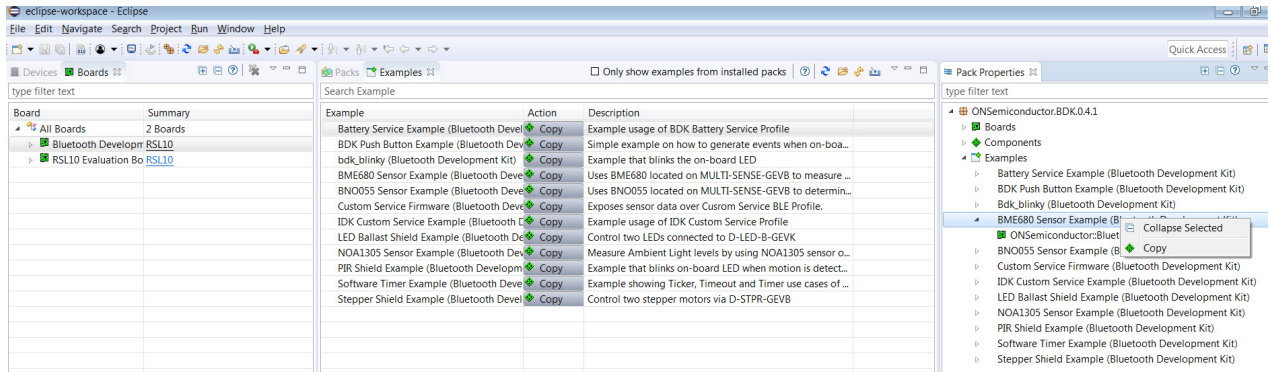
6. For application debugging, confirm perspective switch by clicking Yes.



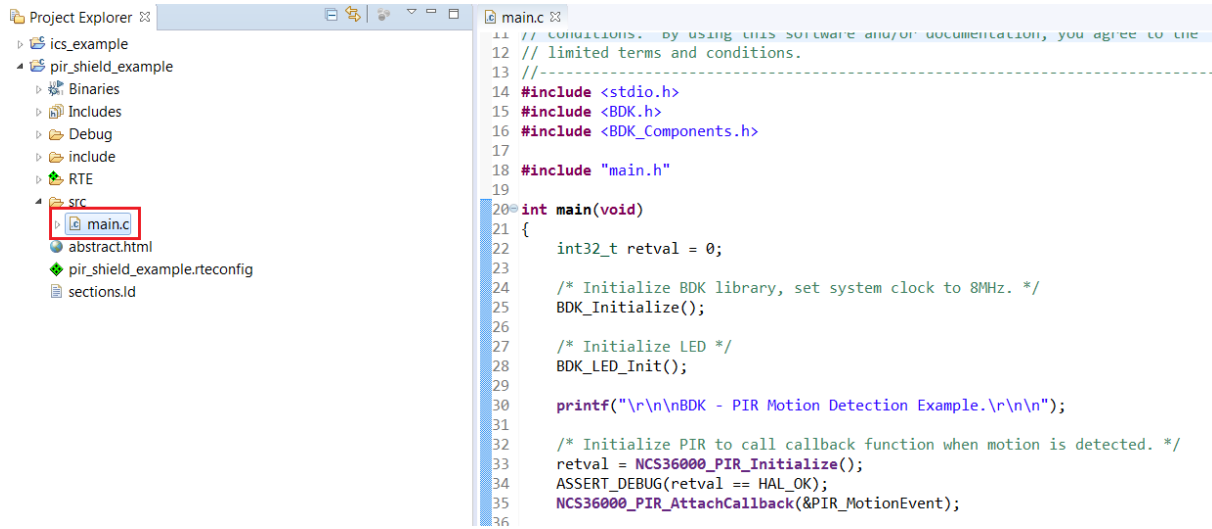
7. The debug session is now launched. Click Resume (F8) to start the target CPU.

Compiling and Flashing

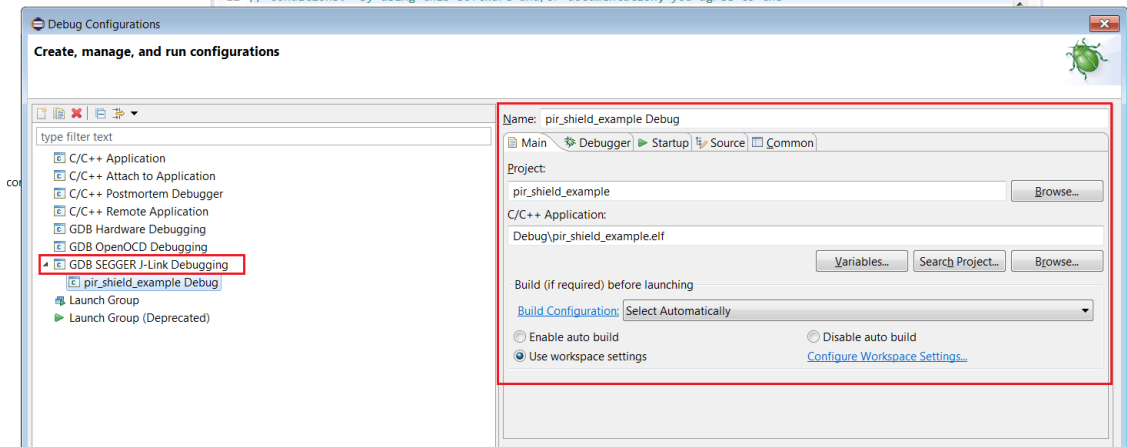
1. Choose an example (for example, pr_shield_example) to flash by copying it to the workspace.



