Getting started with nRF5 SDK and SES (nRF51 & nRF52 Series)

Getting Started Guide

v1.4

NORDIC® SEMICONDUCTOR

Contents

Revision history

Date	Version	Description
April 2020	1.4	• Changed the document title to clarify that this Getting Started Guide targets the nRF5 SDK • Editorial changes
September 2019	1.3	Fixed broken links
January 2019	1.2	Updated Importing Keil projects on page 17
October 2018	1.1	Added Adding files on page 26
July 2018	1.0	First release

1 Introduction

This guide will help you get started with your nRF51 or nRF52 Series *Development Kit (DK)* and developing your application with the nRF5 SDK with *SEGGER Embedded Studio (SES)*.

If you have worked with any of Nordic Semiconductor's products before, you are probably familiar with the *Software Development Kit (SDK)* and the required tools. In this case, this guide will mostly provide reference information.

Use this guide to set up your development toolchain so you can develop, program, test, and debug your application.

This guide describes how to work with *SES*. *SES* is a cross-platform *Integrated Development Environment (IDE)*, so you can run it on different operating systems. For use with Nordic Semiconductor devices, you can get a free license that has no limitations.

The following Getting Started Guides show how to work with different software development platforms and devices:

- Getting started with nRF Connect SDK (nRF53 Series)
- Getting started with nRF Connect SDK (nRF52 Series)
- Getting started with nRF5 SDK and SES (nRF51 & nRF52 Series) (this document)
- Getting started with nRF5 SDK and Keil (nRF51 & nRF52 Series)

Check out the Nordic DevZone for additional setup information and help.

2 Minimum requirements

Ensure that you have all the required hardware and that your computer fulfills the software requirements.

Hardware requirements

- One of the following development kits:
  - nRF52840 DK
  - nRF52833 DK
  - nRF52 DK
  - nRF51 DK
- Micro-USB 2.0 cable
- Personal computer (PC)
- Optional for testing:
  - Smartphone or tablet that supports *Bluetooth*® Low Energy
  - nRF52840 Dongle, nRF51 Dongle, or a second Nordic *DK*

Software requirements

One of the following operating systems:

- Windows 8 or Windows 10
- macOS
- Linux

3 Related documentation

In addition to the information in this document, you may need to refer to other documents.

Development Kit User Guides

- nRF52840 DK
- nRF52833 DK
- nRF52 DK
- nRF51 DK

Dongle User Guides

- nRF52840 Dongle
- nRF51 Dongle

Compatibility Matrices

- nRF52840 Compatibility Matrix
- nRF52833 Compatibility Matrix
- nRF52832 Compatibility Matrix
- nRF52811 Compatibility Matrix
- nRF52810 Compatibility Matrix
- nRF51 Series Compatibility Matrix

SDK documentation

- nRF5 SDK v16.0.0

Tools User Guides

- nRF Connect Bluetooth Low Energy
- nRF Command Line Tools

4 Development kits, PCA numbers, and chips

Nordic Semiconductor's software tools either target the chip that is soldered onto the kit's development kit, or target the development kit itself.

The following table lists the PCA number and the chip bundled in each kit.

Development kit	PCA number	Chip
nRF52840 DK	PCA10056	nRF52840
nRF52840 Dongle	PCA10059	nRF52840
nRF52833 DK	PCA10100	nRF52833
nRF52 DK	PCA10040	nRF52832/nRF52810
nRF51 DK	PCA10028	nRF51422
nRF51 Dongle	PCA10032	nRF51422

Table 1: Relation between development kits, PCA numbers, and chips

5 SoftDevices

A *SoftDevice* is a wireless protocol stack that complements an nRF5 Series *System on Chip (SoC)*. Nordic Semiconductor provides them as qualified, precompiled binary files. While it is possible to build applications without using a *SoftDevice*, all nRF5 SDK example applications that use Bluetooth Low Energy or ANT™ require a *SoftDevice*.

See the compatibility matrices for detailed information about which *SoftDevice* versions are supported for each chip. The following table summarizes the usage scenarios for each *SoftDevice*.

Protocol	Role	Chip	SoftDevice
Bluetooth Low Energy	Peripheral	• nRF51422 • nRF51822	S110
		• nRF52810 • nRF52832	S112
		• nRF52833	S113
	Central or Peripheral	• nRF51422 • nRF51822	S120
	Central and Peripheral	• nRF51422 • nRF51822	S130
		• nRF52832	S132
		• nRF52833 • nRF52840	S140
ANT		• nRF51422	S210
		• nRF52832	S212
Bluetooth Low Energy and ANT	Peripheral	• nRF51422	S310
	Peripheral and Broadcaster	• nRF52810	S312
	All roles	• nRF52832	S332
		• nRF52840	S340

Table 2: SoftDevice overview

6 Running a first test

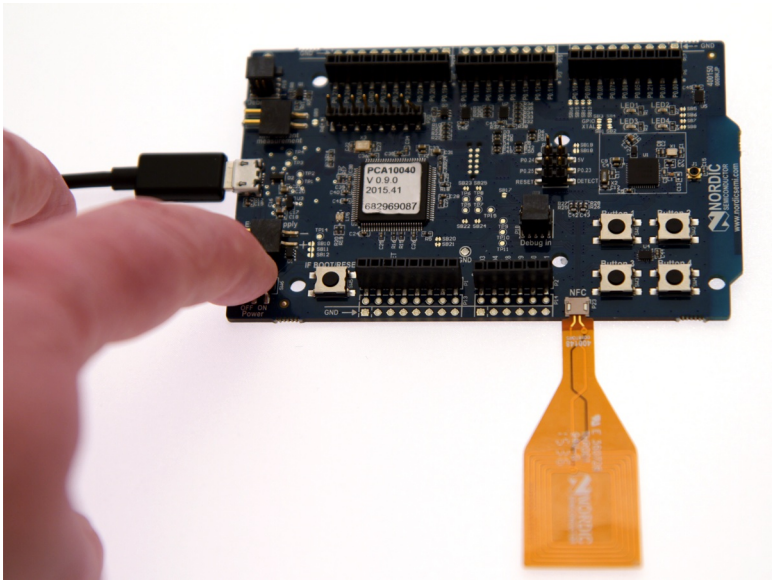
Before you start developing, program and run a precompiled application on your development kit to ensure that the kit functions as expected and the communication between your computer and development kit works.

1. Download the latest compatible version of the nRF5 SDK.

   The nRF5 SDK contains precompiled HEX files of the most common examples. Extract the zip file into a folder of your choice.

   For information about which SDK supports which IC revisions, check the compatibility matrices.

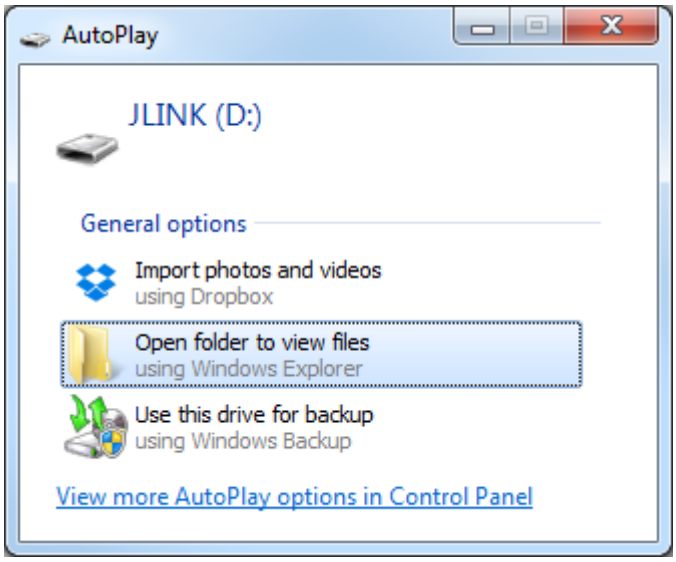
2. Power up the development kit:
   a) Connect one end of a micro-USB 2.0 cable to the *Universal Serial Bus (USB)* connector on the kit and the other end to one of your PC's *USB* host ports.
   b) Slide the **power switch** to `ON`.



   Observe that **LED1** starts blinking.

3. Open a file explorer and confirm that the development kit has appeared as a removable drive named **JLINK**.

   On Windows, you should see a pop-up window similar to this:



4. In the folder where you extracted the nRF5 SDK, navigate to `examples\ble_peripheral\ble_app_hrs\hex`.
5. Select the HEX file that corresponds to your development kit and copy it to the JLINK drive.
   The development kit will now restart and run the application. Note that while restarting, the JLINK drive will be disconnected.
6. Download and install the Nordic nRF Toolbox app from Google Play or App Store.
7. Open nRF Toolbox.

> **Note:** Enable Bluetooth if prompted.

8. Tap **HRM**.
9. Tap **Connect**.
10. Select **Nordic_HRS**.
    A simulated heart rate and battery charge percentage is displayed.

For more advanced testing scenarios, see Testing the application on page 32.

Next, continue to set up your development toolchain and build and program an application from the source code.

7 Setting up your toolchain

Before you can start developing, you must install the required software. This software includes tools to connect to your development kit, an *IDE* for developing your application, and the nRF5 SDK that provides libraries and example applications.

See Nordic tools and downloads on page 11 for an overview of available tools and the links to download the latest versions for your operating system.

The following tools are required for this Getting Started Guide:

- nRF5 SDK
- SEGGER J-Link Software and Documentation Pack
- SEGGER Embedded Studio (SES)

The following tool is optional:

- nRF Command Line Tools (including nrfjprog)

See the following sections for installation instructions.

7.1 Nordic tools and downloads

This overview lists all available Nordic Semiconductor tools and supported *IDE*s. Not all of these tools are required. To help you pick the *IDE* and tools you want to use, see the following sections for common setup scenarios.

