Renesas RA Family

# QE for BLE usage for Keil® MDK

## Introduction

This document explains how to generate QE BLE code in e² studio and copy the generated code to Keil® MDK for Renesas RA Microcontrollers.

## Target Device

EK-RA4W1 Evaluation Kit for RA4W1 group.

## Operating Environment

| | |
|---|---|
| **IDE** | Keil® Microcontroller Development Kit Version 5.36 or later<br>e² studio version 2021-10 is used for BLE Custom Profile creation and code generation |
| **Configuration Tool** | Smart Configurator (RA SC) v2021-10 and FSP v3.5.0 |
| **Toolchains** | GNU Arm Embedded Toolchain: 10.3-2021.10<br>(GNU ARM Embedded 10.3.1.20210824) |
| **QE** | Renesas QE for BLE[RA,RE,RX] V1.4.0 |

Note: Please download and install tools from the following URLs in before starting.

- Renesas QE download site:
  https://www.renesas.com/software-tool/qe-tools-particular-applications
- FSP with e² studio installer download site:
  https://github.com/renesas/fsp/releases
- Keil® MDK Getting Started site:
- https://www2.keil.com/mdk5/install

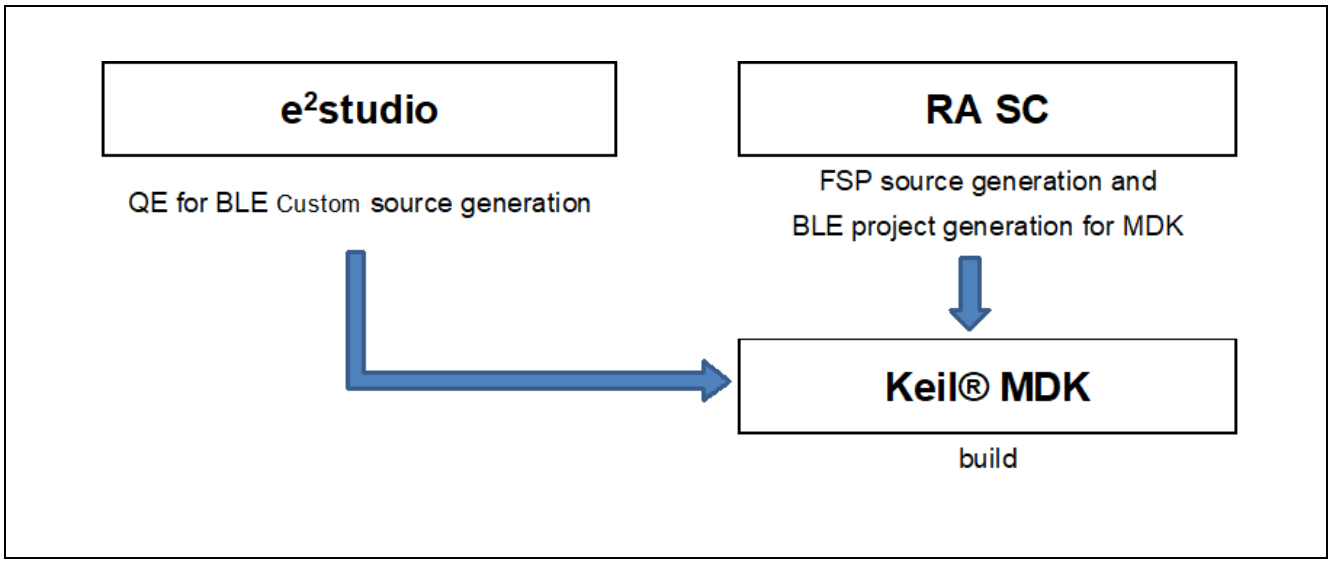


**Figure 1. Configuration diagram when using QE for BLE[RA,RE,RX] with Keil® MDK**

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# 1. Creating a project in e² studio

A project generation wizard is available in e² studio to generate a RA project with a project name and the associated device and board, including board-level drivers.

Start the e² studio application and choose a workspace folder in the Workspace Launcher. To create a new RA project, follow these steps.

1. Select **File > New > C/C++ Project**.
2. Select **Renesas RA: Renesas RA C/C++ Project** template. Click **Next** to continue.

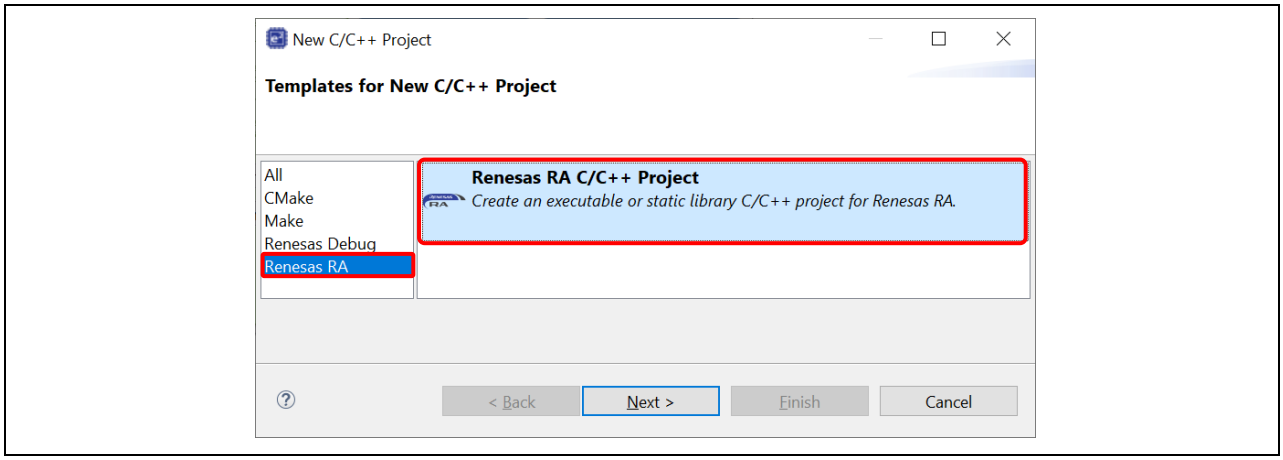


**Figure 2. Templates Selection**

3. In the next dialog box, enter a project name and click **Next**.

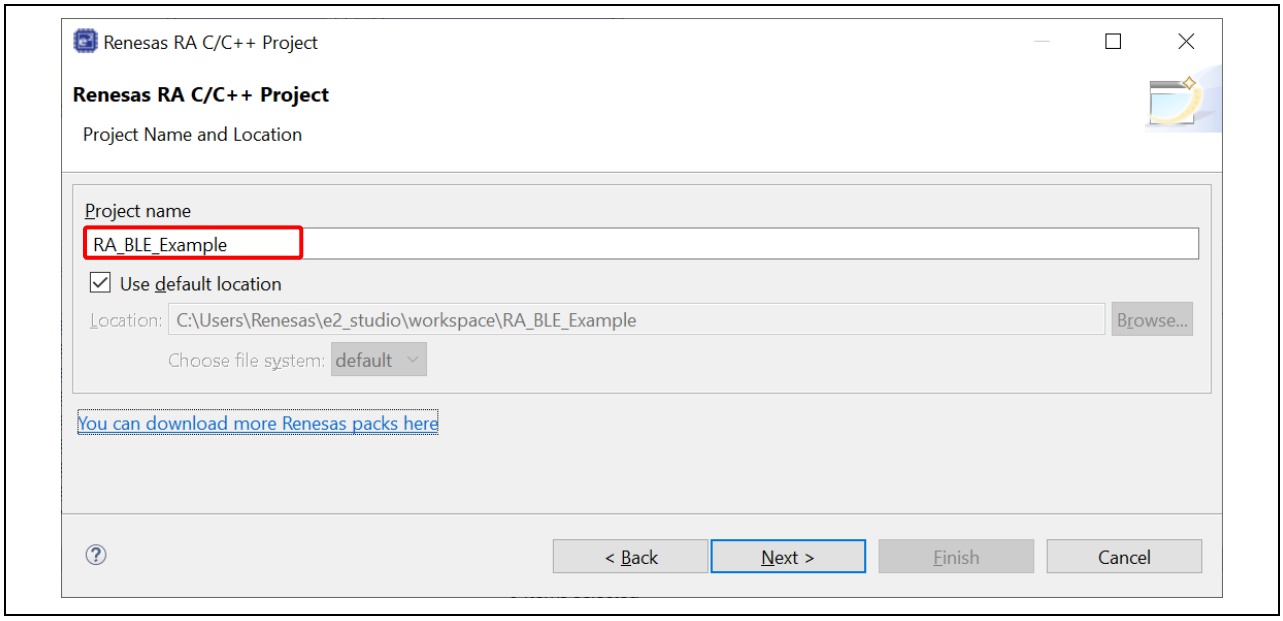


**Figure 3. Project Name and Location**

4. In the device selection dialog, enter device and tool information:
   - FSP version: **3.5.0**
   - Board: **EK-RA4W1**
   - Device: Auto selected
   - Language: **C**
   - Toolchain version: Latest GNU Arm Embedded Toolchain approved for use with Renesas RA (for example, **GNU ARM Embedded 10.3.1.20210824**)
   - Debugger: **J-link ARM**

   Click **Next** to continue.