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

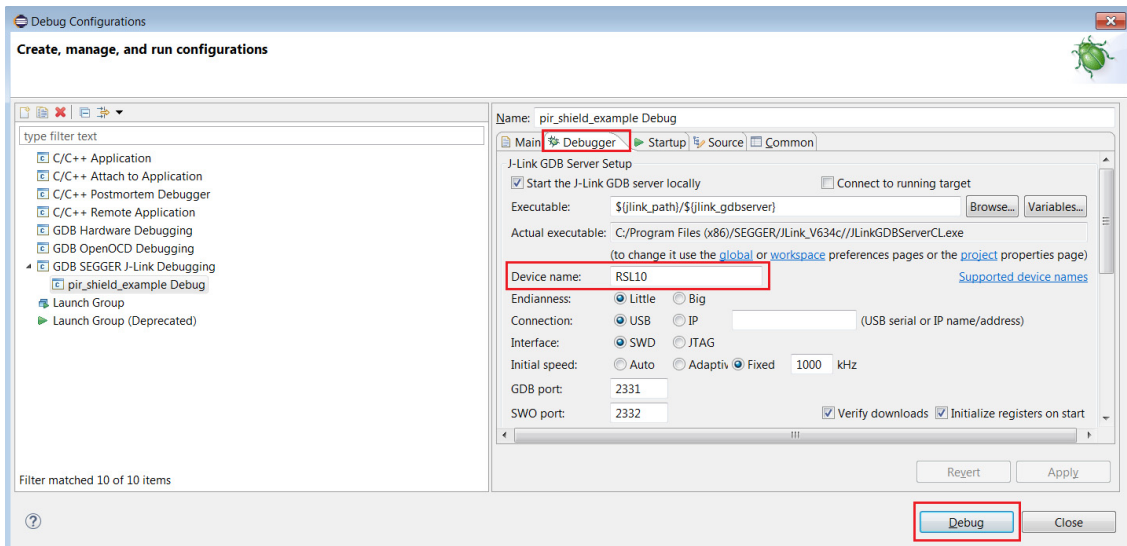


4. Double click GDB Segger J-Link Debugging to create the debug configuration for the selected example.

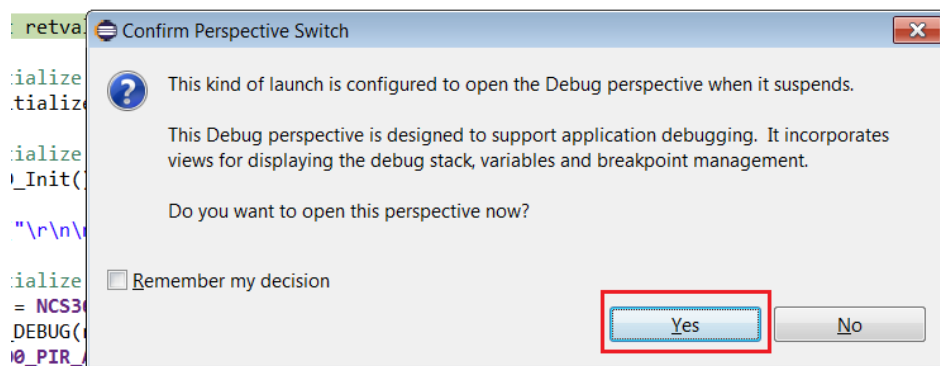


NOTE: The debug configuration for the selected example is automatically saved and there's no need to re-create it.

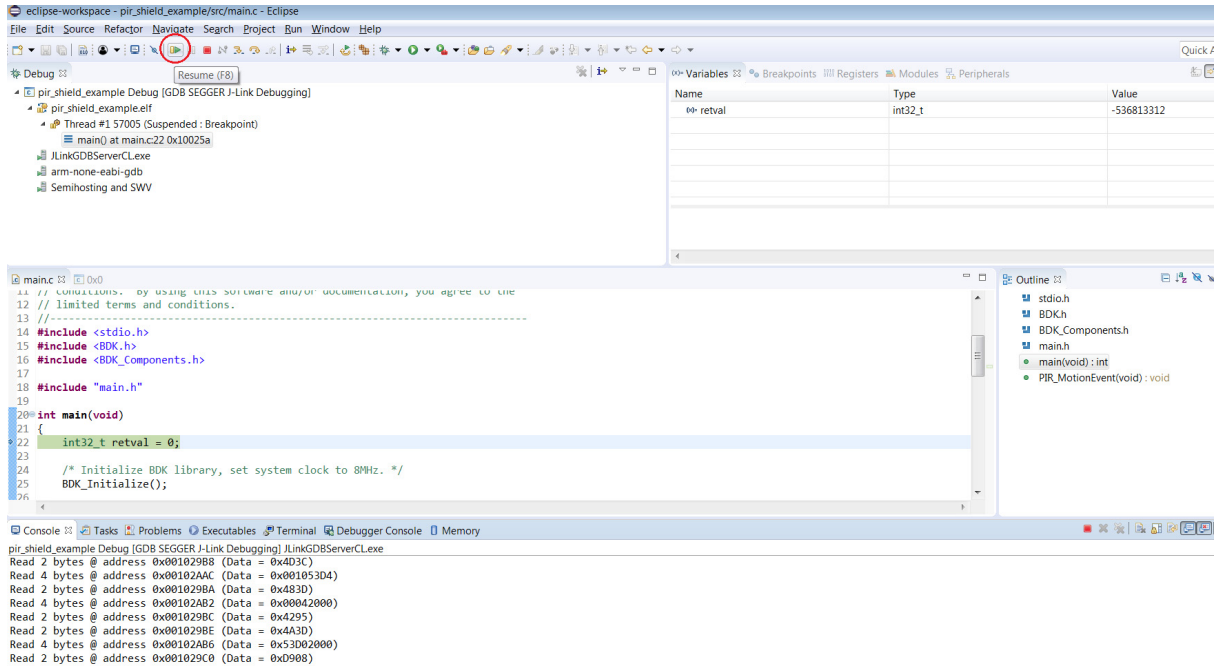
5. On the Debugger tab, set RSL10 as the device name. Click Debug to launch the code.



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



7. The debug session is now launched. Click Resume (F8) to start the target CPU.



Logging/Debugging

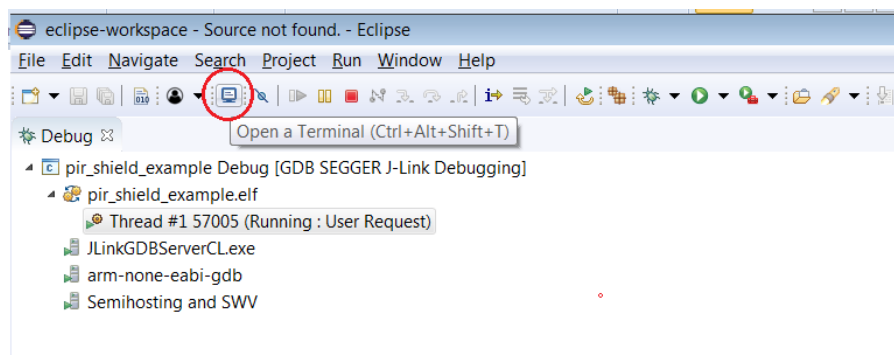
The following options are available to log/debug the downloaded firmware:

- Eclipse RTT Console
- J-Link RTT
- AX8052F100 UART-SPI bridge

This section provides instructions for each of the above options.

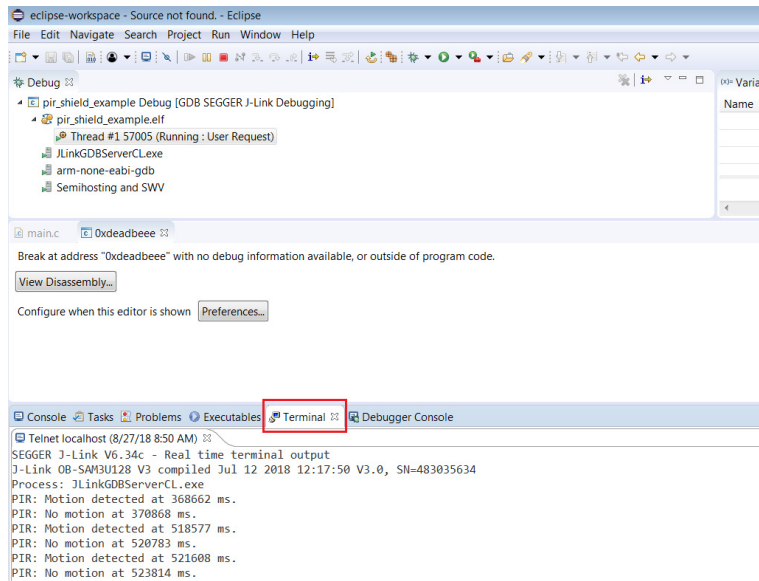
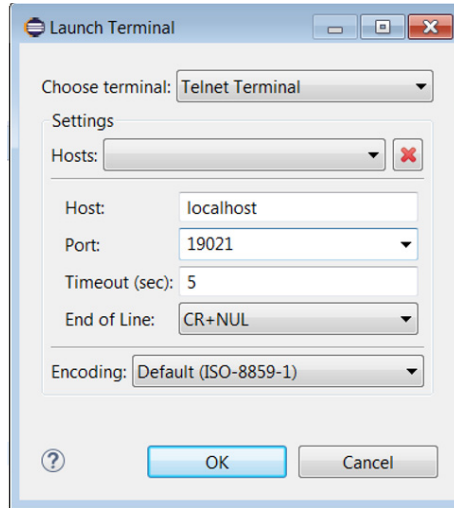
Using Eclipse Console

