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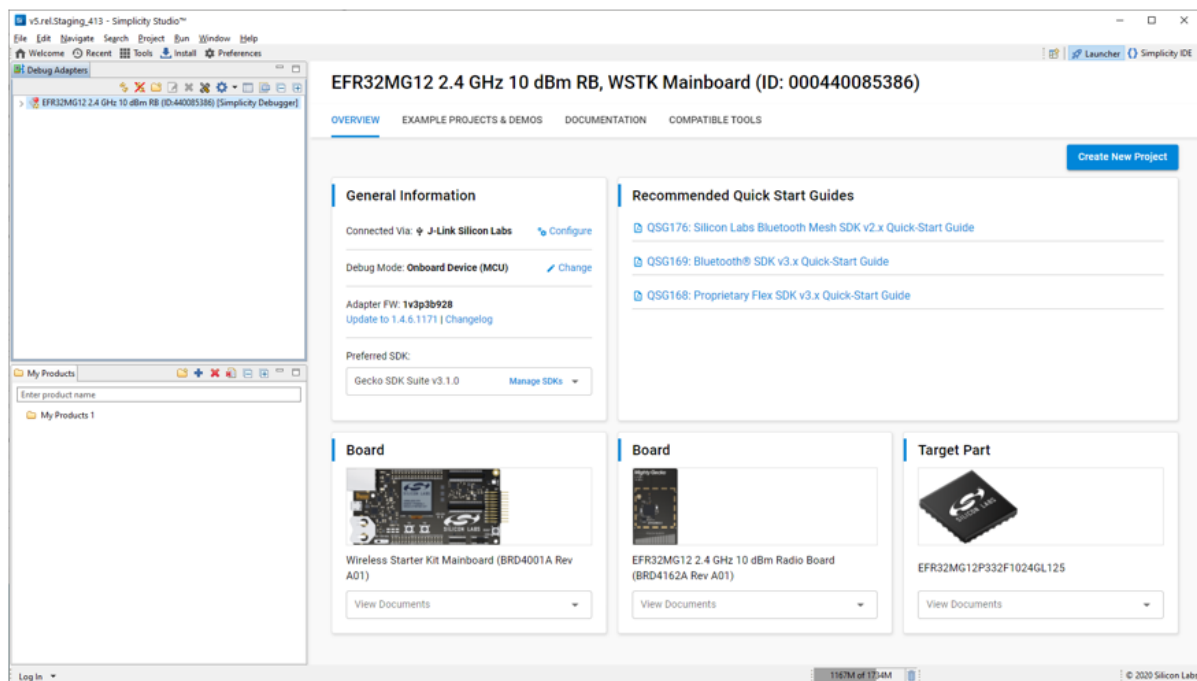
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Overview

Simplicity Studio® 5 User's Guide

Simplicity Studio is the core development environment designed to support the Silicon Labs IoT portfolio of system-on-chips (SoCs) and modules. It provides access to target device-specific web and SDK resources; software and hardware configuration tools; an integrated development environment (IDE) featuring industry-standard code editors, compilers and debuggers; and advanced, value-add tools for network analysis and code-correlated energy profiling.



Simplicity Studio is designed to simplify developer workflow. It intelligently recognizes all evaluation and development kit parts released by Silicon Labs and, based on the selected development target, presents appropriate software development kits (SDKs) and other development resources.

Simplicity Studio 5 (SSv5) focuses on developer experience, leveraging feedback from customers, employees and competitive reviews. Developers of all experience levels will benefit from an optimized workflow that supports them through the development journey and produces quicker project progression and device configuration.

The *Simplicity Studio 5 User's Guide* pages are organized into the following groups.

- [Getting Started](#) describes how to install SSv5 and the relevant development resources, and provides general overviews of using the SSv5 interface and of developing projects in SSv5. If you are new to SSv5, start here.
- [About the Launcher](#) is a reference guide to the features and functions available when you first open SSv5. This is a general reference, although some items may not be applicable to all devices.
- [About the Simplicity IDE](#) is a reference guide to the features and functions in the Simplicity integrated development environment. This is a general reference, although some items may not be applicable to all devices.
- [Developing for 32-Bit Devices](#) provides instructions and reference material for 32-bit device development in the two development environments: Project Configurator and AppBuilder.
- [Developing for 8-Bit Devices](#) provides instructions and reference material for 8-bit device development using the Hardware Configurator.

- [Building and Flashing](#) describes how to compile and flash images to various device types.
- [Testing and Debugging](#) outlines tools and strategies for testing your applications on Silicon Labs devices.
- [Using the Tools](#) is a reference guide to the various tools packaged with SSV5. Not all tools are applicable to every development path. Their specific use is described in the individual **Developing for** pages.

New Features

New Features

Simplicity Studio® 5 version 5.3.0.0

This release includes the following key features:

- NCP Commander enhancements
- Bluetooth LE Direction Finding tools suite v1.0
- Installation of GSDKs published on GitHub
- Dynamic GATT Configuration
- IDE Dark Theme improvements
- Multi-Project [Solutions](#)

Simplicity Studio® 5 version 5.2.0.0

This release includes the following key features:

- Support for upgrading SLC projects to a newer SDK
- NCP Commander updates:
 - Advertiser improvements including ability to build custom advertisement data packets, fine tune the TX Power, and export to incorporate settings into firmware.
 - Devices discovery improvements: ability to favorite devices and new filter by device name, address, RSSI, raw advertising data or favorite devices.
 - RF Regulatory Tests: ability to add CTE to DTM packets
 - Standalone version with access to all system COM ports may be launched through Tools dialog or Compatible Tools tab (see the [Bluetooth NCP Commander](#) page for more information)
- Bluetooth Mesh Configurator updates
 - New warnings if Device Composition Data does not comply with the specification
 - Various bug fixes and improvements to validate model rules
- Upgrade to support integrations with IAR Embedded Workbench v8.50.9
- Upgraded default GCC compiler to version Arm GCC v10.2

Simplicity Studio® 5 version 5.1.0.0

This release includes the following key features:

- [Beta release of GNU Debugger \(GDB\) support](#)
Simplicity Studio 5.1 includes Beta-level support for a GDB client and SEGGER's GDB server.
- [GitHub integration for access to software example repositories](#)
Starting in Simplicity Studio 5.1, developers may clone sample projects from within the Gecko SDK or within compatible GitHub repos.
- [Bluetooth Mesh support](#)
Starting in Simplicity Studio 5.1 and Gecko SDK 3.1, Bluetooth Mesh is supported in the new Project Configurator workflow. Studio 5.1 introduces the all-new Bluetooth Mesh Configurator tool for configuring a Bluetooth Mesh node's Device Composition Data (DCD).
- [Bluetooth NCP Commander](#)

Bluetooth NCP Commander is a new Simplicity Studio 5 interactive console tool for sending BGAPI commands to a Bluetooth NCP application connected to a development host machine.

Simplicity Studio® 5 version 5.0.0.0

The initial release of SSv5 includes the following key features:

- Launcher
 - Fresh, clean user interface
 - Automatic detection of connected development boards
 - Context-aware development board and target device developer resources
 - SDK download and update manager
 - Easy programming of pre-built demo apps
 - Simple cloning of software examples
 - Quick access to software and hardware documentation with search and filter capabilities
- Software creation & management tools
 - Support for Gecko SDK Suite 3.0 and later
 - Creation of projects for
 - The integrated Simplicity Studio IDE
 - IAR Embedded Workbench
 - Command-line GNU toolchain (GNU makefiles)
 - Searchable library of device-relevant software making it easy to add software components to projects
 - Configure software components in a GUI or text (C source) editor
 - Configurable peripheral initialization, drivers, middleware, kernels and utilities
 - Built-in software configuration error-checking
 - Software dependency manager simplifies porting from
 - SDK to SDK
 - Silicon Labs development kits to custom hardware designs
 - Graphical configuration tools
 - Pin tool to assign pin and peripheral hardware resources
 - Proprietary radio configurator tool
 - Editor for Bluetooth LE Generic Attribute Profile (GATT)
 - Source/Project management and revision control
 - Option to copy or link SDK source
 - No hard-coded paths
 - Clear separation between SDK and customer source code
 - Easy transfer of projects (share/import/export of projects)
 - Source code management and software engineering workflows
- Development Tools
 - Powerful integrated development environment (IDE)
 - Built on latest Eclipse framework (v4.14 and newer)
 - C/C++ Development Tooling (CDT, v9.10 and newer)
 - Eclipse marketplace to enhance and customize
 - Valuable insights with Silicon Labs analysis tools
 - Wireless network traffic capture and analysis
 - Test and analyze the traffic of your wireless devices and networks
 - Data collected directly from devices under test
 - Includes signal strength, LQI (Link Quality Indicator) and filtering information (unique to Silicon Labs)
 - Capture and display energy usage
 - Monitor single device or multiple nodes on a wireless network
 - Code-correlated energy data – identify where your embedded application is consuming energy and design power-optimized applications
 - Advanced trigger and search functions locate power events

Known Issues

Known Issues

Simplicity Studio® Version 5.3.1.0

ID	Issue	Workaround
620727	When Radio Boards are used that contain both an EFR32 or EFM32 target as well as one of the Energy Friendly EFP parts, the Launcher perspective incorrectly shows the EFP as the target part and so the Preferred SDK is wrong and there are no software examples for the board.	Create a new project through File > Silicon Labs Project Wizard so that the Target, SDK, and Toolchain Selection dialog opens. In the Target Device drop down, select the other target part on the board. If it is not already displayed, select the correct Gecko SDK Suite in the SDK drop down list. from the list. Click Next . Now the correct software examples will be listed for the board.
639643	When building projects with the IAR ARM toolchain, local variables are not always displayed correctly in the Simplicity Studio debugger.	Use the GDB debugger. Select Preferences > Simplicity Studio > Debuggers > GNU Debugger (GDB) and click Apply and Close . When a debug session is started it will use GDB.
648620	Simplicity Studio 5 adapter packs and tools that use Python do not work correctly on MacOS Big Sur.	Follow the steps in the procedure at the end of this table.
676681	Drag and Drop of the various windows in the Simplicity Studio IDE or the Debugger perspectives does not work with MacOS Big Sur. This is an issue with the underlying Eclipse and it will be fixed in a future release.	None
702086	Slower project build times are seen on Windows compared to Linux.	Use an external 64-bit make.exe such as the one available from mingw. Once the make.exe is available, use a text editor on the studio.ini line in the Simplicity Studio installation directory and add a line like this to the end of the file: <code>-Dstudio.makeLocation=C:/msys64/usr/bin/</code> This helps most noticeably on incremental builds. Note using an external make.exe may not work with the Keil 8051 toolchain.
701928	Most EFR32xG22 and EFM32xG22 peripheral registers are not displayed correctly with the Simplicity Studio debugger.	Use the GDB debugger. Select Preferences > Simplicity Studio > Debuggers > GNU Debugger (GDB) and click Apply and Close . When a debug session is started it will use GDB.
726091	Linux: Font for Launch Console and TCP/IP Adapter preferences is sometimes not readable.	No known workaround. A suggestion is to copy the text and paste it into a text editor. The preferences can be edited in the text editor and then pasted back to the preference window.
735426	A GNU ARM C++ created project (such as an OpenThread project) may generate build errors similar to this: <code>cc1plus.exe: fatal error: sl_gcc_preinclude.h: No such file or directory compilation terminated.</code>	Open the Project Configurator (.slcp) file and click Force Generation from the Overview tab.
751748	Because MacOS Monterey is currently not supported by Simplicity Studio 5, Project Configurator projects cannot be created.	For Intel-based Macs, the only known workaround is to run Simplicity Studio 5 in a VM running Ubuntu 20.04, Windows 10, or MacOS Catalina. M1-based Macs do not have a workaround.

758963	Navigation buttons (back, forward, etc.) do not show on the Simplicity IDE toolbar after restart in the Simplicity IDE perspective.	Change to a different perspective, such as the Launcher perspective, and then change back to the Simplicity IDE perspective.
76584	If a Linux installation does not already have git-lfs installed, the Gecko SDK 4.0 will not be installed (cloned) correctly from GitHub.	Install git-lfs outside of Simplicity Studio and then install Gecko SDK 4.0 again.
773819	If a project's properties are changed, and then the project is renamed, the Refresh Policy folder name is not updated and every build is treated as a full rebuild.	Right-click the project folder and select Properties >C/C++ Build . Go to the Refresh Policy tab and delete the folder name. Click Add Resource... and add the folder for the renamed project.

To work around issue 648620, Simplicity Studio 5 adapter packs and tools that use Python do not work correctly on MacOS Big Sur:

1. Download the Python 3.6.8 installer for macOS from <https://www.python.org/downloads/release/python-368/> Python 3.6 (64 bit, for OS X 10.9 and later).
2. Then enter the following from a terminal window:

```

1 | sudo /usr/local/bin/python3 -m pip install jinja2 pyxb html2text pyyaml
2 | cd "/Applications/Simplicity Studio.app/Contents/Eclipse/developer/adapter_packs/python/bin/"
3 | mv python python.orig
4 | mv python3 python3.orig
5 | mv python3.6 python3.6.orig
6 | ln -s /usr/local/bin/python3 python
7 | ln -s /usr/local/bin/python3
8 | ln -s /usr/local/bin/python3.6

```

For Users of Previous Versions

For Users of Previous Versions

If you are migrating from Simplicity Studio 4 to SSv5, or if you are transitioning from AppBuilder projects to the component-based architecture, see [Project Migration](#) for additional information.

Getting Started

Getting Started

To get started with Simplicity Studio® 5 (SSv5):

1. [Install SSv5 and development software](#)
2. [Explore the main features of SSv5](#)
3. [Start a project](#)

You do not need hardware to install SSv5 and the relevant software packages or, for 32-bit devices, to explore the project configuration interface for a particular SDK. However, having your target hardware connected during installation ensures that your SSv5 installation is configured precisely for your environment.

You should also have an account set up in the Silicon Labs Customer Support Portal. Access to some software packages is controlled by your customer profile.

See [Prerequisites](#) for more information.

If you have features or functions that are provided as an SDK extension, you need to install it separately after you have installed the main SDK. See [Install SDK Extensions](#) for more information.

Prerequisites

Prerequisites

To streamline your Simplicity Studio® 5 (SSv5) installation:

- Connect [development hardware](#) to your PC
- Log in to your [customer account](#)

SSv5 System Requirements

Operating Systems

Operating System	Version
Windows	Windows 10 (x64)
macOS	10.24 Mojave or 10.25 Catalina (GNU toolchain)
Linux	Ubuntu 20.04 LTS

Hardware

Hardware Component	Item
CPU	1 GHZ or better
Memory	1 GB RAM minimum, 8 GB recommended for Wireless Protocol development
Disk Space	600 MB disk space for minimum FFD installation; 7 GB for Wireless Dynamic Protocol support

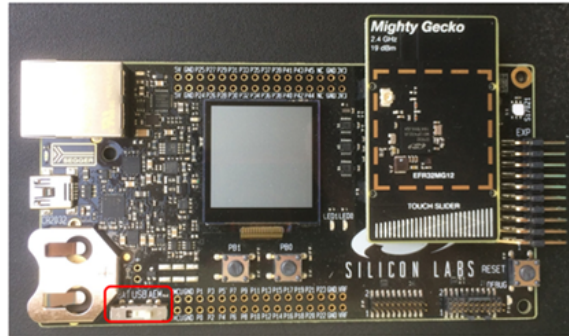
Hardware

A Silicon Labs development kit is not required to get started with Simplicity Studio. However, if Simplicity Studio detects an official development kit, it can be used to help select the appropriate software and tools for installation. If you don't have a development kit, you can explore the available options [here](#).

EFR32 Kits

If you have a Silicon Labs Wireless Starter Kit (WSTK) or Pro Kit, mount a radio board on the mainboard and connect the mainboard to your PC using the USB cable supplied with the kit.

Note: For best performance in SSv5, be sure that the power switch on the mainboard is in the Advanced Energy Monitoring or “AEM” position.



Customer Account

If you do not already have one, create an account on the Silicon Labs Customer Support portal. Be sure to record your account username and password as you will use it to log in through SSv5. Your account properties determine not only what software components you can download, but also what notifications you will receive.

To review or change your notification subscriptions, log in to the portal, click **HOME** to go to the portal home page and then click the Manage Notifications tile. Make sure that **Software/Security Advisory Notices & Product Change Notices (PCNs)** is checked, and that you are subscribed at minimum for your platform and protocol. Silicon Labs strongly recommends that you receive these notifications. Click **Save** to save any changes.

Install SSv5 and Software

Install SSv5 and Software

This section discusses [how to install SSv5](#) and, once SSv5 is installed, [how to install software](#).

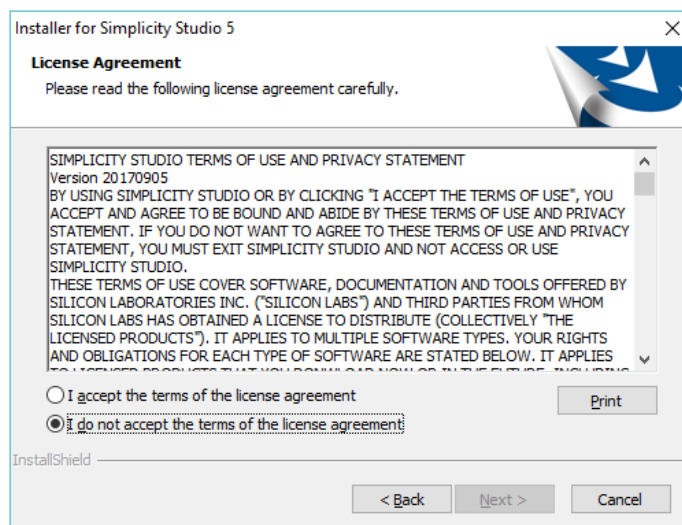
NOTE: Depending on your corporate environment, you may encounter installation problems. For example, if you cannot log in to Simplicity Studio® 5 (SSv5) but know you are entering your Customer Account username and password correctly, or if you get an error about connecting to the update server and your computer is definitely connected to the Internet, see [SDK installation or updates are not working](#) for possible causes and solutions.

Install SSv5

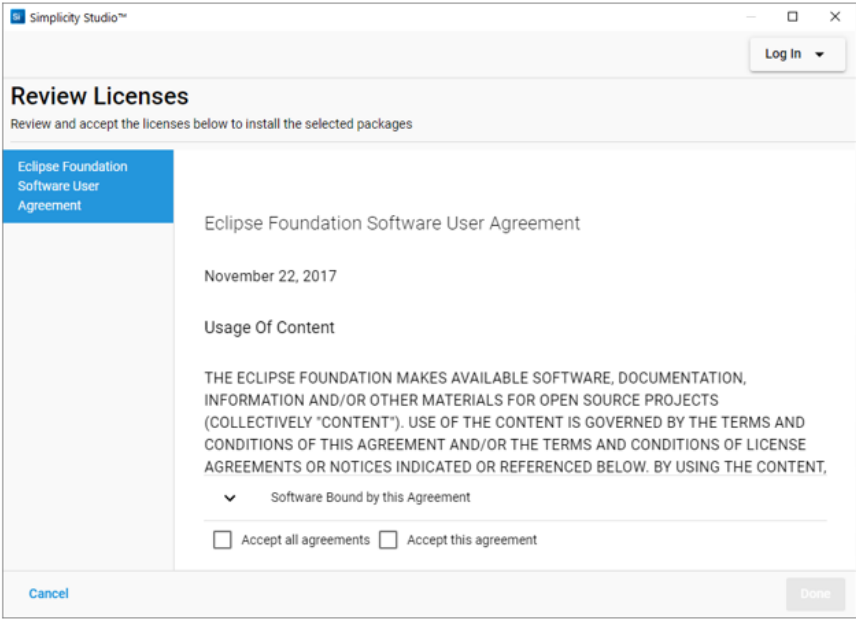
Instructions for installation [on Windows and MacOS](#) and [on Linux](#) are provided.

On Windows and MacOS

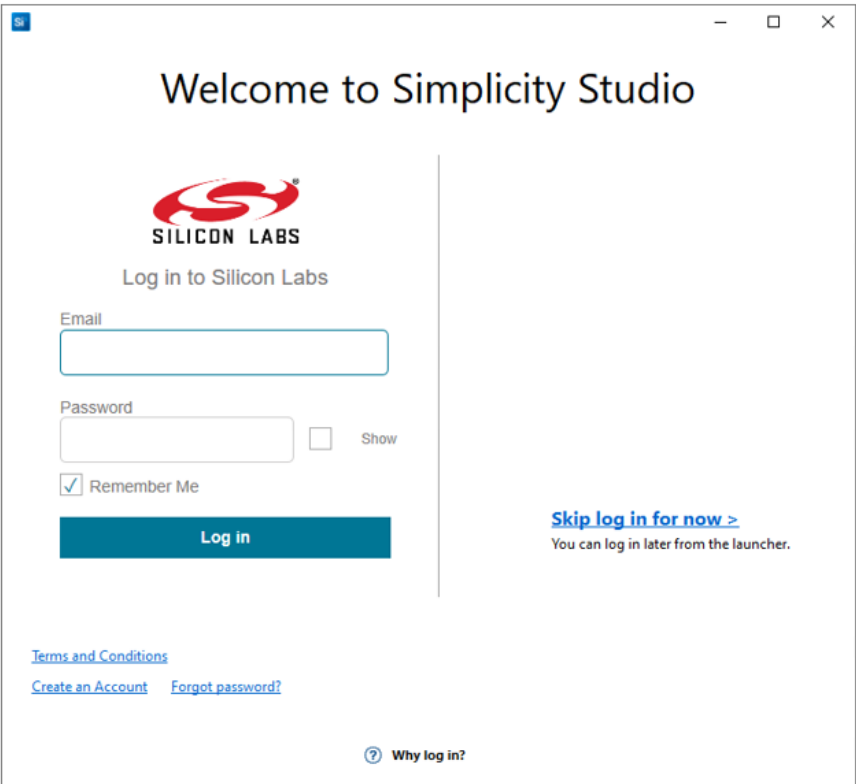
1. Download the SSv5 installation package from the Silicon Labs website. The Windows package is an '.iso' disk image. After the package finishes downloading, double-click it to mount the iso image as a drive and then double-click the setup.exe file inside the drive to launch the installer.
2. When the SSv5 installer first launches, it presents a Simplicity Studio License Agreement dialog. Accept the terms of the agreement and click **Next >**.