Development IDE

Pick one of the IDEs with a compiler supported by Nordic:

IDE	Windows	Linux	OSX
SEGGER Embedded Studio (SES)	Yes	Yes	Yes
MDK-ARM Keil µVision	Yes	No	No
GNU/GCC	Yes	Yes	Yes
IAR	Yes	No	No

SES is the recommended platform. It is free for use with nRF devices.

Essential tools

You need to download these Nordic tools to develop with our devices.

Tool	Description	Download	Documentation	Protocol
SDK (Software Development Kit)	Application examples, source files, SoftDevices	Windows/Linux	nRF5 SDK v16.0.0 nRF5 SDK for Mesh v4.1.0 nRF5 SDK for Thread and Zigbee v4.0.0	BLE/ANT Bluetooth Mesh Thread and Zigbee
nRF Command Line Tools	Collection of command line tools, like nrfjprog, mergehex	nRF Command Line Tools	nRF Command Line Tools	BLE/ANT

Optional tools

These tools are not essential, but we recommend that you use them.

Tool	Description	Download	Documentation	Protocol
SoftDevice	Wireless protocol stack	Compatible downloads for nRF52840 Compatible downloads for nRF52833 Compatible downloads for nRF52832 Compatible downloads for nRF52811 Compatible downloads for nRF52810 Compatible downloads for nRF51822 Compatible downloads for nRF51422	nRF51 SoftDevice Specifications nRF52 SoftDevice Specifications	BLE/ANT
nRF Connect for Desktop	Expandable desktop tool with several apps, including: • Peer device emulator • Power Profiler • Programmer • Cloud Gateway	nRF Connect for Desktop	nRF Connect Bluetooth Low Energy	BLE
nRF Connect for Mobile	Peer device emulator app for smartphones	Android v4.3 or later IOS v8 or later		BLE
Nordic nRF Toolbox app	App that contains all the Nordic apps	Android v4.3 or later IOS v8 or later Windows Phone v8.1 or later		BLE
nRF pynrfjprog	Simple Python interface for the nrfjprog DLL	nRF pynrfjprog	nRF5x pynrfjprog	BLE/ANT
ANTware II	Peer device emulator for the ANT protocol running on computers	ANTware II		ANT
nRF Sniffer	App for monitoring on-air traffic	nRF Sniffer download	nRF Sniffer for Bluetooth LE	BLE
nRF Thread Topology Monitor	Tool for visualizing Thread mesh network topology in real time	nRF Thread Topology Monitor	nRF Thread Topology Monitor	Thread
Thread Border Router	Gateway for connecting Thread	Thread Border Router	Thread Border Router	Thread

Tool	Description	Download	Documentation	Protocol
	network to the Internet			

See also Nordic mobile apps for a list of available Bluetooth Low Energy and Mesh mobile apps for iOS, Android, and Windows Phones.

7.2 Setting up the nRF5 SDK

The nRF5 SDK does not require installation. You only need to download and extract the files.

If you followed the instructions in Running a first test on page 9, you already downloaded and extracted the nRF5 SDK files and are all set up.

Complete the following steps to set up your SDK environment:

1. Download the nRF5 SDK zip file.

   If you have an nRF52 device, select the latest version. For nRF51 devices, select the latest version with support for nRF51 (currently, v12.3.0). For information about which SDK supports which IC revisions, check the compatibility matrices.
2. Extract the zip file to the directory that you want to use to work with the SDK.

   This folder will be referred to as *SDK_dir* in the following documentation.

   Note: Compilers tend to run into problems with long path names. Therefore, place the folder as close to the root level of your file system as possible (for example, at `C:/Nordic/SDK`). Also, avoid using spaces in the file path and folder name.

7.3 Installing SEGGER tools

Download and install the most recent releases of *SES* and the J-Link Software and Documentation Pack.

1. Download the software packages for your operating system from SEGGER downloads.

   You need the following packages:

   - Embedded Studio for ARM (version 3.30 or later)
   - J-Link Software and Documentation Pack (version 6.10g or later)
2. Install both packages.
3. Obtain and activate your free license for *SES*:

   a) Open *SES*.

   SES will automatically load a test project.

   b) Click **Build** > **Build and Debug**.

   A window asking for a license will pop up. *SES* is free of charge for use with Nordic Semiconductor devices, but you still need to request and activate a license.

   c) Select **Activate Your Free License** and fill in your information to request a license.

   Note: In *SES* versions before 3.34, this option was called **Get a Free License**.

   The license is sent to you in an email.

   d) After you receive your license key, enter it to activate the license.

7.4 Installing the nRF Command Line Tools

The nRF Command Line Tools are used for developing, programming, and debugging Nordic Semiconductor's *SoC*s.

Complete the following steps to install the nRF Command Line Tools and verify the installation:

1. Follow the instructions in Installing the nRF Command Line Tools to download and install the nRF Command Line Tools.
2. Enter the following command in a command line to make sure that nrfjprog is installed correctly:
   `nrfjprog --version`

   If you get an error message that the command cannot be found, nrfjprog must be manually added to the PATH.

   On Windows:

   a) Go to the Windows **Advanced system settings** and click **Environment Variables**.
   b) Select the Path variable and click **Edit**.
   c) Add the following text at the end of the variable value: `;C:\Program Files (x86)\Nordic Semiconductor\nrf5x\bin`

      Make sure that you add a semicolon (;) between entries in the PATH values: `path1;path2`
   d) Click **OK** twice.

   On Linux, assuming that you have extracted the `.tar` archive into `/opt/nrfjprog`:

   a) Add the following command to the configuration file for your command line, for example, to `~/.bashrc`:

   ```
   export PATH=$PATH:/opt/nrfjprog
   ```

   Open a new command prompt and repeat the command. It should now succeed.

8 Programming an application

After setting up the required toolchain, you are ready to compile your application and program (or "flash") it to your development kit.

Starting with v14.1.0, the nRF5 SDK supplies SEGGER Embedded Studio projects. If you are using an older version of the nRF5 SDK (for example, nRF5 SDK v12.3.0, which supports nRF51 Series devices), you must import and convert the Keil µVision projects.

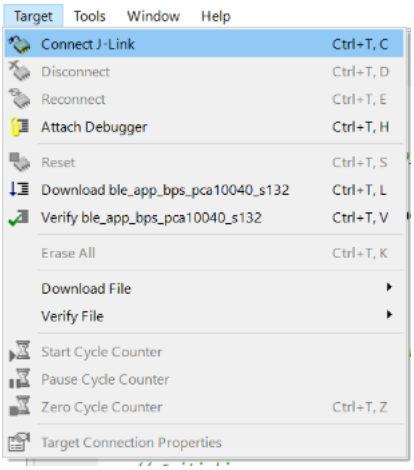
There is a series of video tutorials that show how to get started with SEGGER Embedded Studio in combination with the nRF5 SDK. Check them out here: Getting started with SEGGER Embedded Studio and the nRF5 SDK

8.1 Erasing the kit

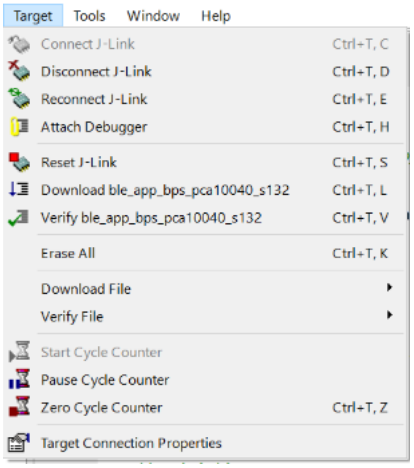
Before you program an example to the development kit, you should erase the contents of the kit.

There are different ways to erase the kit. You can, for example, use *SES* or the command line tool nrfjprog (part of the nRF Command Line Tools).

- To erase the contents of the kit with *SES*, complete the following steps:
  a) Select **Target** > **Connect J-Link**.



  b) After the connection is established, select **Target** > **Erase All**.



- To erase the contents of the kit with nrfjprog, enter the following command:

- For nRF51 devices: `nrfjprog --family nRF51 --eraseall`
- For nRF52 devices: `nrfjprog --family nRF52 --eraseall`

8.2 Importing Keil projects

If you are using a version of the SDK that supports *SES*, thus nRF5 SDK v14.1.0 or later, you should open one of the supplied *SES* projects and skip this step. If you are using an older version of the SDK, for example, nRF5 SDK v12.3.0 for nRF51 Series devices, you must create your own *SES* projects based on the supplied Keil projects.

Before you begin, install the CMSIS-CORE Support Package. To do so, open *SES*, go to **Tools** > **Package Manager**, and select and install **CMSIS-CORE Support Package**.