1. Click the Open a Terminal Icon



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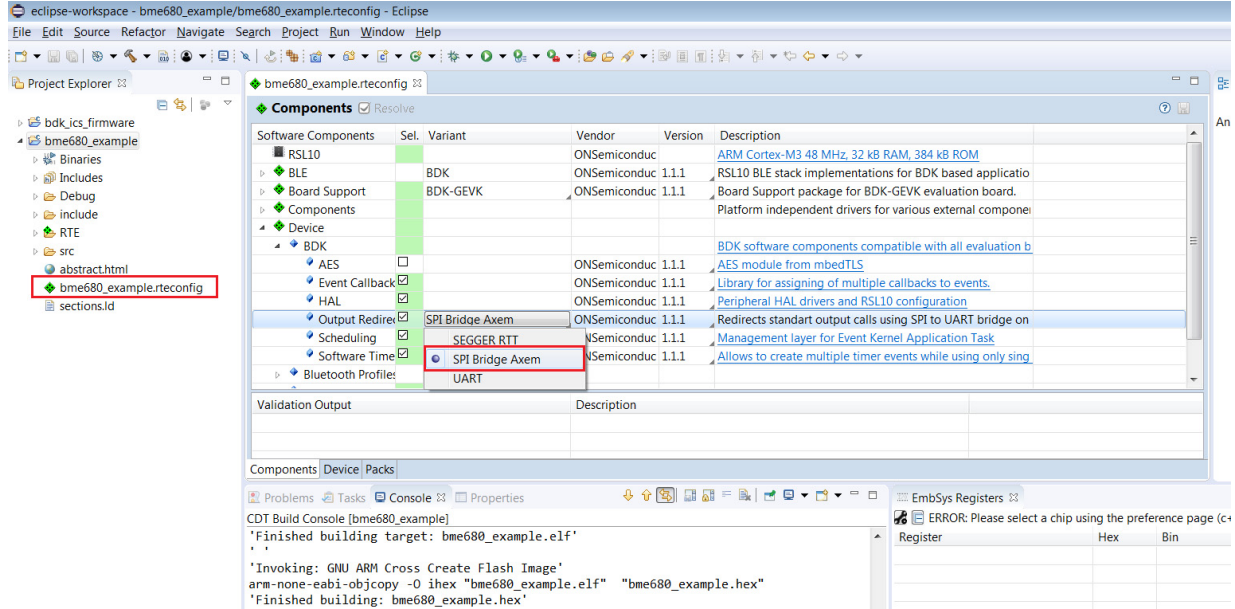
2. Enter the values shown below and launch the session. The incoming events are printed on the terminal window.



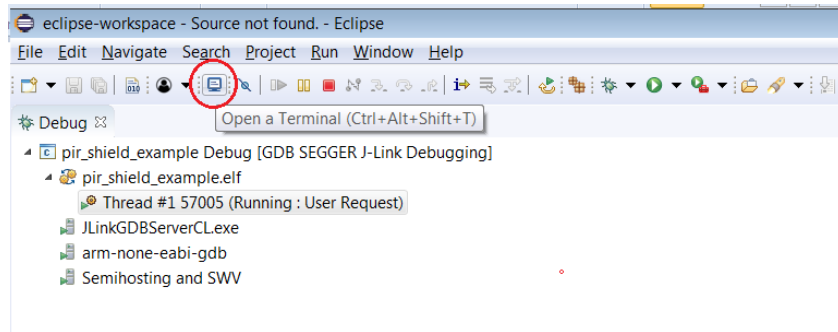
Using Eclipse Serial Console via UART–SPI Bridge.

When you do not want to use the Segger RTT viewer as serial console, the BDK–GEVK board is equipped with UART–SPI uC AX8052F100 flashed with special firmware, taking care of the entire serial communication with values returned on Terminal.

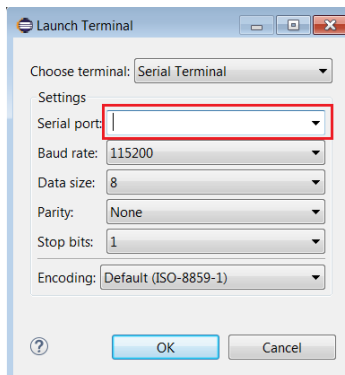
- Click on the example’s rteconfig file and choose under *Device/BDK/Output redirection*, SPI Bridge AXEM. Save, compile and flash the whole project.



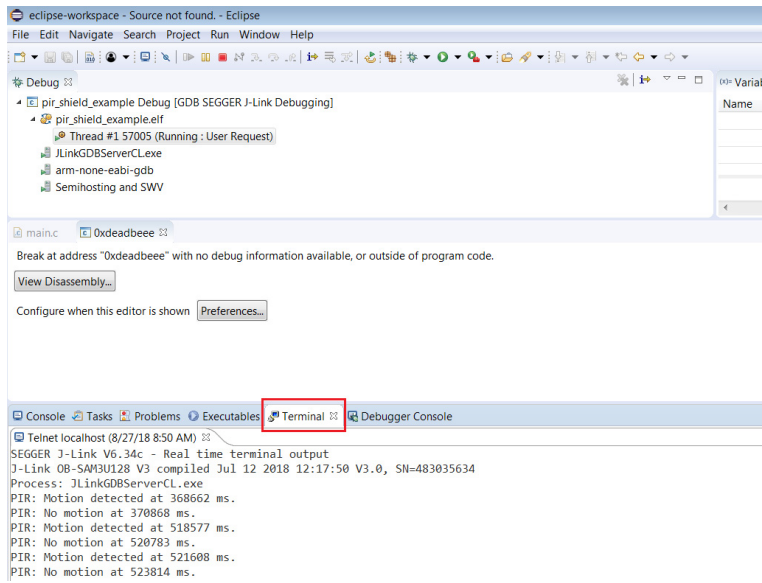
- When the project runs, Click the **Open a Terminal Icon**.



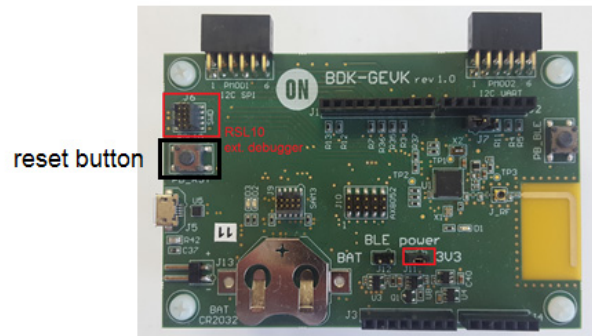
- Enter the appropriate COM port as shown below, and launch the session. The incoming events are entered on the terminal window.



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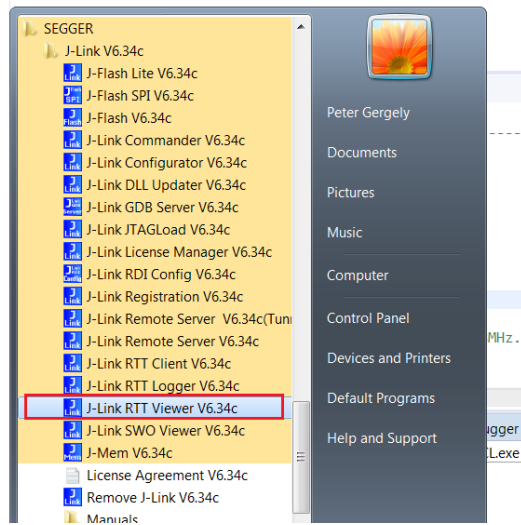


NOTE: You may reset (PB_RST) the BDK-GEVK (shown below) to launch the RTT terminal without needing to launch Eclipse.



Using J-Link RTT

6. After step 14 is done, open J-Link RTT viewer (should be installed when J-Link software package was installed per Step 2).