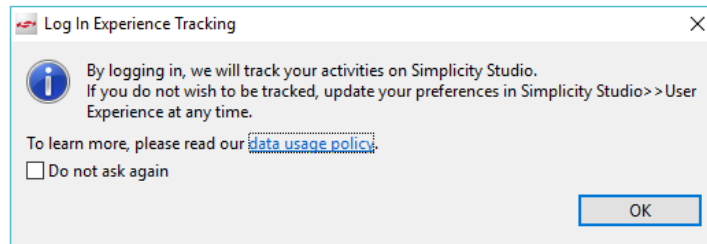
3. Choose a destination location, click **Next >**, and then click **Install**.
4. When SSv5 launches, you are presented with one or more additional license agreements. You can accept them individually or all at once. Click **DONE** when finished.



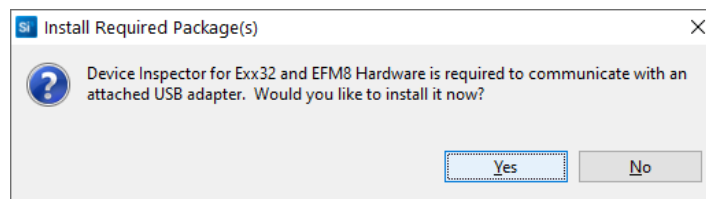
5. Next, you are invited to log in. Log in using your Silicon Labs account username and password. **NOTE:** Although you can skip log in here, you must be logged in to access some restricted access software packages.



6. Before login completes, you must agree to Experience Tracking. You can change the status later in SSv5 Preferences >> Simplicity Studio >> User Experience.



7. If you have hardware connected, depending on your operating system and security settings, you may need to allow SSv5 to make changes to your system. SSv5 prompts you to install the Device Inspector. Click **Yes**.



On Linux

Simplicity Studio for Linux® OS is only officially supported on Ubuntu® LTS distributions. Simplicity Studio might work on other distributions, but it is only tested and verified to work with Ubuntu® LTS.

The base Simplicity Studio platform (not an installer) is delivered in a tar file that should be expanded into the desired installation directory. The recommended installation directory is the user's root directory (`/home/USERNAME/SimplicityStudio_v5`). This directory must be one that can be updated without root permissions.

Before launching Simplicity Studio the first time, execute the following:

```
1 | sudo apt-get update
2 | sudo apt-get upgrade
3 | cd SimplicityStudio_v5
4 | sudo ./setup.sh
```

See Notices for more information on the setup.sh script.

When the Simplicity Studio executable 'studio' is launched, it starts a first-time installation process to add support either by a [connected debug adapter](#) or by [technology type](#).

Notices

setup.sh will:

1. Attempt to install dev rules for USB device connectivity
2. Install missing packages (libraries) through your system's package manager.

setup.sh will only install required external Linux® packages on Ubuntu® distributions. For other distributions, the setup.sh script should be examined for a list of possible packages that will need to be installed for Simplicity Studio to work.

The Wayland display protocol server is currently not supported, so make sure that X11 display protocol is being used by the Linux distribution or else use a script or otherwise set and export the GDK_BACKEND variable to x11 before starting Simplicity Studio. For example:

```
1 | export GDK_BACKEND=x11
2 | ./studio
```

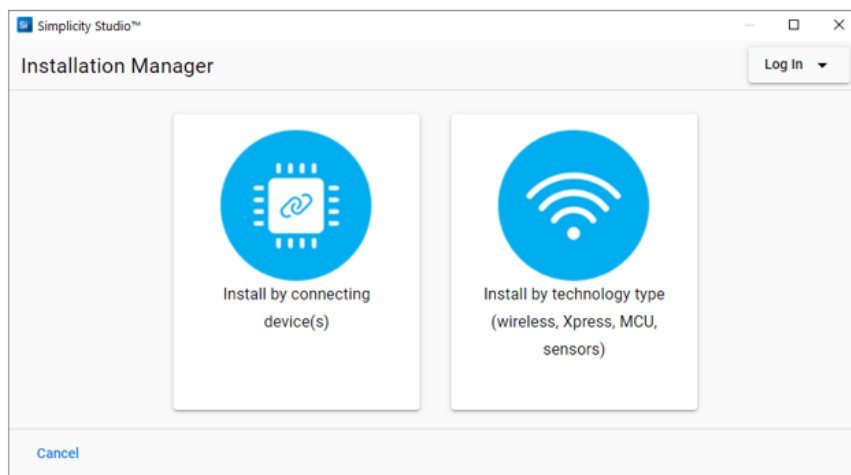
JxBrowser: Simplicity Studio uses the third party product JxBrowser to render several windows, including the installation window, Launcher perspective and Project Configurator windows. By default JxBrowser expands the Chromium browser into the /tmp folder. If this is not a good option because of file permissions of the /tmp folder, the location can be changed by adding a line to the studio.ini file specifying a different path such as: `-Djxbrowser.chromium.dir=/home/USERNAME/.jxbrowser`

Install Software

After SSv5 installation is complete, you are prompted to install software packages, such as the Gecko SDK (GSDK). SSv5 offers two options:

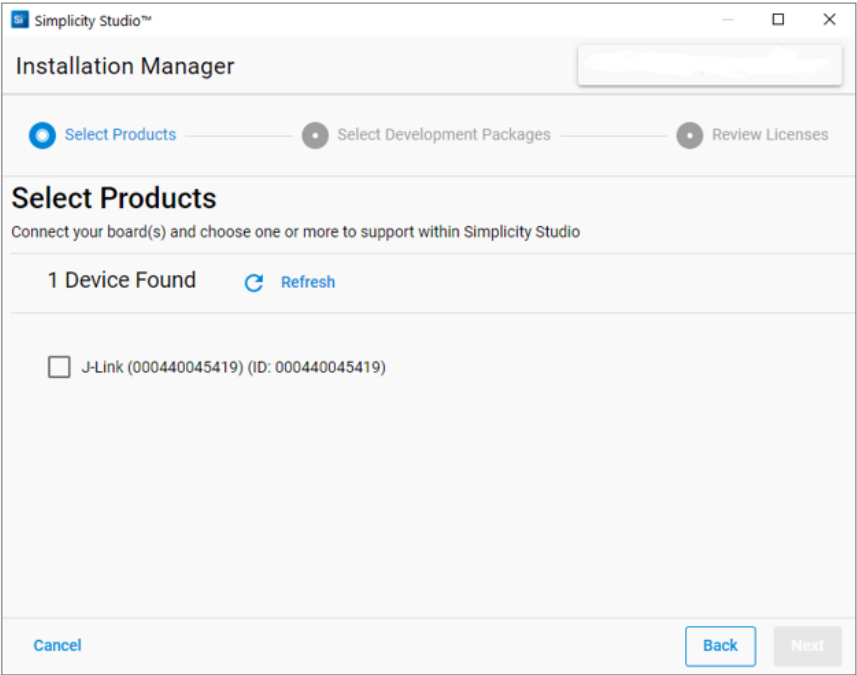
- [Install by Connecting Device\(s\)](#)
- [Install by Technology Type](#)

You do not need to have a target device connected to install by Technology Type.

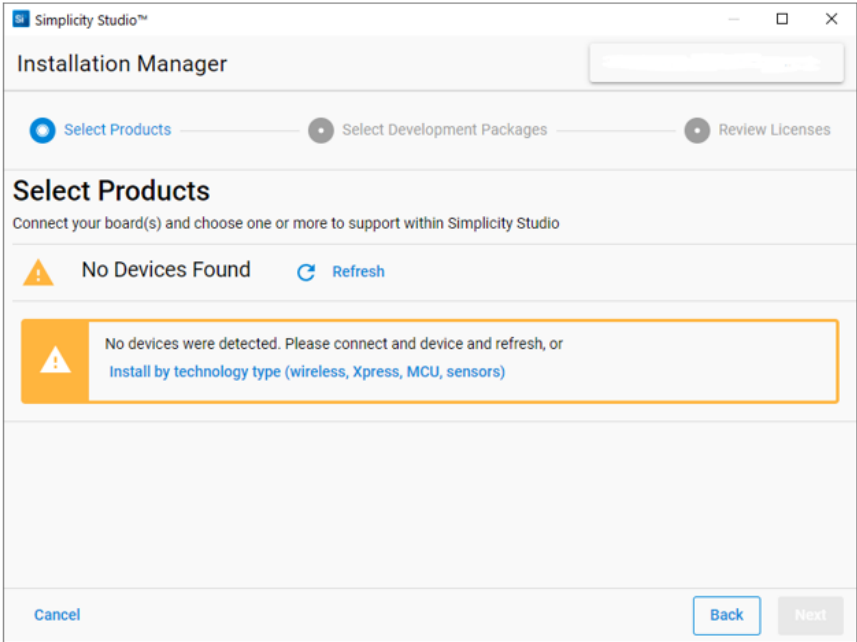


Install Software by Connecting Devices

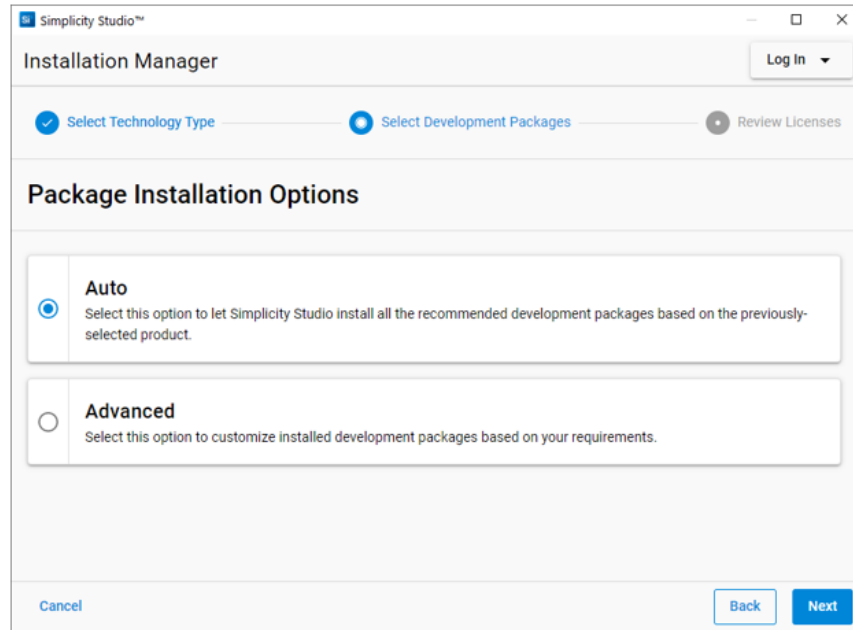
1. Make sure you have a device connected and click **Install by Connecting Devices**. The connected devices are shown.



If you do not see a connected device, or if you connect a device after this dialog is presented, click **Refresh**. If you do not have a device connected you cannot continue.

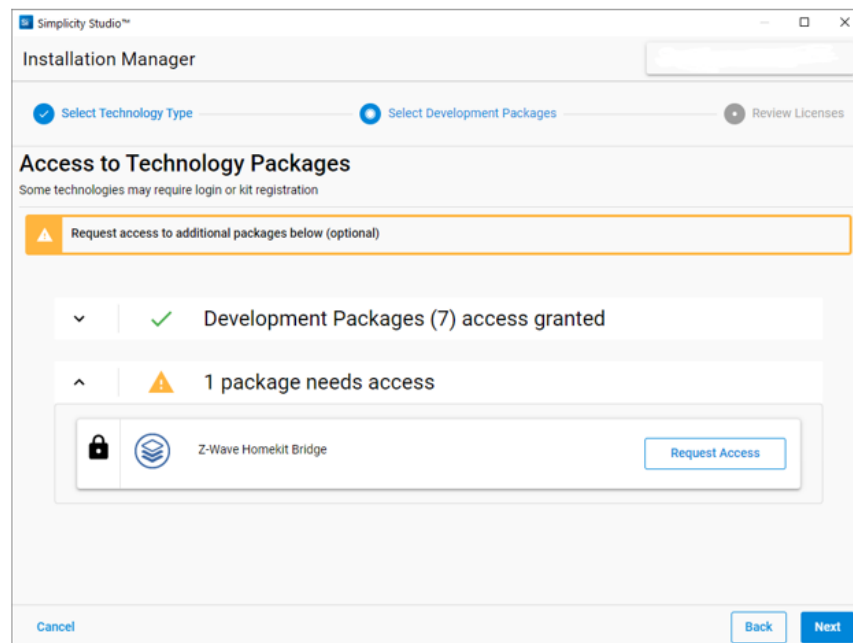


- 2. Select the device(s) to use. If you select more than one device with different software compatibilities, Studio will download any package that is compatible with any of the devices. Click **NEXT**.
- 3. You have two installation options, **Auto** and **Advanced**.

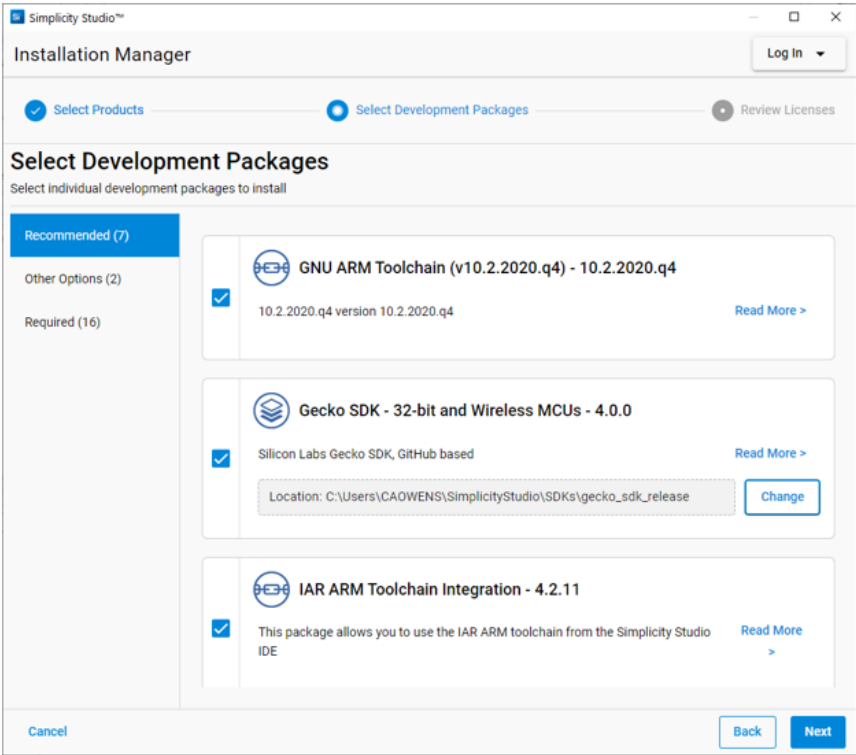


- Select **Auto** to have SSv5 automatically download all packages that are compatible with the connected hardware and to which you have permissions based on your login.
- Select **Advanced** to select which packages you want to install or to specify an installation location for the Gecko SDK.

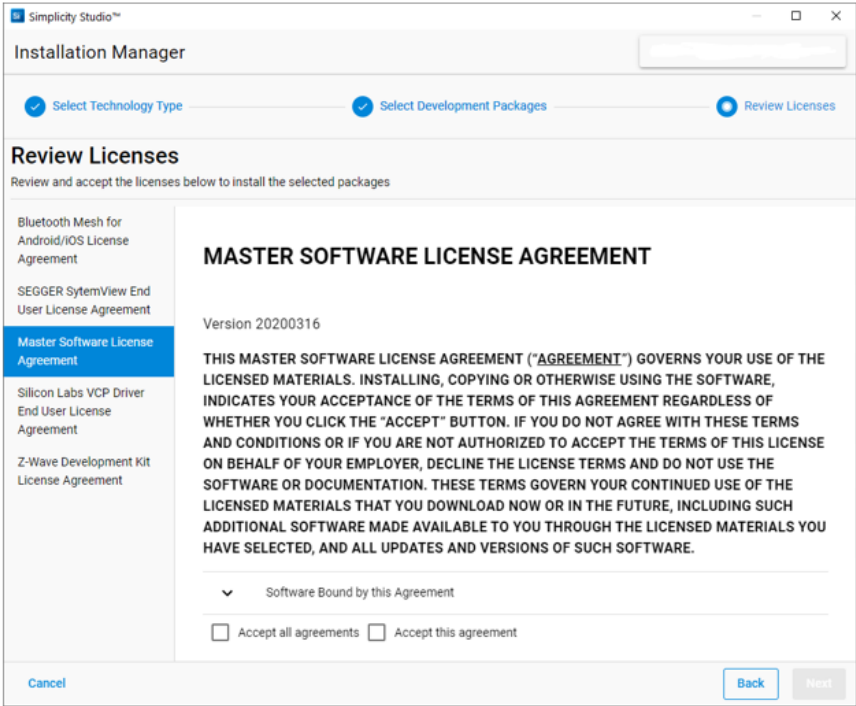
Depending on your connected device and login/account status, you may be requesting access to software for which you do not have permissions. If you have not logged in, do so now, as that may resolve access issues. If you are logged in, you can request access through this dialog.



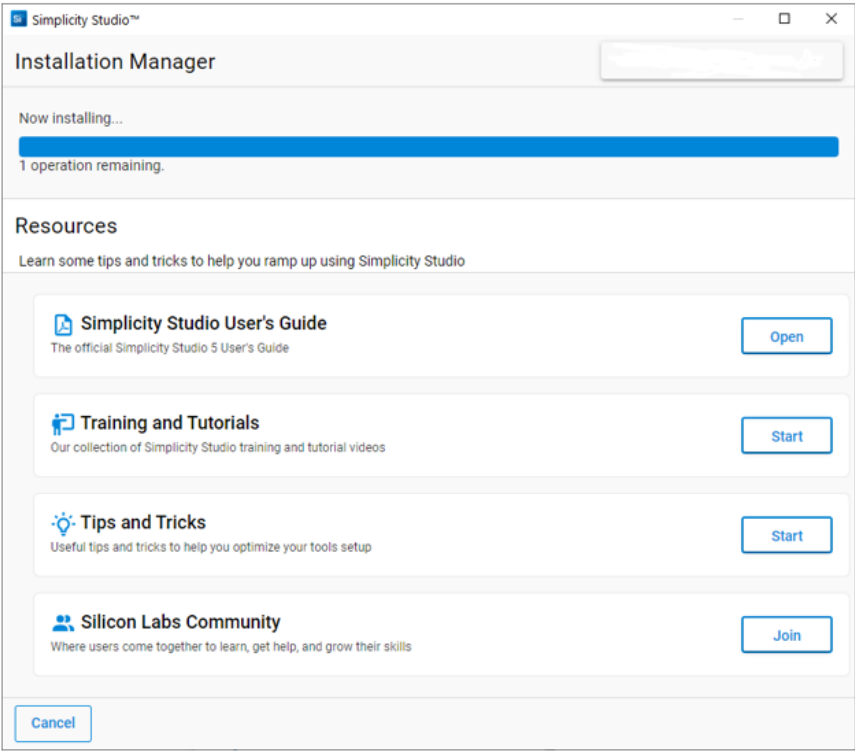
If you selected **Advanced**, all 'Required' packages must be installed. **NOTE:** Do not exclude packages unless you understand the full effect of the decision. Click **Read More** to see release notes for each item. Optionally change the default installation location for the Gecko SDK (GSDK). The GSDK installs as a clone of a GitHub repository. Do not select an existing folder with other content already in it, as your cloned repository will no longer be clean.



4. Before package installation begins, accept one or more software license agreements.

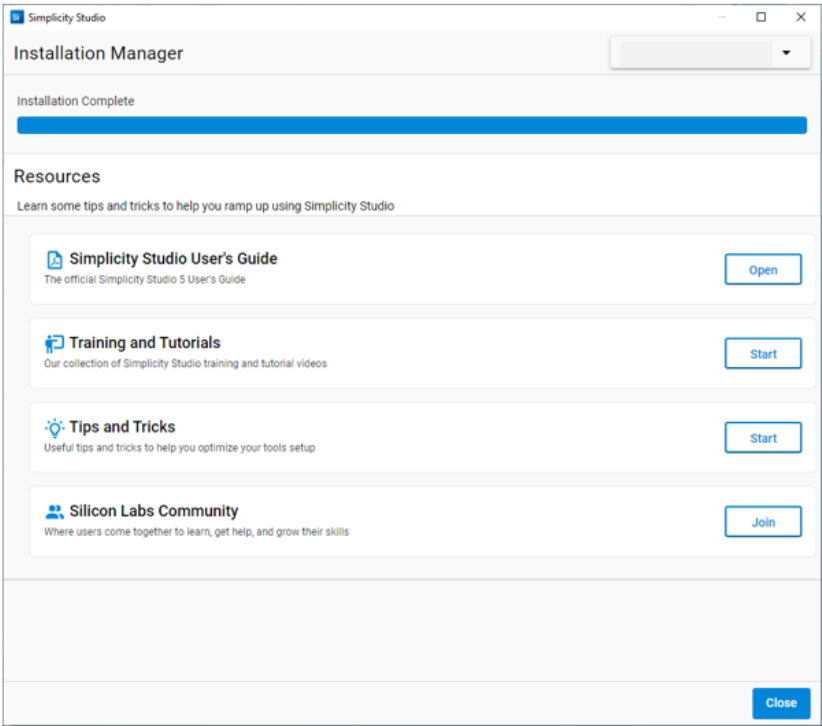


5. Once you click **NEXT**, installation begins.

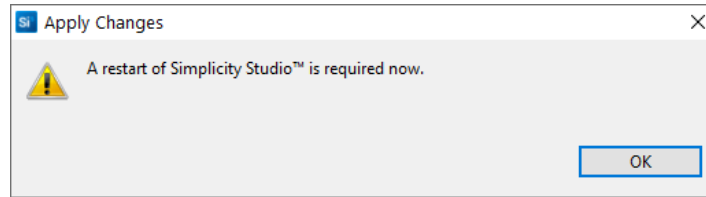


Depending upon your selections, installation may take some time. The progress bar may pause at points where large files are being installed, but will resume as they complete. If there is a problem during installation, SSv5 displays an error. You must restart SSv5 to resume.