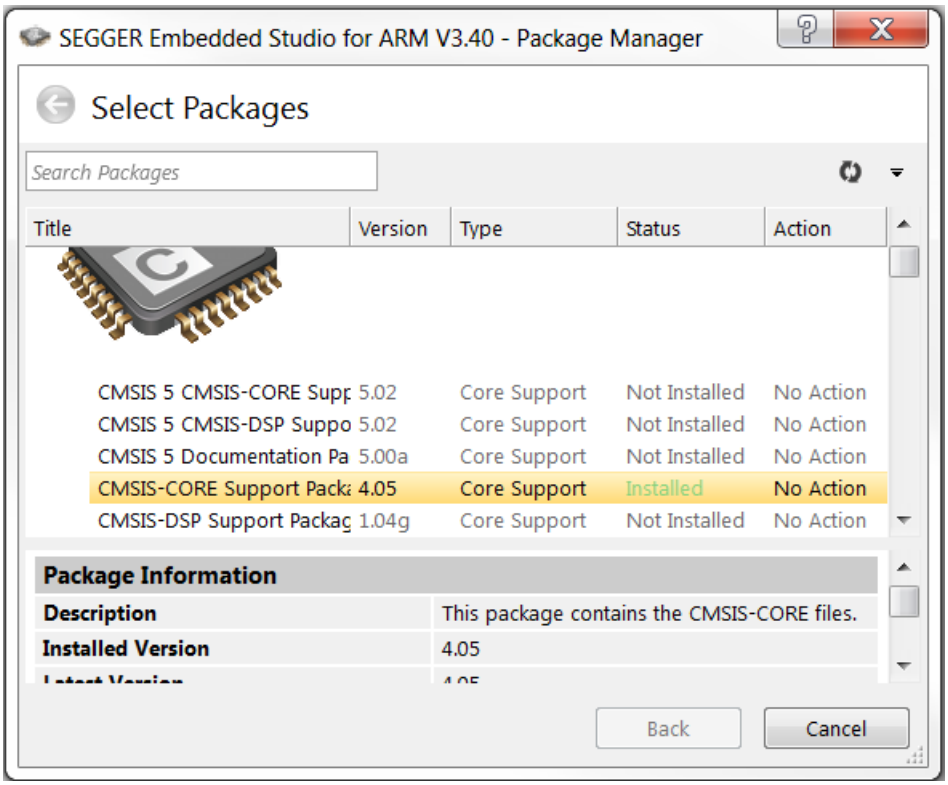


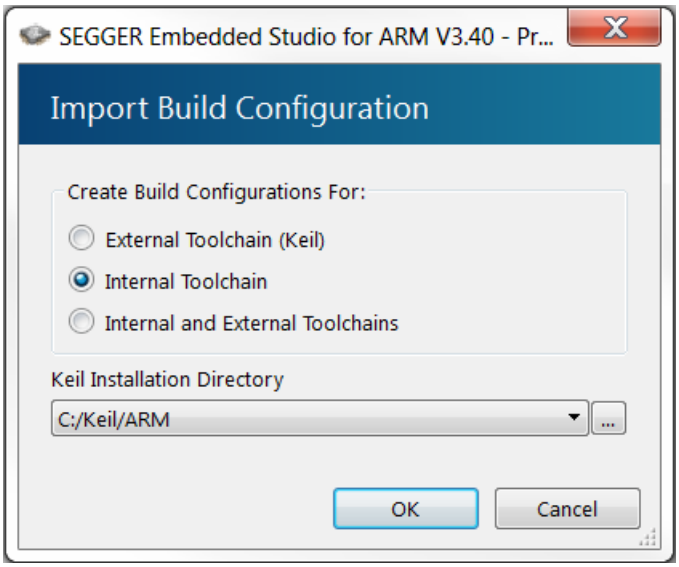
Figure 1: SES Package Manager

Complete the following steps to import a Keil project into *SES*:

1. Select **File** > **Import Project** > **Import Keil MDK Project**.

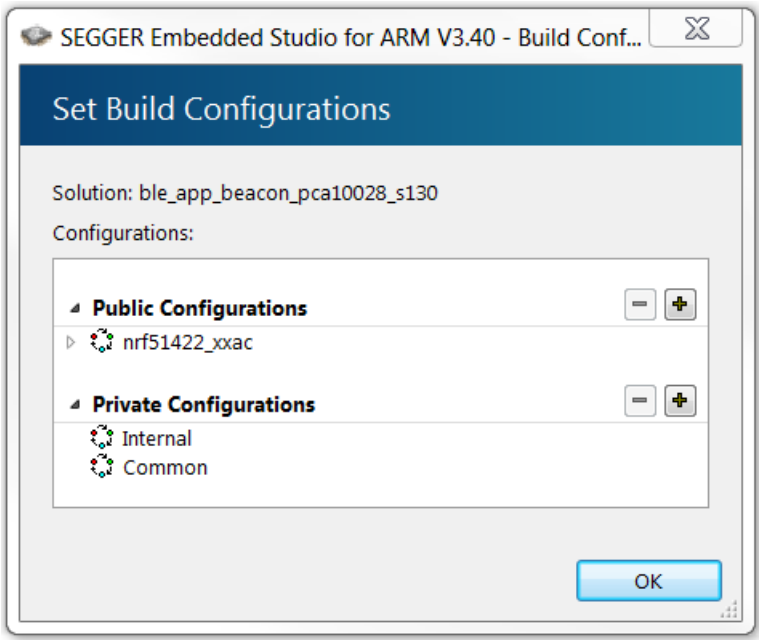
   In *SES* versions before 3.40, this option was located under **File** > **Import IAR EWARM / Keil MDK Project**.
2. Navigate to the folder that contains the nRF5 SDK and select the example that you want to import.

   Use the `*.uvprojx` file that is located in the `arm5_no_packs` folder.
3. In the **Import Build Configuration** window that appears, select **Internal Toolchain**.



4. If the project that you imported contains a *Target* for flashing the *SoftDevice*, delete this *Target* in *SES*:
   a) Select **Project** > **Build Configurations**.
   b) Under **Public Configurations**, select the *Target* (for example, **flash_s130_nrf51_2.0.1_softdevice**).
   c) Click the **-** symbol to remove the *Target*.

   The build configuration should now look similar to this:

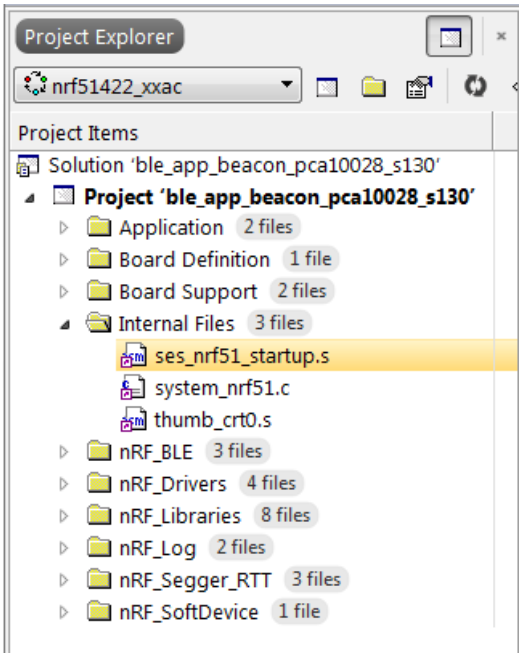


5. Add the nRF5 MDK files that are required for startup and system setup.

   In Keil µVision, these files are provided by the nRF_DeviceFamilyPack. Since this pack is not available for *SES*, you must add them manually to the *SES* project.

   a) Download ses_nrf51_startup.s and ses_nrf52_startup.s and save them in a new folder *SDK_dir*/components/toolchain/embedded_studio.
   b) In the Project Explorer, navigate to **Internal Files** and remove the `Cortex_M_Startup.s` file.
   c) Right-click **Internal Files** and select **Add Existing File**.
   d) Browse to the *SDK_dir*/components/toolchain/ folder and select the `.c` file that corresponds to your device (for example, `system_nrf52.c`).
   e) Right-click **Internal Files** and select **Add Existing File** again. This time, select the startup file that you downloaded, for example, *SDK_dir*/components/toolchain/embedded_studio/ses_nrf51_startup.s.

The Project Explorer should now look similar to this:



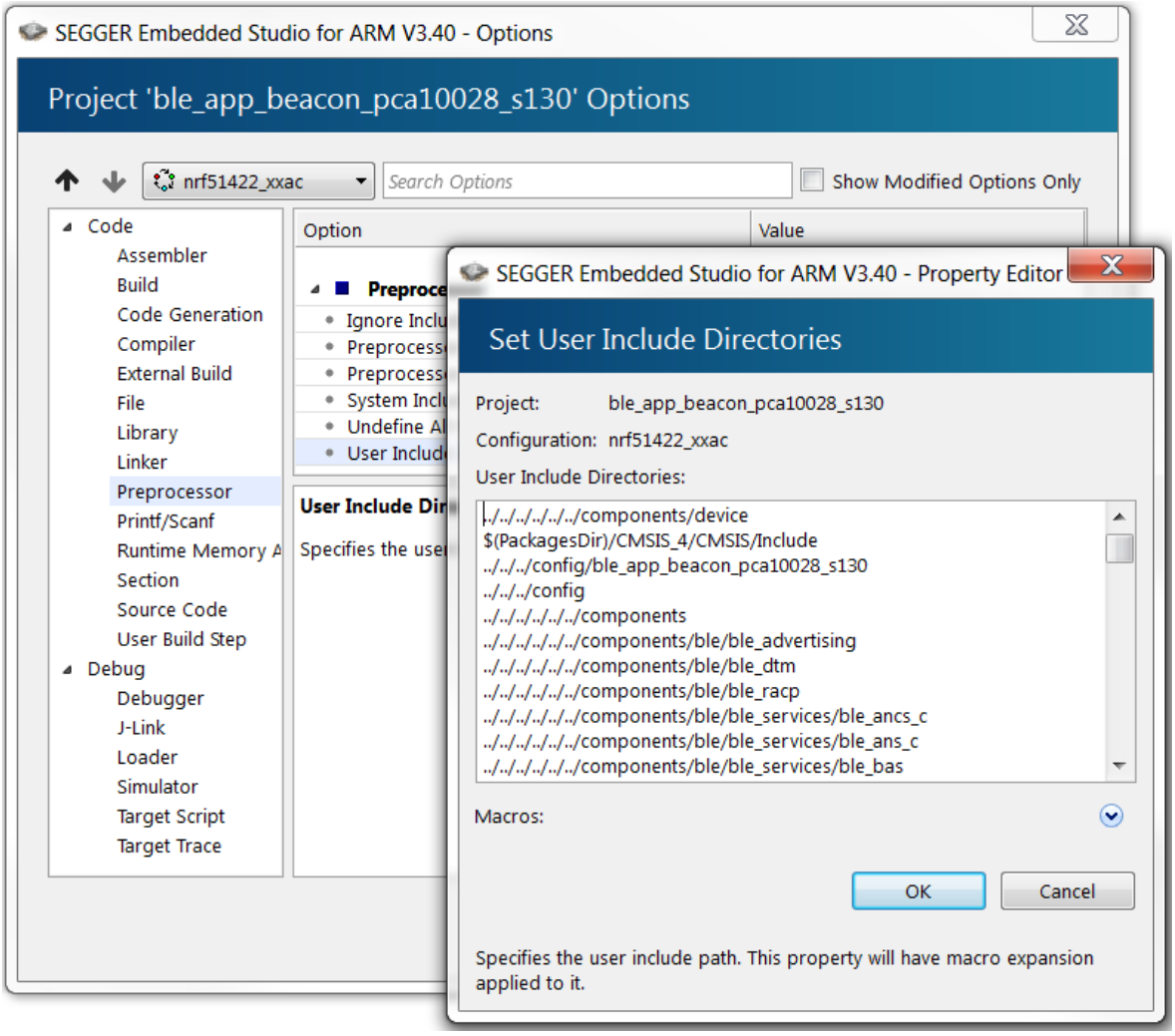
6. Include the device header files in the project:

a) Right-click your project and select **Edit Options**.