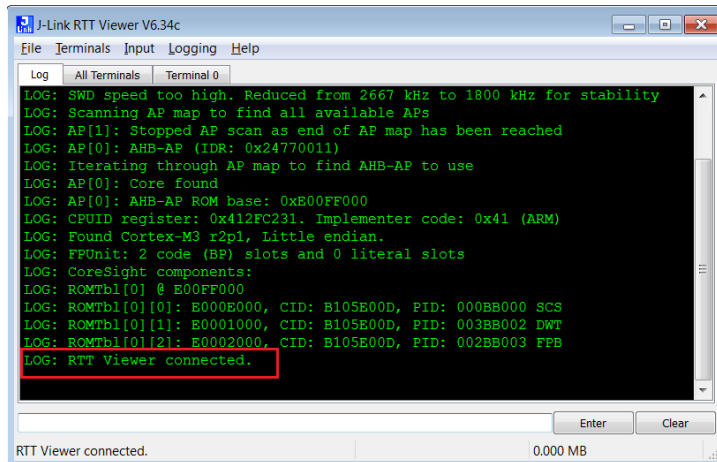
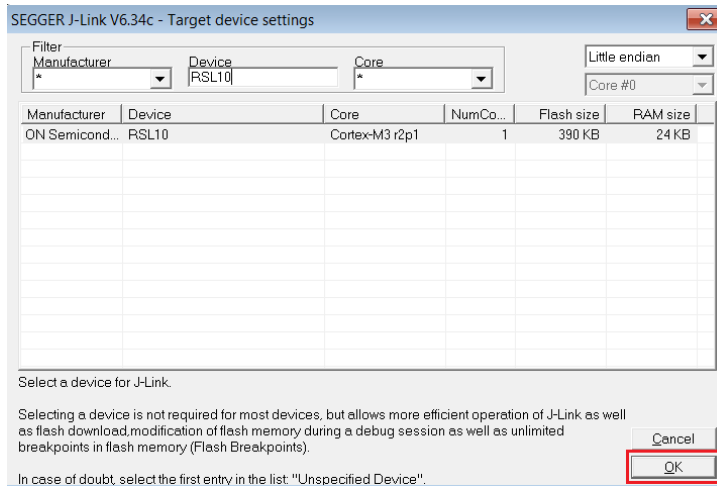
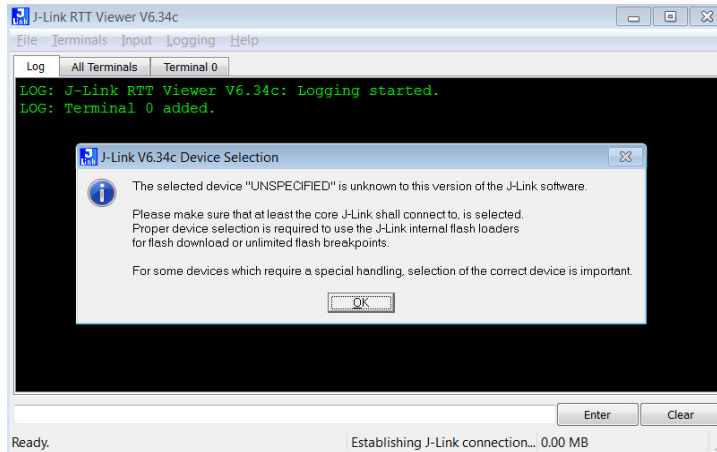


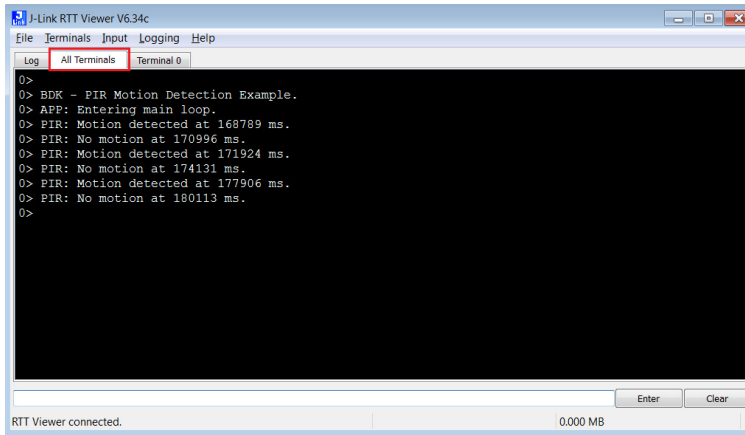
7. Select USB and click OK.



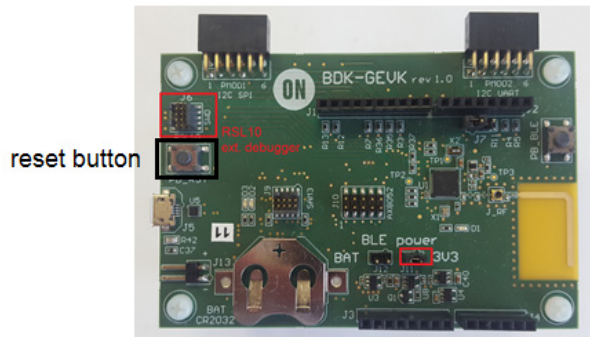
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8. RTT prompts you to select the appropriate microcontroller. Select RSL10 and click OK. The serial terminal is ready to use and the events from RSL10 can be observed by clicking the All Terminals Window.





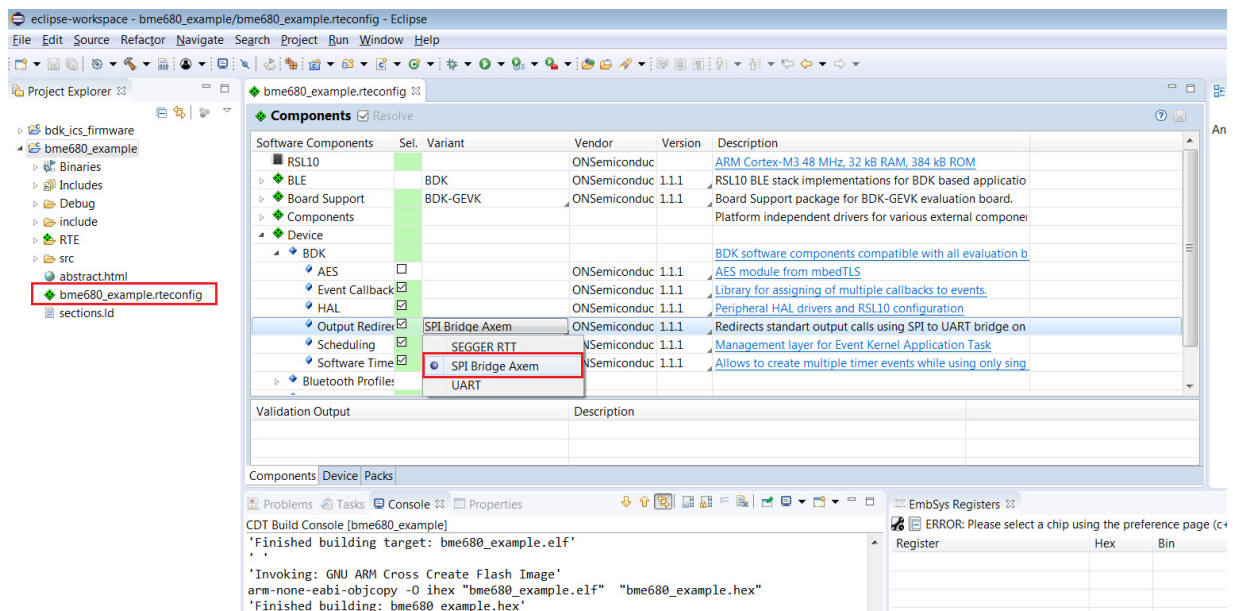
NOTE: You may reset (PB_RST) the BDK-GEVK (shown below) to launch RTT terminal without needing to launch Eclipse.