6. When installation is complete, click **CLOSE**.

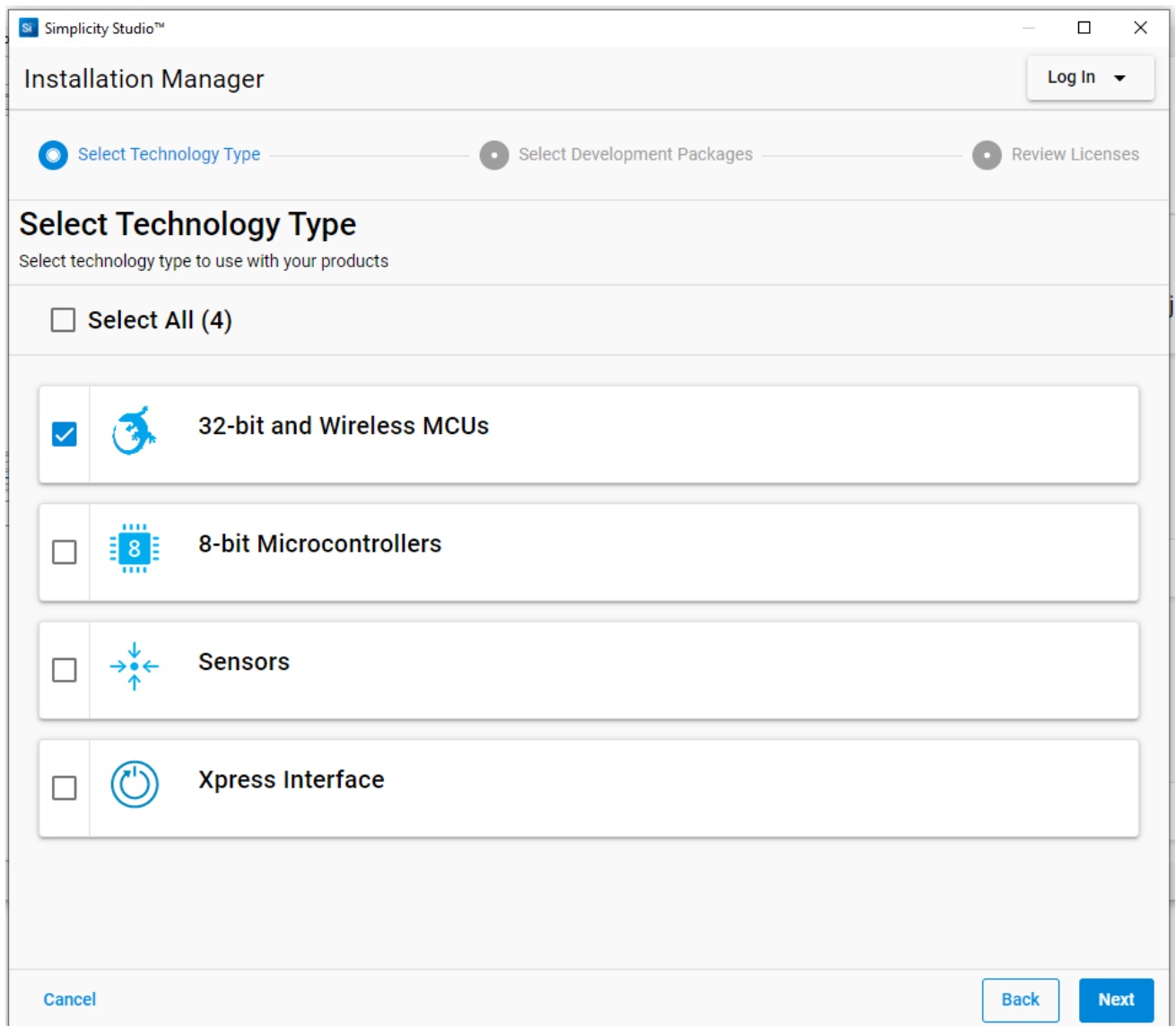


7. Click **RESTART** to begin working with projects.

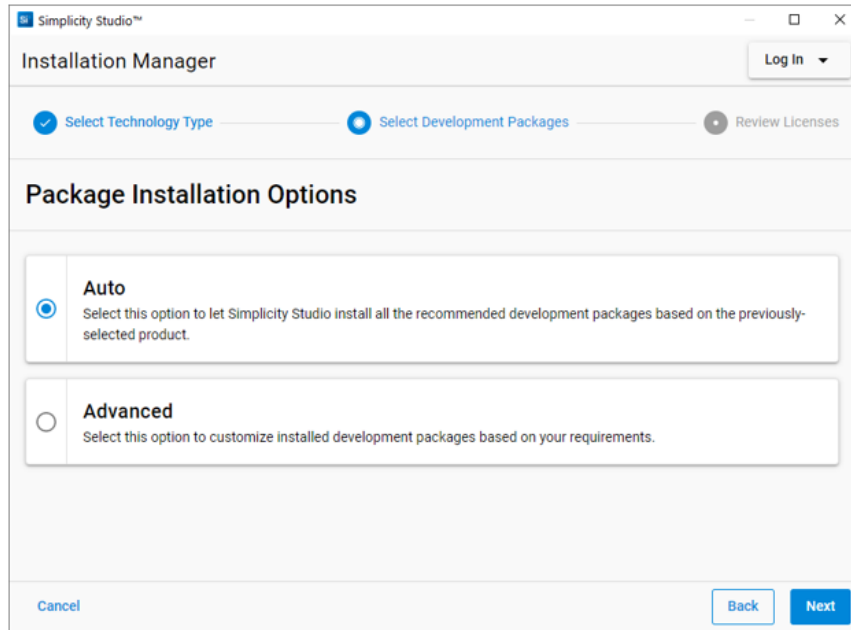


Install Software by Technology Type

1. Click **Install by Technology Type**
2. Select the technology(s) to install and click **NEXT**. To install the Gecko SDK Suite, select **32-Bit and Wireless MCUs**.

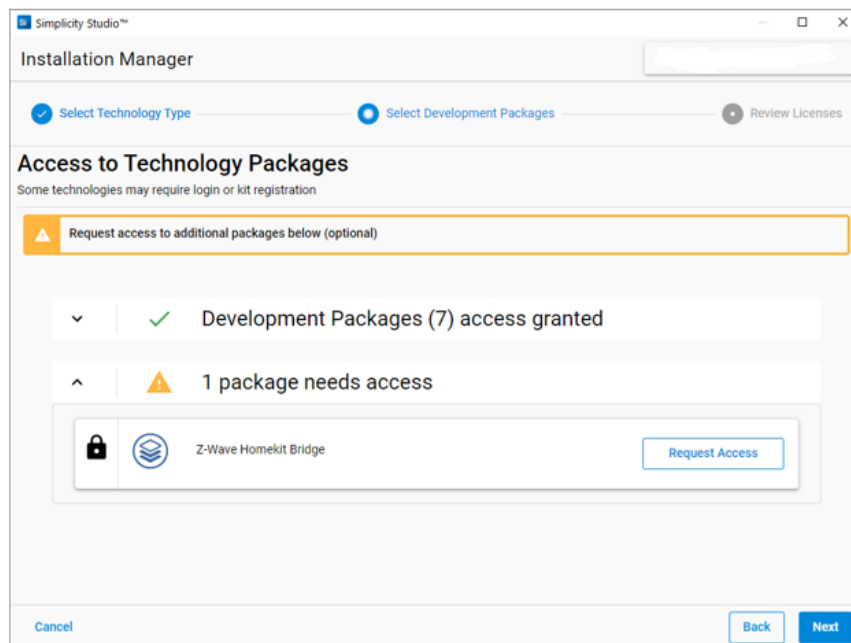


3. You have two installation options, **Auto** and **Advanced**.

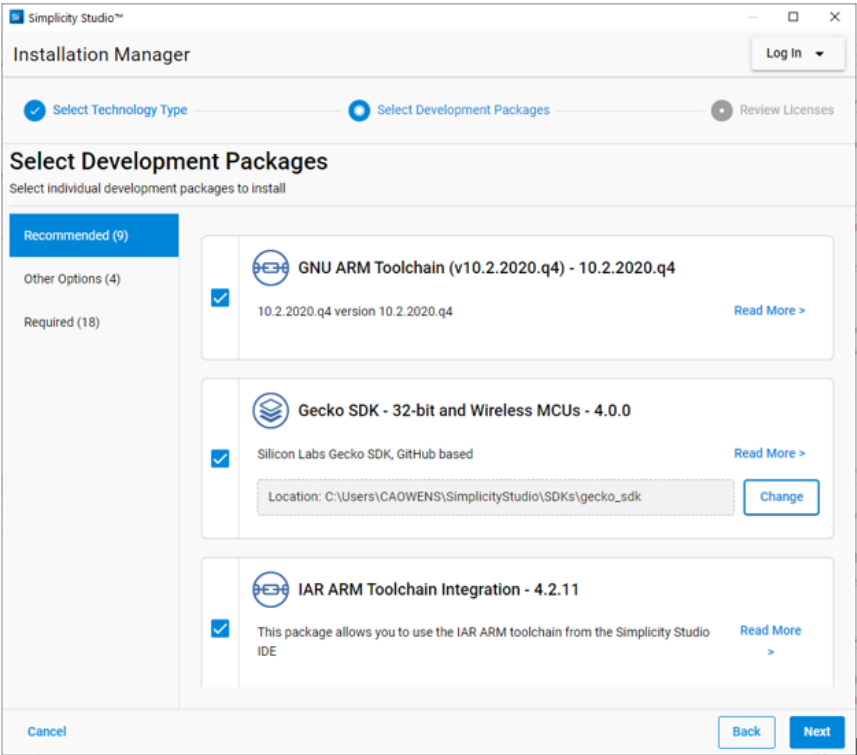


- Select **Auto** to have SSv5 automatically download all packages related to the selected technologies and to which you have permissions based on your login.
- Select **Advanced** to select which packages you want to install.

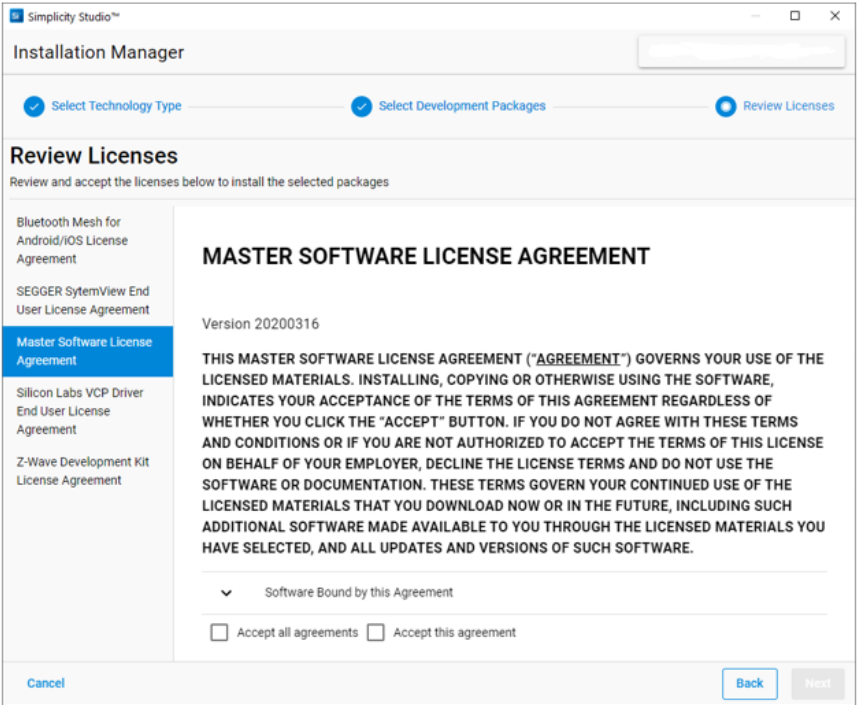
Depending on your connected device and login/account status, you may be requesting access to software for which you do not have permissions. If you have not logged in, do so now, as that may resolve access issues. If you are logged in you can request access through this dialog



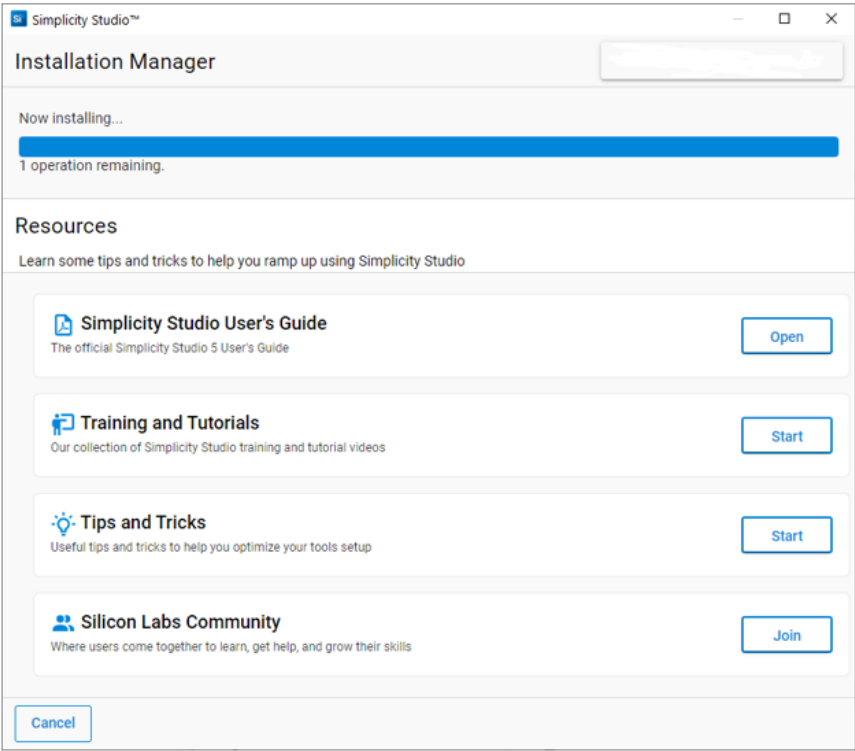
If you selected **Advanced**, all 'Required' packages must be installed. **NOTE:** Do not exclude packages unless you understand the full effect of the decision. Click **Read More** to see release notes for each item. Optionally change the default installation location for the Gecko SDK. The GSDK installs as a clone of a GitHub repository. Do not select an existing folder with other content already in it, as your cloned repository will no longer be clean.



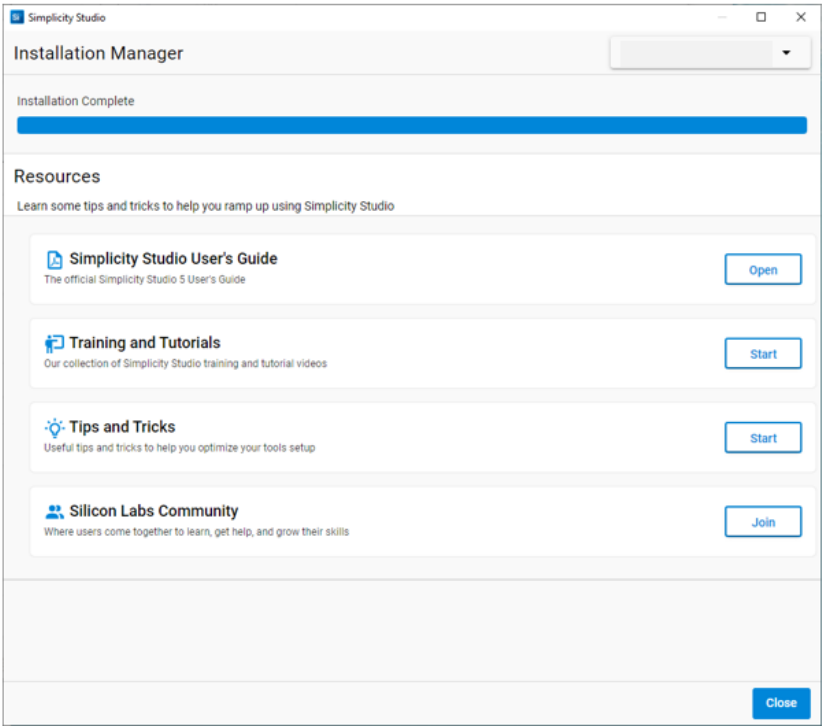
4. Before installation begins, accept one or more software license agreements.



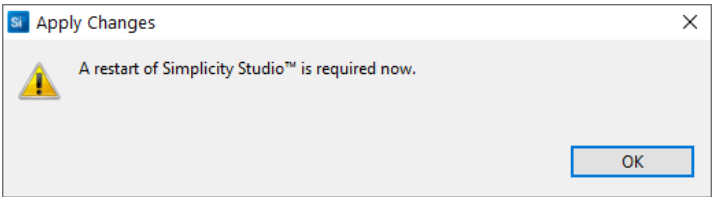
5. Once you click **NEXT**, installation begins.



- Depending upon your selections, installation may take some time. The progress bar may pause at points where large files are being installed, but will resume as they complete. If there is a problem during installation, SSv5 displays an error. You must restart SSv5 to resume.
6. When installation is complete, click **CLOSE**.



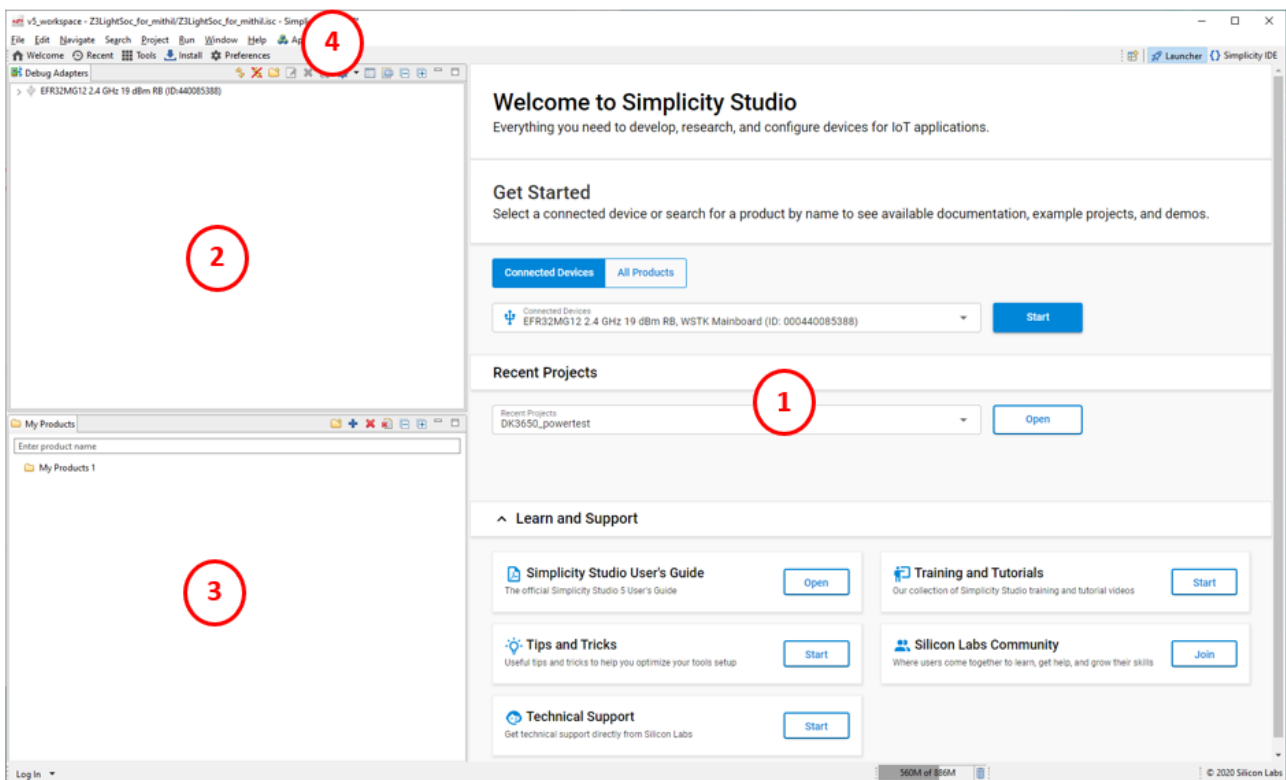
7. Click **RESTART** to begin working with projects.



Explore SSv5

Explore SSv5

When Simplicity Studio® 5 (SSv5) opens, the first screen is the Welcome page within the Launcher perspective. A "perspective" is an Eclipse term for an arrangement of views and an editor area. This page provides an overview of the Launcher perspective's main parts. A detailed reference to all of the functions accessed through the Launcher perspective can be found in the [About the Launcher](#) reference section.

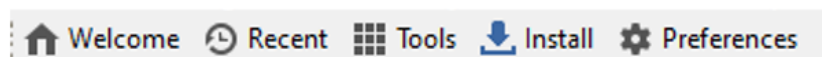


1 - **Editor**. The editor begins in Welcome mode. Here you get started by selecting a part, and then find resources and create projects based on that part. Note that, when you drop down the Learn and Support area, you have access to technical support, the Silicon Labs Community, and educational resources.

2 - **Debug Adapters view**: Shows devices physically connected to your computer with a debug adapter, or detected on a local network. Select a device to begin a project

3 - **My Product view**: Here you can add devices, boards, or kits and select them just like a connected kit. You can then explore resources or create and configure projects for the selected (target) device.

4 - **Menu and Toolbar**: Many of the main functions of interest are provided on the toolbar.



- **Welcome** returns you to the Launcher Welcome page.
- **Recent** shows you a list of recent projects. Select one to go to that project in the Simplicity IDE Project Explorer view.
- **Tools** provides a list of available tools.
- **Install** brings you to a menu where you can install or uninstall software packages and tools, or review available updates.
- **Preferences** is a shortcut to the list of preferences also available through the menu selection Window > Preferences.

Throughout SSv5, the contents of the launcher and other perspectives depends on the device you have selected as your development target, as well as your software environment. When you first open SSv5, the Launcher perspective does not have a target device context. When you connect a kit, it appears both in the the Debug Adapters view and in the device selector in the **Get Started** editor area.

Get Started

Select a connected device or search for a product by name to see available documentation, example projects, and demos.

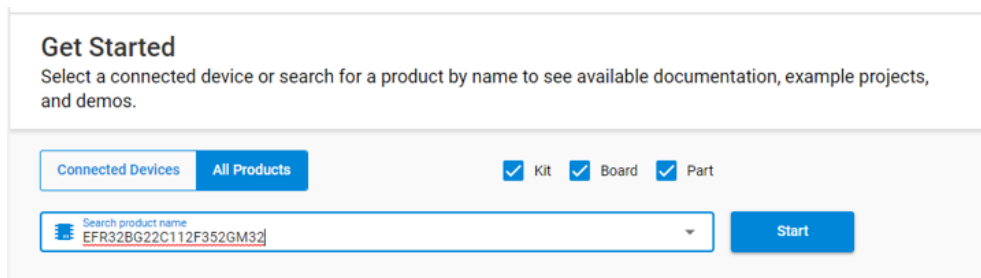


Connected Devices All Products

Connected Devices
J-Link Silicon Labs (440085390) (ID: 000440085390)

Start

If you don't have a Silicon Labs kit to connect, but would like to explore more of SSv5's functions, click **All Products**, and enter a part number for a kit, board, or device. As you type you will be presented with a list. Use the checkboxes to filter the list.



Get Started

Select a connected device or search for a product by name to see available documentation, example projects, and demos.