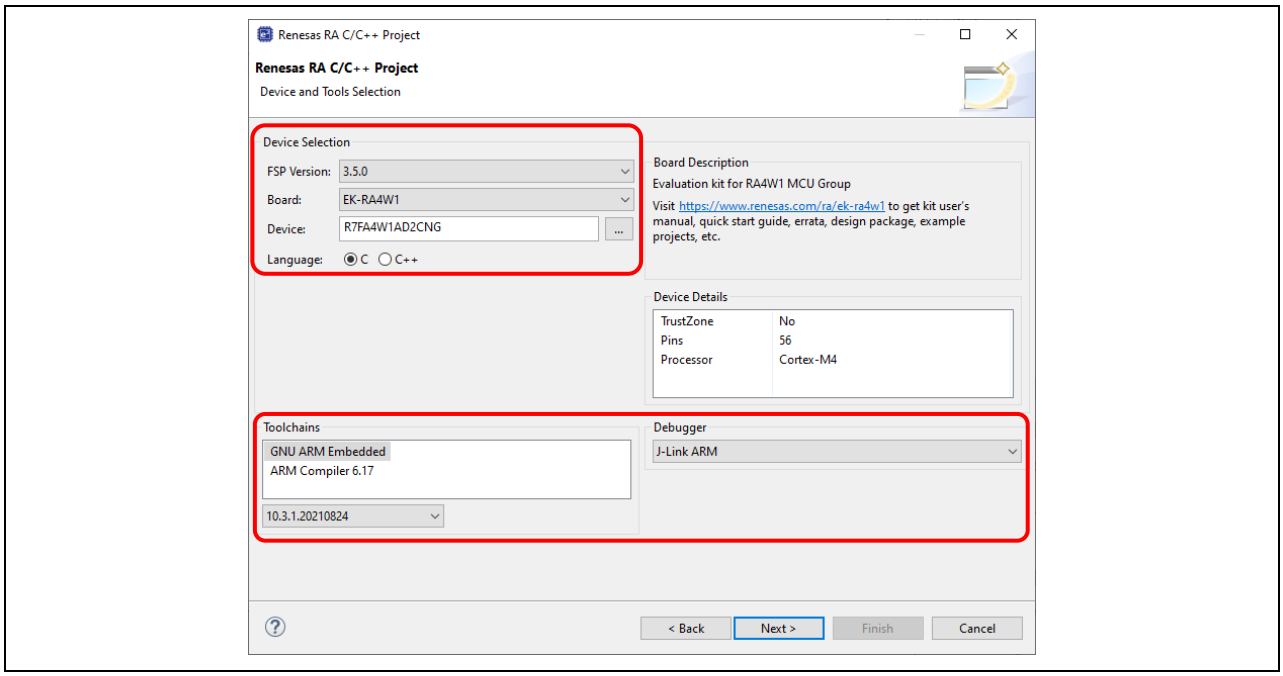


**Figure 4. Create New Project For EK-RA4W1**

5. Build Artifact Selection: **Executable**
   RTOS Selection: **No RTOS**

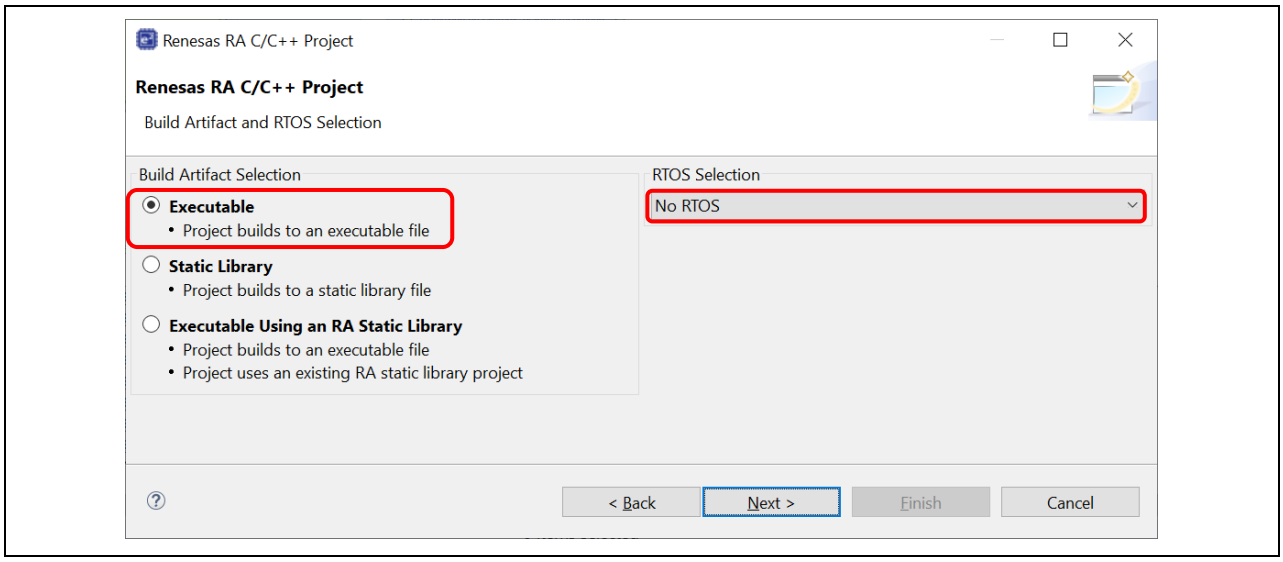


**Figure 5. Build Artifact and RTOS Selection**

6. In the project template dialog, select **Bare Metal - Minimal** and click **Finish.**

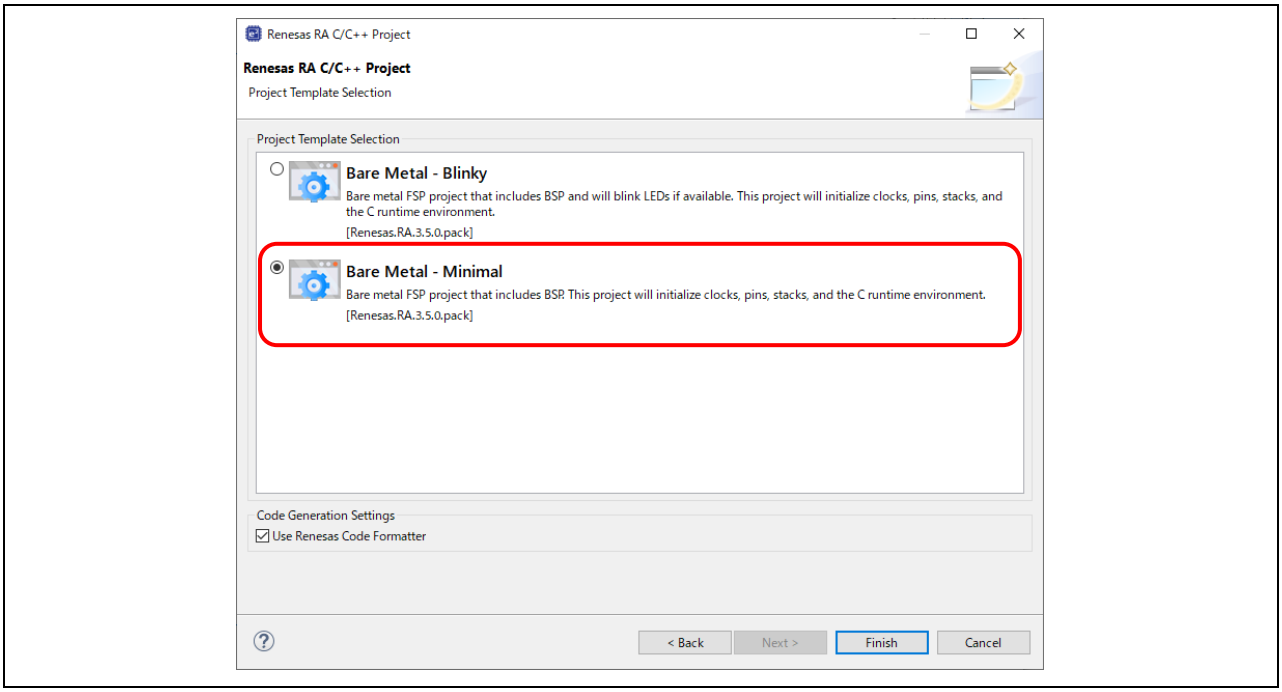


**Figure 6. Project Template Selection**

7. e$^2$ studio creates a project with the **FSP Configuration** perspective open and ready for project configuration.

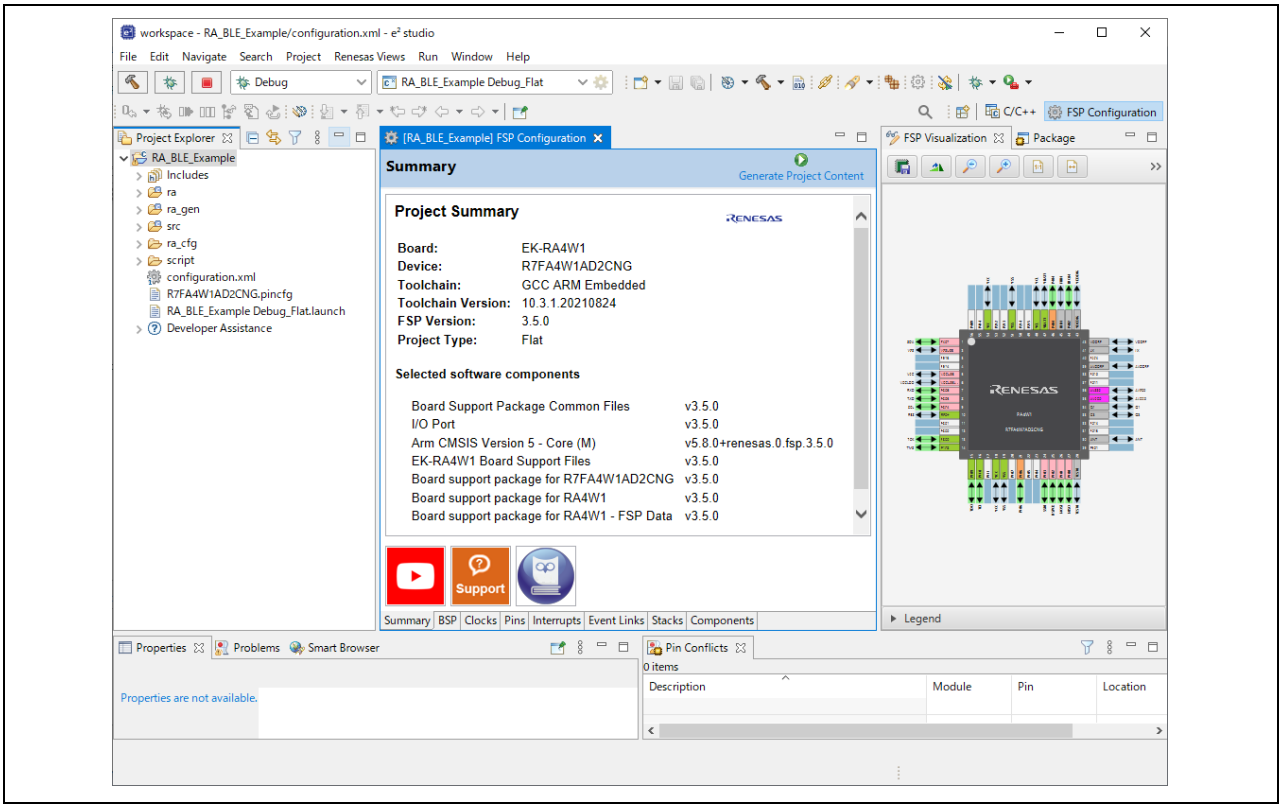


**Figure 7. New Project is opened with FSP Configuration perspective**

## 2. Creating BLE Custom Profile in e² studio

1. If **QE for BLE[RA,RE,RX]** has not been installed, select **Renesas Views > Renesas Software Installer** from the menu of e² studio to install it.
2. In the **Renesas Software Installer** dialog box, select **Renesas QE**, then click **Next**.
3. Select **QE for BLE[RA,RE,RX]** and click **Finish** to install it.

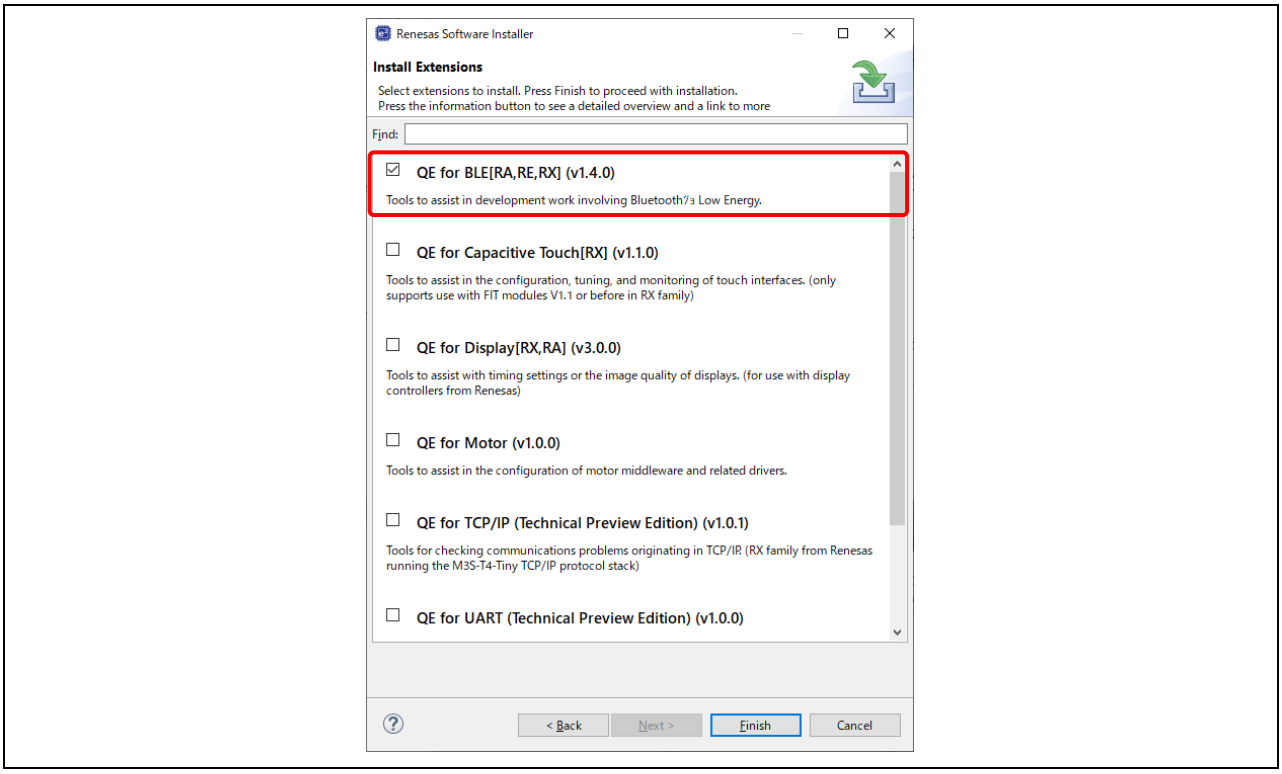


**Figure 8. Install QE for BLE[RA,RE,RX]**

4. From the menu of e² studio, select **Renesas Views > Renesas QE > R_BLE Custom Profile RA,RE,RX (QE)** to open the main perspective for configuring BLE custom profile to the project.

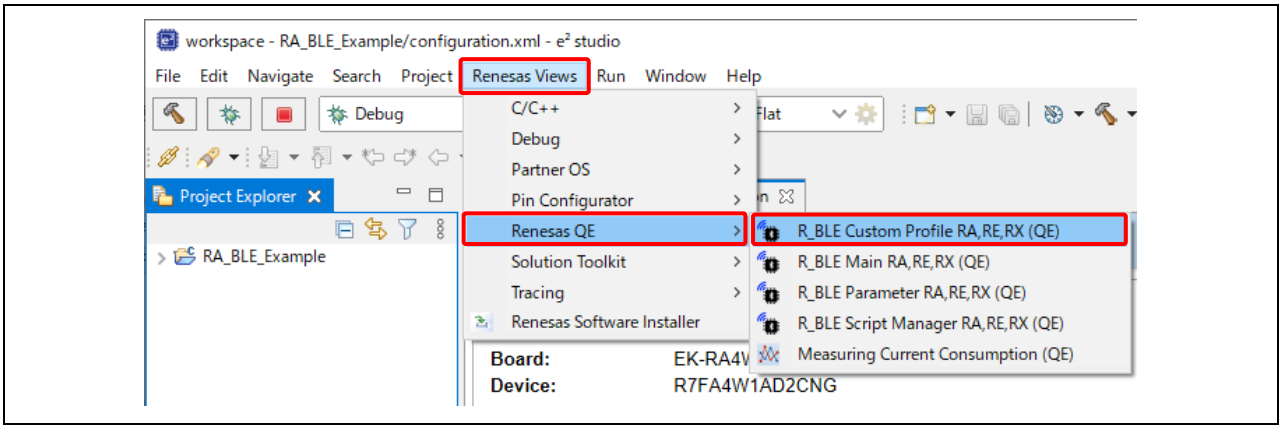


**Figure 9. Open R_BLE Custom Profile RA,RE,RX (QE)**

5. In the **R_BLE Custom Profile RA,RE,RX (QE)** pane, select the project to configure the BLE custom profile by using the pull-down tab and selecting the **RA_BLE_Example** project as shown below.