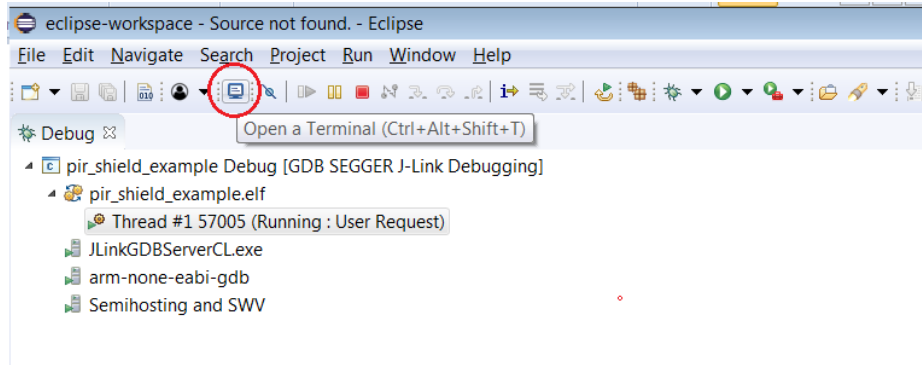
Using Eclipse Serial Console via UART-SPI Bridge

The BDK-GEVK board is equipped with UART-SPI microcontroller AX8052F100 flashed with special firmware, to enable serial communication with values returned to Terminal.

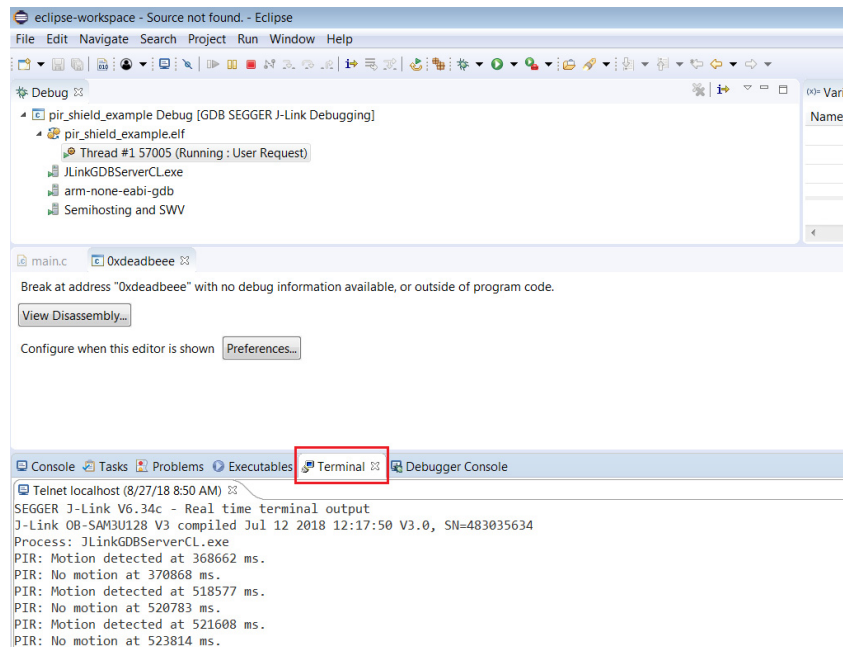
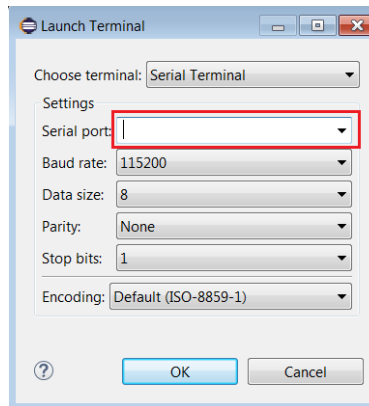
- Click on example's rteconfig file and choose "SPI Bridge AXEM" under *Device/BDK/Output redirection*. Save, compile and flash the whole project.



10. When the project runs, Click the Open a Terminal Icon.

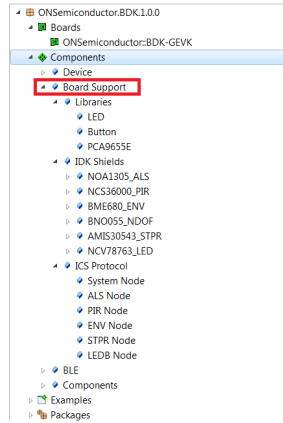


11. Enter the appropriate COM port as shown below and launch the session. The incoming events are printed on the terminal window.



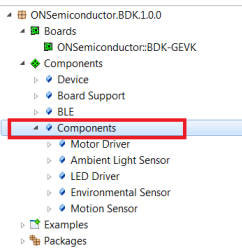
Board Support

- Libraries to support BDK-GEVK, GPIO Expander, Various daughter cards and custom protocol (required for the mobile app)



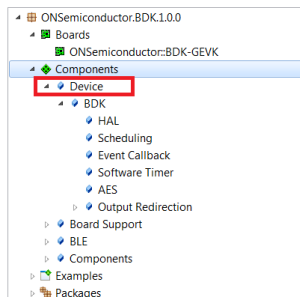
Components

- Libraries attached to board support



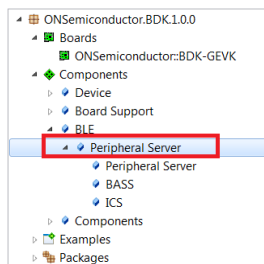
Device

- Abstraction layers for interfaces, timers, AES, serial re-direction, etc.