Connected Devices All Products

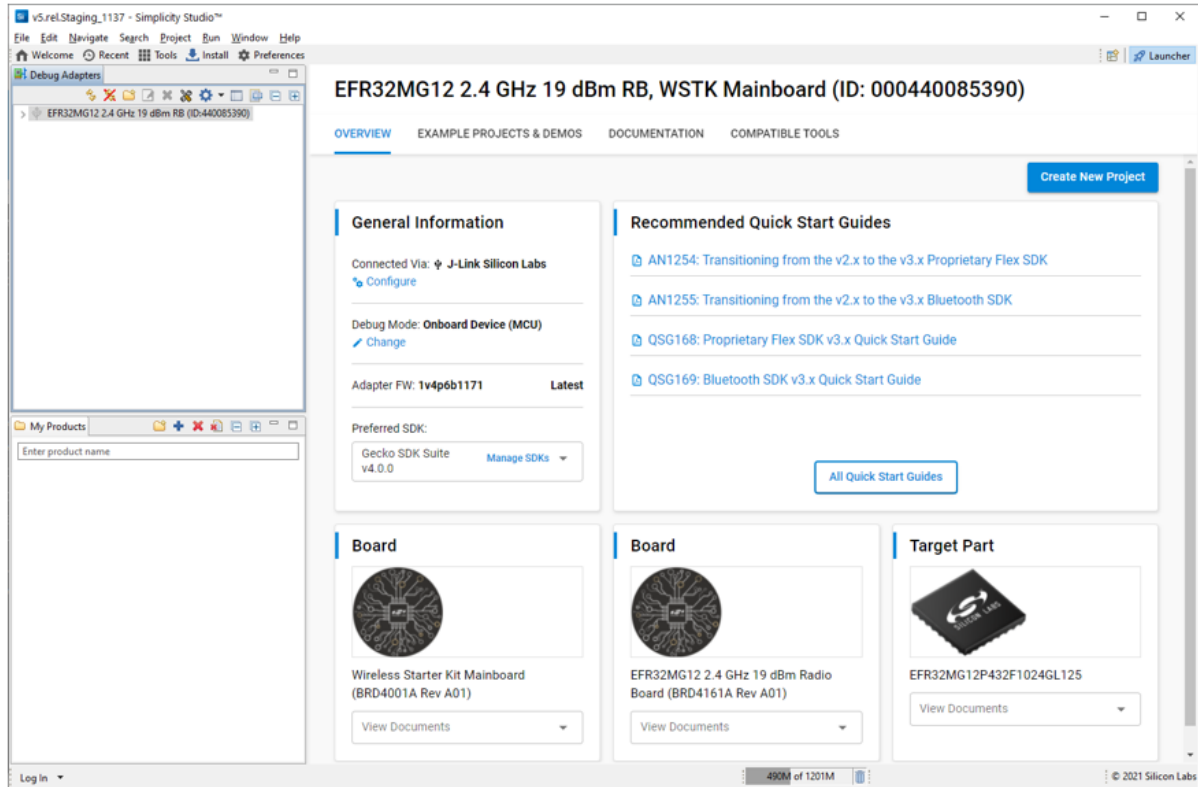
✓ Kit ✓ Board ✓ Part

Search product name
EFR32BG22C112F352GM32

Start

You can also add products to the My Products view, and select a target device there. If you have added a product under **Get Started**, once you click **Start** the selected product is added to the My Products view for easy access in the Welcome page or other Launcher perspective views.

Once you have connected or selected a target device, click **Start** to move to the Launcher perspective's OVERVIEW tab, showing the details about that device.



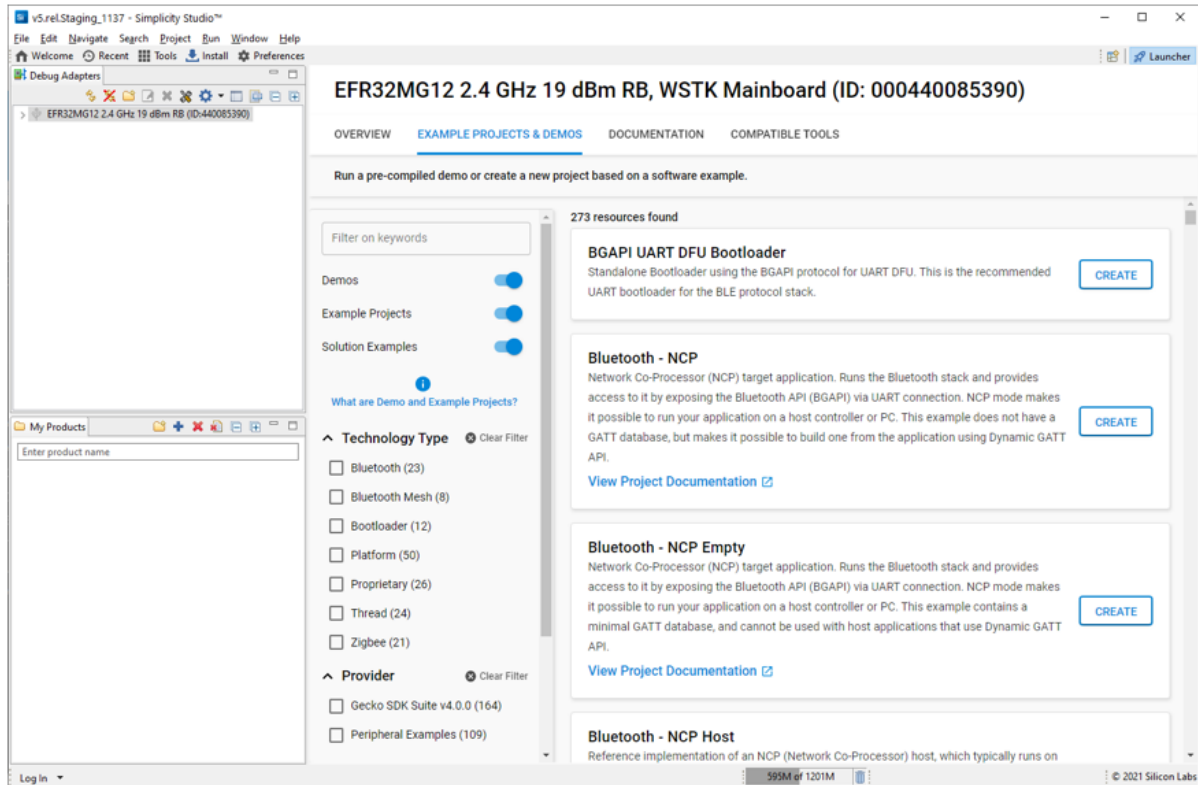
You'll find several "cards" on the OVERVIEW tab. The first is the **General Information** card where you can update the debug adapter firmware of your Silicon Labs kits, change the mode of the debug adapter, manage the security settings of the target device (if applicable), and change the active/preferred SDK.

The **Recommended Quick Start Guides** card highlights some of the getting-started resources available for the selected target device. Click **All Quick-Start Guides** to quickly go to the DOCUMENTATION tab, pre-filtered for quick-start guides. Cards are also available for each board and device of the selected target. The **View Documents** drop-down list on each hardware card provides a filtered view of hardware documentation for that item.

You can start a project with the **Create New Project** control. See [Start a Project](#) for an introduction to creating projects.

The EXAMPLE PROJECTS & DEMOS tab shows a list of example projects and demos compatible with the selected device. A demo is a prebuilt software example that can be loaded into a compatible device and used to show and test application functionality. Every demo comes with an associated example project. See the Quick Start Guide for your SDK for more information about the examples and demos provided.

Use the checkboxes and search box to filter the list. Click **RUN** on any demo to install it on a target device. Click **CREATE** on any project to create it. This is equivalent to creating a project from the OVERVIEW tab, except that the project is already selected.



EFR32MG12 2.4 GHz 19 dBm RB, WSTK Mainboard (ID: 000440085390)

OVERVIEW **EXAMPLE PROJECTS & DEMOS** DOCUMENTATION COMPATIBLE TOOLS

Run a pre-compiled demo or create a new project based on a software example.

Filter on keywords

273 resources found

BGAPI UART DFU Bootloader
Standalone Bootloader using the BGAPI protocol for UART DFU. This is the recommended UART bootloader for the BLE protocol stack. [CREATE](#)

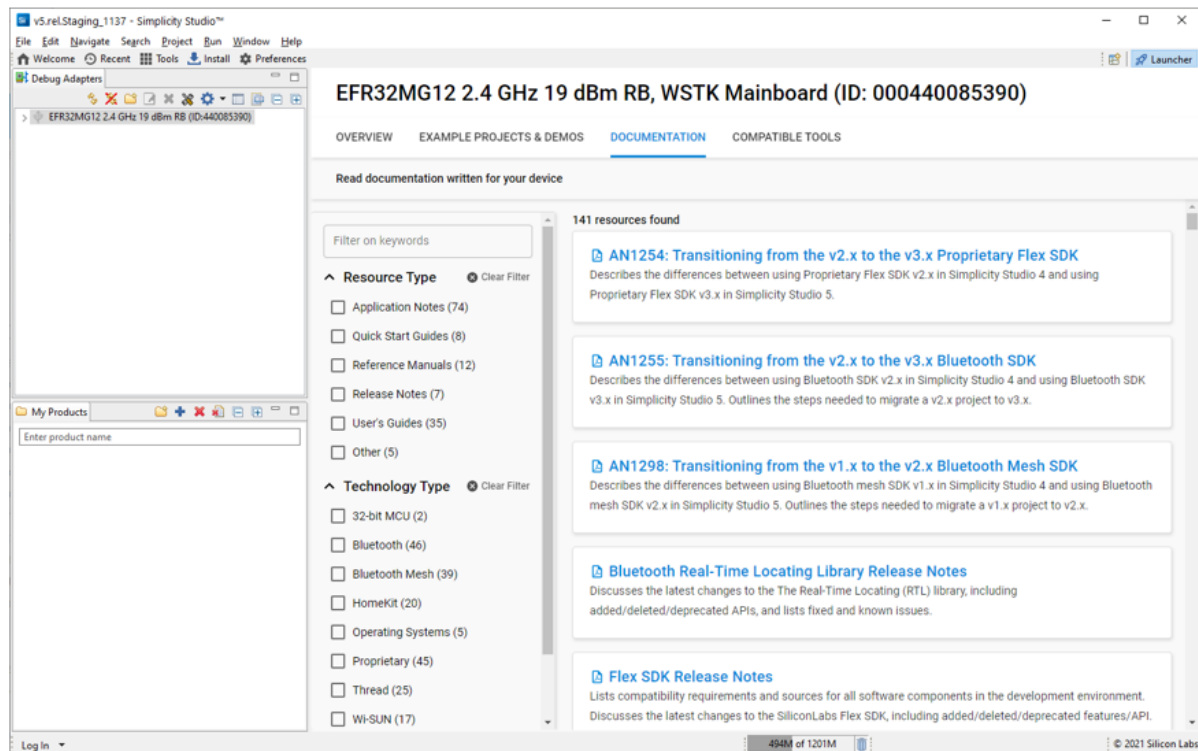
Bluetooth - NCP
Network Co-Processor (NCP) target application. Runs the Bluetooth stack and provides access to it by exposing the Bluetooth API (BGAPI) via UART connection. NCP mode makes it possible to run your application on a host controller or PC. This example does not have a GATT database, but makes it possible to build one from the application using Dynamic GATT API. [CREATE](#)
[View Project Documentation](#)

Bluetooth - NCP Empty
Network Co-Processor (NCP) target application. Runs the Bluetooth stack and provides access to it by exposing the Bluetooth API (BGAPI) via UART connection. NCP mode makes it possible to run your application on a host controller or PC. This example contains a minimal GATT database, and cannot be used with host applications that use Dynamic GATT API. [CREATE](#)
[View Project Documentation](#)

Bluetooth - NCP Host
Reference implementation of an NCP (Network Co-Processor) host, which typically runs on

Log In

The DOCUMENTATION tab shows all documentation compatible with the selected device. Use the checkboxes or text filter field to find a resource of interest. The technology filter corresponding to your development environment will show you most software documents relevant to that environment.



EFR32MG12 2.4 GHz 19 dBm RB, WSTK Mainboard (ID: 000440085390)

OVERVIEW EXAMPLE PROJECTS & DEMOS **DOCUMENTATION** COMPATIBLE TOOLS

Read documentation written for your device

Filter on keywords

141 resources found

AN1254: Transitioning from the v2.x to the v3.x Proprietary Flex SDK
Describes the differences between using Proprietary Flex SDK v2.x in Simplicity Studio 4 and using Proprietary Flex SDK v3.x in Simplicity Studio 5.

AN1255: Transitioning from the v2.x to the v3.x Bluetooth SDK
Describes the differences between using Bluetooth SDK v2.x in Simplicity Studio 4 and using Bluetooth SDK v3.x in Simplicity Studio 5. Outlines the steps needed to migrate a v2.x project to v3.x.

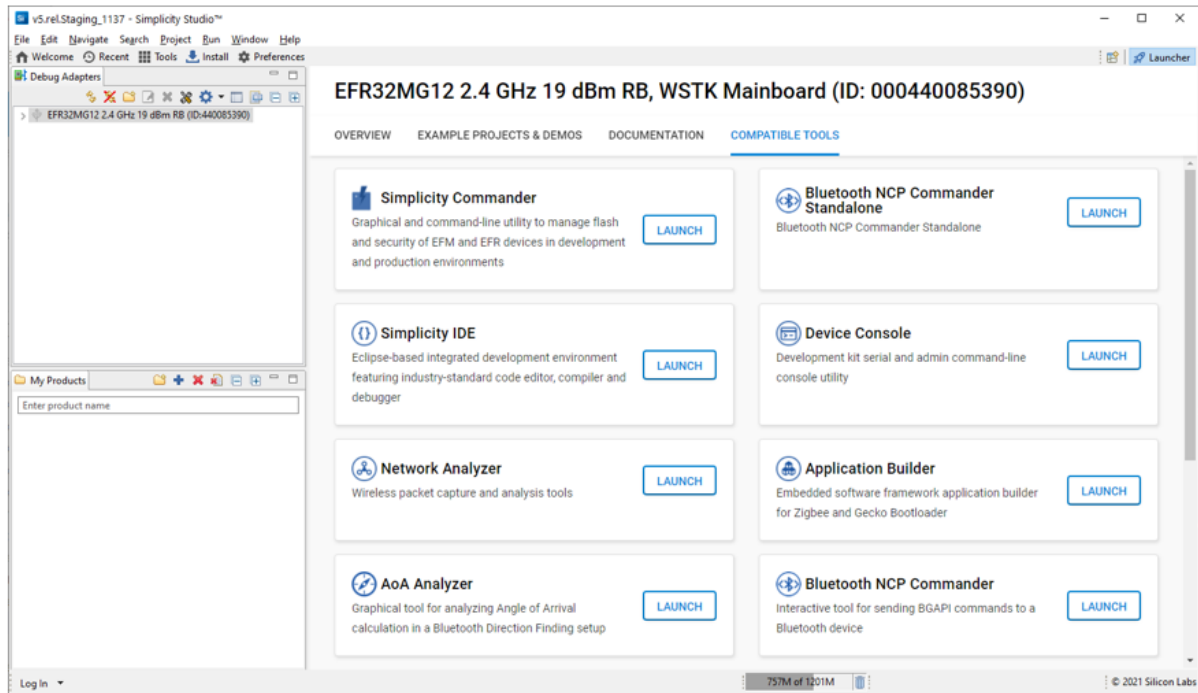
AN1298: Transitioning from the v1.x to the v2.x Bluetooth Mesh SDK
Describes the differences between using Bluetooth mesh SDK v1.x in Simplicity Studio 4 and using Bluetooth mesh SDK v2.x in Simplicity Studio 5. Outlines the steps needed to migrate a v1.x project to v2.x.

Bluetooth Real-Time Locating Library Release Notes
Discusses the latest changes to the The Real-Time Locating (RTL) library, including added/deleted/deprecated APIs, and lists fixed and known issues.

Flex SDK Release Notes
Lists compatibility requirements and sources for all software components in the development environment. Discusses the latest changes to the SiliconLabs Flex SDK, including added/deleted/deprecated features/API.

Log In

The COMPATIBLE TOOLS tab shows the tools compatible with the selected device. The Tools button on the toolbar shows all tools unfiltered.



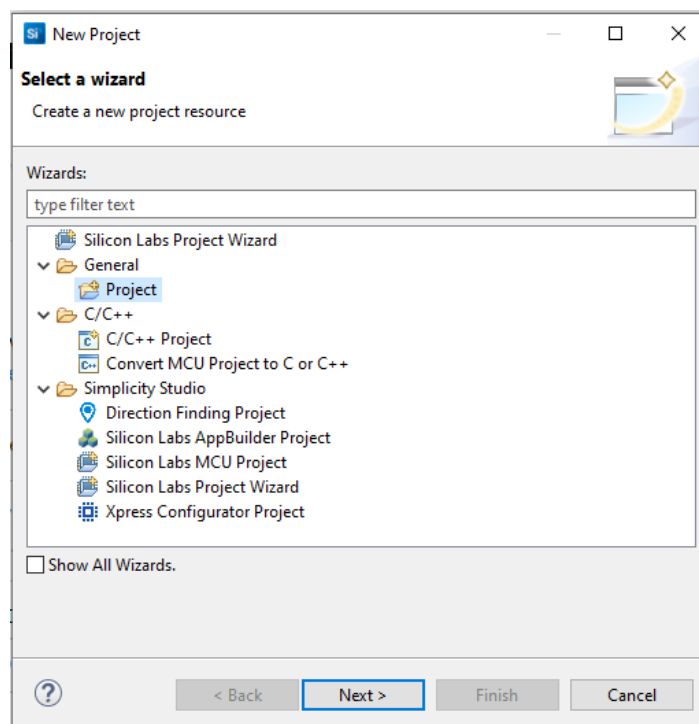
Start a Project

Start a Project

Simplicity Studio® 5 (SSv5) supports several different project types, which can be created through **File > New**. These include:

- Silicon Labs Project Wizard (creates Project Configurator projects, as described in this section)
- [Solution...](#)
- Project... (opens the New Project Wizards dialog)
- Other (combines all of the above selections with other, rarely used options)

Select **Files > New > Project** to open the New Project Wizards dialog.



Most notably:

- Silicon Labs Project Wizard (two instances) and also Silicon Labs MCU Project Wizard: Creates Project Configurator projects, as described in this section.
- Direction Finding Project Wizard: Creates [Bluetooth multi-locator direction-finding projects](#)
- AppBuilder Project Wizard: Creates an [AppBuilder Project](#)

This page focuses on Project Configurator (*.slcp) projects. On this page:

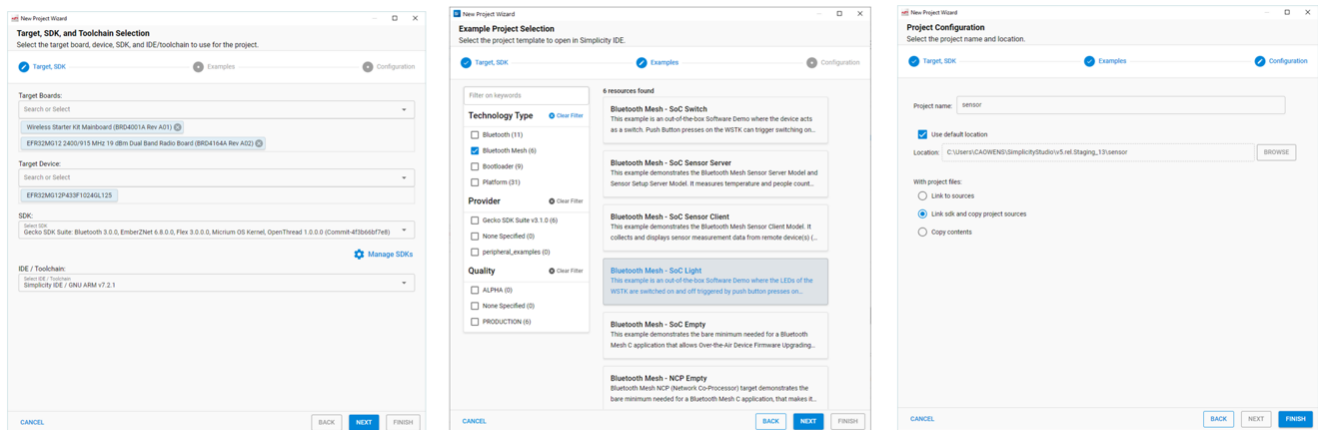
- [Configurator Project Creation](#)
 - [Target, SDK, and Toolchain Selection](#)
 - [Examples](#)
 - [Configuration](#)
- [About Project Configurator Projects](#)
 - [Pin Tool](#)
 - [Bluetooth GATT Configurator](#)
 - [Bluetooth Mesh Configurator](#)
 - [Proprietary Radio Configurator](#)

- [Zigbee Cluster Configurator](#)
- [About AppBuilder Projects](#)

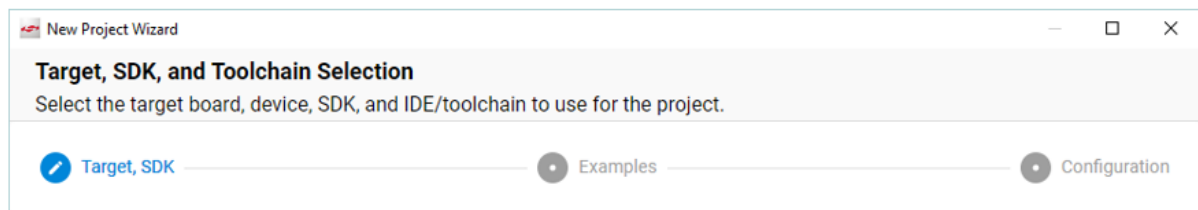
Project Creation

New Simplicity Studio® 5 (SSv5) projects are created through a sequence of three dialogs:

- [Target, SDK, and Toolchain](#)
- [Examples](#)
- [Configuration](#)



An indicator at the top of the dialog shows you where you are.