b) Select **Preprocessor**.

c) Add the following path to the User Include Directories field: `../../../../../../components/device`

The user include directories should now look similar to this:



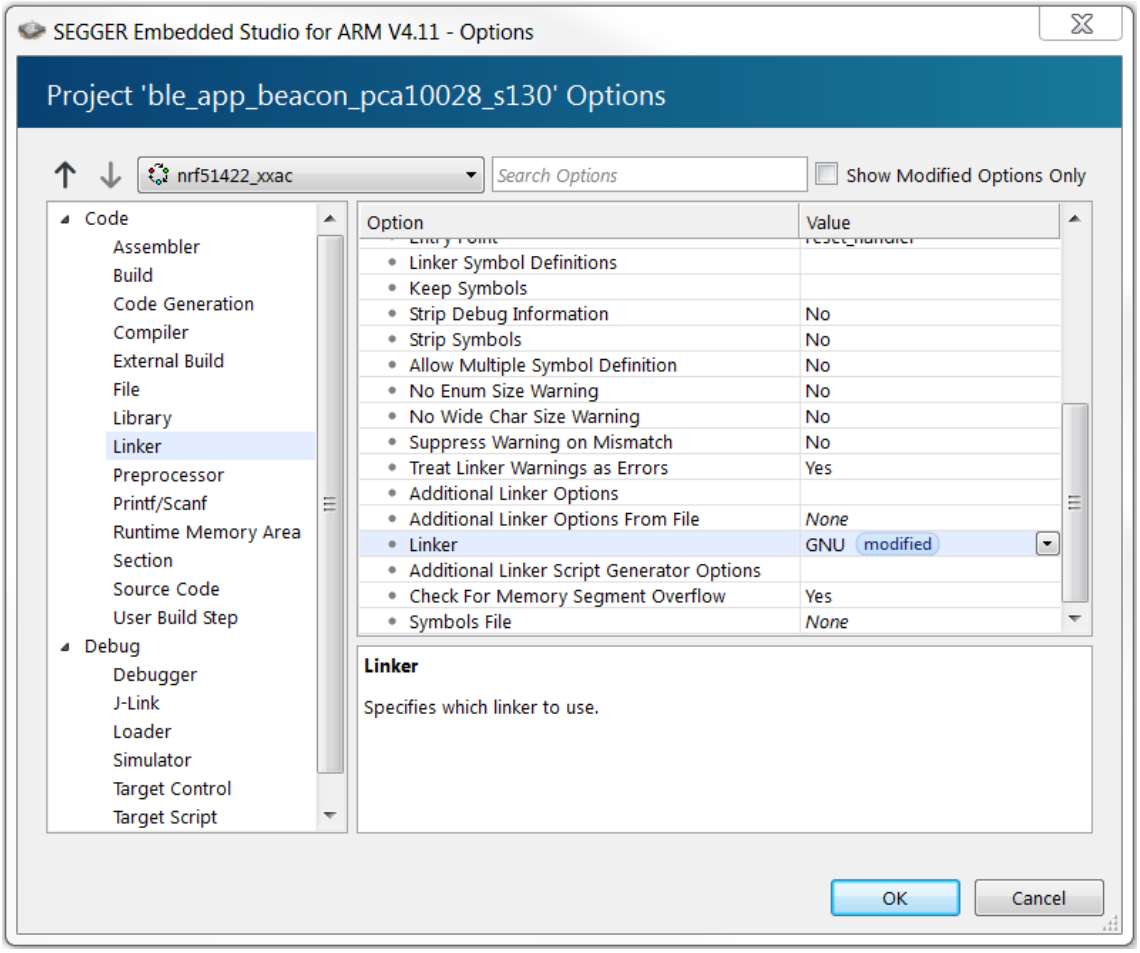
7. If your project uses modules that require section variables (for example, the Peer Manager, Flash Data Storage, or Flash Storage), define where in the flash information from these modules should be stored.

a) Download the `flash_placement.xml` and place it in your project directory.

Files are provided for the following versions of the nRF5 SDK:

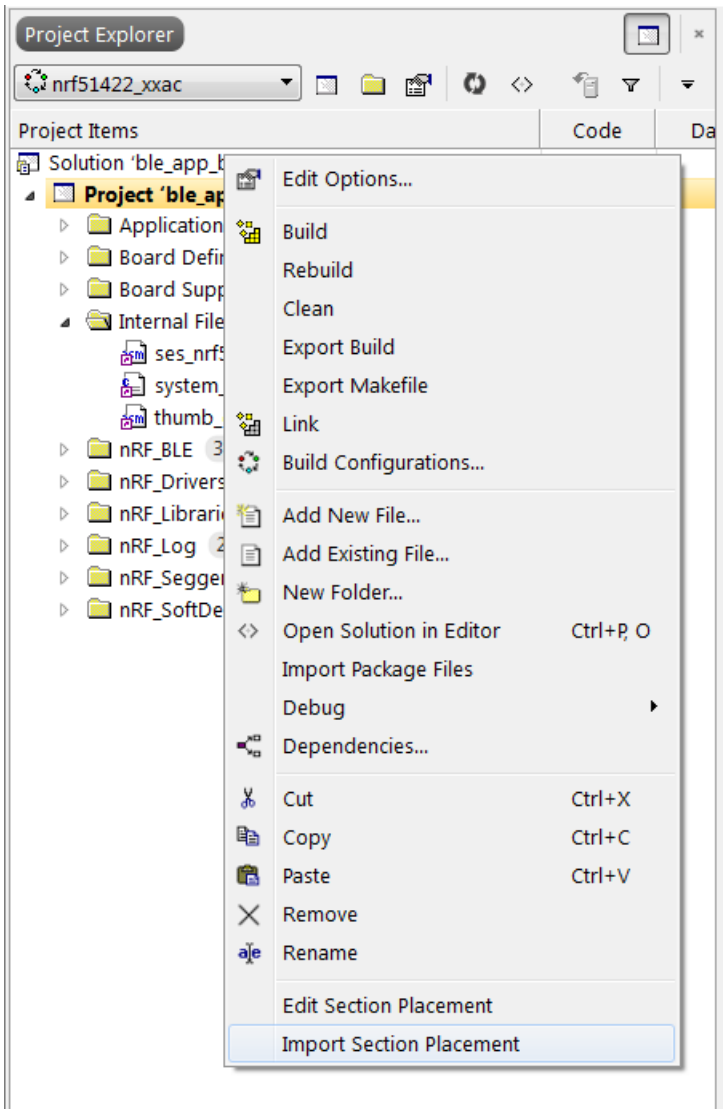
- For nRF5 SDK v12.x.x: flash_placement.xml
- For nRF5 SDK v13.x.x and nRF5 SDK v14.0.0: flash_placement.xml

b) If you are using *SES* v3.50 or later, right-click your project, select **Edit Options**, select **Linker**, and change the **Linker** option to **GNU**.



Note: This option does not exist in *SES* versions before 3.50.

c) Right-click on your project in the Project Explorer and select **Import Section Placement**.



d) Confirm that you want to use the section placement for the current build configuration.

8.3 Compiling the application

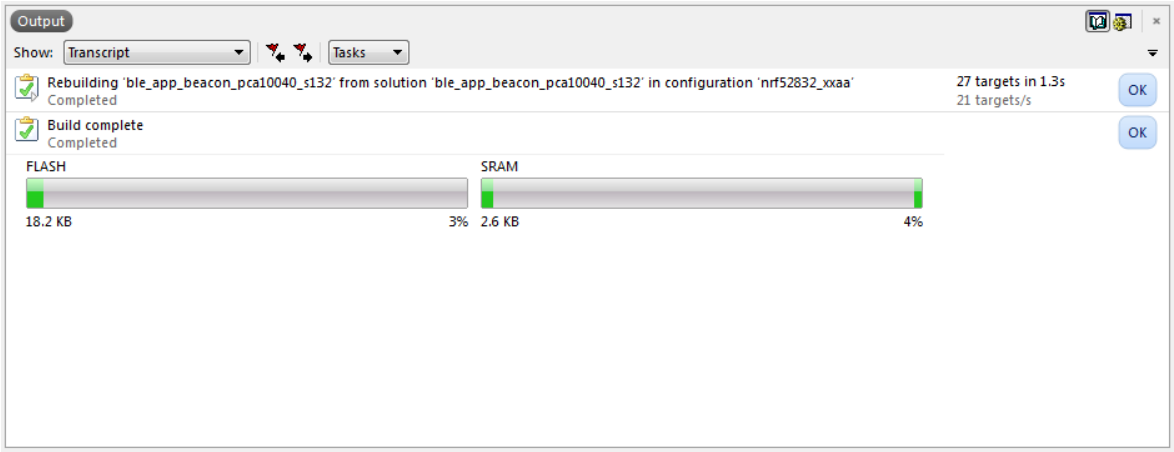
You can compile the application from a *SES* project provided by the nRF5 SDK v14.2.0 or later, or from the project that you created based on an older SDK example.