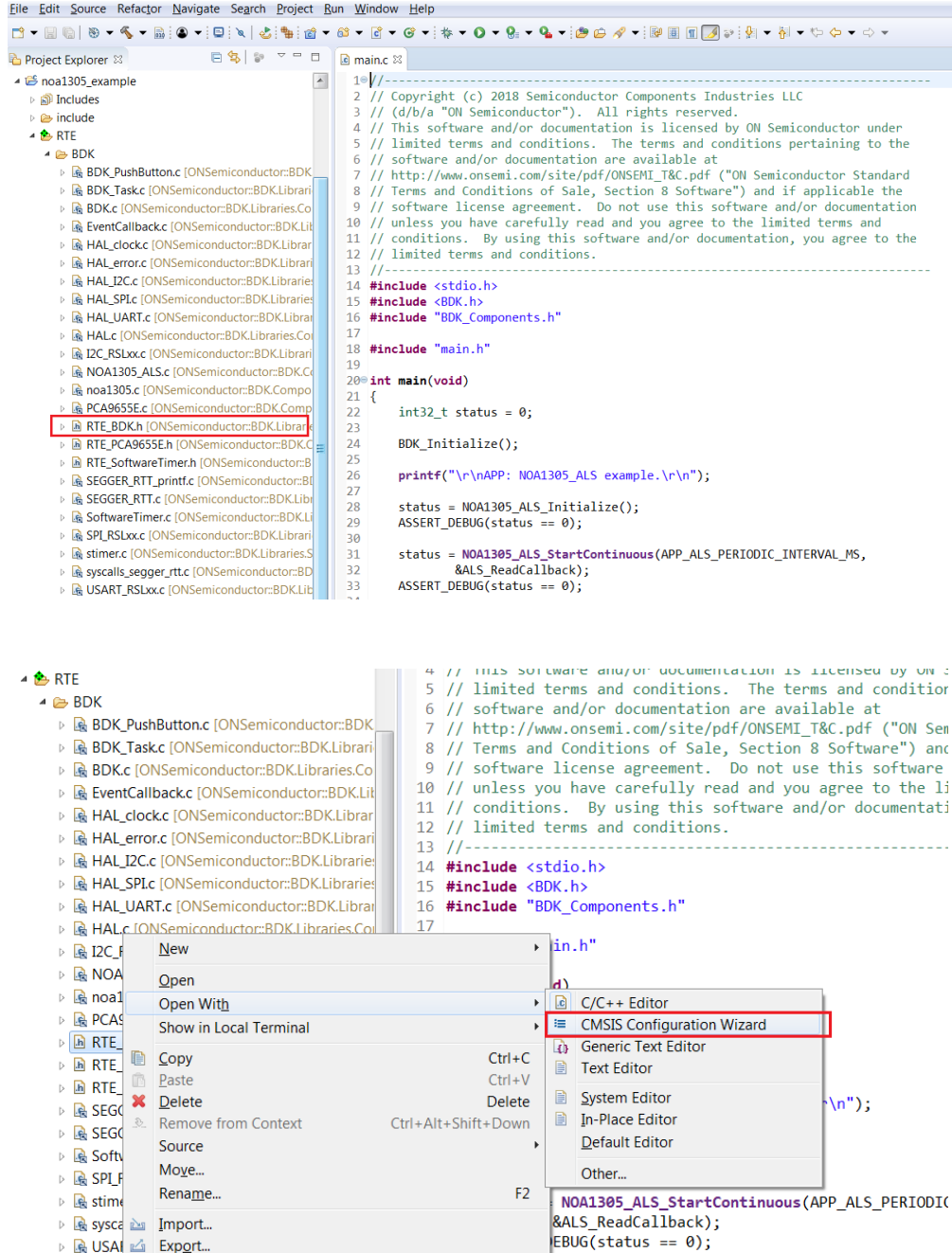
BLE

- Peripheral Server Support



CONFIGURATION SETUP

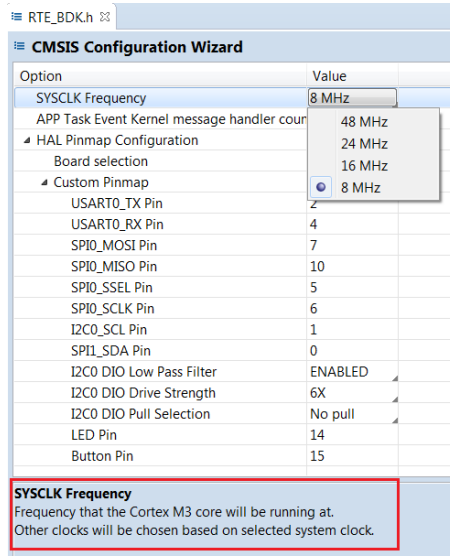
System settings can be configured directly from within the CMSIS pack. Each example is equipped with basic system configuration that covers three main categories. These are accessible in the RTE/BDK folder within the project. Each system configuration starts with “RTE_”. As shown below, opening the RTE_... 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.



A brief description on the header files is given below.

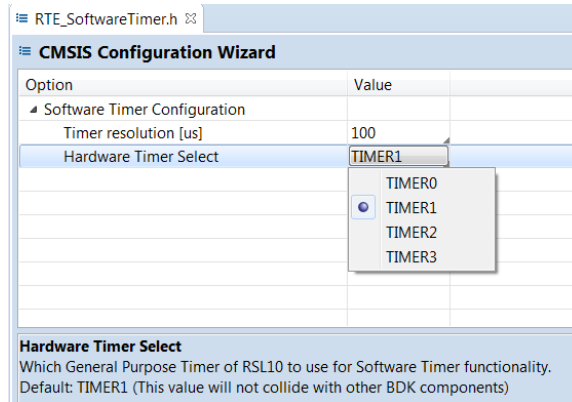
RTE_BDK.h

Parameters such as system clock frequency and the board that feature RSL10 (default set to BDK-GEVK), etc. can be set. Descriptions of each of these parameters are also provided.



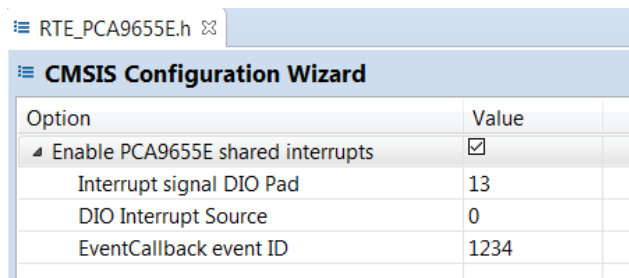
RTE_Software_Timer.h

Various timers (4) supported by RSL10 can be configured by invoking the CMSIS configuration wizard on this header file. Timer 1 is used for B-IDK components.



RTE_PCA9655.h

PCA9655 is the GPIO expander chip assembled on most daughter cards to expand interface functionality. Parameters related to this chip can be set here.



RTE_x.h

In addition to configuring system settings, all the supported daughter cards' parameters can be configured directly using the configuration wizard, without the need for programming. Once the parameters are changed per the application requirements, saving, rebuilding and flashing the project will let the new parameters take effect. Examples for the stepper and LED ballast daughter cards are shown below. Other daughter cards can be configured in a similar fashion.

RTE_AMIS30543_STPR.h

CMSIS Configuration Wizard

Option	Value
Stepper Shield Left Channel	
Step Mode	1 / 4 Micro - Step
Coil Peak Current	245 mA
Direction Of Rotation	CW motion
NXT Edge Trigger	Rising Edge
Turn On / Off Slopes of Motor Driver	Very Fast
Speed Load Angle Transparency Bit	SLA is not transparent
Speed Load Angle Gain	0.5
Enables doubling of the PWM frequency	<input type="checkbox"/>
Enables jittery PWM	<input type="checkbox"/>
Steps Per Revolution	200
Stepper Shield Right Channel	
Step Mode	1 / 4 Micro - Step
Coil Peak Current	1 / 32 Micro - Step
Direction Of Rotation	1 / 128 Micro - Step
NXT Edge Trigger	1 / 64 Micro - Step
Turn On / Off Slopes of Motor Driver	Compensated Full Step, 2 phase on
Speed Load Angle Transparency Bit	Compensated Full Step, 1 phase on
Speed Load Angle Gain	1 / 16 Micro - Step
Enables doubling of the PWM frequency	1 / 8 Micro - Step
Enables jittery PWM	<input checked="" type="radio"/> 1 / 4 Micro - Step
Steps Per Revolution	Compensated Half Step
	Uncompensated Half Step
	Uncompensated Full Step

Step Mode
Default: 1 / 4 Micro - Step (for motors provided with Stepper shield)