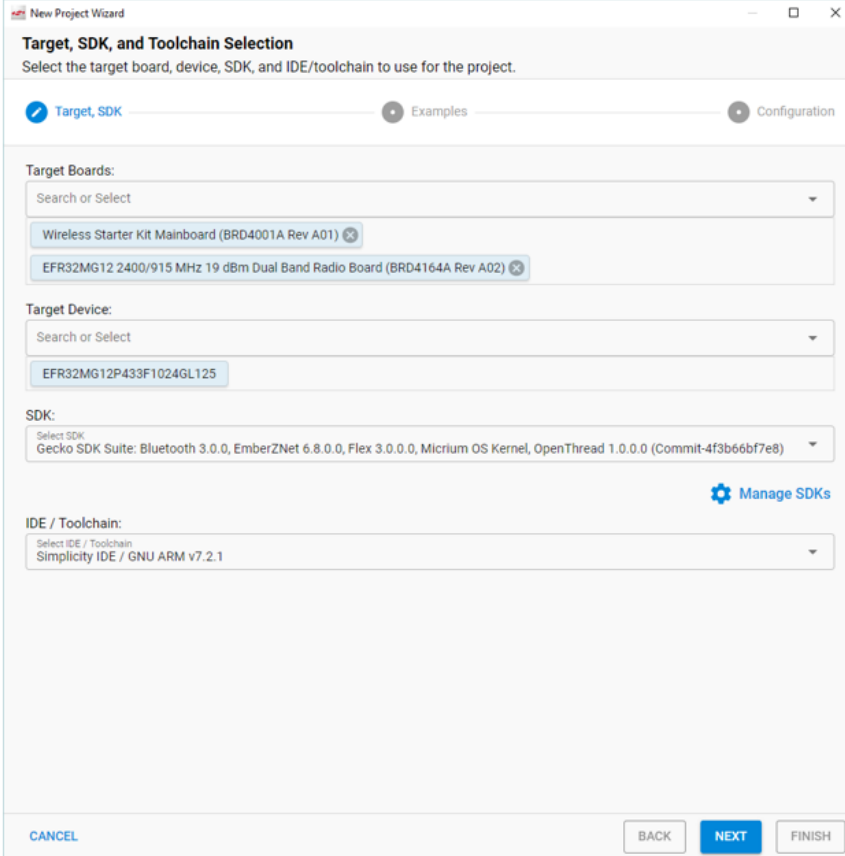
You can start a project from three different locations in the Launcher Perspective. Where you start determines which of the three dialogs you will land on. Click **BACK** to move to an earlier dialog, if you need to make a change.

- **From the OVERVIEW tab:** Click **Create New Project**. Starts on the Examples dialog.
- **From the EXAMPLE PROJECTS tab:** Use the filters as needed, select a project, and click **CREATE**. Starts on the Project Configuration dialog.
- **From the file menu:** Select New >> Silicon Labs Project Wizard. Starts on the Target, SDK, and Toolchain Selection dialog.

While you are getting started, you can leave the default values in place.

Target, SDK, and Toolchain Selection

If you have connected or selected a target, all information is pre-populated. Otherwise you can select target parts here. Click **NEXT**.



The image shows a 'New Project Wizard' window with the title 'New Project Wizard'. Below the title bar is a header section titled 'Target, SDK, and Toolchain Selection' with the instruction 'Select the target board, device, SDK, and IDE/toolchain to use for the project.' Below this is a progress bar with three steps: 'Target, SDK' (selected), 'Examples', and 'Configuration'. The main content area is divided into four sections: 'Target Boards:' with a search bar and two results ('Wireless Starter Kit Mainboard (BRD4001A Rev A01)' and 'EFR32MG12 2400/915 MHz 19 dBm Dual Band Radio Board (BRD4164A Rev A02)'); 'Target Device:' with a search bar and one result ('EFR32MG12P433F1024GL125'); 'SDK:' with a dropdown menu showing 'Gecko SDK Suite: Bluetooth 3.0.0, EmberZNet 6.8.0.0, Flex 3.0.0.0, Micrium OS Kernel, OpenThread 1.0.0.0 (Commit-4f3b66bf7e8)' and a 'Manage SDKs' link; and 'IDE / Toolchain:' with a dropdown menu showing 'Simplicity IDE / GNU ARM v7.2.1'. At the bottom are 'CANCEL', 'BACK', 'NEXT', and 'FINISH' buttons.

New Project Wizard

Target, SDK, and Toolchain Selection
Select the target board, device, SDK, and IDE/toolchain to use for the project.

Target, SDK Examples Configuration

Target Boards:

Search or Select

Wireless Starter Kit Mainboard (BRD4001A Rev A01)

EFR32MG12 2400/915 MHz 19 dBm Dual Band Radio Board (BRD4164A Rev A02)

Target Device:

Search or Select

EFR32MG12P433F1024GL125

SDK:

Select SDK:
Gecko SDK Suite: Bluetooth 3.0.0, EmberZNet 6.8.0.0, Flex 3.0.0.0, Micrium OS Kernel, OpenThread 1.0.0.0 (Commit-4f3b66bf7e8)

[Manage SDKs](#)

IDE / Toolchain:

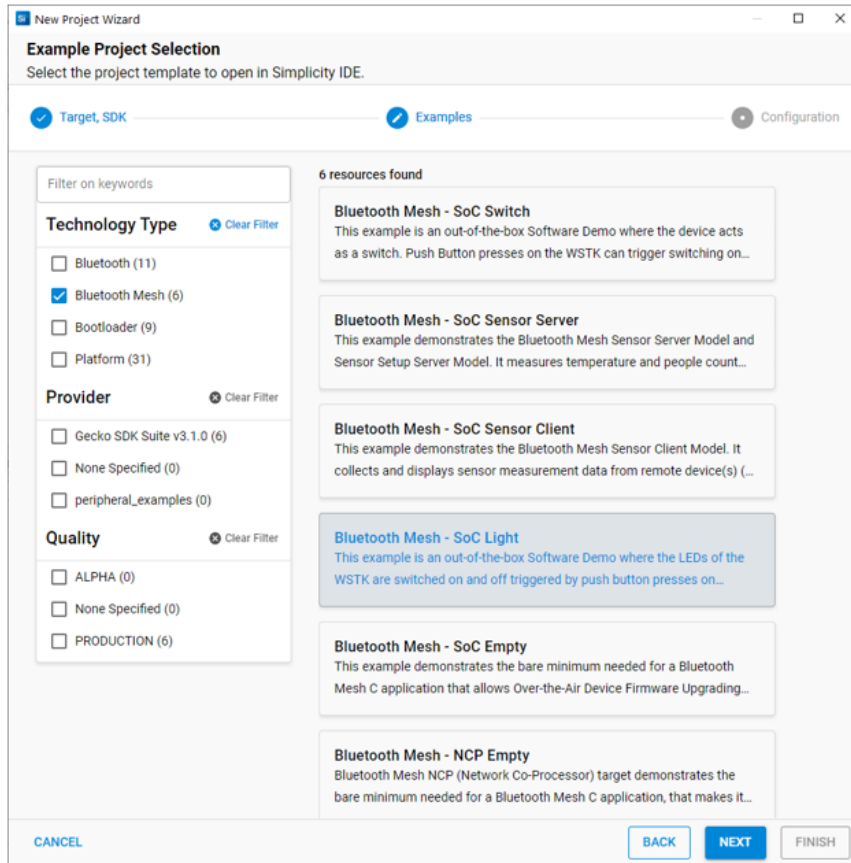
Select IDE / Toolchain:
Simplicity IDE / GNU ARM v7.2.1

CANCEL BACK NEXT FINISH

Note that if you want to use IAR in SSV5, select it here. If you are developing in the Project Configurator environment, it is difficult to change compilers once the project is created.

Examples

Use the checkboxes or keywords to find the example of interest, then select it and click **NEXT**.

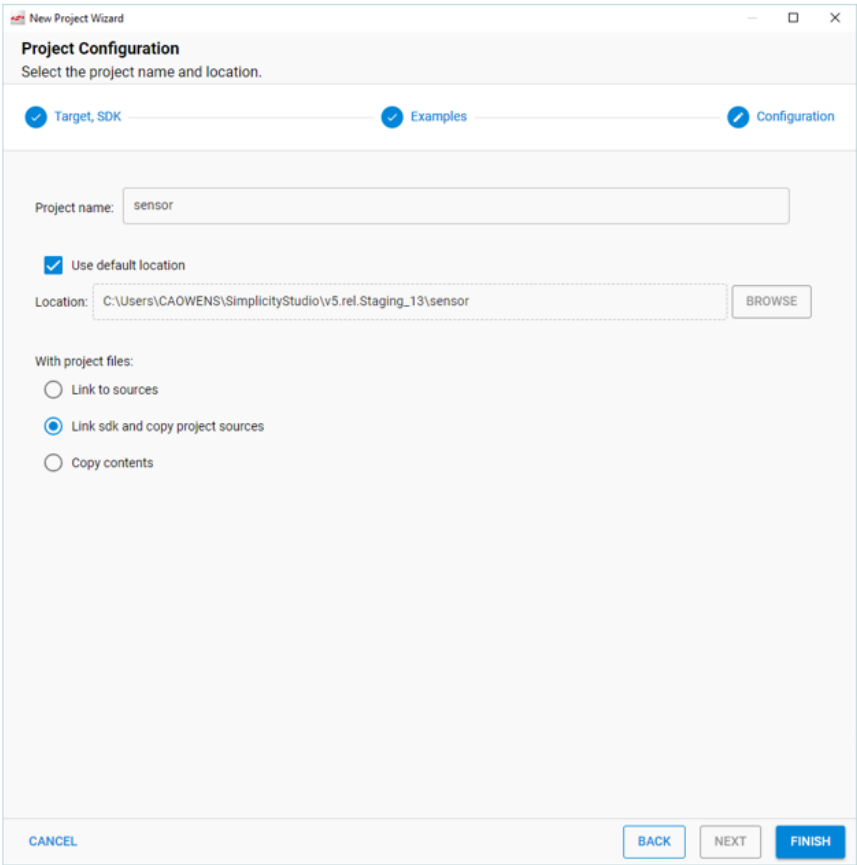


Configuration

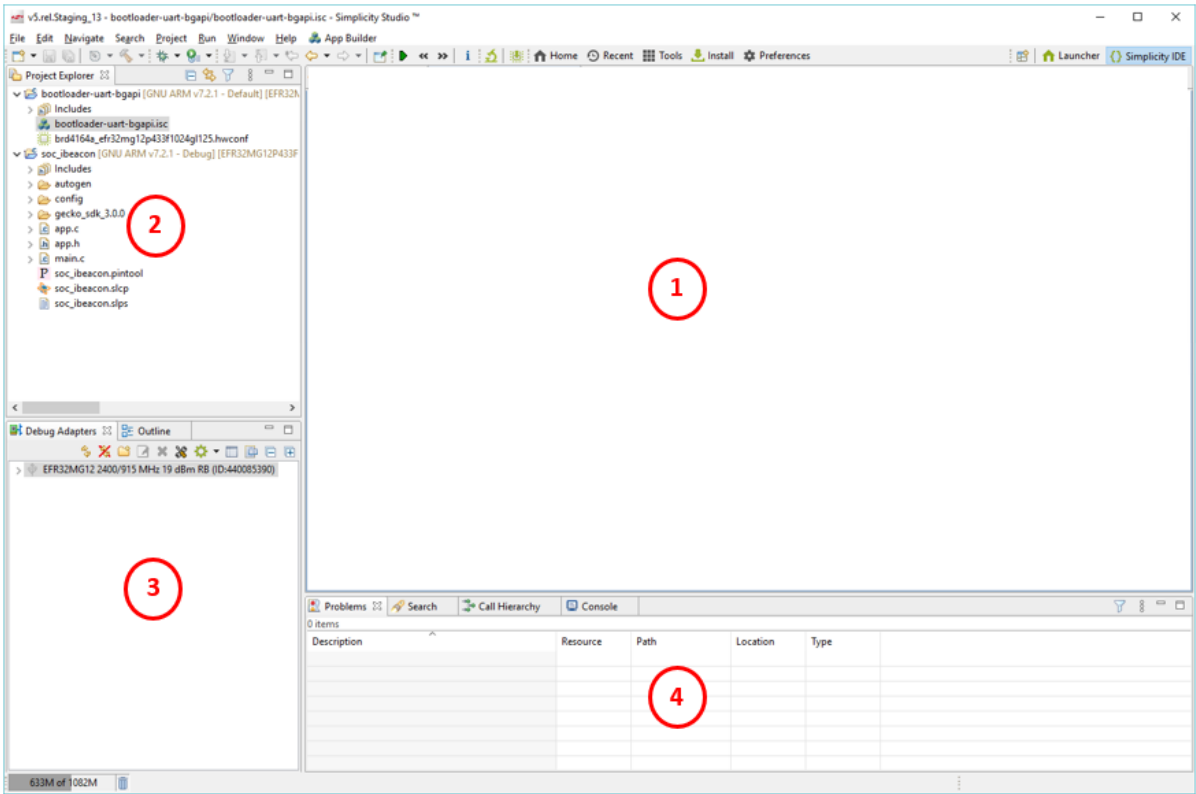
Rename your project if you want. The three selections under "With project files" control which sources are copied and which are linked. If a linked source is modified, the changes apply to any other project linking to that source.

- Link to sources: The project links both to the SDK files and to project files such as app.c.
- Link SDK and copy project sources (default): Project sources are copied to your workspace. Note that the SDK folder structure is created but if you drill down you will see that all folders are empty.
- Copy contents: Both project files and the SDK files are copied to your workspace.

Click **FINISH**.



Once you finish project creation, the Simplicity IDE perspective opens. There may be a slight delay for initial configuration. For details on all the features and functions available in this perspective, see [About the Simplicity IDE](#).



- 1 - **Editor area** (depends on the project).
- 2 - **Project Explorer** view: Lists the projects and solutions available in your workspace.
- 3 - **Debug Adapters** view: Lists the kits or SEGGER J-Links connected to your computer via USB or detected on a local network.
- 4 - **Developer** views: A set of views of use during the development process.

The editor in the Simplicity IDE perspective depends on the project:

- **Project Configurator**: Used for all Gecko SDK protocols and tools beginning with Gecko SDK 4.0; Project files end in .slcp.
- **8-bit Hardware Configurator**: Used for 8-bit device applications.
- **AppBuilder**: Used for Zigbee EmberZNet and Gecko Bootloader in Gecko SDK 3.2 and lower; Project files end in .isc.

Project Configurator Projects

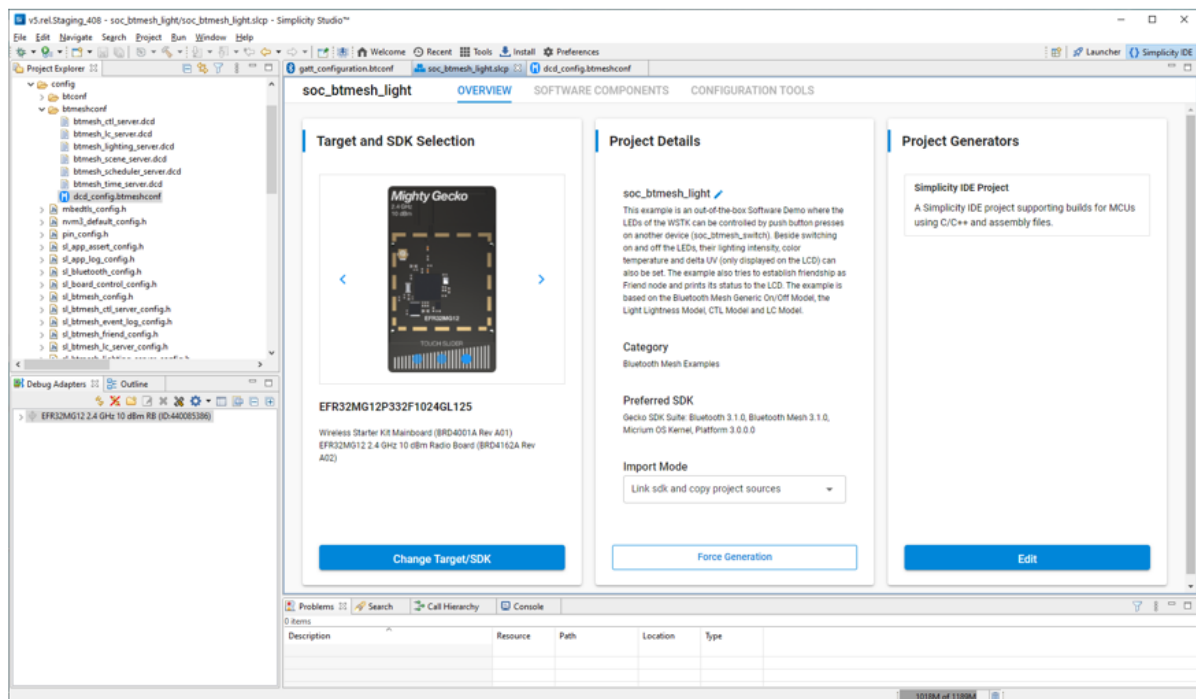
As well as introducing Project Configurator projects, this page also introduces

- The [Pin Tool](#)
- Bluetooth and Bluetooth Mesh SDK's [GATT Configurator](#)
- Bluetooth Mesh SDK's [Bluetooth Mesh Configurator](#)
- Proprietary SDK's [Radio Configurator](#)
- Zigbee EmberZNet SDK's [Zigbee Cluster Configurator](#)

Project Configurator projects are defined in **.slcp** (Silicon Labs Configurator project) files. Users can modify the project by adding, removing, and configuring components on the Software Components tab. See [Developing with Project Configurator](#) for details.

NOTE: Beginning with Simplicity Studio version 5.3, you can create a project in the Simplicity IDE by importing an .slcp file. See [Import and Export](#) for more information.

The project opens, generally either on a README tab containing an example project description, or on an OVERVIEW tab.



The OVERVIEW tab has three cards with information, some with settings that may be changed:

- **Target and SDK selection**, where you can change your development target and SDK.
- **Project Details**, where you can rename the project, change the project source import mode and, if necessary, force the generation of project and source files (in the *autogen* folder).
 - **Import mode** controls which resources are copied and which are linked. If you modify a linked source, your changes apply to any other project linking to that source.
 - **Force Generation** can be used in rare cases when auto-generation is not triggered, usually because of some change made outside of SSV5 such as editing the .slcp file.
- **Project Generators** allows you to change the IDE or build system project files that SSV5 will automatically generate (and update) as you configure your project. (Note: The compiler / toolchain used by Simplicity IDE is configurable in **Project > Build Configurations**. The default IDE is configurable in **Preferences > Simplicity Studio > Preferred IDE**.)

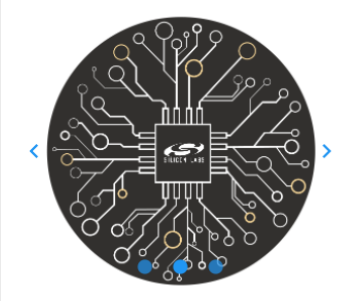
ZigbeeMinimal

OVERVIEW

SOFTWARE COMPONENTS

CONFIGURATION TOOLS

Target and SDK Selection



EFR32MG12P432F1024GL125

Wireless Starter Kit Mainboard (BRD4001A Rev A01)
EFR32MG12 2.4 GHz 19 dBm Radio Board (BRD4161A Rev A02)

Change Target/SDK

Project Details

ZigbeeMinimal

This is a Zigbee minimal SoC network-layer application suitable as a starting point for new application development.

Category
ZigBee Application

Preferred SDK
Gecko SDK Suite: Amazon, Bluetooth 3.3.0, Bluetooth Mesh 2.2.0, EmberZNet 7.0.0.0, Flex 3.3.0.0, MCU 6.2.0.0, Micrium OS Kernel, OpenThread 2.0.0.0 (GitHub-9dedd1869), Platform 4.0.0.0, USB 1.0.0.0, Wi-SUN 1.2.0.0, Z-Wave SDK 7.17.0.0

Import Mode
Link sdk and copy project sources

Force Generation

Project Generators

Select the type of projects to be generated.

☒ **SIMPLICITY IDE PROJECT**
A Simplicity IDE project supporting builds for MCUs using C/C++ and assembly files.

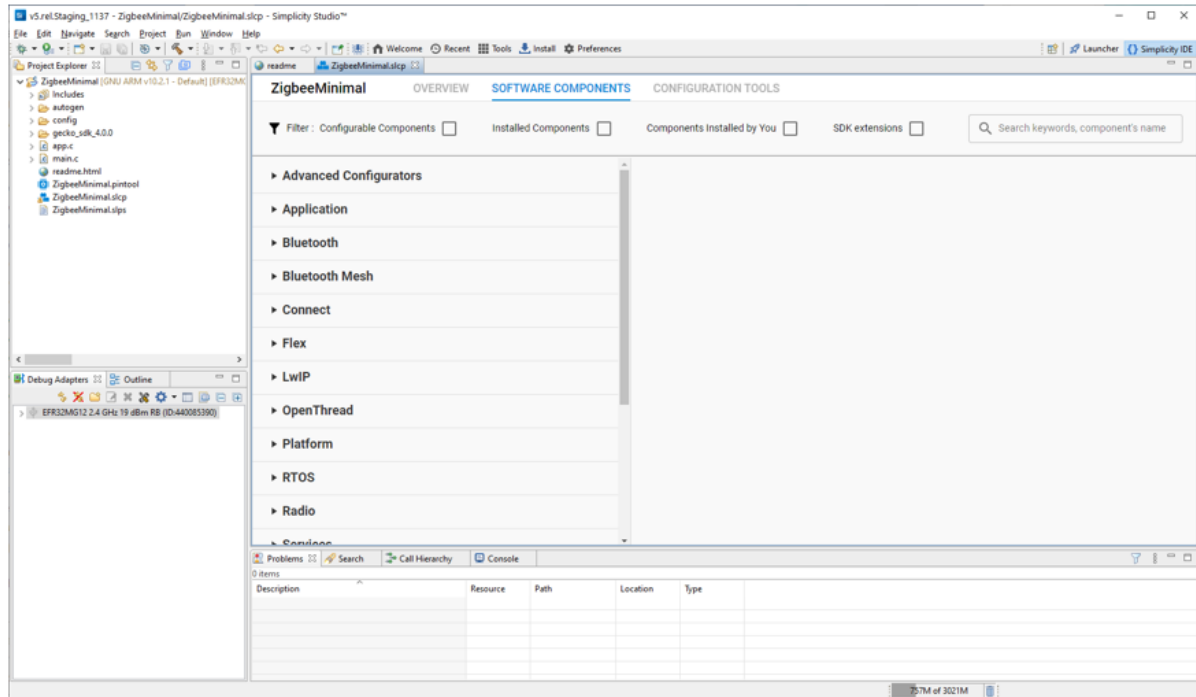
☐ **GCC MAKEFILE**
Generate a Makefile (.mak)

☐ **IAR EMBEDDED WORKBENCH PROJECT**
Generate an IAR Embedded Workbench project (.ewp)

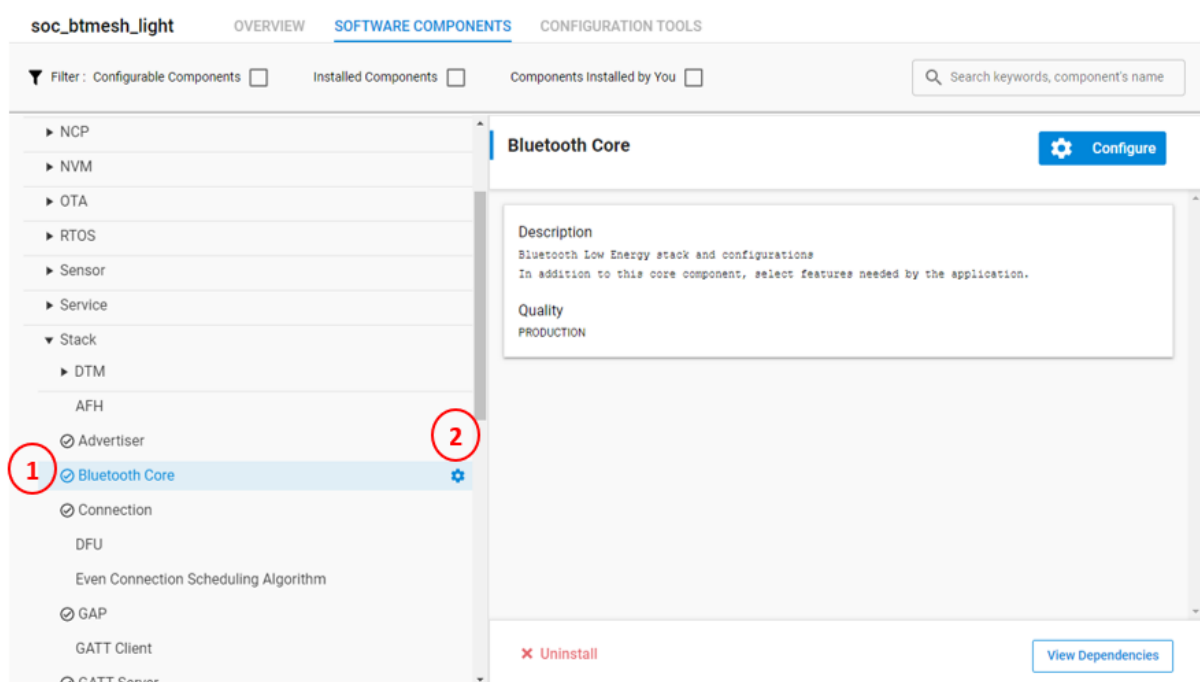
☐ **SEGGER EMBEDDED STUDIO SOLUTION**
Generate a Segger Embedded Studio solution file (*.emProject)

Cancel Save

To configure the project through the component library, click the SOFTWARE COMPONENTS tab. A number of filters as well as a keyword search are available to help you explore the various component categories. Note that components for all installed SDKs are presented.