1. Open your project in *SES*.

   In nRF5 SDK v14.2.0 or later, *SES* projects are located in the `ses` subfolder of the example folder, for example, *`SDK_dir`*`/examples/ble_peripheral/ble_app_uart/pca10040/s132/ses`.
2. Select **Build** > **Build *project_target***.

   Alternatively, press `F7`. Make sure that there are no build errors.

   The output should look similar to this:



8.4 Configuring placement of the SoftDevice

If your application uses Bluetooth or ANT, you must program a *SoftDevice* in addition to the application.

Note:

If your application does not use a *SoftDevice*, you can skip this step.

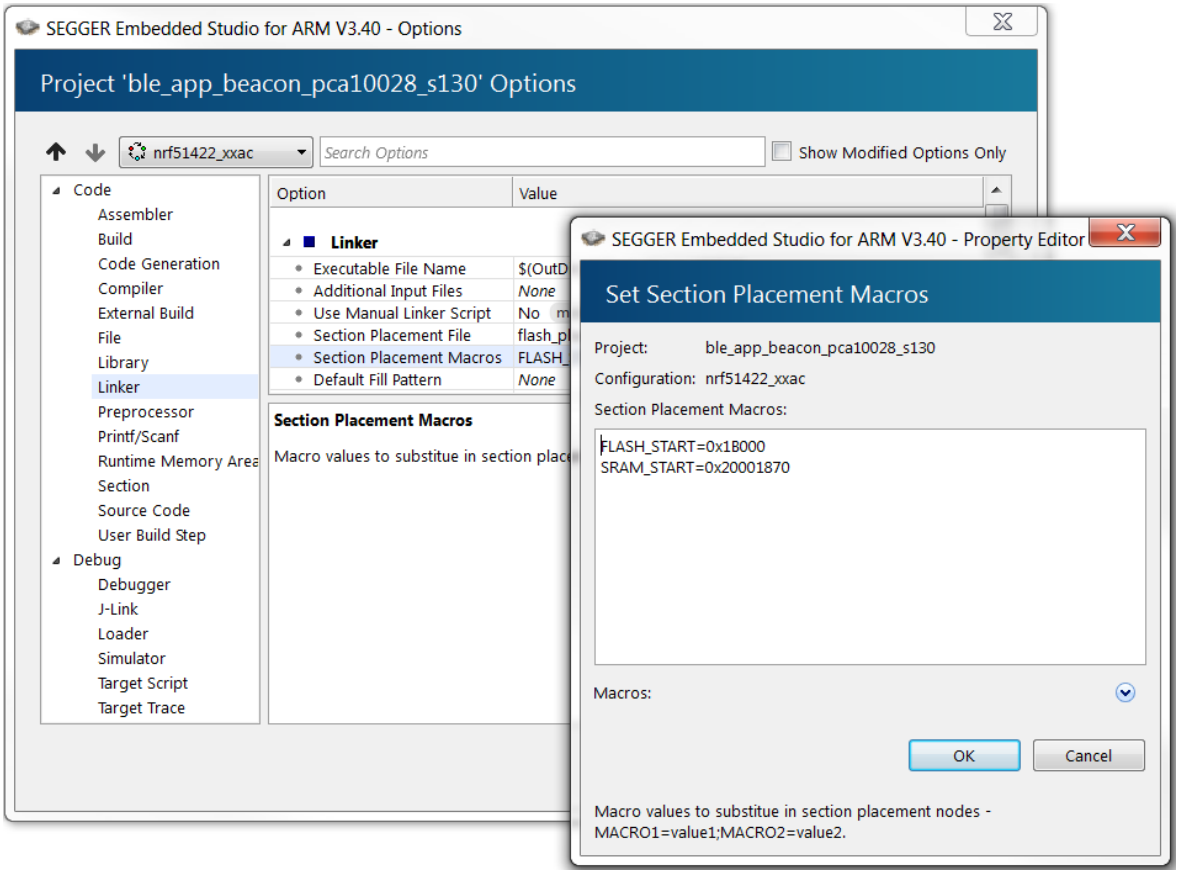
If you are using a *SES* project from nRF5 SDK v14.2.0 or later, the placement of the SoftDevice is already configured correctly and you can skip this step.

If your application requires a *SoftDevice*, the flash and SRAM position where the compiled binary will be placed must be configured as follows:

1. In *SES*, right-click your project and select **Edit Options**.
2. Select **Linker**.
3. In the Section Placement Macros field, add values for FLASH_START and SRAM_START.

   To find the correct values, check the Keil project that you imported (in Keil µVision, select **Options for Target** > **Target**), or program the firmware with approximate values, run it, and check the log output in the debug terminal for the recommended values.

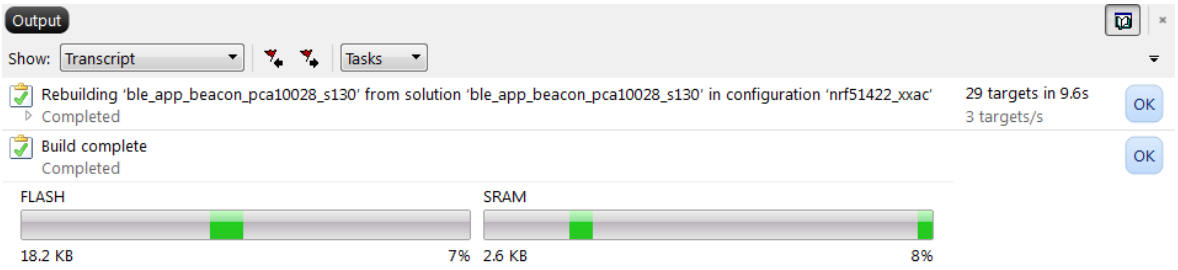
   For example, when running the ble_app_uart example application from nRF5 SDK v12.3.0 on PCA10028 with SoftDevice S130 v2.0.1, specify the section placement macros as shown:



4. Select **Build** > **Rebuild *project_target*** to rebuild the project.

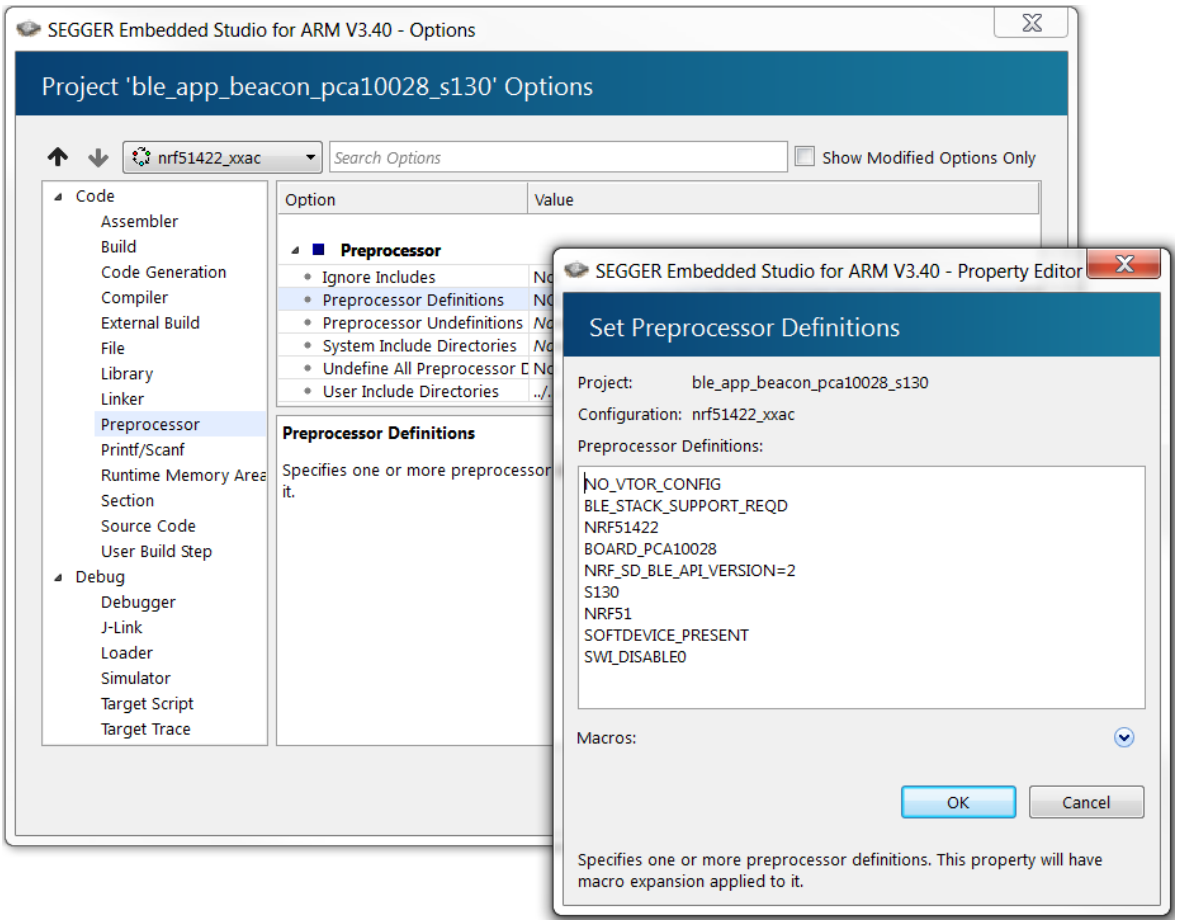
   Alternatively, press `ALT + F7`.