RTE_NCV78763_LED.h

CMSIS Configuration Wizard

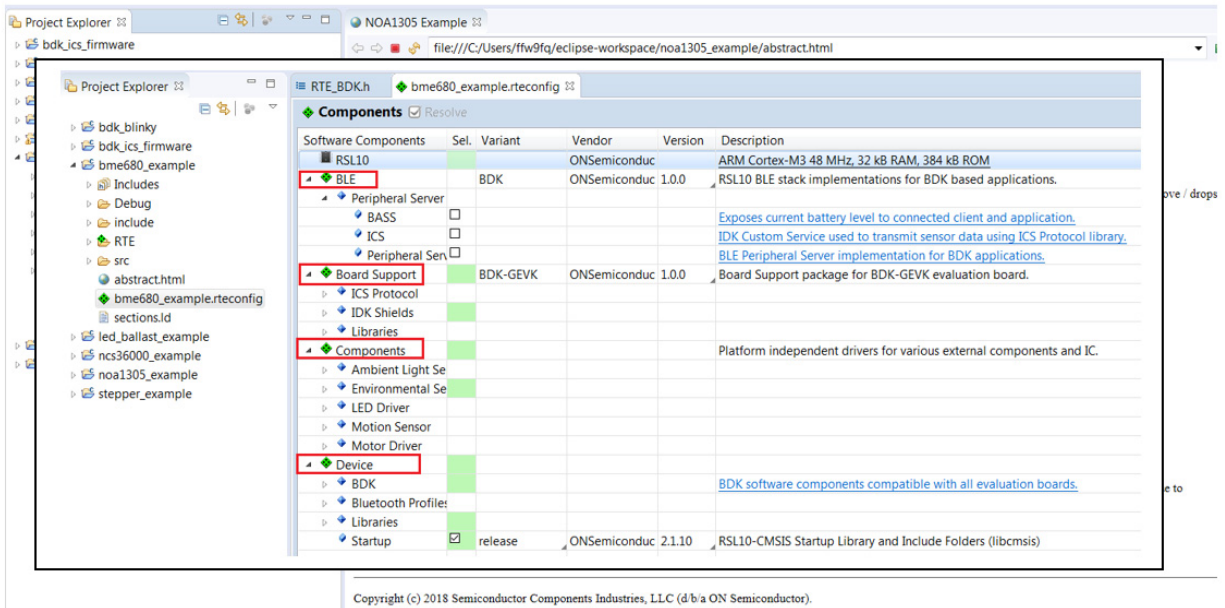
Option	Value
Enable Booster	<input checked="" type="checkbox"/>
Booster PWM generation	Internal
Booster PWM Frequency	242 kHz
Booster Clock Inversion	<input type="checkbox"/>
Booster Slope Compensation	10 mV / us
Booster Error Amplifier Gain [Siemens]	30 uS
Booster Overvoltage Shutdown	5.8 V
Booster Overvoltage Reactivation	-1 V
Booster Gate Voltage Threshold	0.4 V
Booster Minimum Off Time	115 ns
Booster Minimum On Time	150 ns
Booster Regulation Setpoint Voltage	45.0 V
Booster Current Limitation Peak Value	100 mV
Activate VBOOST_AUX_SUPPLY	<input type="checkbox"/>
Booster Skip Clock Cycles	Disabled
Enable Buck Regulator Channel 1	<input checked="" type="checkbox"/>
D-LED-B-GEVK Channel 1 Peak current [m]	252
D-LED-B-GEVK Channel 1 Average current	140
Enables the offset compensation for buck	<input type="checkbox"/>
Comparator Threshold Voltage	0
Tunes the Toff x VLED value for channel 1	0
> Overcurrent Settings	
Enable Buck Regulator Channel 2	<input checked="" type="checkbox"/>
General Settings	
Thermal warning threshold	0
LED sampling duration selection	88

Booster Overvoltage Reactivation
Defines the hysteresis for the reactivation once the overvoltage shutdown is triggered.
Default: -1 V for D-LED-B-GEVK

Source Editor: CMSIS Configuration Wizard

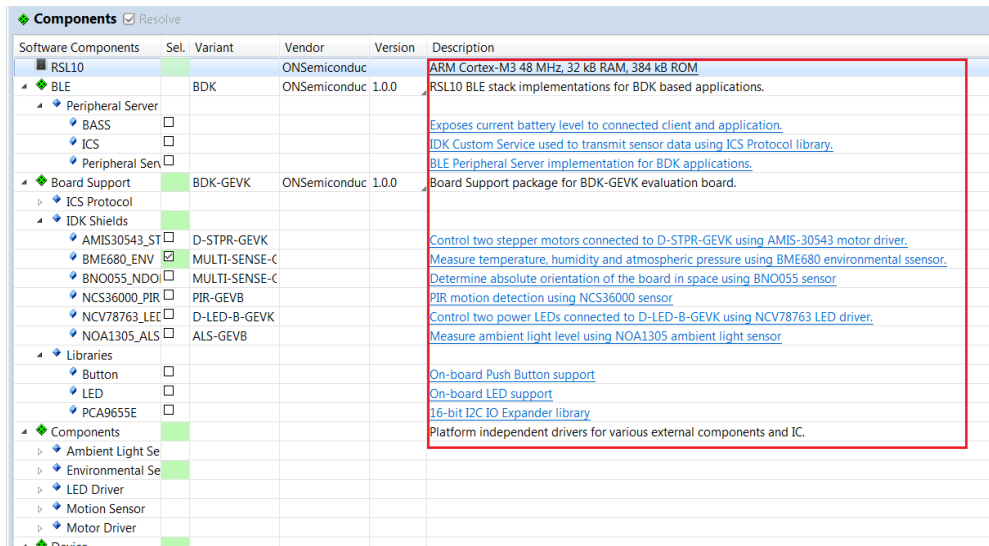
DOCUMENTATION

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 as described in the B_IDK CMSIS Software Organization section. To access the components, double click *.rteconfig file. Extensive help is provided under the description tab.



ON Semiconductor **BDK** v1.0.0
Bluetooth LE Development Kit for RSL10

BNO055 Absolute Orientation Sensor
BNO055 COMPONENTS

Absolute orientation sensor library (accelerometer, gyroscope, magnetometer). More...

Data Structures

```

struct BNO055_NDOF_CalStatus
    BNO055 calibration status structure. More...
struct BNO055_NDOF_Resources
    
```

Macros

```

#define BNO055_NDOF_IOEXP_ADDRESS (0x48 >> 1)
    I2C address of IO expander on Multisensor shield.
#define BNO055_NDOF_IOEXP_PORT (1)
    IO expander port containing BNO055 related signals.
#define BNO055_NDOF_IOEXP_RST_PIN (2)
    IO expander pin number for BNO055 reset signal.
#define BNO055_NDOF_IOEXP_RST_PIN_MASK (1 << BNO055_NDOF_IOEXP_RST_PIN)
#define BNO055_NDOF_IOEXP_INT_PIN (1)
    IO expander pin number for BNO055 interrupt signal.
#define BNO055_NDOF_IOEXP_INT_PIN_MASK (1 << BNO055_NDOF_IOEXP_INT_PIN)
    
```

Enumerations

```

enum BNO055_NDOF_PowerMode { BNO055_NDOF_POWER_MODE_NORMAL = 0, BNO055_NDOF_POWER_MODE_LOW_POWER = 1, BNO055_NDOF_POWER_MODE_SUSPEND = 2 }
    Available power modes of BNO055. More...
    
```

Functions

```

int32_t BNO055_NDOF_Initialize (void)
    Initializes the BNO055 and sets it into Nine Degrees of Freedom (NDOF) operation mode. More...
int32_t BNO055_NDOF_SetPowerMode (enum BNO055_NDOF_PowerMode mode)
    Allows to set chips power mode to reduce current consumption or disable sensors. More...
int32_t BNO055_NDOF_GetCalibrationStatus (struct BNO055_NDOF_CalStatus *status)
    Reads calibration status of BNO055 sensors. More...
int32_t BNO055_NDOF_ReadLinearAccel (struct bno055_linear_accel_float_t *ps)
    Reads latest linear acceleration vector in MS2 from device. More...
int32_t BNO055_NDOF_ReadGravity (struct bno055_gravity_float_t *ps)
    Reads latest gravity vector in MS2 from device. More...
int32_t BNO055_NDOF_ReadAngRotation (struct bno055_gyro_float_t *ps)
    Reads latest angular rotation vector in DPS from device. More...
int32_t BNO055_NDOF_ReadAbsOrientation (struct bno055_suler_float_t *ps)
    Reads latest absolute orientation vector in degrees from device. More...
    
```

Run Time Environment Configuration

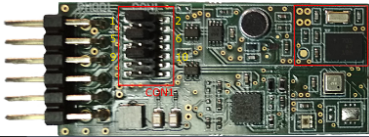
These parameters are part of the RTE_BNO055_NDOF.rte configuration file and can be used to adjust library behavior. This file is copied into the Eclipse project when the BNO055_NDOF component is selected and can be edited by using the CMSIS Configuration Wizard editor.

```

#define RTE_BNO055_NDOF_EXT_CLK_SRC 1
    
```

Detailed Description

Absolute orientation sensor library (accelerometer, gyroscope, magnetometer).
The BNO055 is a System In Package integrating a triaxial accelerometer, a triaxial gyroscope, a triaxial geomagnetic sensor and 32 bit microcontroller.