Expand a component category\subcategory to see individual components. Components installed in the project are checked (1), and can be uninstalled. Configurable components are indicated by a gear symbol (2).



Click the gear symbol next to the component name or **Configure** in the configurable component description to open the Component Editor. Here you can change parameters or edit the component source directly.

Bluetooth Core

</> View Source

✕

>>

Bluetooth Stack Configuration

Max number of connections

4

Max number of advertisers reserved for user

1

Max number of software timers

4

Max number of periodic advertising synchronizations

0

Buffer memory size for Bluetooth stack

3150

TX Power Levels

Minimum radiated TX power level in 0.1dBm unit

-30

Maximum radiated TX power level in 0.1dBm unit

80

RF Path

RF TX path gain in 0.1dBm unit

RF RX path gain in 0.1dBm unit

Changes are autosaved in the Component Editor.

Bluetooth Core

</> View Source

✕

>>

✓ Saved Changes

✕

Bluetooth Stack Configuration

Max number of connections

4

Max number of advertisers reserved for user

1

Max number of software timers

4

Max number of periodic advertising synchronizations

0

Buffer memory size for Bluetooth stack

3150

TX Power Levels

Minimum radiated TX power level in 0.1dBm unit

-30

Maximum radiated TX power level in 0.1dBm unit

80

RF Path

RF TX path gain in 0.1dBm unit

RF RX path gain in 0.1dBm unit

As you make changes in the Project Configurator, for example installing or uninstalling a component, project output files are autogenerated. Progress is shown in the lower right of the Perspective.

440M of 682M

Generate Project

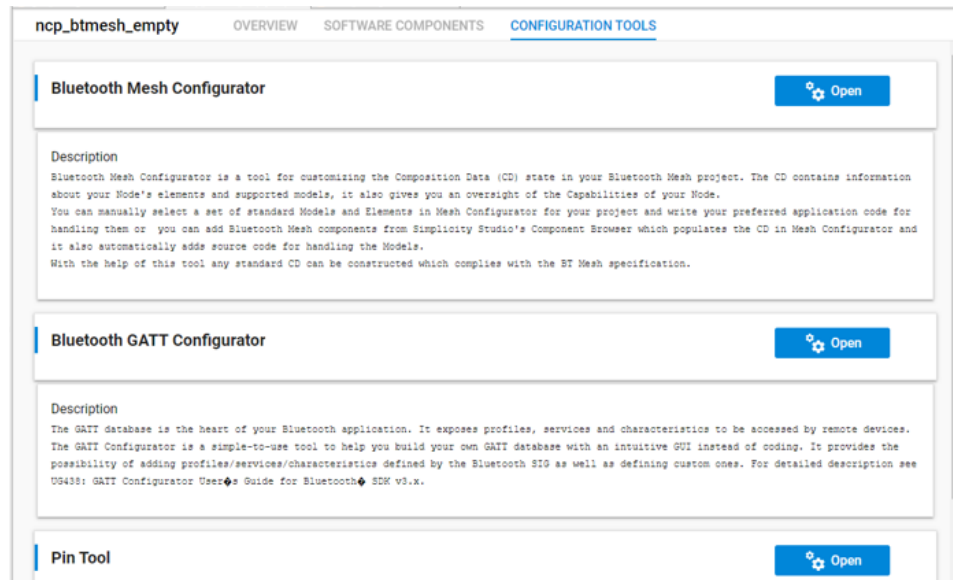
474M of 948M

C/C++ Indexer: (0%)

Speed varies depending on your system. Be sure that generation is complete before building the application image.

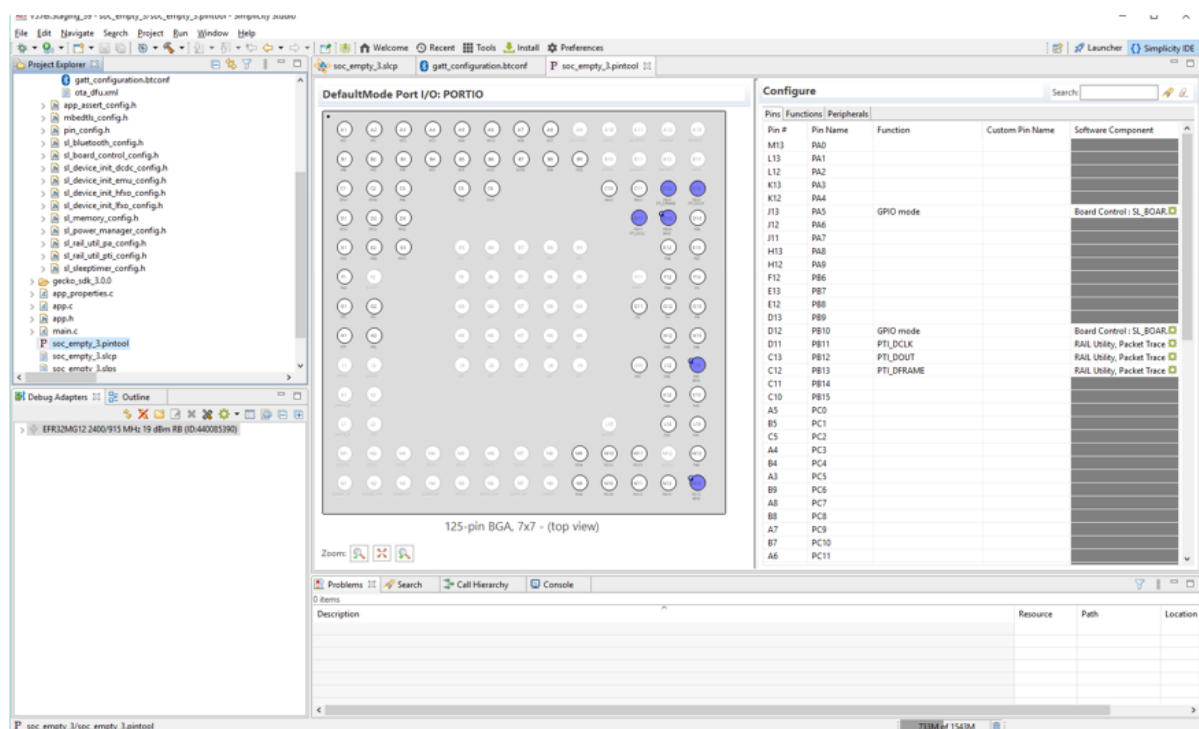
Build the application image and flash it to your target device as described in [Building and Flashing](#).

A CONFIGURATION TOOLS tab provides an easy way to open a tool when the tool's tab is not already open. It shows configuration tools relevant to the project type. For example, a Bluetooth Mesh project shows a number of tools, while an OpenThread project might only show the Pin Tool. Click **Open** on the tool's card to open it in a separate tab.



Pin Tool

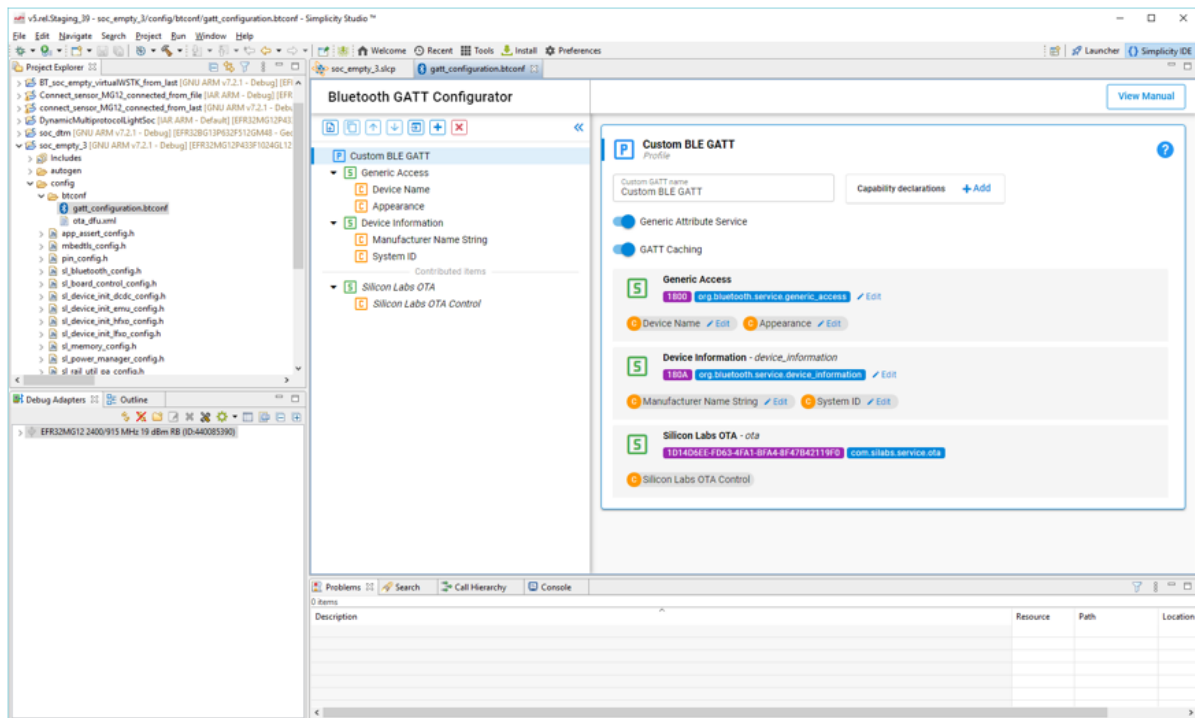
The [Pin Tool](#) lets you modify the target device's pin use and parameters. As well as opening the Pin Tool through the CONFIGURATION TOOLS tab, you can also double-click the <project>.pintool file in the Project Explorer view.



Double-click a Software Component to open the Component Editor and configure that function. Pin Tool does not autosave.

Bluetooth GATT Configurator

Bluetooth and Bluetooth Mesh projects are also configured with the [Bluetooth GATT Configurator](#).



The Bluetooth GATT configurator menu allows you to add and remove services and characteristics.

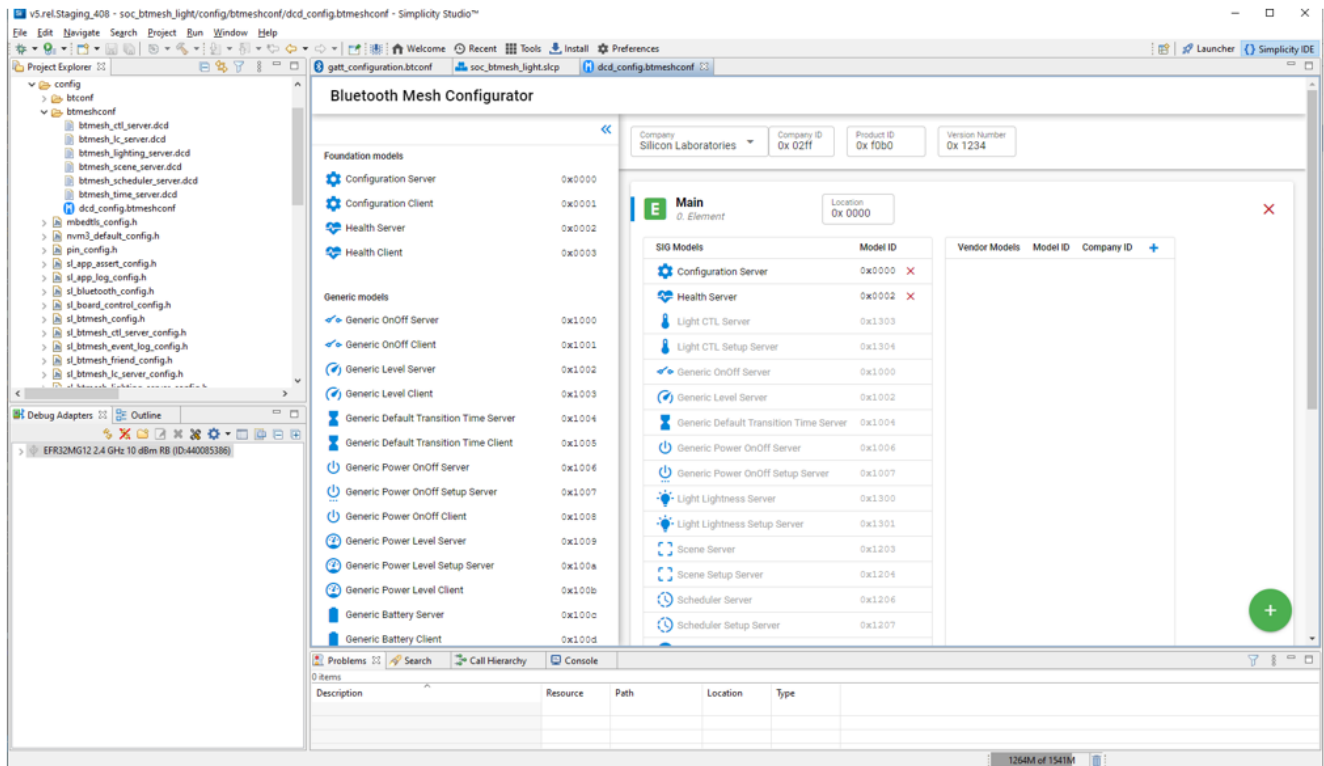


1. Add an item.
2. Duplicate the selected item.
3. Move the selected item up.
4. Move the selected item down.
5. Import a Bluetooth GATT database.
6. Add Predefined.
7. Delete the selected item.

To add a custom service, click **Profile (Custom BLE GATT)**, and then click **Add** (1). To add a custom characteristic, select a service and then click **Add** (1). To add a predefined service/characteristic click **Add Predefined** (6).

Bluetooth Mesh Configurator

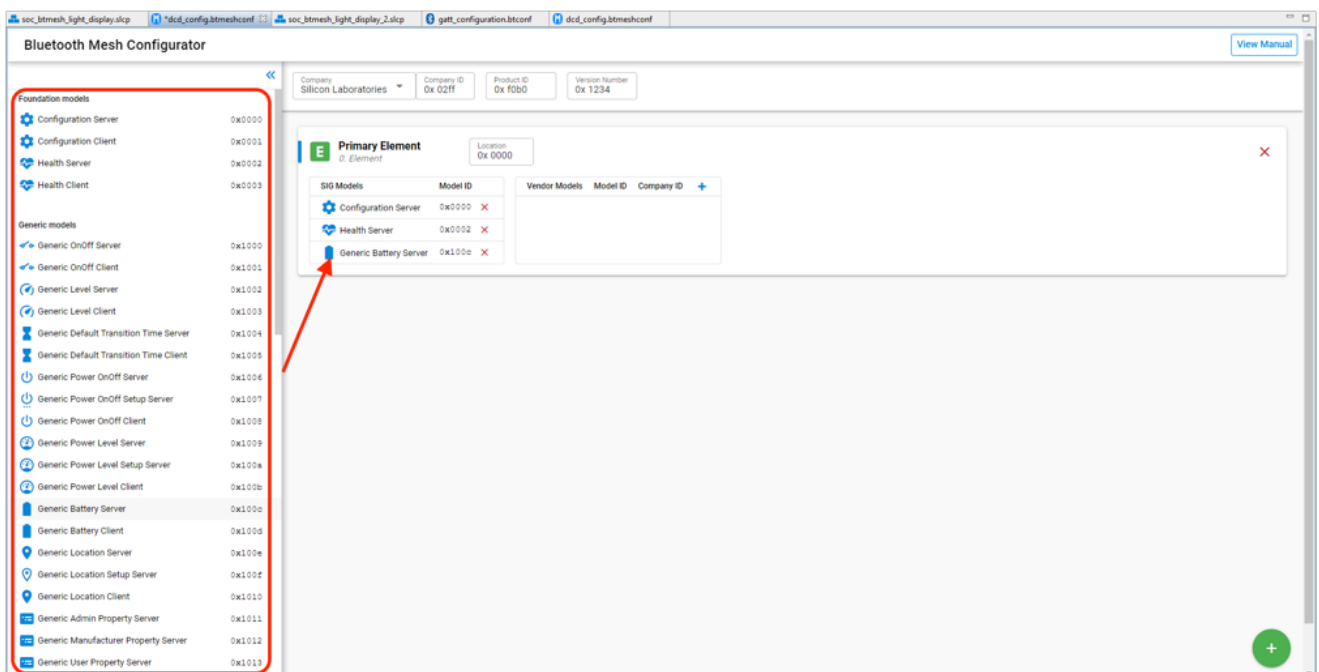
Bluetooth Mesh project Device Composition Data is configured through the [Bluetooth Mesh Configurator](#). The Device Composition Data is presented in three areas: device information, elements, and models.







Device information is determined by the company selected in the first field.

Each node has at minimum a primary element. To add more elements click the green + symbol in the bottom right.

The Bluetooth Mesh Configurator has editors for both SIG-adopted models and vendor models. SIG-adopted model components are provided but cannot be edited. You can, however, delete those models, and then add models to meet your needs. To delete a model, select it and click the red X symbol. To add a SIG-adopted model, drag the model from the left model pool to the SIG Models table in the correct element. A list of all the SIG-adopted models is displayed, and you can choose the one you want.

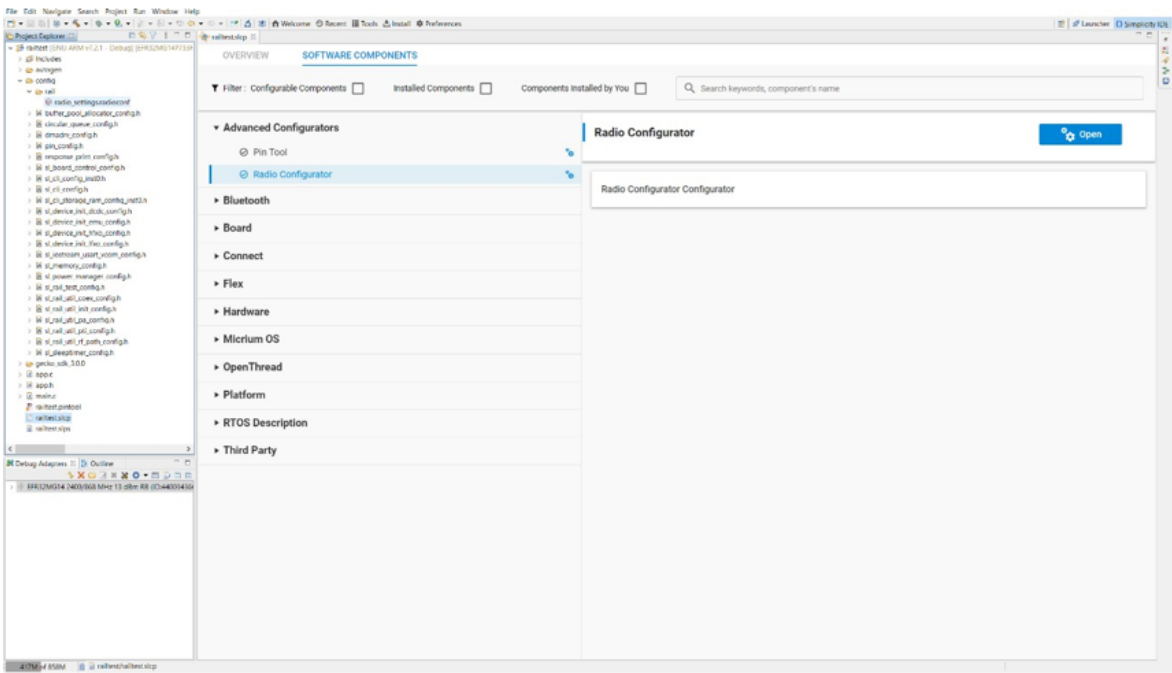


Vendor models give you more flexibility when developing products not covered by the SIG-adopted models. Vendors can define their own specification in these vendor models, including states, messages, and the associated behaviors. The vendor model editor is shown in the following figure.