   The output should now look similar to this, with space reserved for the *SoftDevice*:

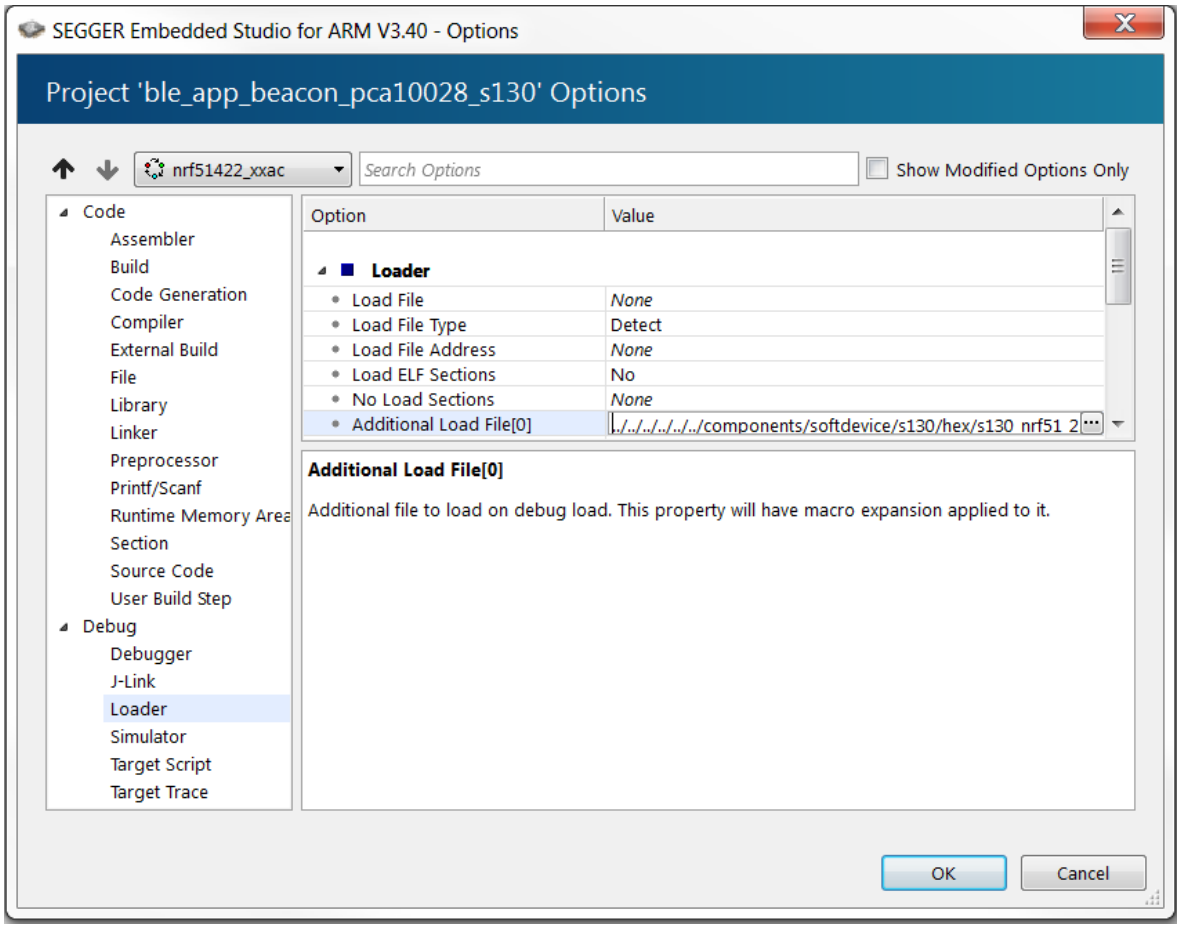


5. Right-click your project and select **Edit Options**.
6. Select **Preprocessor**.
7. Add the definition `NO_VTOR_CONFIG` to the Preprocessor Definitions.

   This definition tells *SES* to expect a *SoftDevice* to be present that will forward exceptions and interrupts to the application.



8. In the Debug section of the project options, select **Loader**.
9. Add the absolute path to the *SoftDevice* to the Additional Load File[0] field, for example, `../../../../../../components/softdevice/s130/hex/s130_nrf51_2.0.1_softdevice.hex`.



8.5 Programming the firmware

After compiling the application, you can program it to the development kit. If you configured a *SoftDevice* to be used, it is programmed together with the application.

1. Connect the development kit to your computer.
2. Select **Debug** > **Build and Run**.

   Alternatively, press `Ctrl + F5`.

8.6 Adding files

After compiling and programming an unmodified example to ensure that your toolchain is set up correctly, modify your project by adding files and libraries.

8.6.1 Adding source files

All source files that are part of the application you are developing must be added to the project.

You can add existing files or create files in the project directory.

- To add an existing file, right-click your project or any subfolder in the **Project Explorer** and select **Add Existing File**. Browse to the file that you want to import and open it.

  The original file is not copied into the project, but it is included from its original location. That means that any modifications that you do will apply to all projects that use this file.

- To create a file, right-click your project or any subfolder in the **Project Explorer** and select **Add New File**.

  By default, the file is created in the project directory.

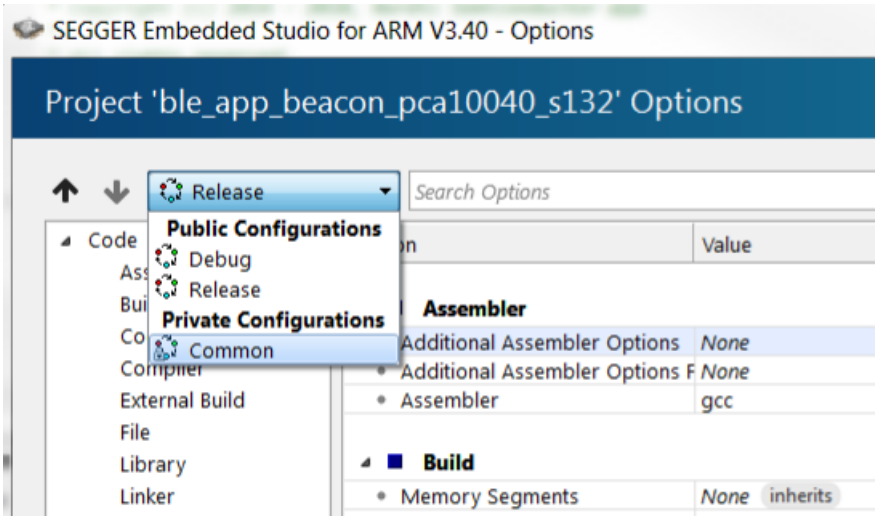
8.6.2 Including header files

Required header files must be linked to your project by adding their path to the user include directories.

Header files contain function declarations and macro definitions. You can request the use of header files by adding a `#include` preprocessing directive in your source files.

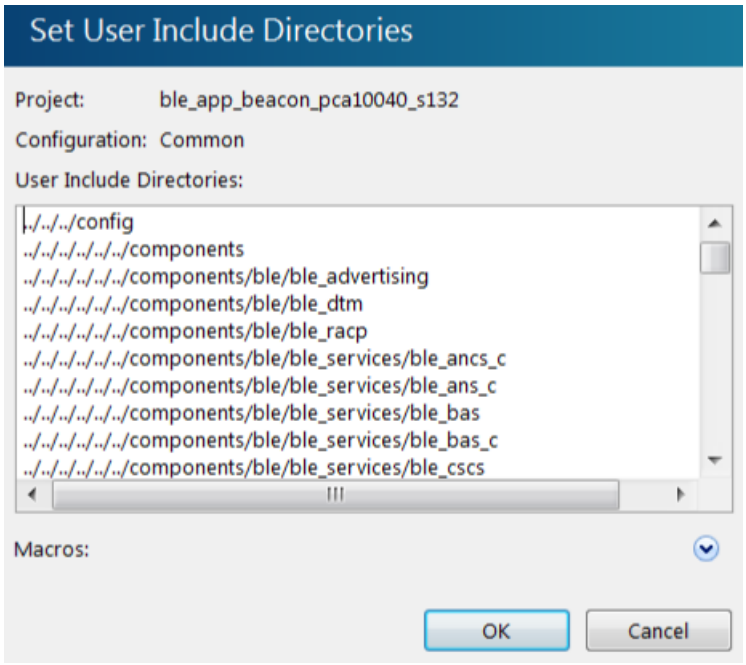
Header files are not linked to the project through the Project Explorer. To include a header file so that *SES* can find it, you must add its path to the list of directories in which *SES* looks for header files:

1. In the **Project Explorer**, right-click your project and select **Edit Options**.
2. In the **Project Options** window, select the **Common** configuration (sorted under **Private Configurations**).



3. Select **Preprocessor**.
4. Double-click **User Include Directories** and add the path to the folder that contains the header file.

   You can specify an absolute path or a path that is relative to the project directory. Using a relative path is preferable if you might want to move or copy your project to, for example, a new SDK version in the future.


Set User Include Directories
Project: ble_app_beacon_pca10040_s132
Configuration: Common
User Include Directories:
../../../config
../../../../../../components
../../../../../../components/ble/ble_advertising
../../../../../../components/ble/ble_dtm
../../../../../../components/ble/ble_racp
../../../../../../components/ble/ble_services/ble_ancs_c
../../../../../../components/ble/ble_services/ble_ans_c
../../../../../../components/ble/ble_services/ble_bas
../../../../../../components/ble/ble_services/ble_bas_c
../../../../../../components/ble/ble_services/ble_cscs
Macros:
OK
Cancel

5. Click **OK**.

9 Communicating with the kit

If your application outputs logging information or needs console input, you should connect the kit to your computer to interact with a console. You can use *Real Time Transfer (RTT)* or *Universal Asynchronous Receiver/Transmitter (UART)* for communicating with the kit.

SEGGER Real Time Transfer (RTT) is a proprietary technology for bidirectional communication that supports J-Link devices and ARM-based microcontrollers. The advantage of using *RTT* is that it is very efficient and does not require any other peripheral than the J-Link debugging interface. *RTT* is directly supported in *SES*.

Connecting via *UART* is quick and power-efficient, but it requires dedicated use of the *UART* peripheral for logging. The nRF5 *DK*s and the nRF51 Dongle include a *UART* to *USB* CDC ACM bridge, which is needed to connect to the *UART*. Alternatively, you can use an external *UART* to *USB* bridge. We use the term CDC-UART to refer to *UART* communication through the *UART* to *USB* CDC ACM bridge, to distinguish it from communication through the Nordic UART Service (NUS) over Bluetooth Low Energy.