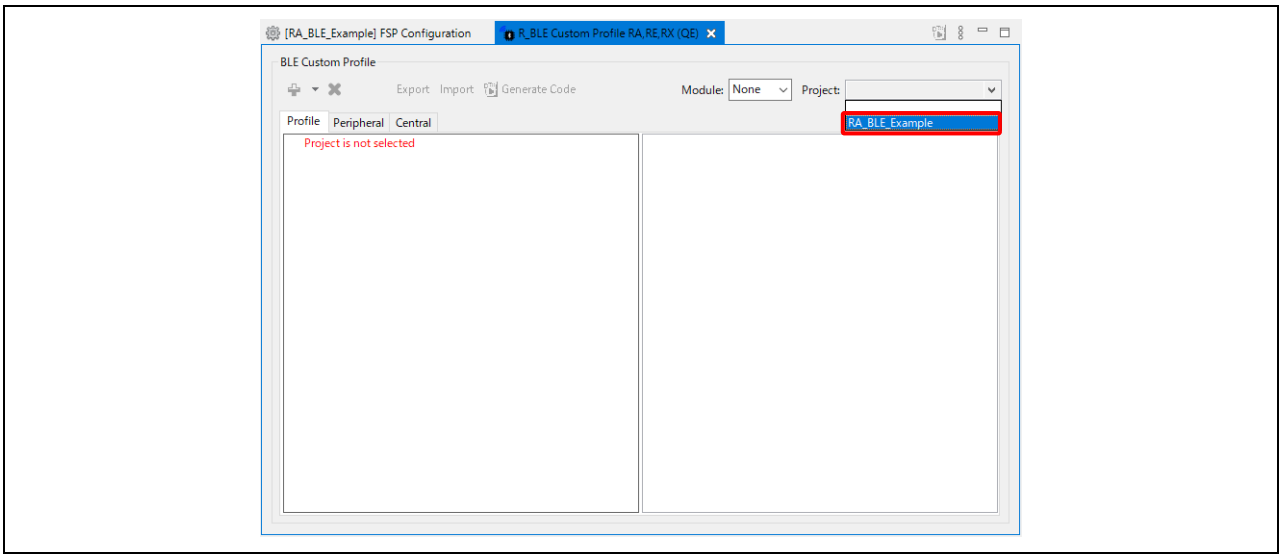


**Figure 10. Select project**

6. Select **Profile**, then click the **Add** button and select **Add Service** to add new BLE service.

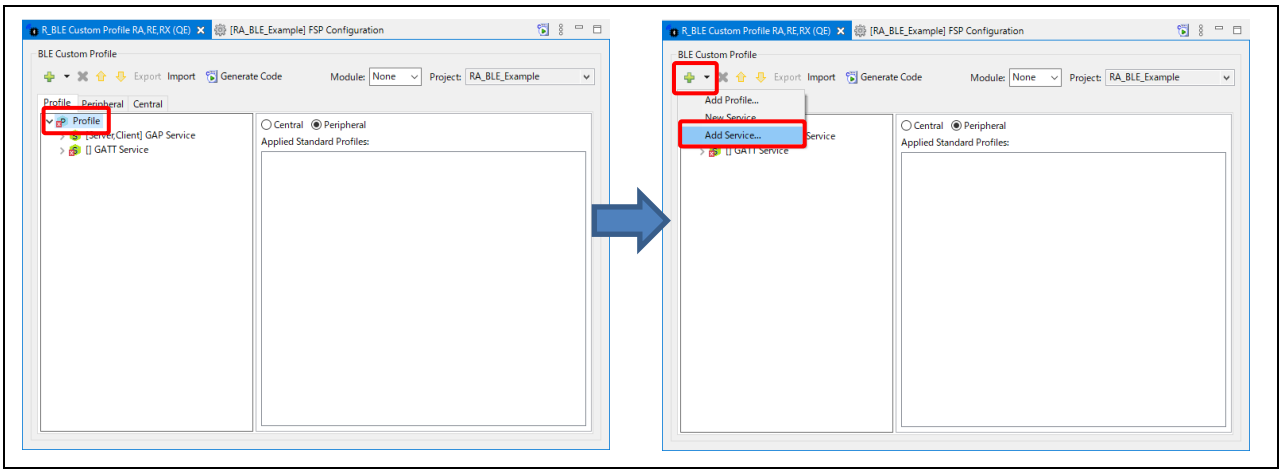


**Figure 11. Add new service**

7. Type **LED** in the filter box and select **LED Switch Service**. Click **OK.**

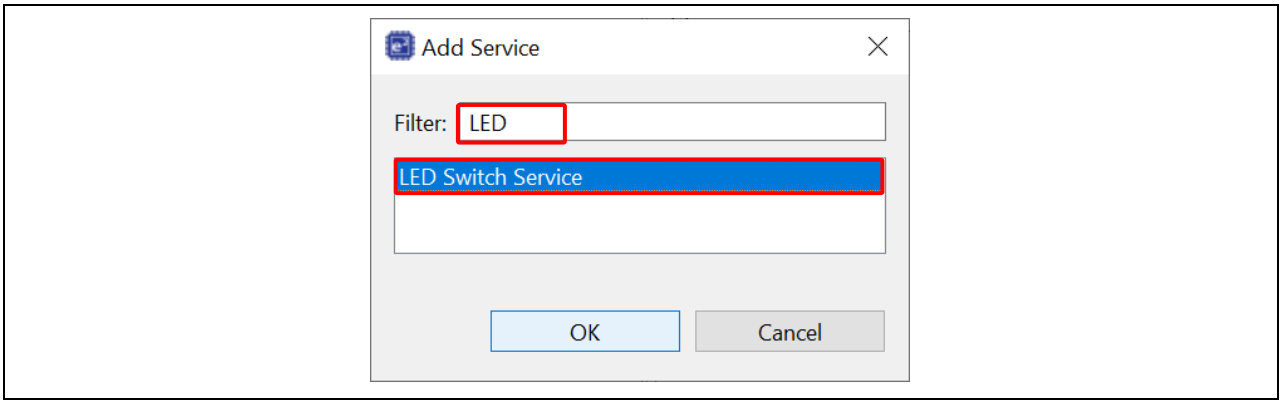


**Figure 12. Add LED Switch Service**

8. Click the **Generate Code** button to generate code.

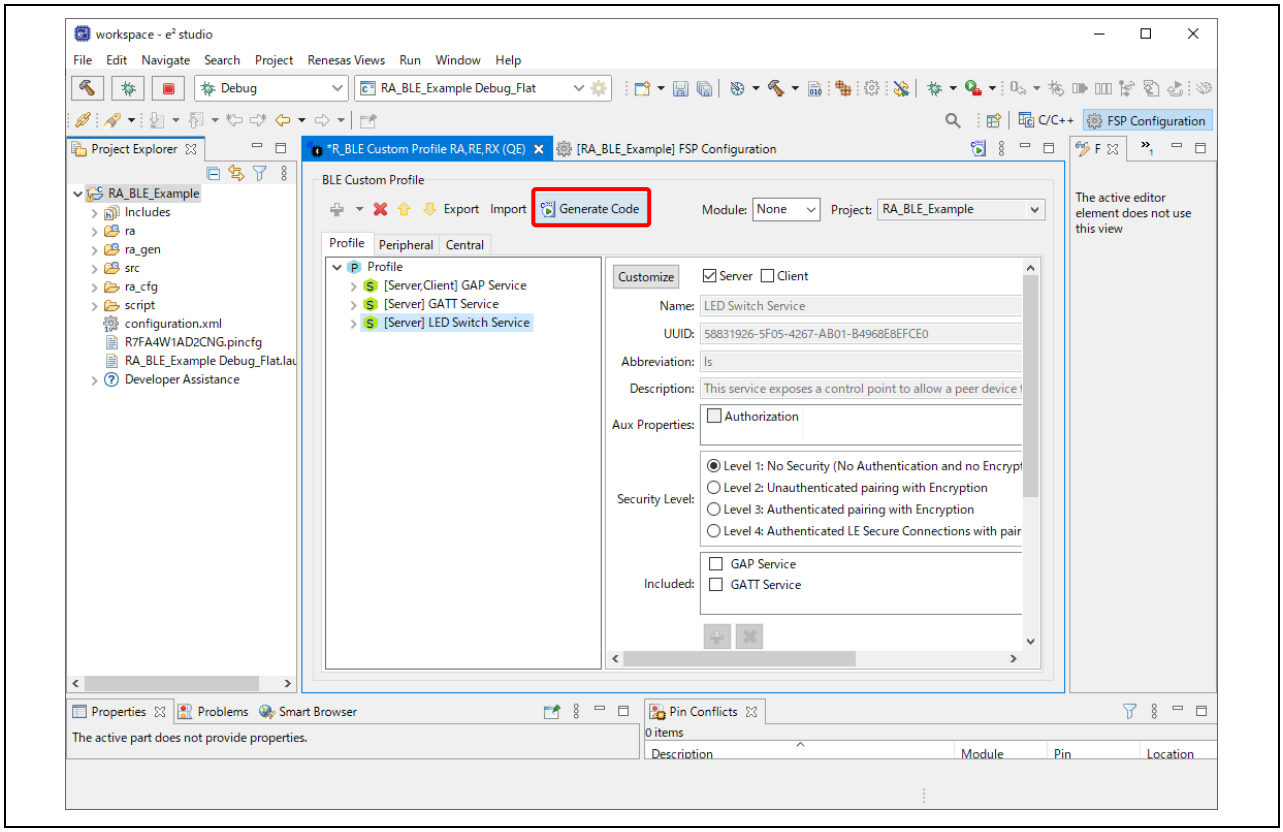


**Figure 13. Generate Code**

9. In the **Project Explorer** window, you will see that new folders and source files have been added to **Project > qe_gen > ble** folder. These files contain the necessary information to enable BLE using the drivers of FSP.

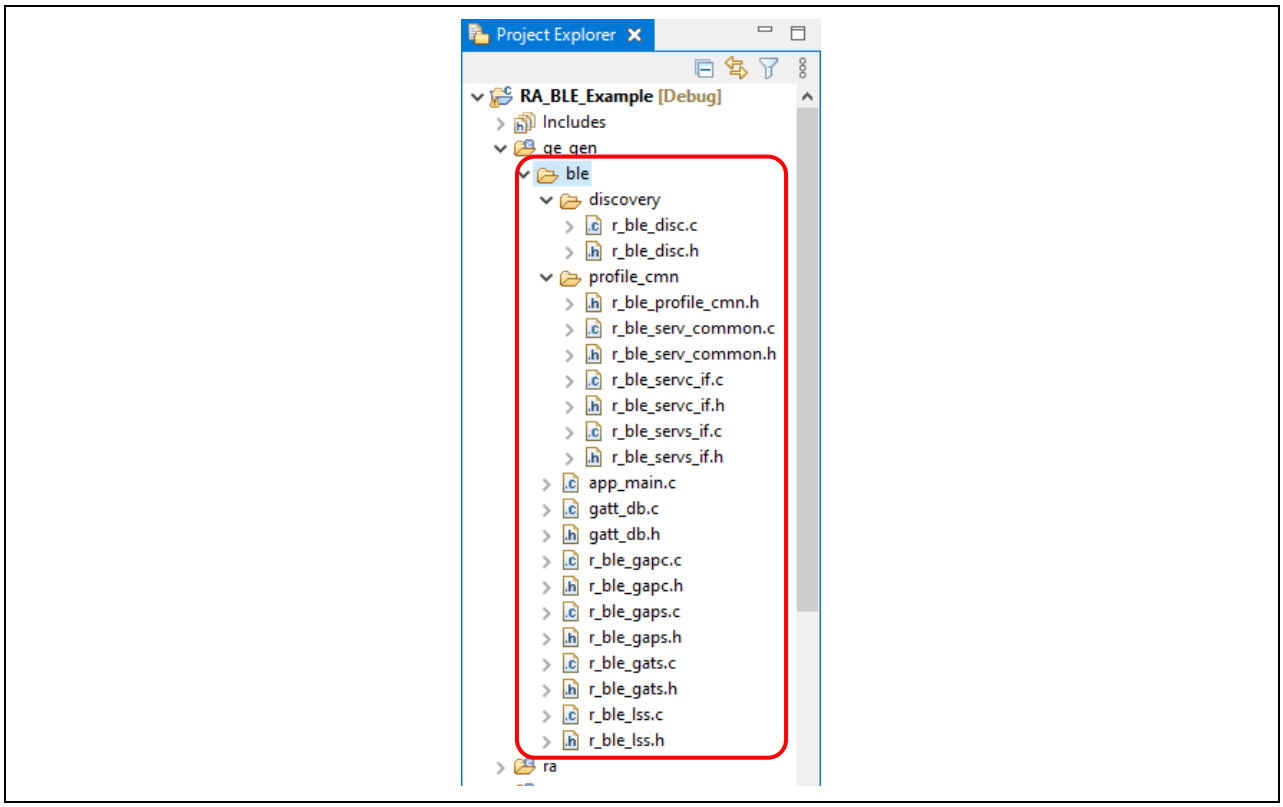


**Figure 14. QE for BLE sources**

## 3. Creating a project in Keil® MDK

1. Install the Keil® Microcontroller Development Kit version 5.36 or later (for RA device support) from https://www2.keil.com/mdk5/install.
2. Install the Smart Configurator (RA SC) from https://www.renesas.com/smart-configurator.
   Note: Please check the version of the Smart Configurator installer. If the FSP is not v3.5.0, download and install the latest version from https://github.com/renesas/fsp/releases.
3. Import the RA device pack. See “2.6.2 Using RA Smart Configurator with Keil MDK” in the Renesas Flexible Software Package (FSP) User's Manual for details.
   https://www.renesas.com/us/en/software-tool/flexible-software-package-fsp#document
4. To create a third-party IDE project with the Smart Configurator, run the “rasc.exe” application. In the **New Renesas RA FSP Project** wizard, enter the **Project name** and **Location**.