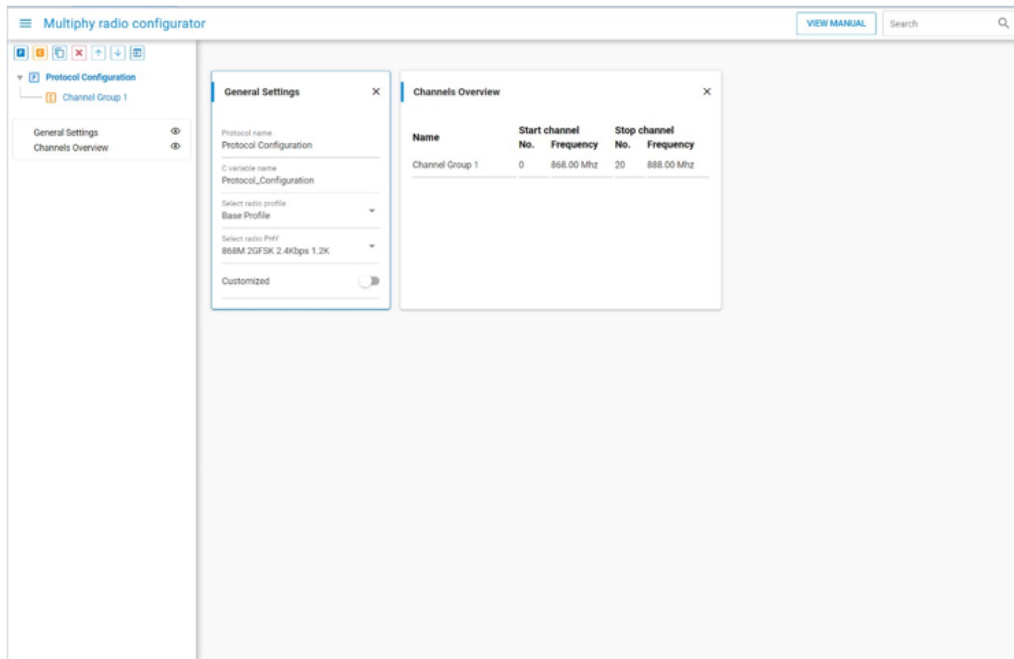
Vendor Models	Model ID	Company ID	+
 My Vendor Model 1	0x0021	0x02ff	
 My Vendor Model 2	0x0022	0x02ff	

Proprietary Radio Configurator

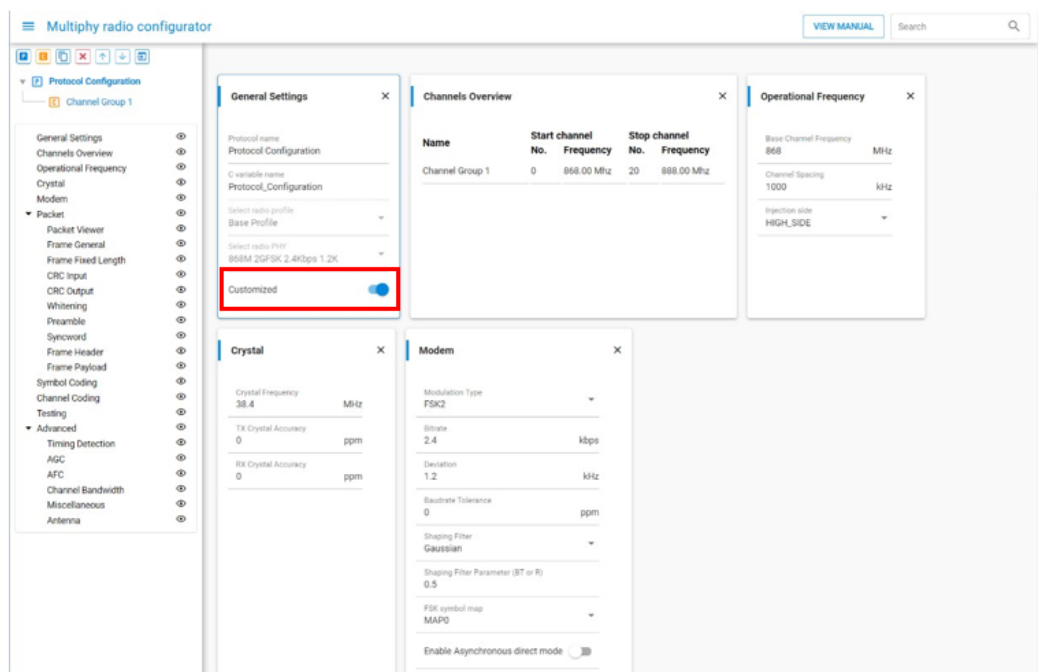
The [Radio Configurator](#) is provided as part of the Proprietary SDK. Use the Radio Configurator to create standard or custom radio configurations for your RAIL-based radio applications.



The parameters in the Radio Configurator are arranged in cards, some of which are grouped together. Different radio profiles offer different views and parameter sets.

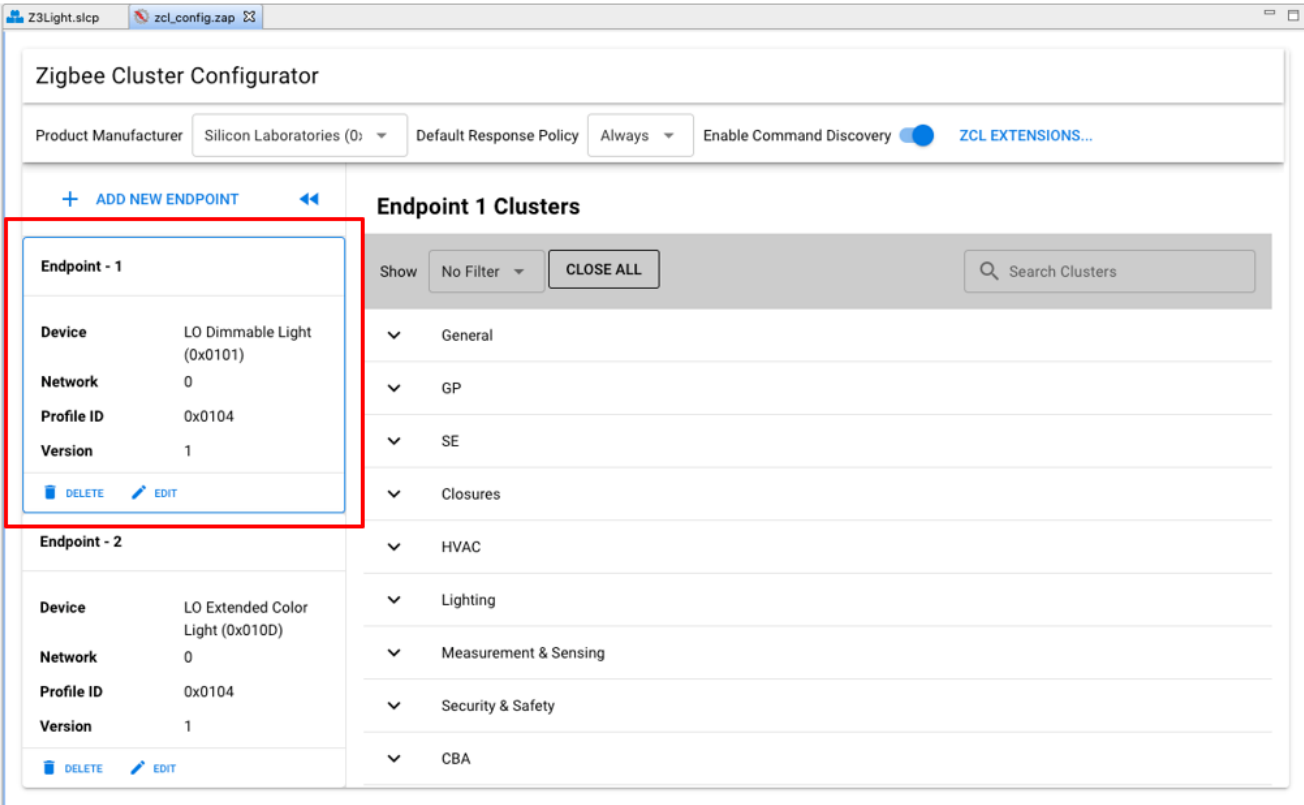


1. In the General Settings card, select a radio profile in the **Select radio profile** drop-down menu. A radio profile may be any supported radio link technology. These technologies can be bound by standards (for example the Sigfox or WMBus protocols) or can be fully customizable. The fully customizable profile is called the "Base Profile".
2. Select a radio PHY (radio configuration) in the **Select a radio PHY** dropdown list. Each profile has "built-in" configurations ready to use.
3. Review and update the profile options. By default, no changes are allowed; fields are grayed out. To enable customization, use the **Customized** switch on the General Settings card. This allows access to all the parameters defined by the profile.



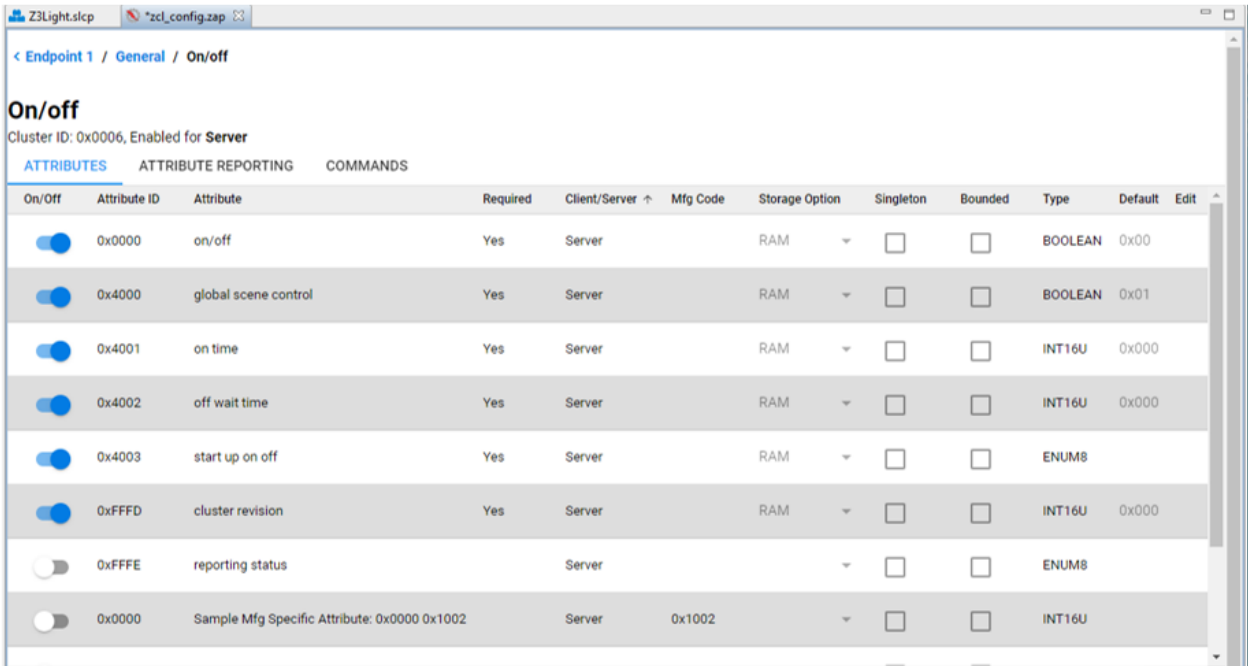
Zigbee Cluster Configurator

The [Zigbee Cluster Configurator](#) is provided as part of the Zigbee EmberZNet SDK. Use it to manage Zigbee endpoints, clusters, and commands. The interface is based on adding or modifying endpoints.



You can add and configure clusters as needed. The cluster configuration interface consists of three tabs:

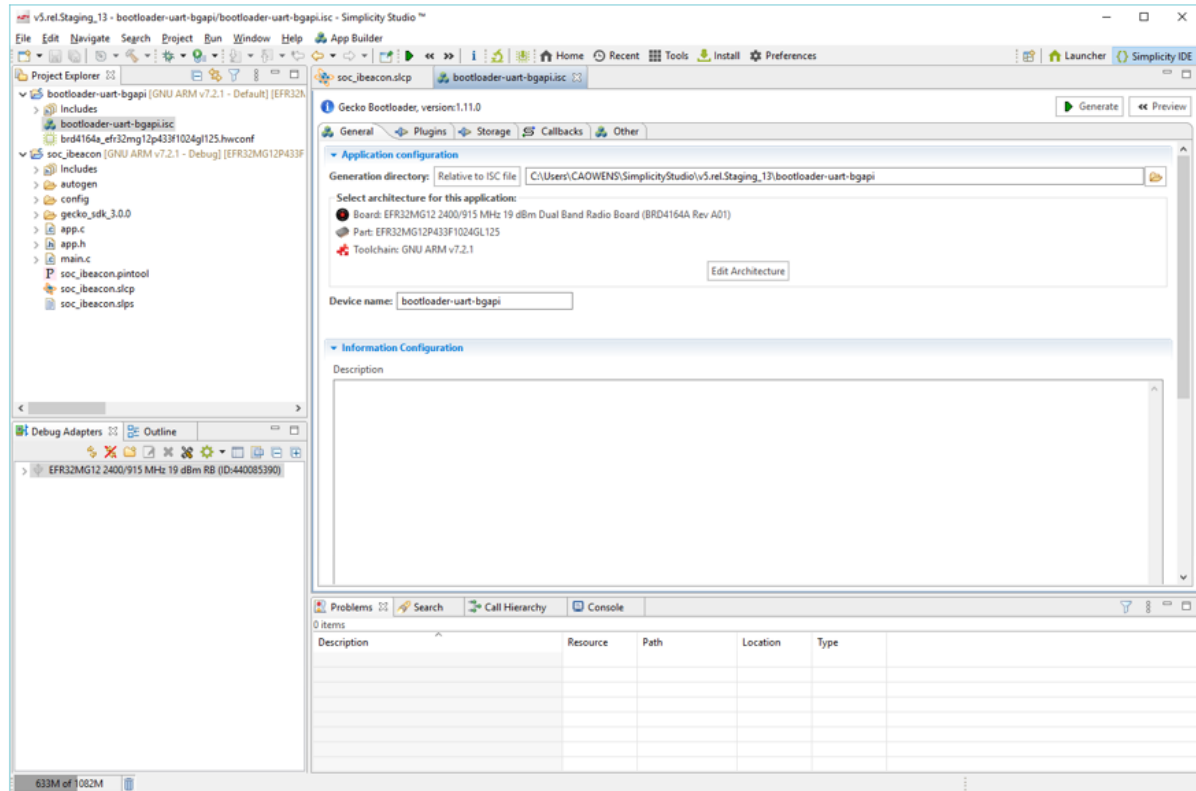
- Attributes
- Attribute Reporting
- Commands



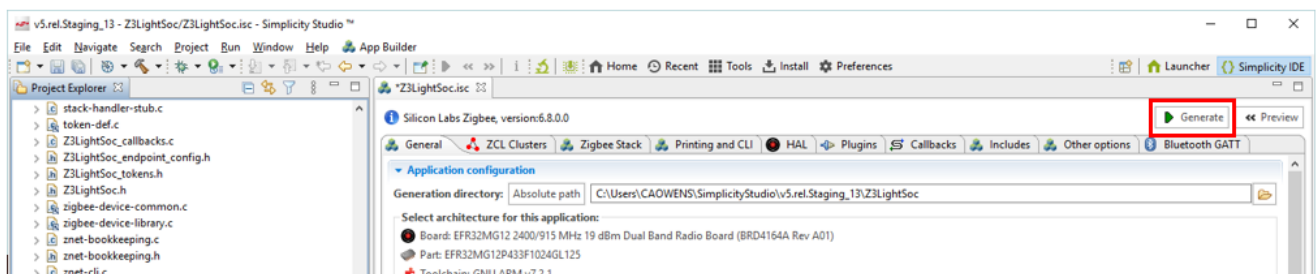
Configuration changes made through the Zigbee Cluster Configurator are saved to the `zcl_config.zap` file. When you save the file, the Zigbee Cluster Configurator not only saves the `.zap` file into your project, but also automatically generates all the `.c` and `.h` files required for your Zigbee application.

AppBuilder Projects

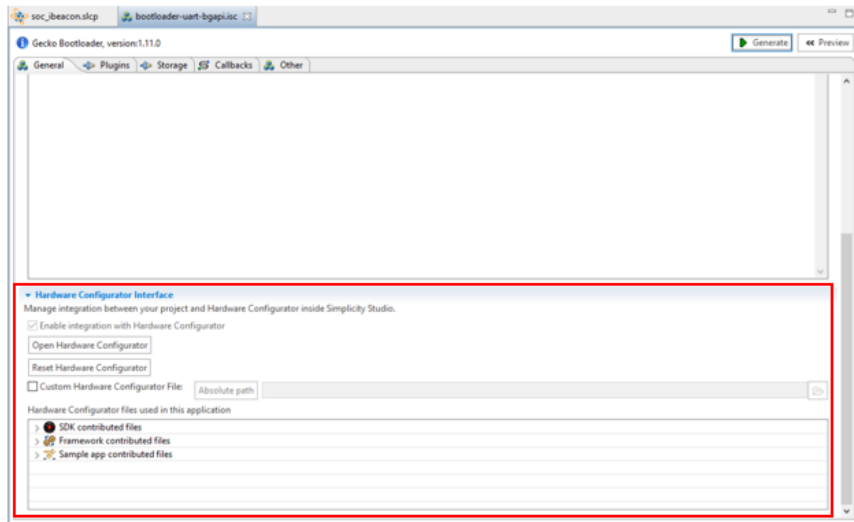
AppBuilder Projects are configured by modifying parameters in various tabs, especially the PLUGINS tab. See [Developing with AppBuilder](#) for details.



When you have configured the project, click **Generate** to create project files. Build the application image and flash it to your target device as in [Building and Flashing](#).



To modify the target device's pin use and parameters, use the [Hardware Configurator](#) available on the HAL tab. Note that, although the interface is similar to the 8-bit Hardware Configurator, this is a different tool.



Changes made through the Hardware Configurator are stored in a board-specific .hwconf file.

Install SDK Extensions

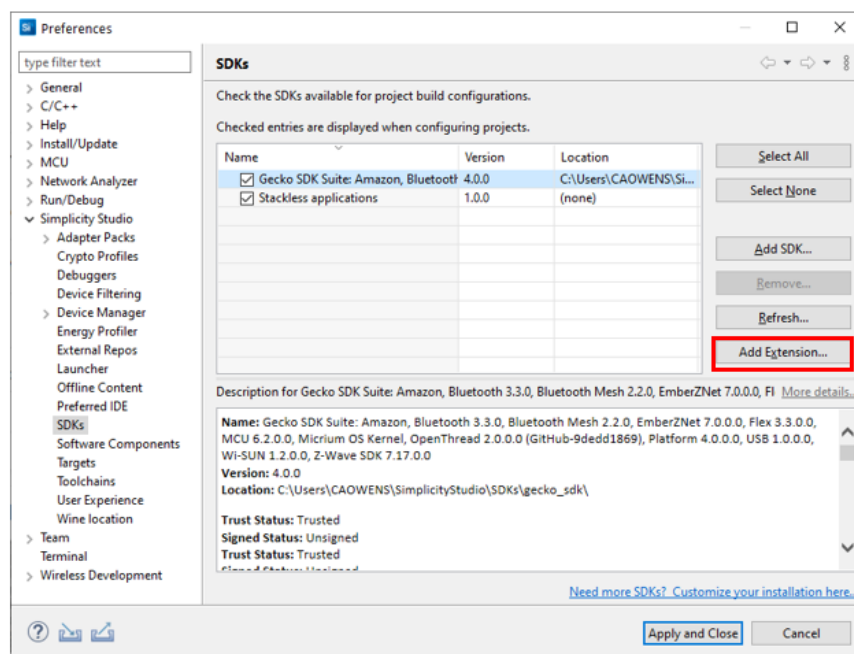
Install SDK Extensions

An SDK Extension is an entity specific to developing for 32-bit devices using Project Configurator and other Silicon Labs Configurator (SLC)-based tools. It is a collection of components and other items, such as example files. The SDK extension has dependencies on the parent SDK, which must be installed first. SDK extensions can be used to control access to certain functions, or to contain customer-created components and other items to be maintained separately from the Silicon Labs SDK.

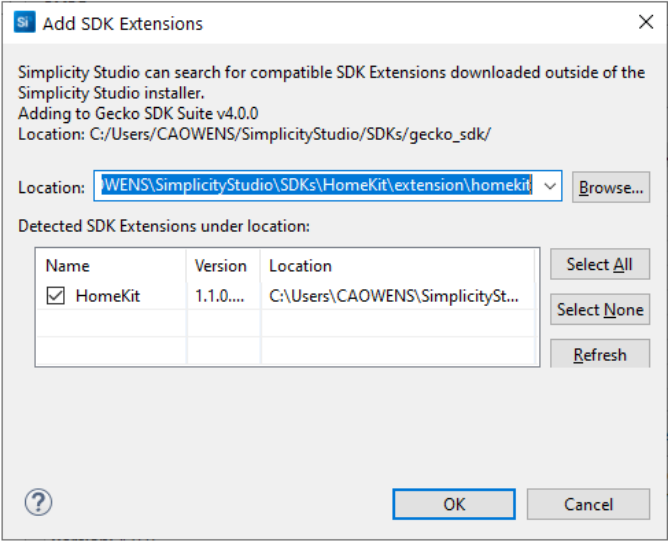
NOTE: Silicon Labs' HomeKit SDK is installed as an SDK extension, because it is only available to licensed Apple developers who have signed the Made For iPhone (MFi) agreement. You must be signed in to your Silicon Labs Customer account to see and download the HomeKit SDK.

If you have an extension available, install it using the following procedure.

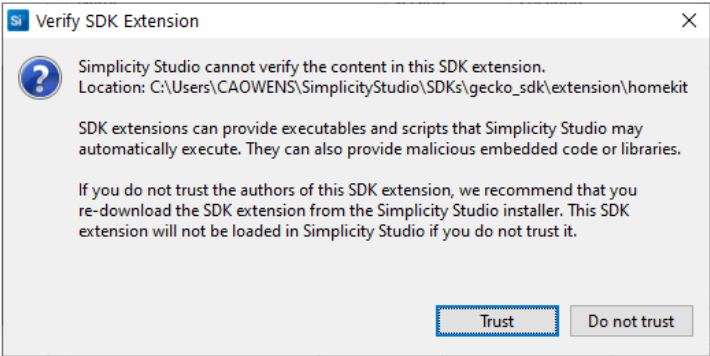
1. Open Preferences > Simplicity Studio > SDKs either from Preferences on the toolbar or by selecting **Manage SDKs** from the Launcher perspective OVERVIEW tab. Select the parent SDK and click **Add Extensions**.