9.1 Connecting via RTT

SES directly supports *RTT*. You can see *RTT* output in the Debug Terminal during debugging sessions.

Alternatively, you can use J-Link RTT to view *RTT* output. See the following sections for instructions for Windows and Linux.

9.1.1 Connecting via RTT on Windows

To communicate via *RTT*, connect your development kit via *USB* and run the J-Link RTT Viewer.

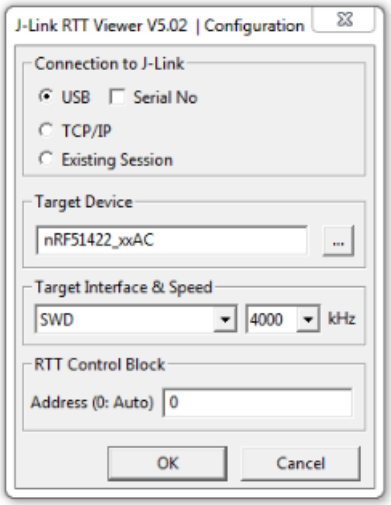
> **Note:** *SES* natively supports *RTT*. If enabled, the monitor shows up when you start debugging. Alternatively, you can use SEGGER's J-Link RTT Viewer as described below.

The J-Link RTT Viewer is installed as part of the nRF Command Line Tools.

To run the J-Link RTT Viewer on Windows, complete the following steps:

1. Select the correct target device.

   The target device is represented by the ID of your development kit.
2. Select **SWD** as the target interface.



9.1.2 Connecting via RTT on Linux

To communicate via *RTT*, connect your development kit via *USB* and use SEGGER's J-Link RTT to establish a connection.

> **Note:** *SES* natively supports *RTT*. If enabled, the monitor shows up when you start debugging. Alternatively, you can use SEGGER's J-Link RTT Viewer as described below.

SEGGER's J-Link RTT is part of the J-Link Software and Documentation Pack, which is available from SEGGER downloads.

To use J-Link RTT on Linux, complete the following steps:

1. Enter `JLinkExe -if SWD` to set up the connection:

```
you@yourcomputer:~$ JLinkExe -if SWD
SEGGER J-Link Commander V5.10u (Compiled Mar 17 2016 19:06:22)
DLL version V5.10u, compiled Mar 17 2016 19:06:19

Connecting to J-Link via USB...O.K.
Firmware: J-Link OB-SAM3U128-V2-NordicSemi compiled Mar 15 2016 18:03:17
Hardware version: V1.00
VTref = 3.300V


Type "connect" to establish a target connection, '?' for help
J-Link>
```

2. Enter `connect` at the prompt to establish the connection.
   JLinkExe will ask for additional information. You can accept the default values.
3. From another terminal, start **`JLinkRTTClient`**.

RTT output is visible in the terminal that runs **`JLinkRTTClient`**.

9.2 Connecting via CDC-UART

To connect via CDC-UART, start a terminal emulator and connect to the used COM port.

There is a wide variety of terminal emulators that you can use, for example, minicom or screen (both terminal-based, available for Linux), Termite (GUI-based, Windows only), or PuTTY (GUI-based, available for multiple operating systems).

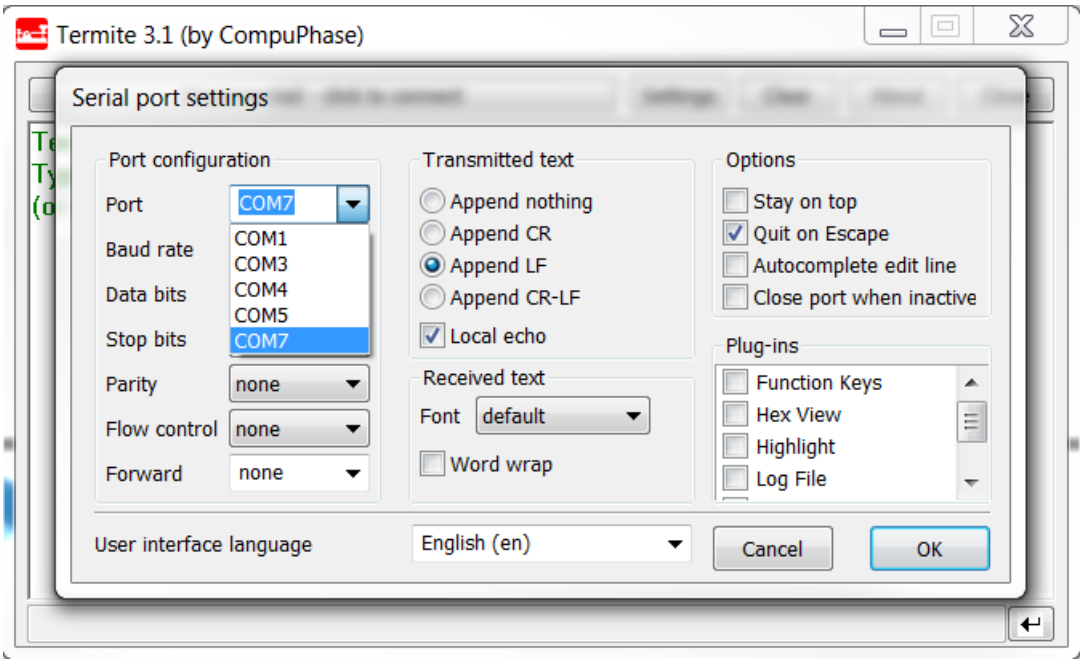
When configuring the connection, use the following *UART* settings:

- Baud rate: 115200 (default baud rate for most examples in the nRF5 SDK)
- 8 data bits
- 1 stop bit
- No parity
- HW flow control: RTS/CTS

The following instructions show how to configure Termite on Windows. Other GUI-based terminal emulators can be set up in a similar way.

1. Download and install the latest version of Termite.
2. Connect the development kit to your computer.
3. Open Termite and click **Settings**.

   Depending on what devices you have connected to your computer, you might have several choices, as shown in the following figure:



4. Select the correct COM port to connect to the kit.

   To find the correct port, follow these steps:

   a) Go to the start menu in Windows and type `devmgmt.msc` to open the Device Manager.
   b) Scroll down and expand **Ports (COM & LPT)**.
   c) Find the port named **JLink CDC UART Port** and note down the number in parentheses.
   d) If you have more than one J-Link UART port, unplug the one that you want to use, plug it back in, and observe which one appeared last.

5. Configure the baud rate and the flow control. Use the default values for the rest of the settings (8 data bits, 1 stop bit, no parity).

   By default, the SDK uses a baud rate of 115200 and RTS/CTS flow control.

6. Make sure that **Append LF** is selected.

   This option appends a newline character to any text that is sent.

7. Configure the terminal to send an RTS (Ready To Send) signal to the development kit:

   a) Go to **Settings** > **Plug Ins**.
   b) Enable **Status LEDs** and click **OK**.
   c) Click on the dark green rectangle above RTS to set this signal high.
   The text `Start...` is displayed in Termite.

10 Testing the application

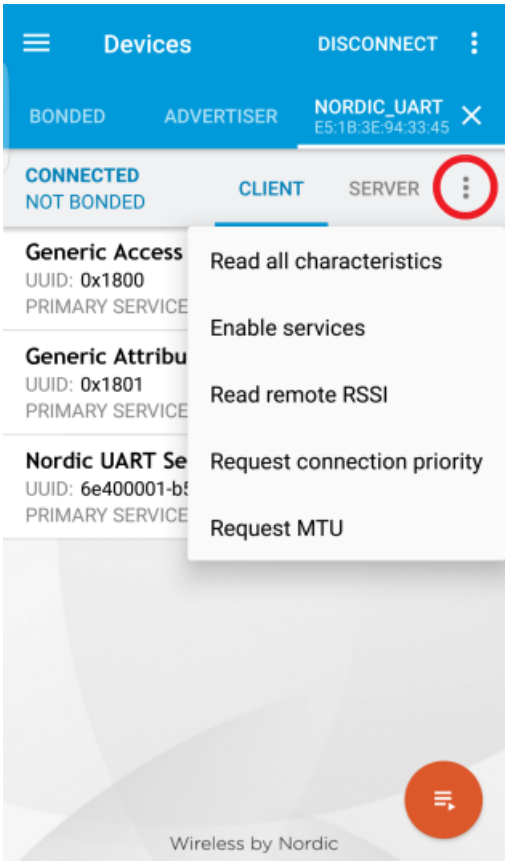
The next step after compiling and programming your application is to test it. With the nRF Connect platform, Nordic Semiconductor provides its own testing apps, which are available both for mobile and for desktop.

10.1 Testing with a mobile device

If you have a mobile device that supports Bluetooth Low Energy, download the nRF Connect app from Google Play or App Store to test your application.

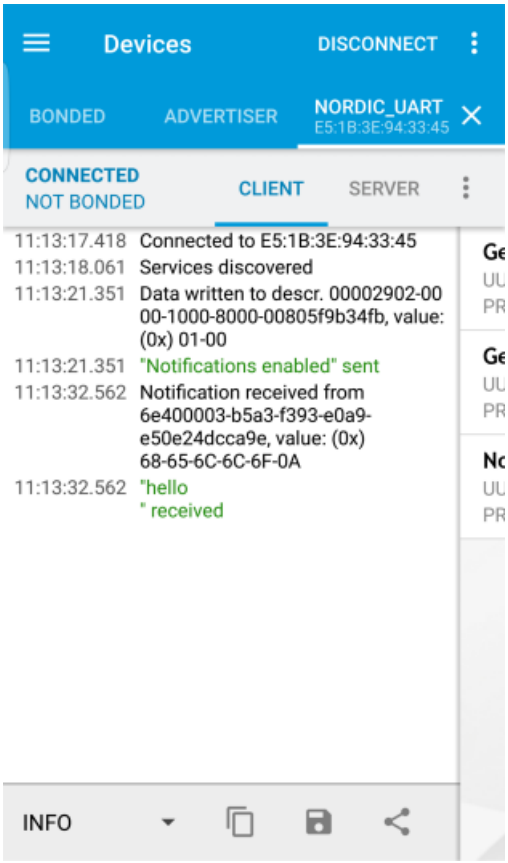
The following procedure assumes that you have programmed the Bluetooth Low Energy Peripheral UART example from the nRF5 SDK (`examples/ble_peripheral/ble_app_uart`) on your development kit. Steps for testing other examples are similar. See the testing instructions for each example in the nRF5 SDK documentation for more information.