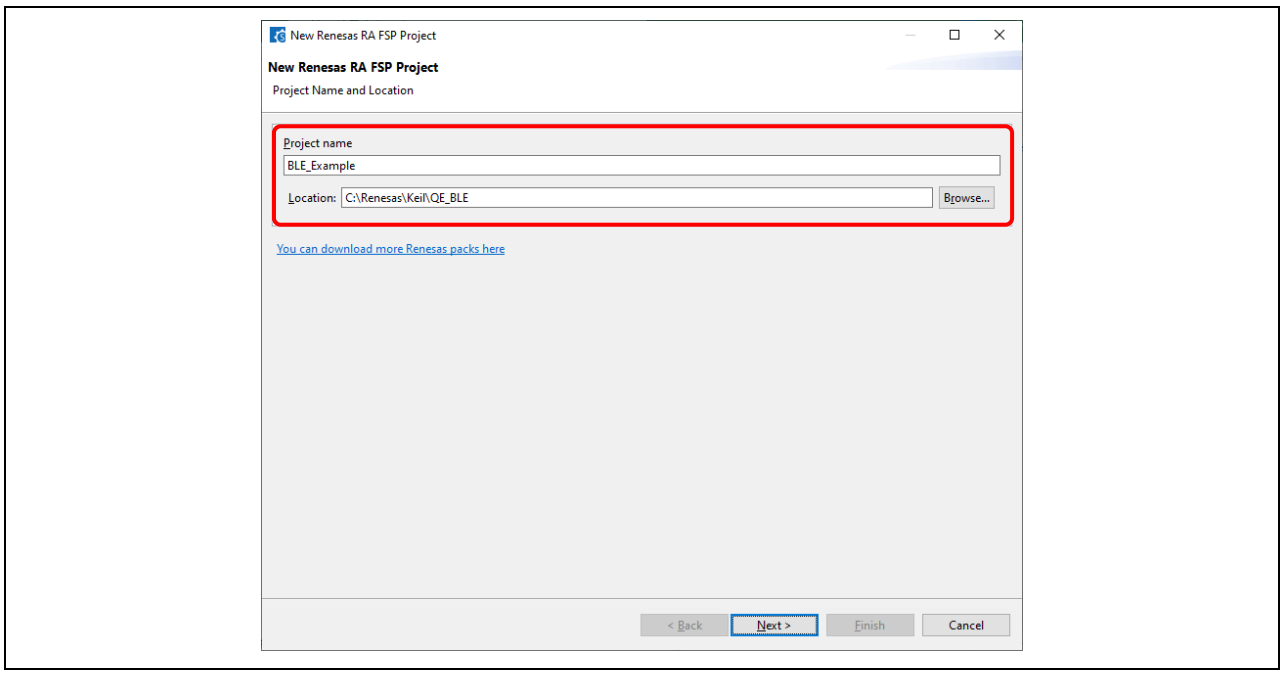


**Figure 15. Project Name and Location**

5. In the device selection dialog, enter device and IDE information:
   - Board: **EK-RA4W1**
   - Device: Auto selected
   - Language: **C**
   - IDE Project Type: **Keil MDK Version 5**
   - Toolchains: **ARM Compiler 6**

   Click **Next** to continue.

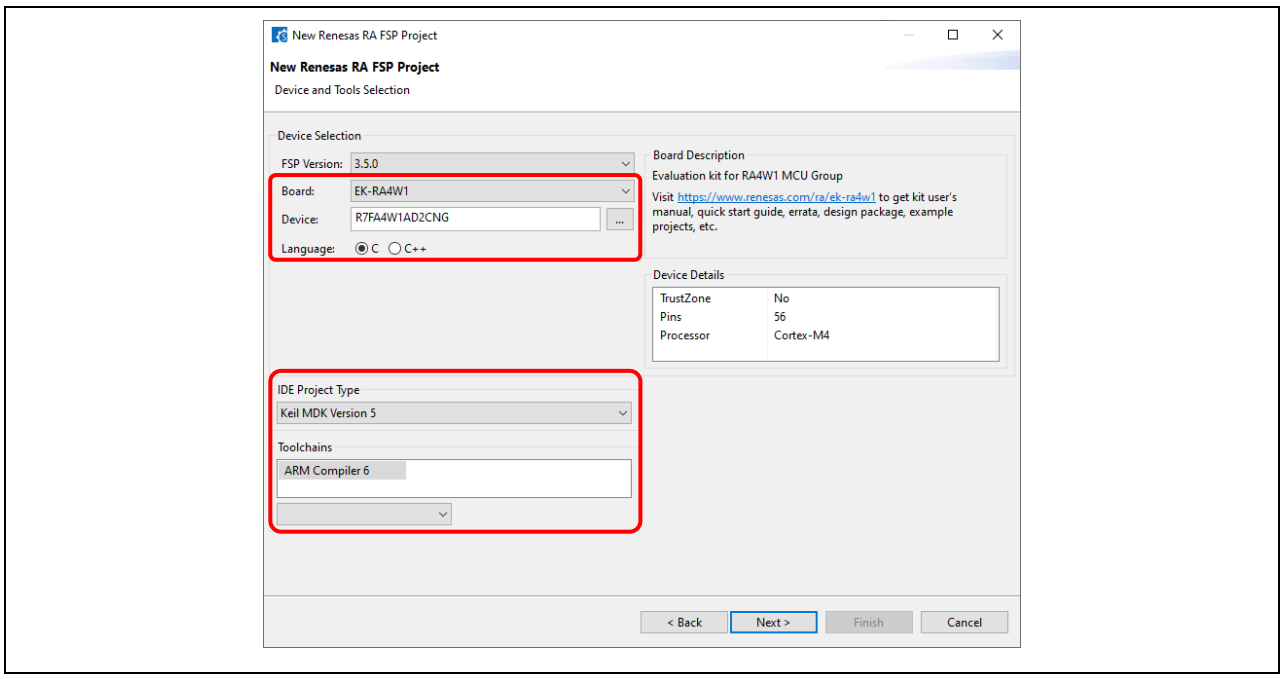


**Figure 16. Board Selection for EK-RA4W1**

6. RTOS Selection: **No RTOS**. Click **Next** to continue.

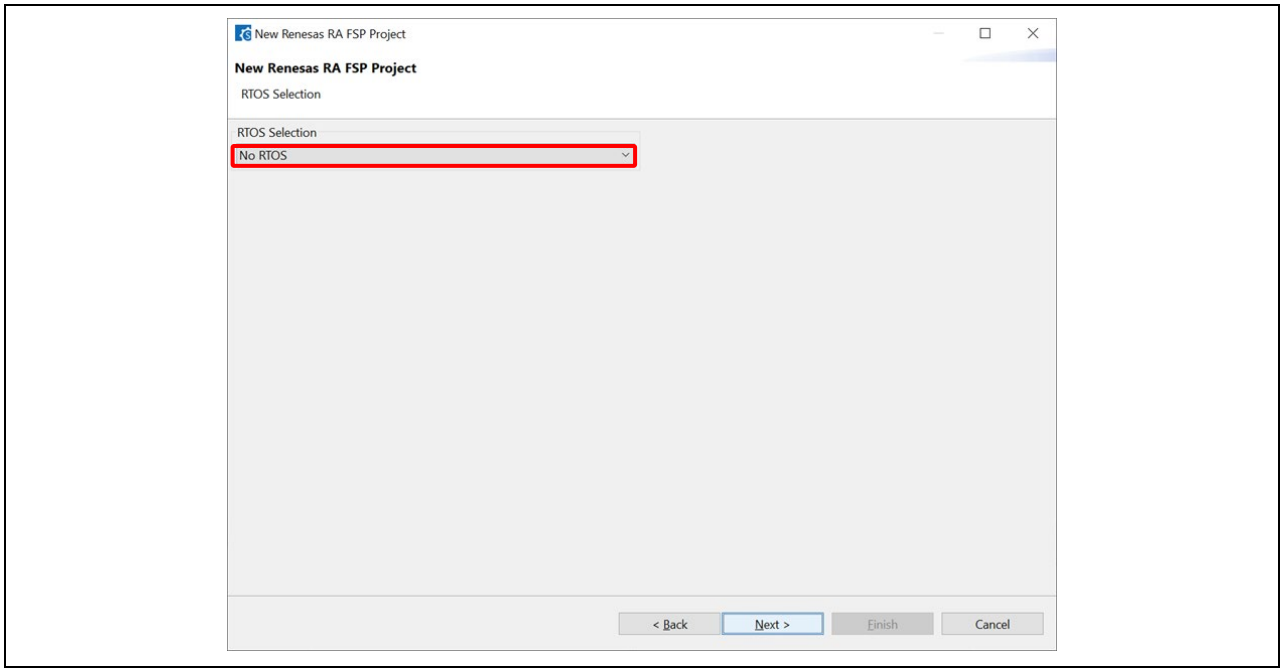


**Figure 17. RTOS Selection**

7. Project Template Selection: **Bare Metal – Minimum**. Click **Finish** to create project.

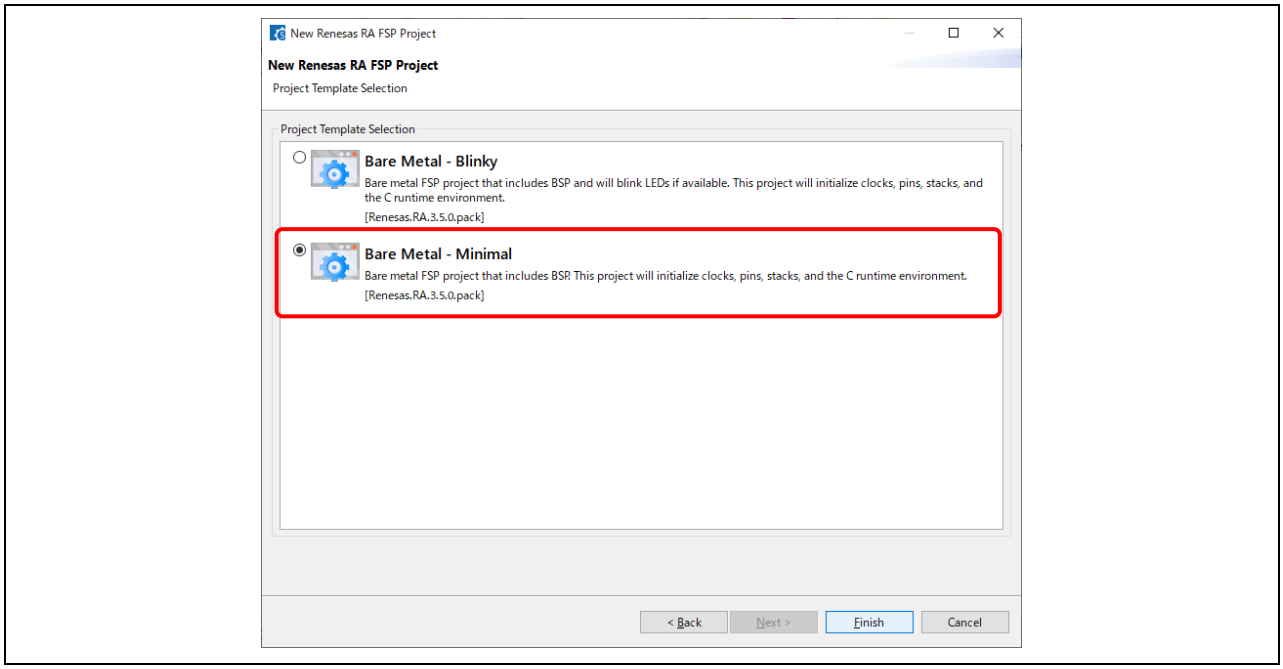


**Figure 18. Template Selection**

8. After creating the project, the **Smart Configurator** window will pop-up.

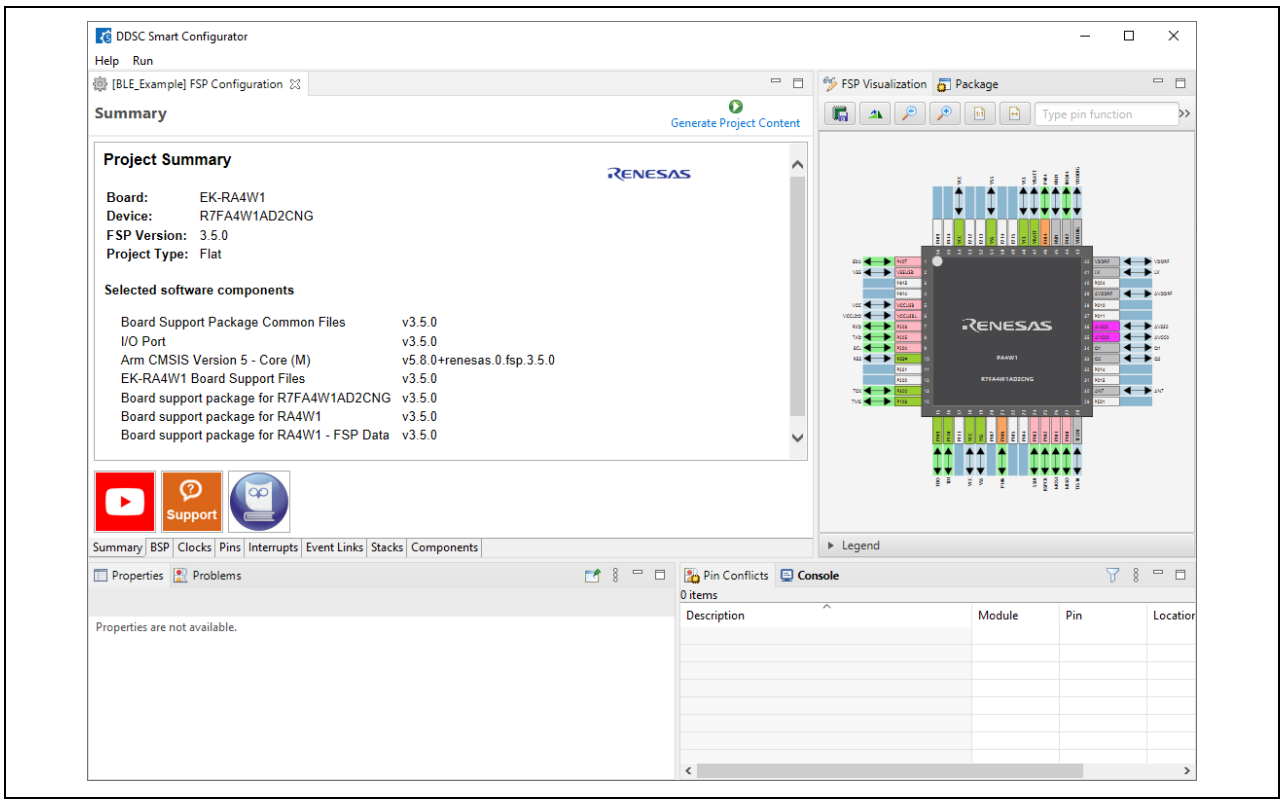


**Figure 19. Smart Configurator Window**

9. In Windows Explorer, navigate to the folder you entered in **3.4.** and see that the main workspace (Keil® MDK ***.uvprojx** file) exists. Close the Smart Configurator window, then double-click on the main workspace to open the project.