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.

Software Components	Sel.	Variant	Vendor	Version	Description
RSL10			ONSemiconduc		ARM Cortex-M3 48 MHz, 32 kB RAM, 384 kB ROM
BLE		BDK	ONSemiconduc	1.0.0	RSL10 BLE stack implementations for BDK based applications.
Board Support		BDK-GEVK	ONSemiconduc	1.0.0	Board Support package for BDK-GEVK evaluation board.
Components					Platform independent drivers for various external components and IC.
Device					
BDK					BDK software components compatible with all evaluation boards.
AES	<input type="checkbox"/>		ONSemiconduc	1.0.0	AES module from mbedtls
Event Callback	<input type="checkbox"/>		ONSemiconduc	1.0.0	Library for assigning of multiple callbacks to events.
HAL	<input checked="" type="checkbox"/>		ONSemiconduc	1.0.0	Peripheral HAL drivers and RSL10 configuration
Output Redirection	<input checked="" type="checkbox"/>	SEGGER RTT	ONSemiconduc	1.0.0	Redirects standart output calls using SEGGER RTT
Scheduling	<input checked="" type="checkbox"/>		ONSemiconduc	1.0.0	Management layer for Event Kernel Application Task
Software Timer	<input checked="" type="checkbox"/>		ONSemiconduc	1.0.0	Allows to create multiple timer events while using only single hardware timer.
Bluetooth Profiles					
Libraries					
Startup	<input checked="" type="checkbox"/>	release	ONSemiconduc	2.1.10	RSL10-CMSIS Startup Library and Include Folders (libcmsis)



BDK

Abstraction layers for RSL10 Bluetooth Development Kit based applications. [More...](#)

Modules

COMPONENTS
TASK_APP Management Application Task management & custom event scheduling.
Event Callback Library for attaching multiple callback functions (listeners) to single event source.
HAL Peripheral Hardware Abstraction Layer for RSL10.
Software Timer Allows creation of unlimited number of software timers with Ticker, Timeout and Timer functionality.
ANSI Terminal Color support Bring color to your terminal screen.
Target Evaluation board specific definitions.
API
Bluetooth Low Energy Library for handling of BLE functionality and libraries of supported BLE profiles.

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

HAL
BDK

Peripheral Hardware Abstraction Layer for RSL10. [More...](#)

Modules

Clock Configurations Defines possible clock configurations for proper operation of BDK.
I2C I2C interface for communication with connected shields.
SPI SPI interface for communication with connected shields.
UART UART interface for communication with connected shields.

Macros

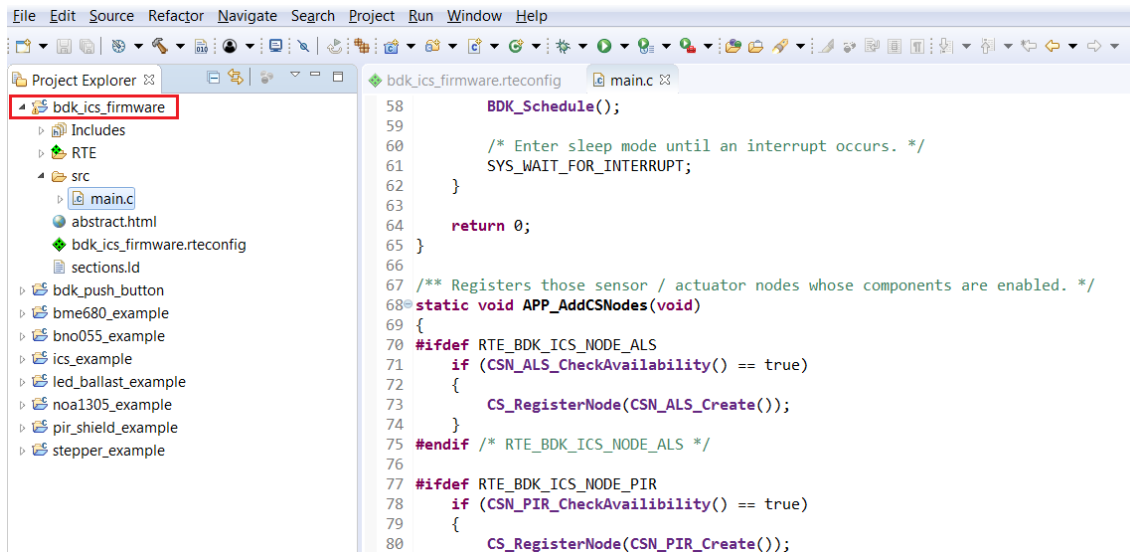
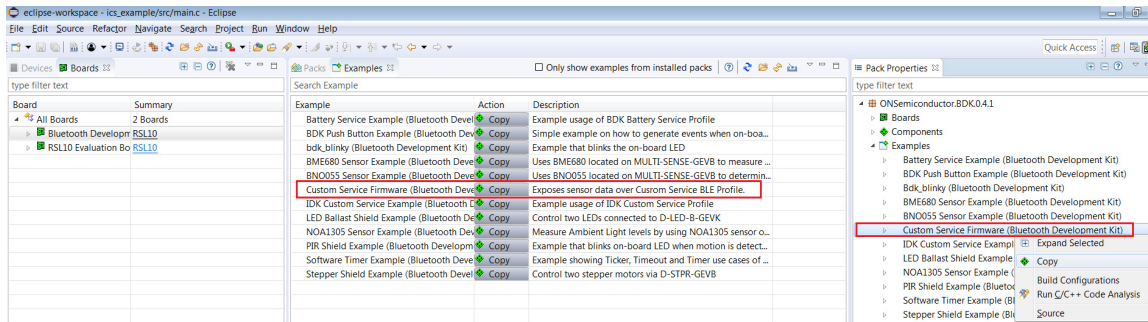
```
#define HAL_TIME_RESOLUTION_US (1000)
#define HAL_TIME_ELAPSED_SINCE(start_timestamp) (HAL_Time() - start_timestamp)
#define HAL_OK (0)
```

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

BDK	
Abstraction layers for RSL10 Bluetooth Development Kit based applications. More...	
Modules	
COMPONENTS	
TASK_APP Management	Application Task management & custom event scheduling.
Event Callback	Library for attaching multiple callback functions (listeners) to single event source.
HAL	
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Software Timer	Allows creation of unlimited number of software timers with Ticker, Timeout and Timer functionality.
ANSI Terminal Color support	Bring color to your terminal screen.
Target	Evaluation board specific definitions.
API	
Bluetooth Low Energy	Library for handling of BLE functionality and libraries of supported BLE profiles.

Custom Service Firmware

In order to read sensor data and control actuators connected to the BDK–GEVK from the RSL10 Sense and Control mobile app, the Custom Service Firmware must be downloaded onto the BDK–GEVK. This firmware can be found as Custom Service Firmware under examples in the CMSIS pack.



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