1. Download and install nRF Connect from Google Play or App Store.
2. Open nRF Connect.
3. Make sure that the development kit is running the `ble_app_uart` example.
   LED1 should be blinking every 2 seconds, indicating that it is advertising.
4. Tap **Scan**.
5. Find the device and tap **Connect**.
   The default device name for the Peripheral UART example is "Nordic_UART".
6. When connected, tap the options button below the device name and select **Enable services**.



This example communicates over Bluetooth Low Energy using the Nordic UART Service (NUS).

7. Tap the options button and select **Show log**.
8. In a terminal connected via CDC-UART, enter `hello` and send it to the development kit.
   The text is sent through the development kit to your mobile device over a Bluetooth Low Energy link. The mobile device will then display it in the nRF Connect log:



10.2 Testing with a computer

If you have a dongle or a second Nordic *DK*, you can test your application with the Bluetooth Low Energy app in nRF Connect for Desktop. nRF Connect for Desktop is available for Windows, Linux, and macOS.

> **Note:** This method requires a dongle or a second Nordic *DK* with Bluetooth Low Energy support to be connected to your computer.

The following procedure assumes that you have programmed the Bluetooth Low Energy Peripheral UART example from the nRF5 SDK (`examples/ble_peripheral/ble_app_uart`) on your development kit. Steps for testing other examples are similar. See the testing instructions for each example in the nRF5 SDK documentation for more information.

1. Download and install nRF Connect for Desktop.
2. Connect the dongle or the second development kit to a *USB* port of your computer.
3. Connect to the kit that runs the ble_app_uart example via CDC-UART.
4. Open nRF Connect for Desktop and install the Bluetooth Low Energy app.

   See nRF Connect for Desktop for information about how to install and open apps.
5. Launch the Bluetooth Low Energy app.
6. Select the serial port for the dongle or the development kit that is connected to your computer (not the kit that runs the Peripheral UART example).

If the device has not been used with the nRF Connect Bluetooth Low Energy app before, you may be asked to update the J-Link firmware and connectivity firmware for the device. You must have the correct connectivity firmware on the nRF SoC to continue. When the nRF SoC has been programmed with the correct firmware, the nRF Connect Bluetooth Low Energy app proceeds to connect to it over *USB*. When the connection is established, the device appears in the main view.

7. Click **Start scan**.
8. Find the device and click **Connect**.

   The default device name for the Peripheral UART example is "Nordic_UART".
9. Select the *UART* RX characteristic value.
10. Write `30 31 32 33 34 35 36 37 38 39` (the hexadecimal value for the string "0123456789") and click **write**.
    The data is transmitted over Bluetooth Low Energy from the app to the development kit that runs the Peripheral UART example. The text "0123456789" is displayed in the terminal that is connected to the kit that runs the Peripheral UART example via *UART*.
11. Enter any text, for example, `Hello`, in the terminal.
    In nRF Connect, the *UART* TX characteristic value changes to the corresponding ASCII value. For example, the value for `Hello` is `48 65 6C 6C 6F`.

11 Debugging

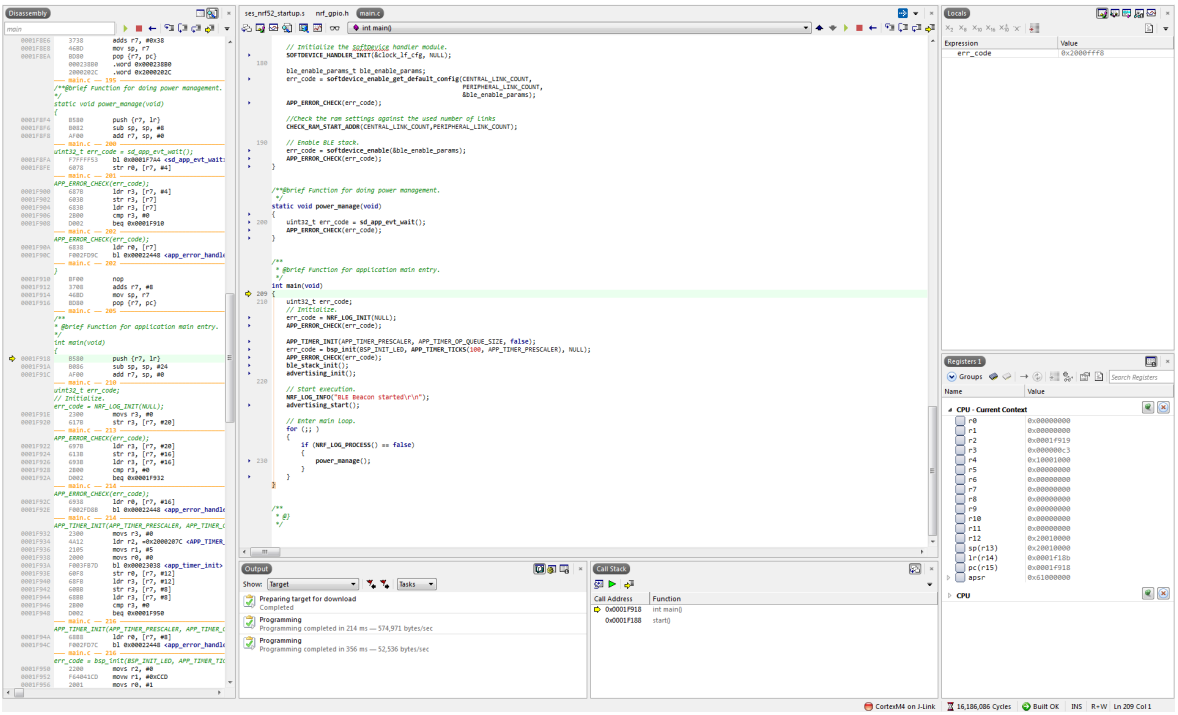
To actually see what is happening on the development kit while the application is running, you must set up a J-Link debugging session. *SES* has an integrated debugger that you can use to step through your application.

Complete the following steps to start debugging:

1. Open your project in *SES*.
2. Build and program your application to the kit as described in Building and programming a sample application.
3. Select **Debug** > **Go**.

   Alternatively, press `F5`.

   The debugging interface looks like this:



   By default, the application will break in main. You can set additional break points, single-step through the application, read registers, and so on.

This video tutorial shows you how to use *SES* for debugging:

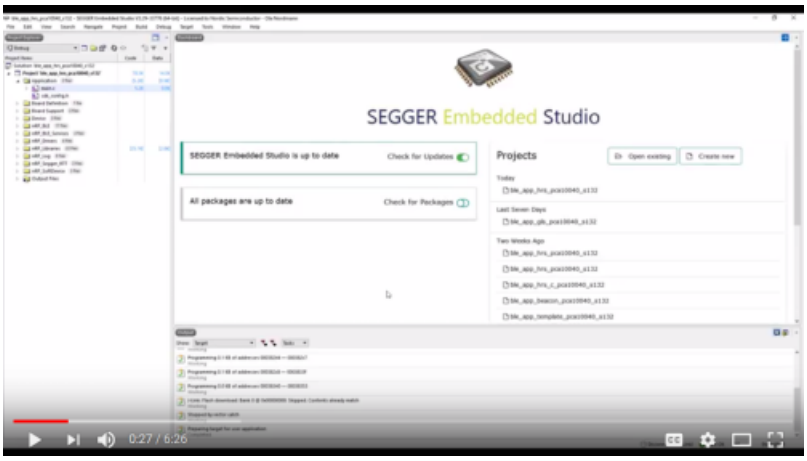


Figure 2: YouTube tutorial

Glossary

Development Kit (DK)

A development platform used for application development.

Integrated Development Environment (IDE)

A software application that provides facilities for software development.

Real Time Transfer (RTT)

A proprietary technology for bidirectional communication that supports J-Link devices and ARM-based microcontrollers, developed by SEGGER Microcontroller.

SEGGER Embedded Studio (SES)

A cross-platform *IDE* for embedded C/C++ programming with support for Nordic Semiconductor devices, produced by SEGGER Microcontroller.

SoftDevice

A wireless protocol stack that complements the nRF5 Series SoCs. Nordic Semiconductor provides these stacks as qualified, precompiled binary files.

Software Development Kit (SDK)

A set of tools used for developing applications for a specific device or operating system.

System on Chip (SoC)

A microchip that integrates all the necessary electronic circuits and components of a computer or other electronic systems on a single integrated circuit.

Target

The goal of an operation, for example, programming a specific image on a device, compiling a specific set of files, or removing previously generated files.

Universal Asynchronous Receiver/Transmitter (UART)

A hardware device for asynchronous serial communication between devices.

Universal Serial Bus (USB)

An industry standard that establishes specifications for cables and connectors and protocols for connection, communication, and power supply between computers, peripheral devices, and other computers.

Acronyms and abbreviations

These acronyms and abbreviations are used in this document.

DK
Development Kit

IDE
Integrated Development Environment

RTT
SEGGER Real Time Transfer

SDK
Software Development Kit

SES
SEGGER Embedded Studio

SoC
System on Chip

UART
Universal Asynchronous Receiver/Transmitter

USB
Universal Serial Bus

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