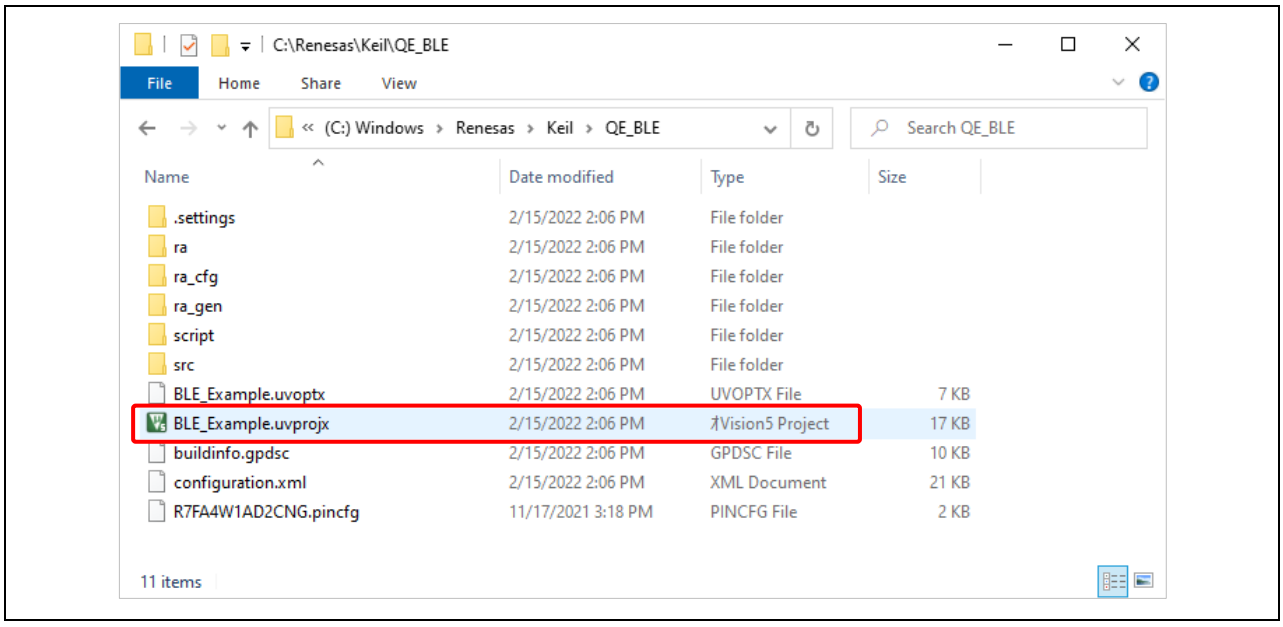


**Figure 20. New project in Keil® MDK**

10. Project is opened by Keil® MDK. Right-click on the project and select **Rebuild all target files**. The project should be built without error.

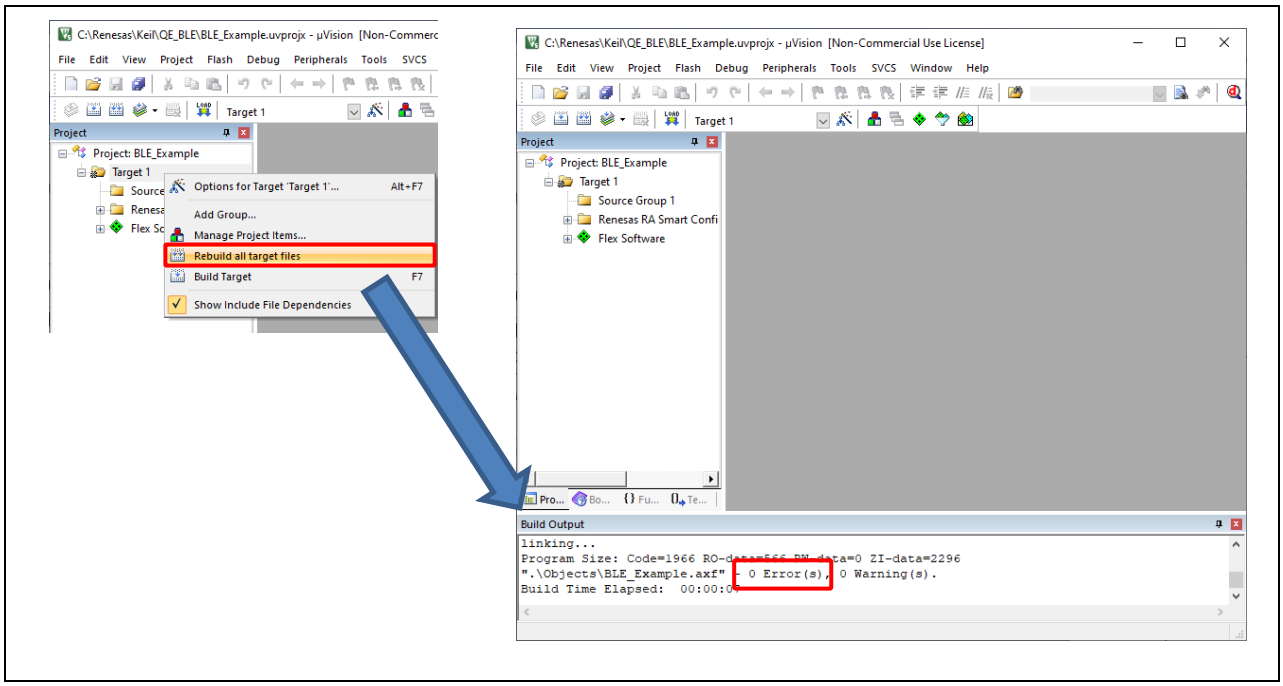


**Figure 21. Project is Built Successfully**

11. After a project created with the Smart Configurator has been opened in Keil® MDK, its FSP configuration can be changed by relaunching the Smart Configurator from the IDE. Follow the instructions below to reopen the Smart Configurator.
12. In the menu of Keil® MDK, select **Tools > Customize Tools Menu…** Then, select **New** and fill in the fields as follows.
    - Menu Text: **RA Smart Configurator**
    - Command: Select **Browse…** and navigate to **rasc.exe**
    - Initial Folder: Select **Browse…** and navigate to **Workspace**
    - Arguments: **--device $D --compiler ARMv6 configuration.xml**

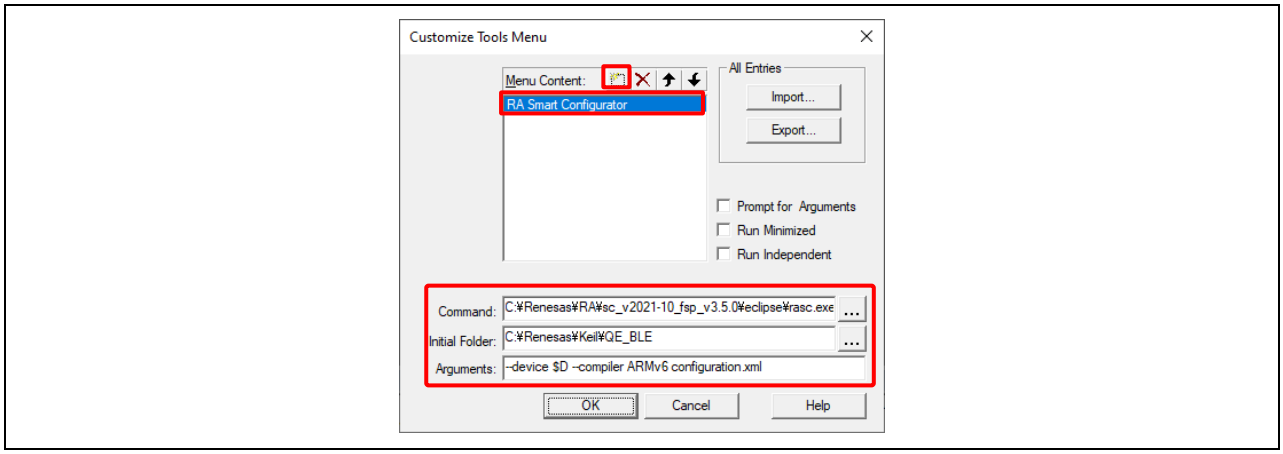


**Figure 22. How to Use Smart Configurator in Keil® MDK**

13. Now, a FSP configuration of a created project can be reopened by select **Tool > RA Smart Configurator** in Keil® MDK.

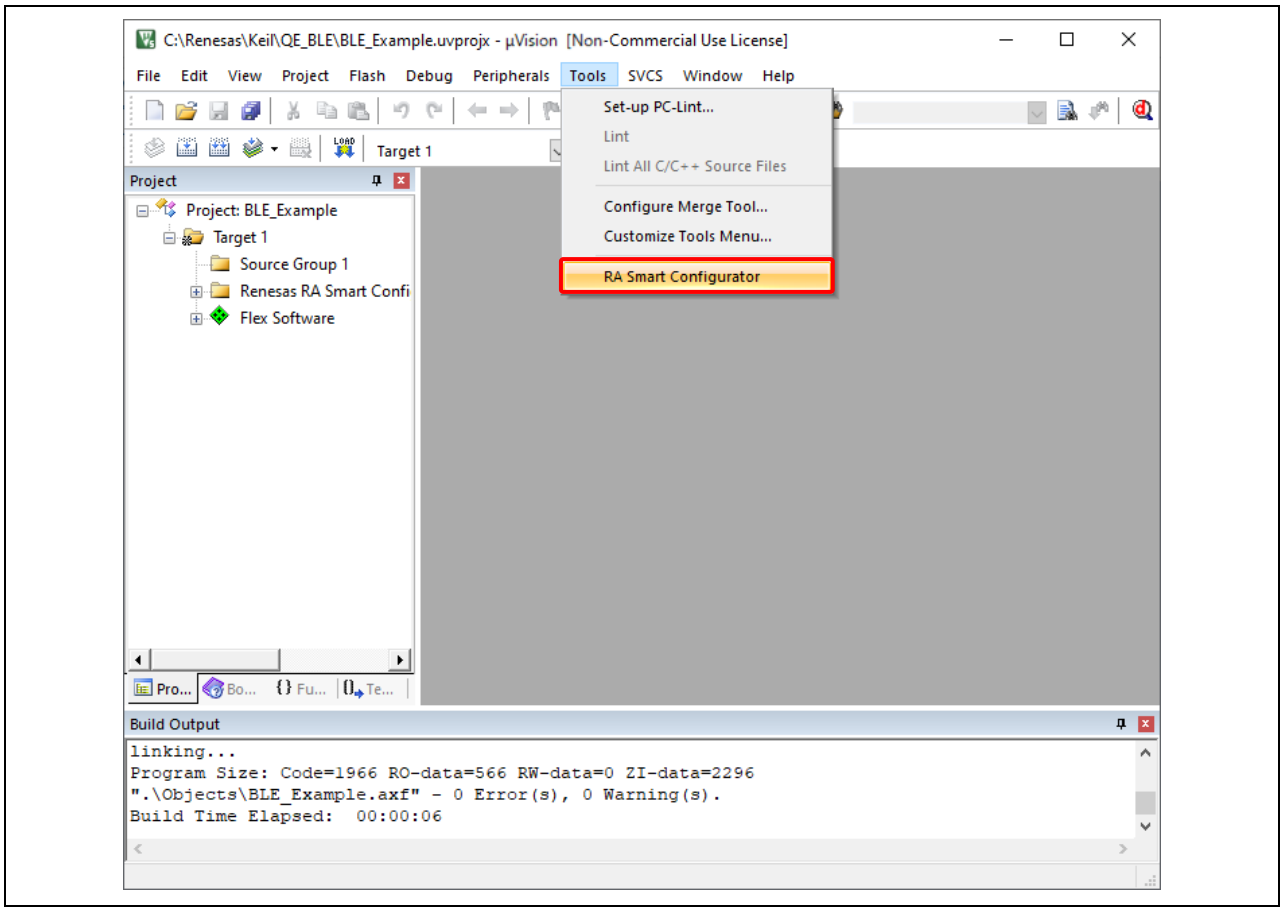


**Figure 23. RA Smart Configurator Has Been Added**

## 4. Adding BLE Driver in Keil® MDK

1. Open Smart Configurator, go to the **Stacks** tab. Select **New Stack > Networking > BLE Abstraction (rm_ble_abs)**.

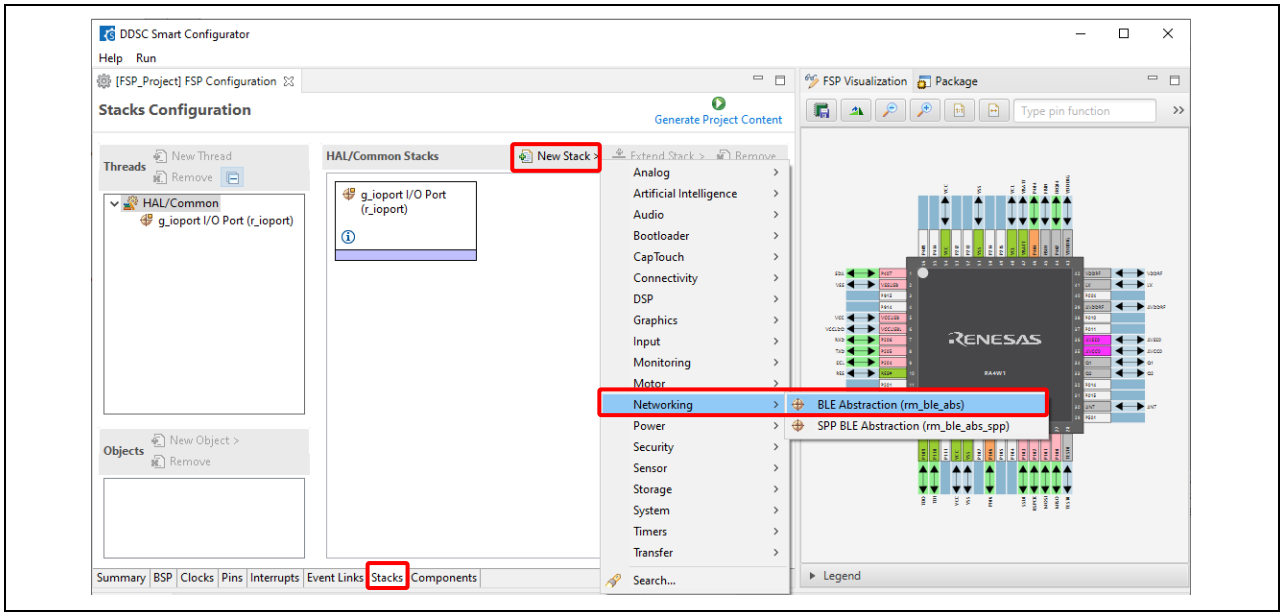


**Figure 24. Add BLE Abstraction Driver**

2. Click on **Add BLE Library for Network** and select **New > BLE Driver (r_ble_extended)**.

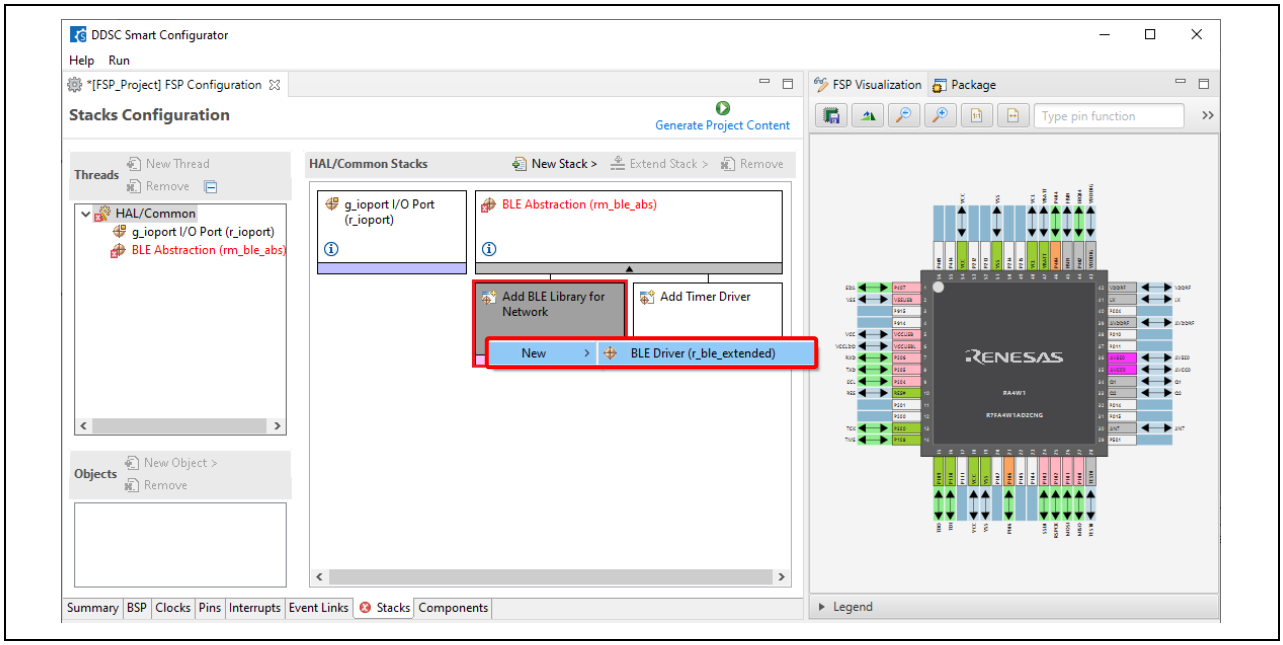


**Figure 25. Add Network Driver**

3. Click on **Add Timer Driver** and select **New > Timer, Low-Power (r_agt)**.

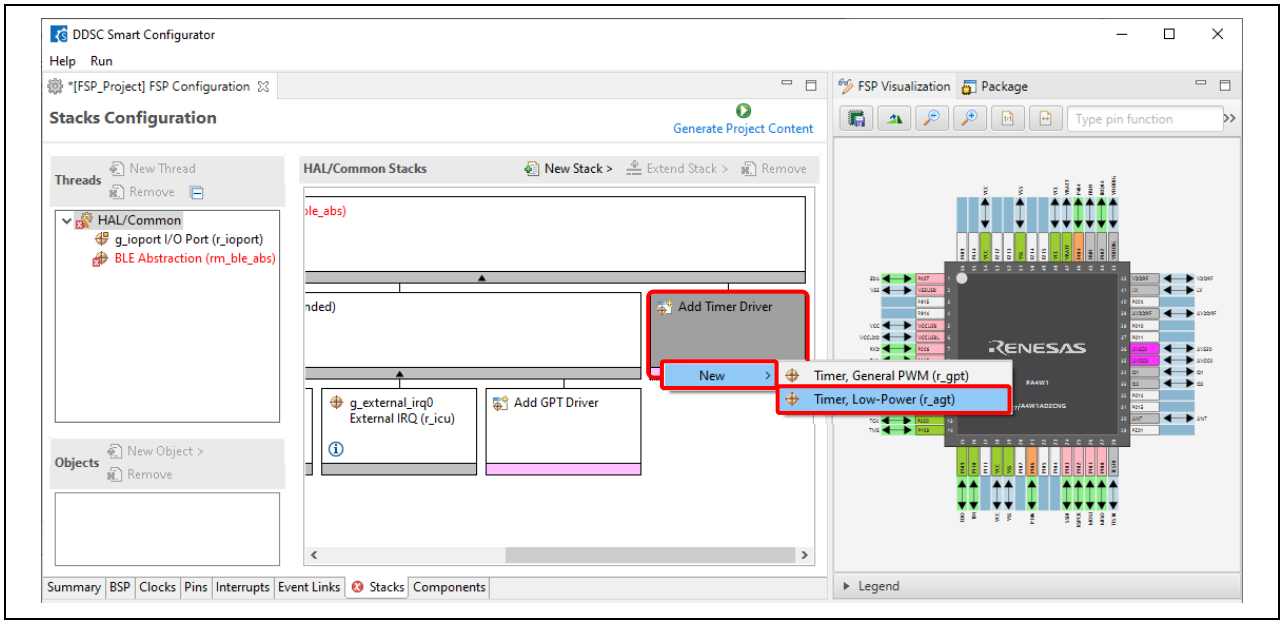


**Figure 26. Add Timer Driver**

4. Select the **r_agt** driver, in the **Property** window, and enable the **Underflow Interrupt Priority** by changing it to **Priority 4**.

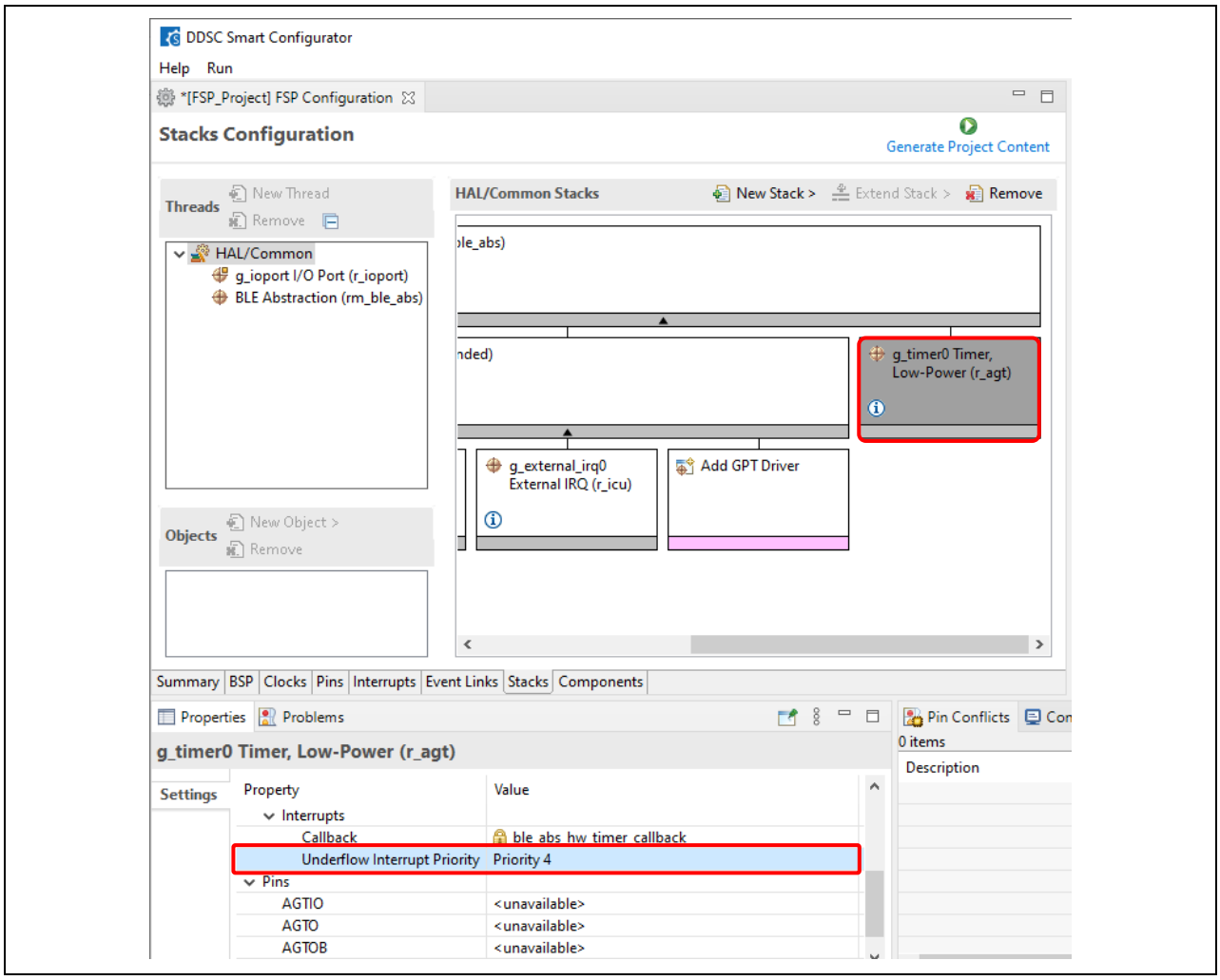


**Figure 27. Enable AGT interrupt**

5. Click on **Add GPT Driver** and select **New > Timer, General PWM (r_gpt)**.

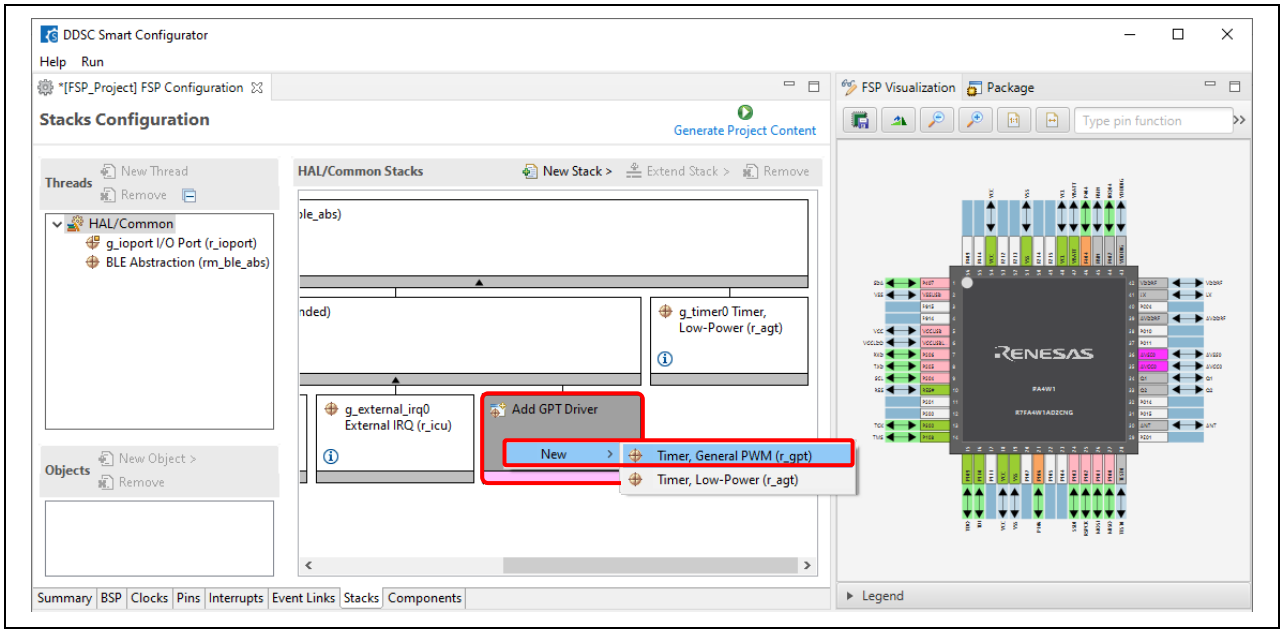


**Figure 28. Add GPT Driver**

6. Select the **r_gpt** driver, in the **Property** window, and enable the **Overflow/Crest Interrupt Priority** by changing it to **Priority 2**.

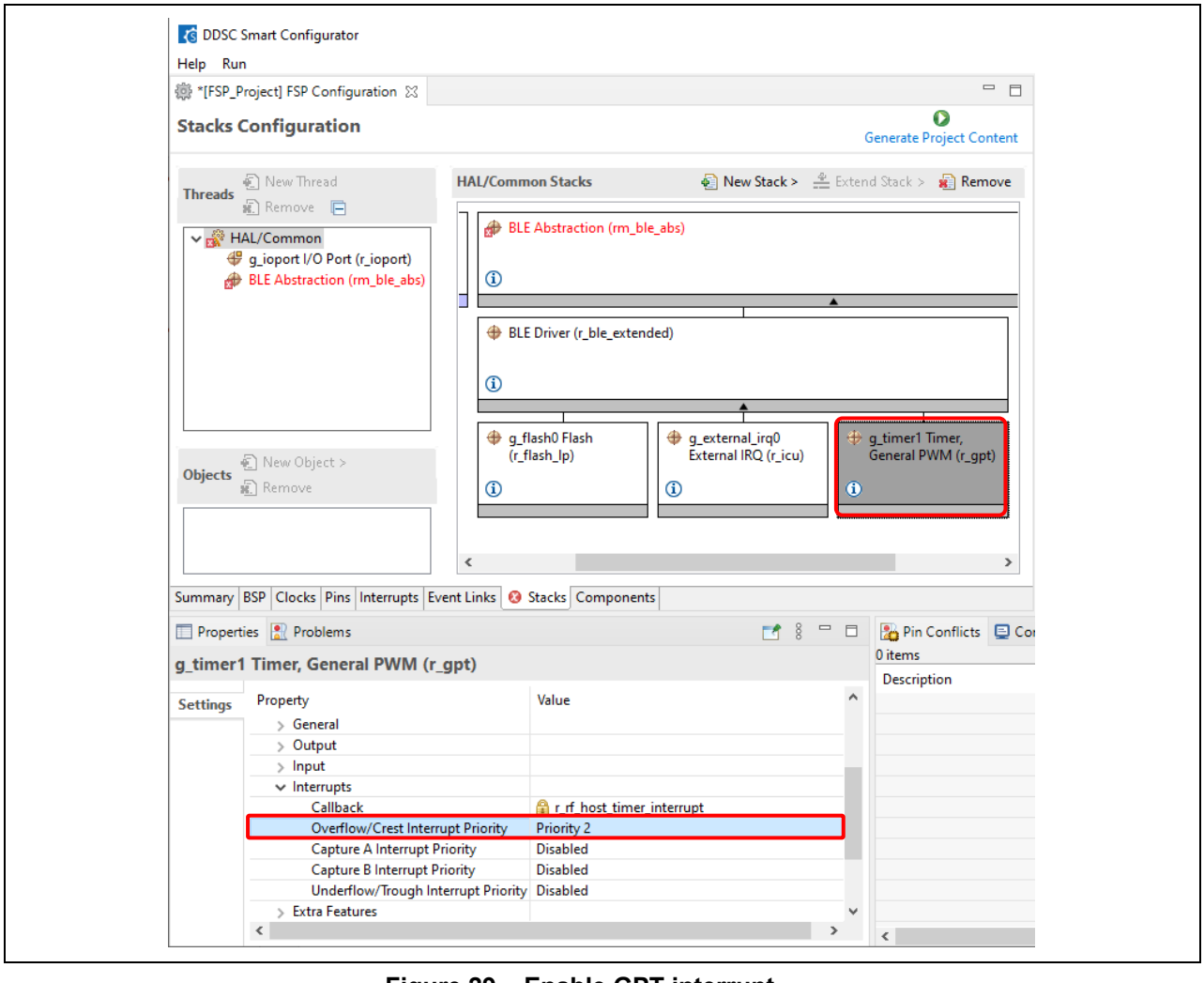


**Figure 29. Enable GPT interrupt**

7. Click on the **BSP** tab, in the **Property** window, and change **Heap size** to **0x2000**.

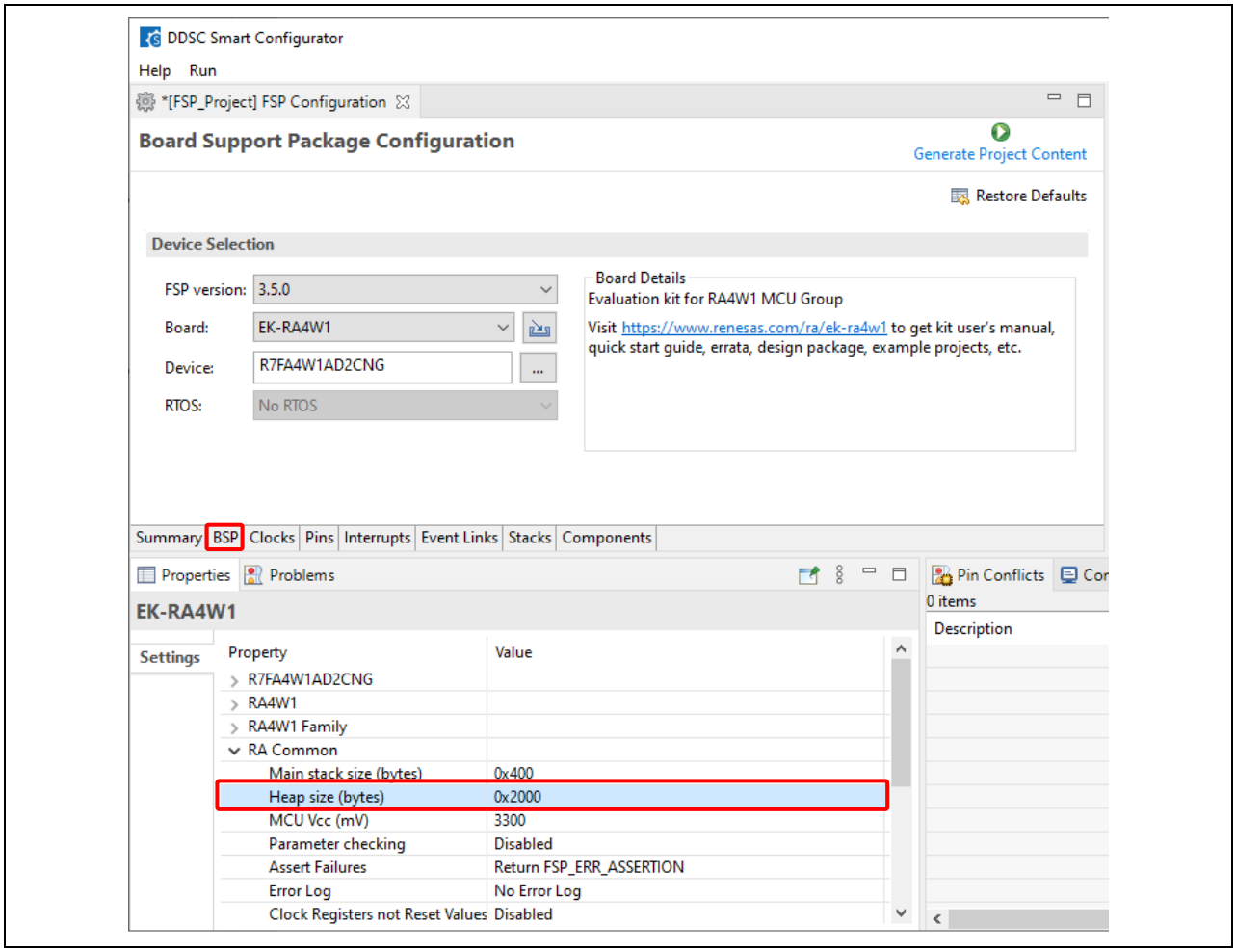


**Figure 30. Change heap size**

8. Click on the **Generate Project Content** button to generate source file.

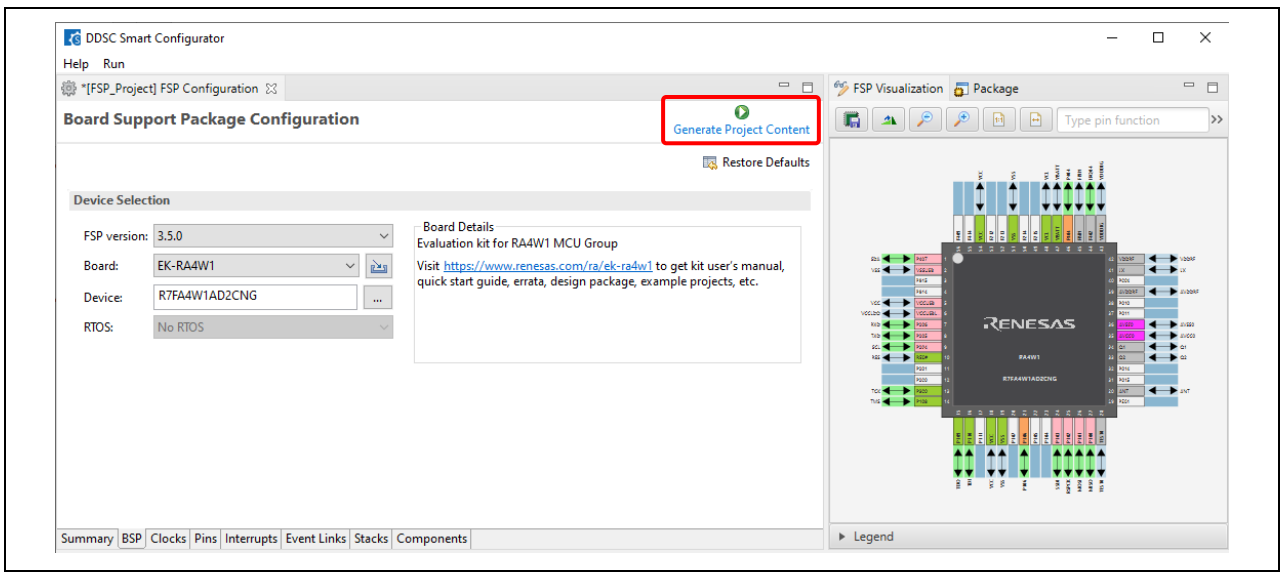


**Figure 31. Generate project content**

## 5. Copying QE files to Keil® MDK

1. In e² studio, right-click the **ble** folder, select **Copy** from the menu, and paste it into the it to the Keil® MDK project folder.

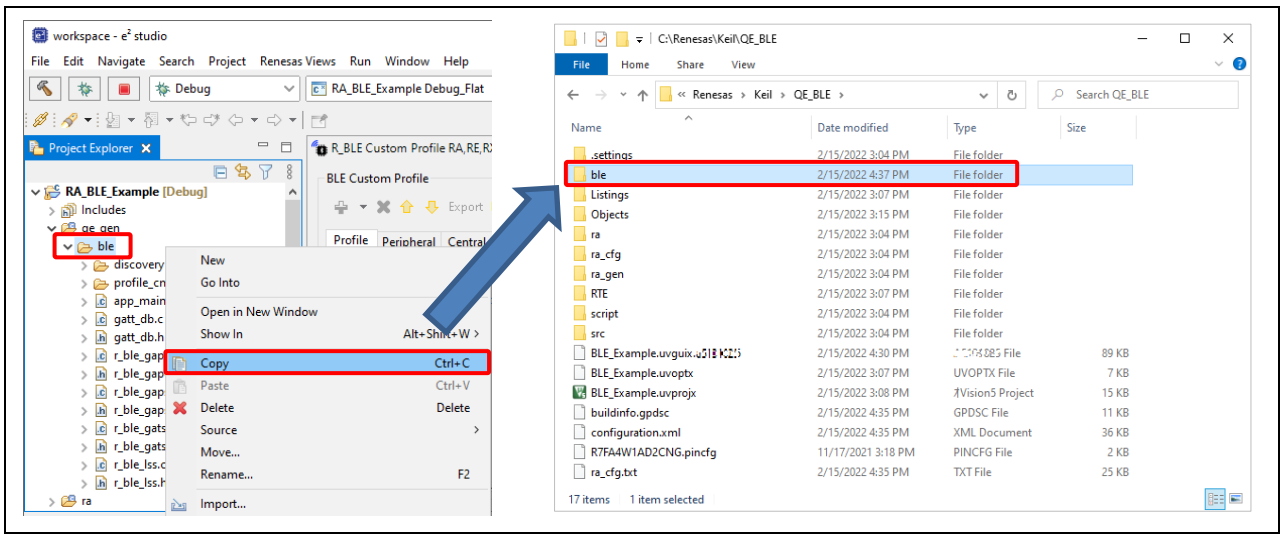


**Figure 32. Copy ble folder to Keil® MDK**

2. In Keil® MDK, change the group name to **ble**.

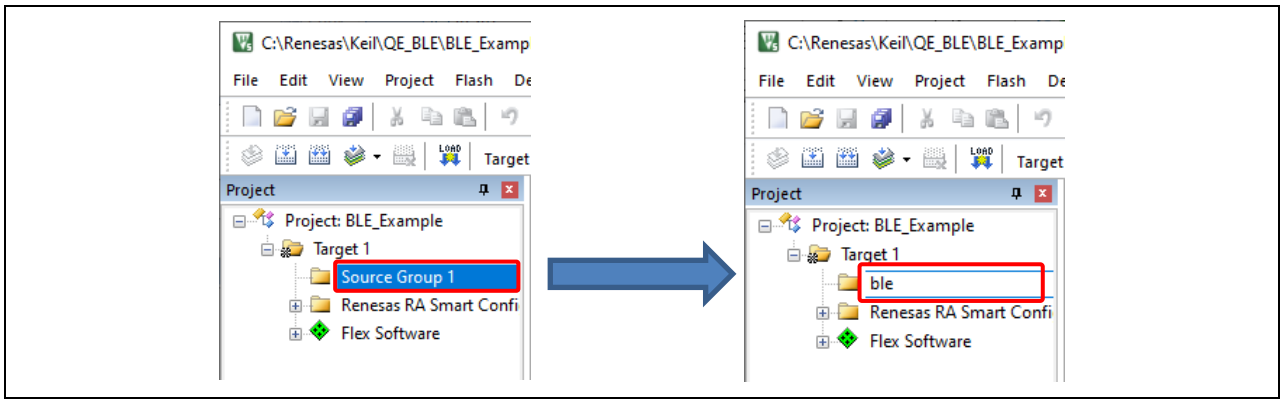


**Figure 33. Create new group**

3. Right-click on **ble** group and select **Add Existing file to Group "ble" …**. Select all the source files inside the **ble** folder and **ble/discovery** folder and **ble/profile_cmn** folder and click **Add** to add them to the project.

   Note: By adding a file to the project, during future operations "Import Changes?" will appear in a dialog box. When you see that dialog box, select "Yes".

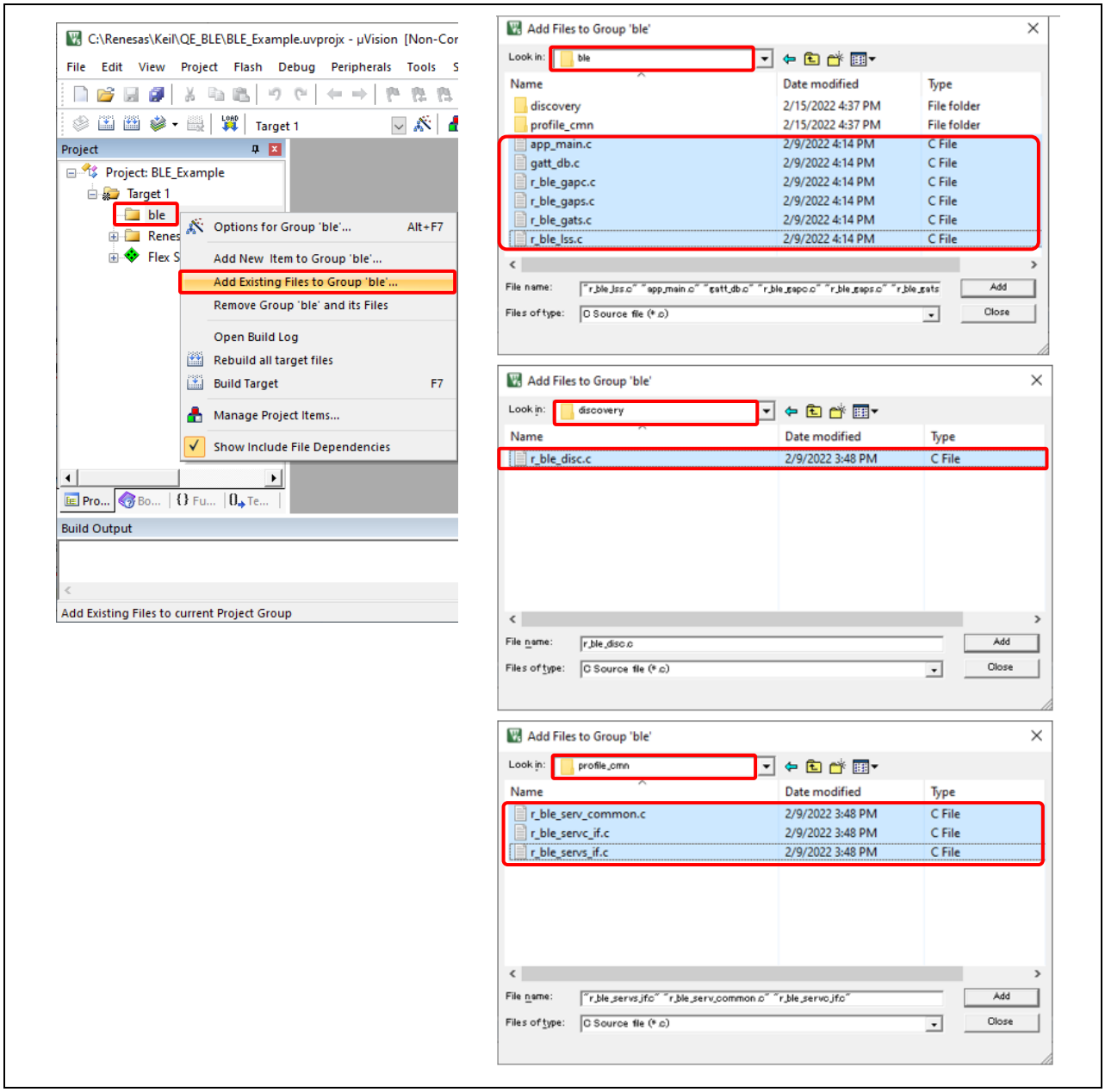


**Figure 34. Add source files for ble group**

4. Right click on Target1 and select **Options for Target "Target1" ….** In the **Options** dialog, select **C/C++ (AC6)**.
   - Preprocessor Symbols Define: **_RENESAS_RA_**
   - Include Paths: Click on "**…**" to add **ble** directory.

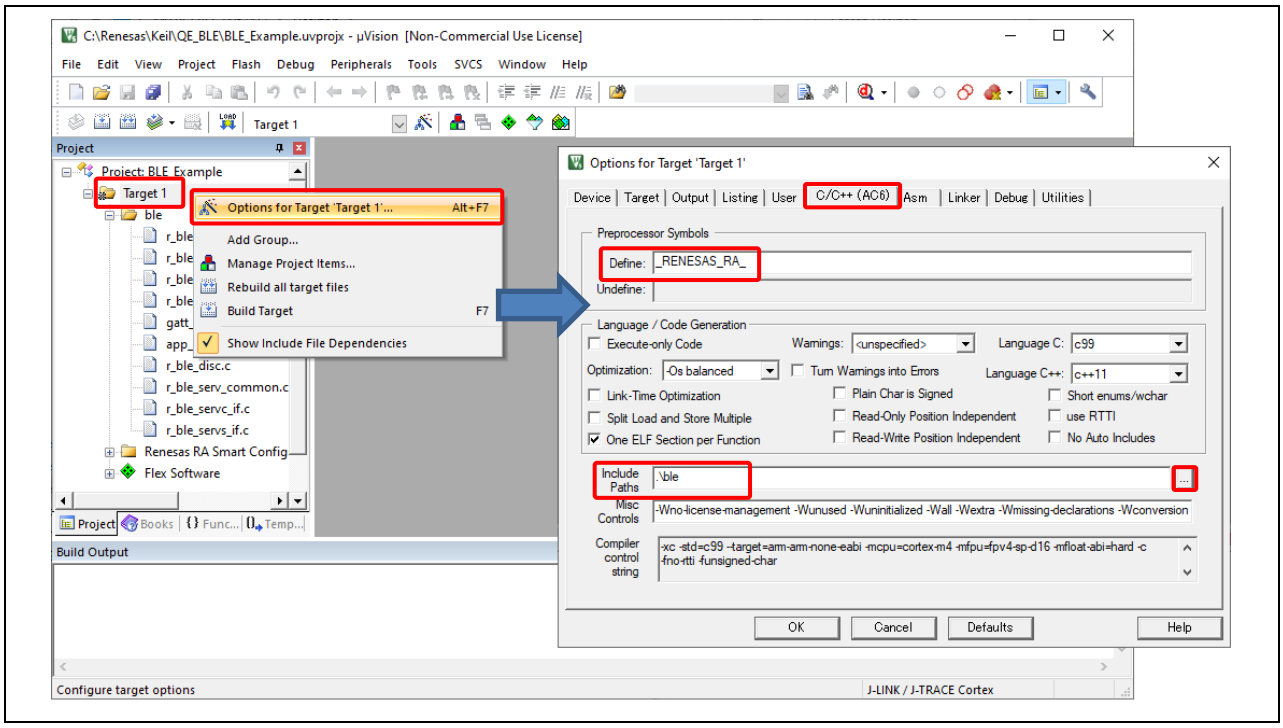


**Figure 35. Open project option**

5. Right-click on **Target 1** and select **Rebuild all target files**. The project should be built without error.

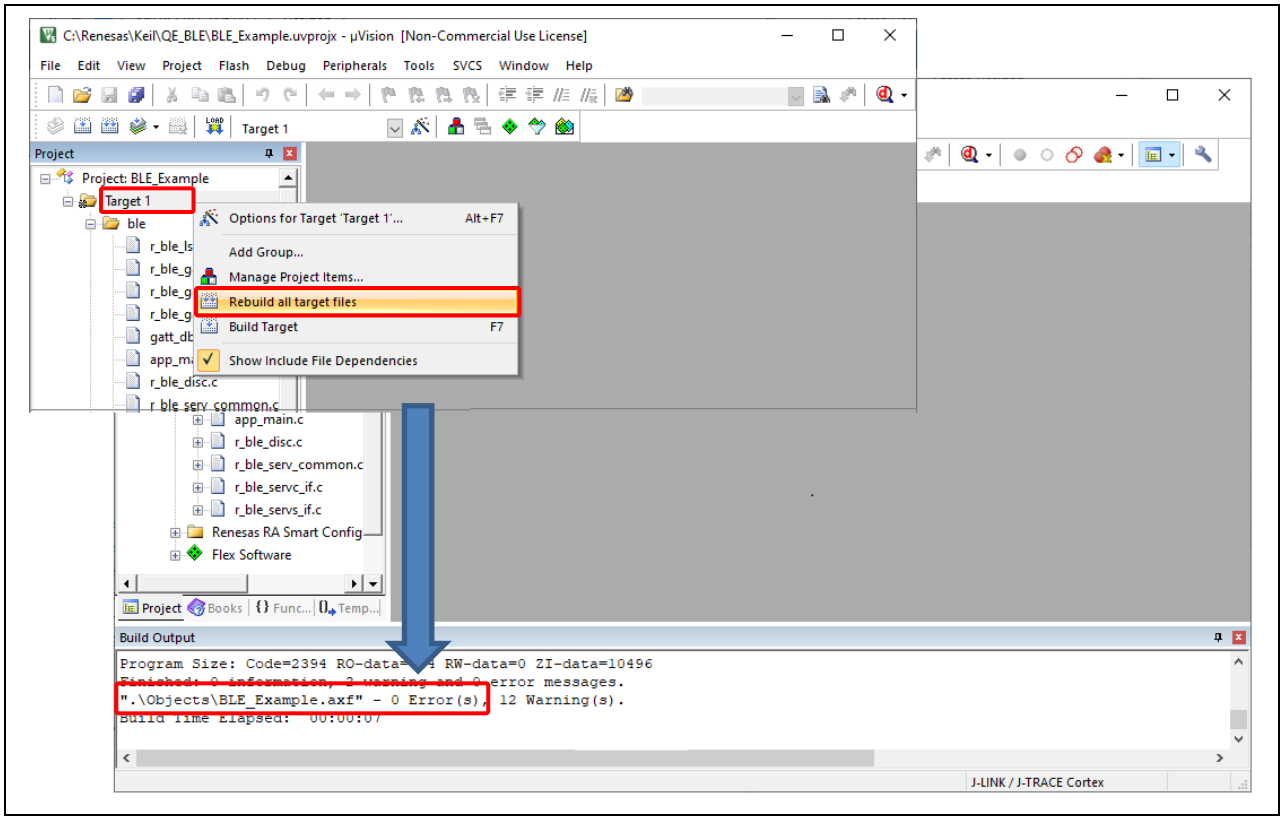


**Figure 36. Build successful**

## Website and Support

Visit the following vanity URLs to learn about key elements of the RA family, download components and related documentation, and get support.

| | |
|---|---|
| RA Product Information | www.renesas.com/ra |
| RA Product Support Forum | www.renesas.com/ra/forum |
| RA Flexible Software Package | www.renesas.com/FSP |
| Renesas Support | www.renesas.com/support |

## Revision History

| Rev. | Date | Description | |
|---|---|---|---|
| | | Page | Summary |
| 1.00 | Feb 04,2021 | 24 | First creation |
| 1.10 | Feb.22.22 | 1 | Update to Operating Environment |
| | | — | Changed version FSP to v3.5.0 |
| | | — | Changed version QE for BLE V1.4.0 |
| | | 9 | 3.3. Added about MDK Device Packs |
| | | 12 | 3.9. Added Smart Configurator Close |
| | | 18 | 5.1. Added ble folder copy operation |
| | | 19 | 5.3. Added note |
| | | 20 | 5.4. Added Preprocessor Symbol definition input |

# General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between $V_{IL}$ (Max.) and $V_{IH}$ (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between $V_{IL}$ (Max.) and $V_{IH}$ (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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