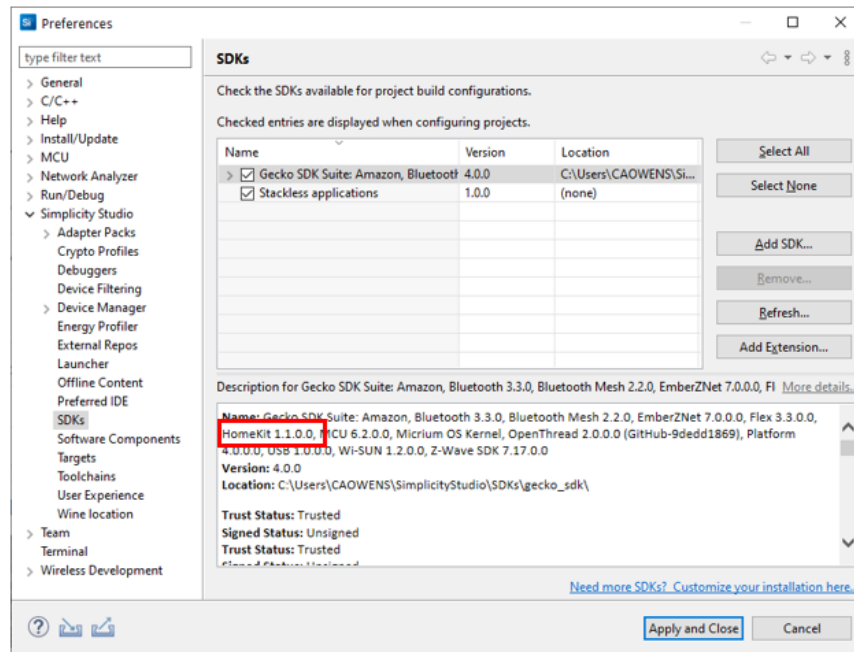
2. In the Add SDK Extensions dialog, browse to the extension directory. If it has a valid SDK extension, SSV5 detects it. Click **OK**.



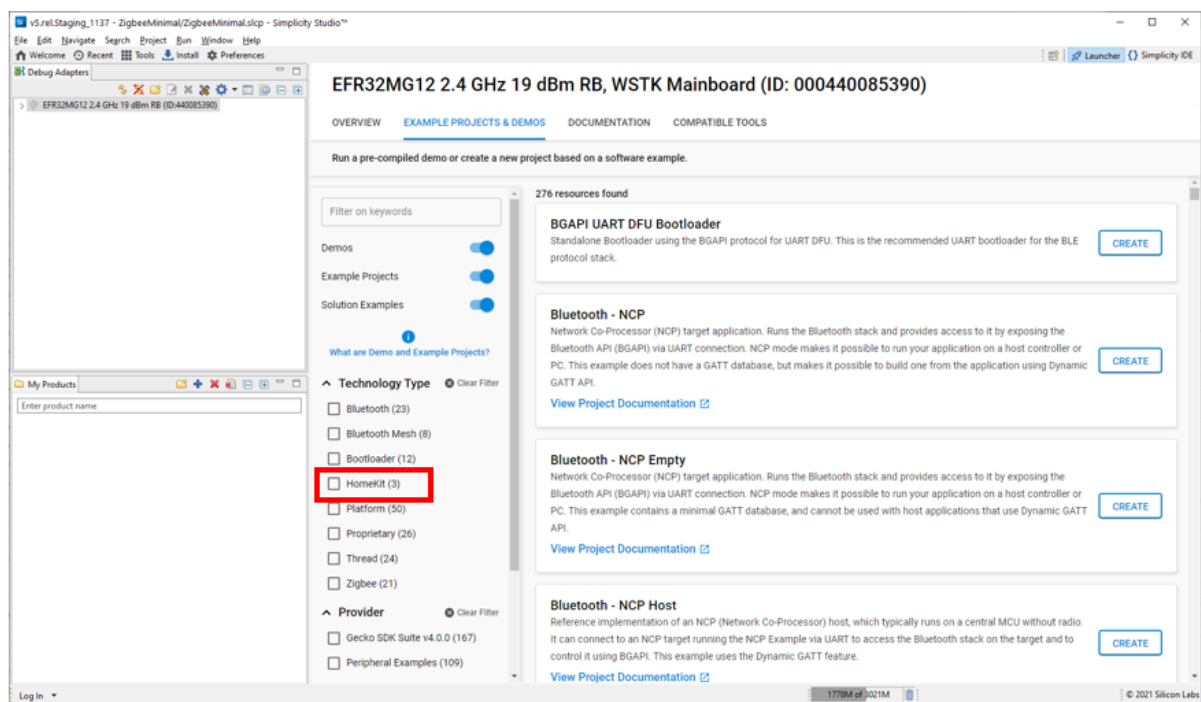
3. You may be asked to trust the SDK extension. If you do, click **Trust**.



4. The extension now appears on the list of SDKs, as HomeKit does in this example. Click **Apply and Close**.



Once you have added an SDK extension, SSV5 treats it like any other SDK, such as showing it in the filters for example projects.



Project Migration

Project Migration

Moving to the Component-Based Architecture

In SSv5 version 5.3, the Gecko Bootloader, Zigbee, and Z-Wave changed to the Silicon Labs Configurator component-based architecture. For more information on transitioning these projects from earlier versions of SSv5 see:

- Zigbee [AN1301: Transitioning from Zigbee EmberZNet SDK 6.x to SDK 7.x](#)
- Gecko Bootloader [AN1326: Transitioning to the Updated Gecko Bootloader in GSDK 4.0 and Higher](#)

Migrate from Simplicity Studio 4 to Simplicity Studio 5

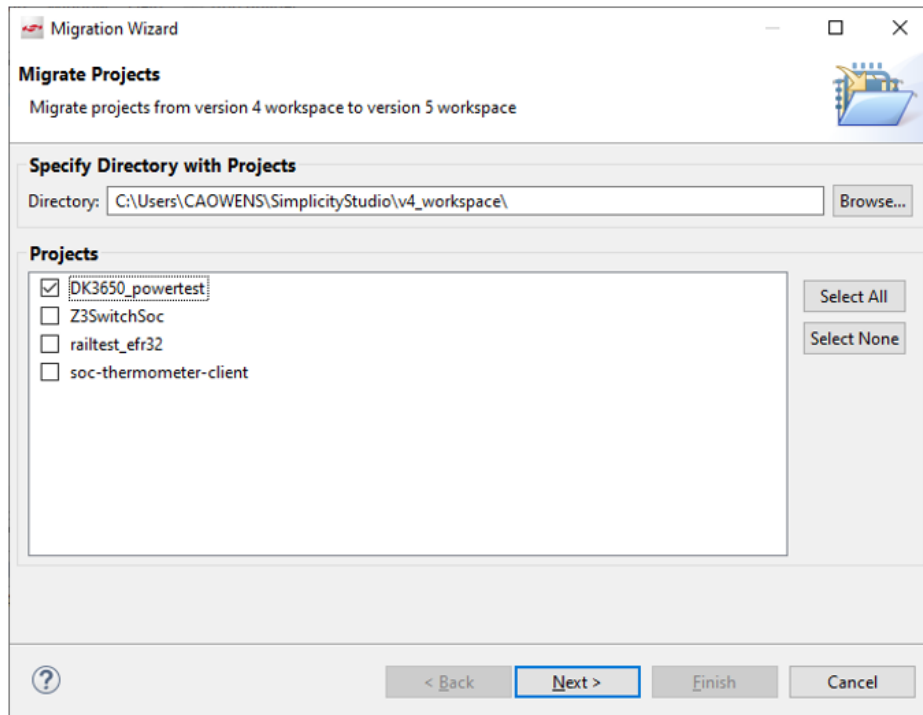
The process to migrate a project from Simplicity Studio® 4 (SSv4) to SSv5 depends on the type of project.

If you are migrating a [Bootloader, EFM32, or EFM8 project](#), use the **Migrate Project** tool. If you are migrating a [Z-Wave, Bluetooth/Bluetooth Mesh, Proprietary Flex, or Zigbee project](#), follow the instructions in the specified documents.

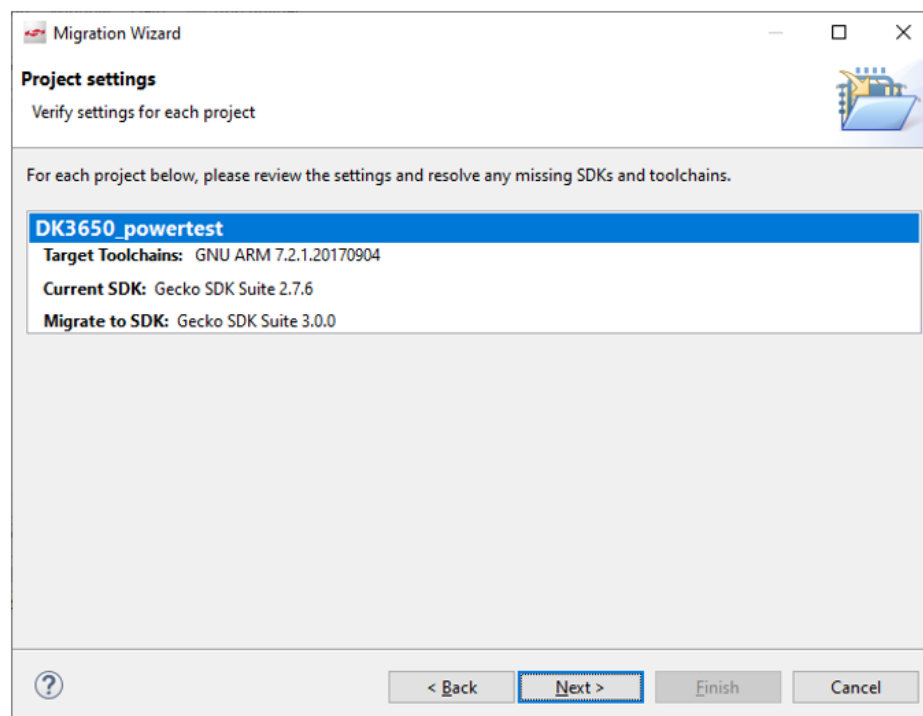
Bootloader, EFM32, and EFM8 Projects

Bootloader note: Use this procedure as a first step in migration.

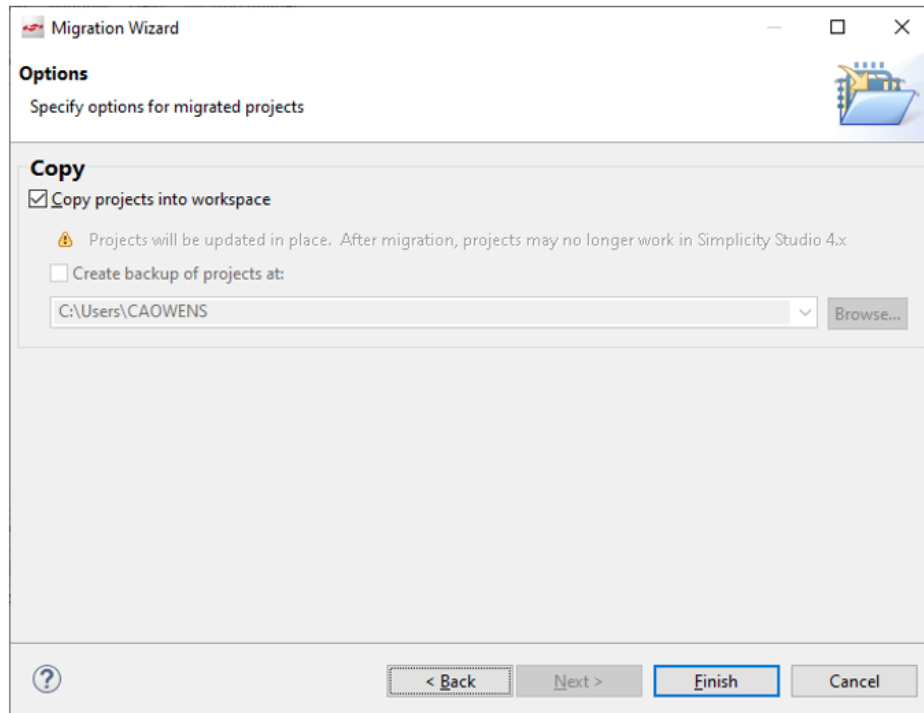
Click the **Tools** toolbar button to open the Tools dialog. Select **Migrate Projects** and click **OK**. Select the project to be migrated and click **Next**.



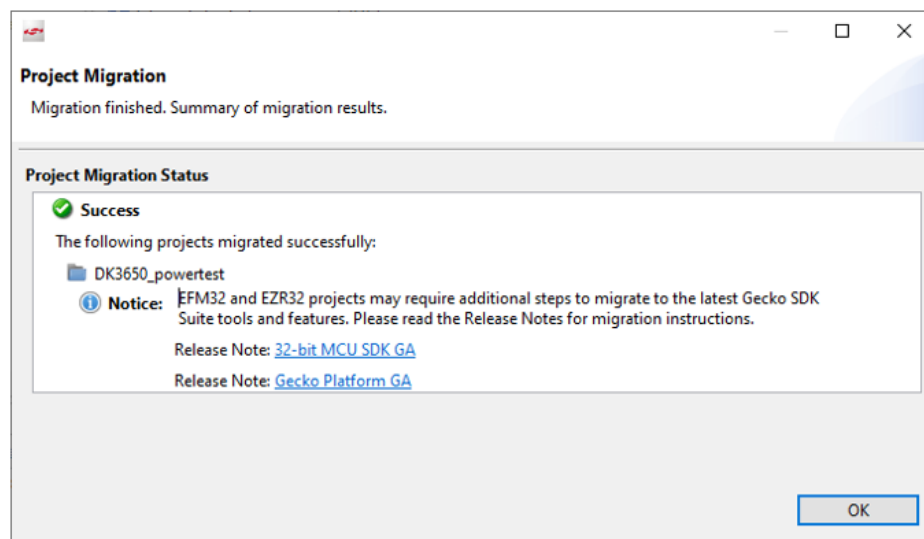
Verify the information displayed and click **Next**.



Decide if you want to copy the project (recommended) and click **Finish**.



The project is migrated from SSv4 to SSv5.



Z-Wave Projects

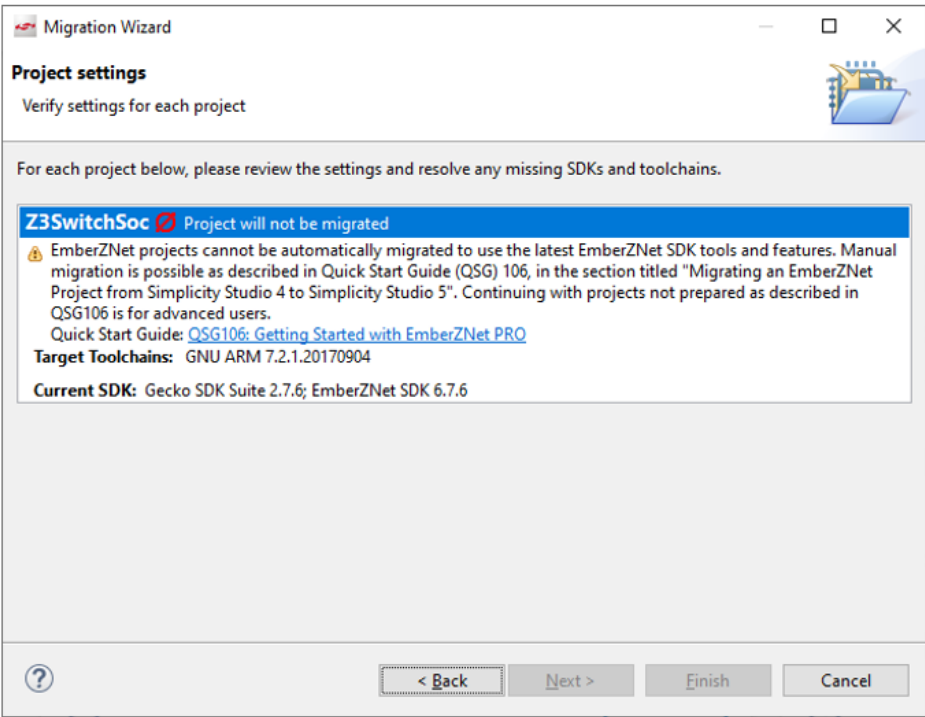
(Through Simplicity Studio 5.2) Follow the instructions in the knowledge base article [Migrating a Z-Wave project from GSDK 2.7.6 to GSDK 3.0.0](#).

Zigbee, Flex, and Bluetooth/Bluetooth Mesh Projects

These projects cannot be migrated using the tool. Instead, refer to the following documents:

- Zigbee (Through Simplicity Studio 5.2): [QSG106: Getting Started with EmberZNet PRO](#)
- Flex: [AN1254: Transitioning from the v2.x to the v3.x Proprietary Flex SDK](#)
- Bluetooth: [AN1255: Transitioning from the v2.x to the v3.x Bluetooth SDK](#)
- Bluetooth Mesh: [AN1298: Transitioning from the v1.x to the v2.x Bluetooth Mesh SDK](#)

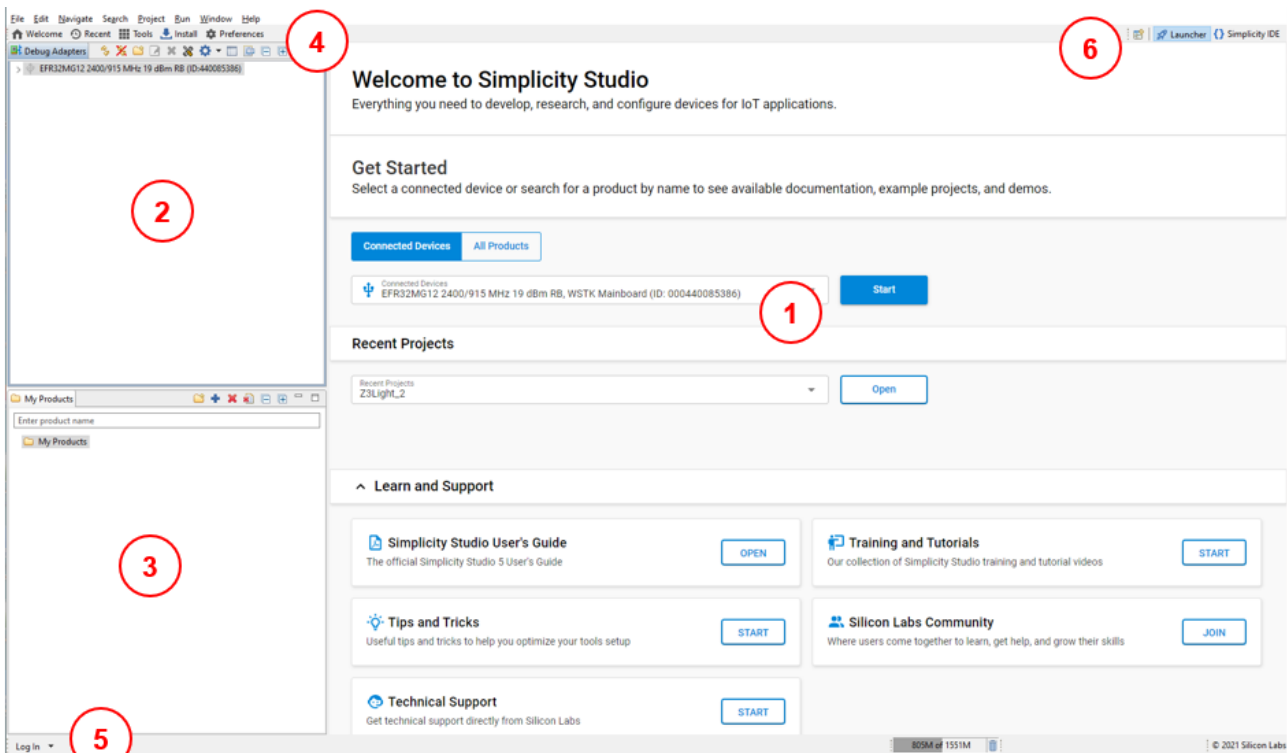
If you try using the tool, in most cases the tool will point you to the documentation for the migration process.



About the Launcher

About the Launcher

This section provides a reference to the functionality available in Simplicity Studio® 5 (SSv5) when you first open the application. This first perspective is called the **Launcher perspective**. A "perspective" is an Eclipse term for an initial arrangement of views and an editor area.



1 - **Welcome and Device-Specific Tabs**: The Welcome page includes a Get Started section to help with target kit, board, or device selection. The Learn and Support section may be expanded to show some of the reference and support resources available. Once a device is connected and/or selected, device-specific tabs provide access to example projects, documentation, and so on.

2 - **Debug Adapters**: Silicon Labs kits and supported debug adapters (for example, SEGGER J-Link products). The icon to the left of the debug adapter item indicates if it is connected over USB or Ethernet.

3 - **My Products**: Shows an editable list of products that you may want to use as target devices to set the Launcher's context. Use this view to select target devices when you don't have a kit available.

4 - A top-level **menu** provides access to a number of functions, including configuration options and help. A **toolbar** offers access to tools and functions on the left and shortcuts to different perspectives on the right.

5 - The Launcher perspective also provides additional functions across the bottom of the perspective:

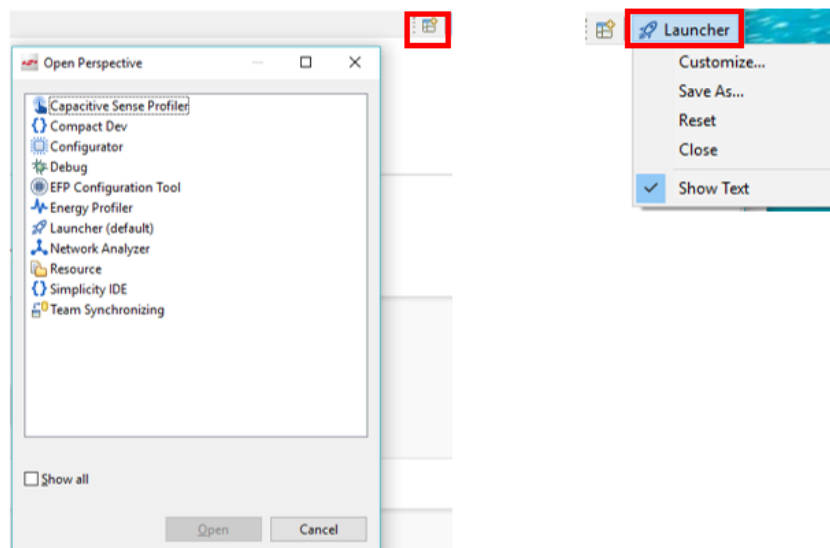


- Log in menu. Here you can:
 - Log in or out
 - Register a software development kit.
 - Change users
 - Clear stored credentials
- Garbage collection status and clear function. Click the trash can to run the garbage collector. This releases memory that may not have been released automatically. You should not need to use this function during normal operation. To turn the display off, go to **Preferences > General** and uncheck **Show heap status**.

6 - A perspectives tool bar in the top right shows open perspectives and allows you to open others.

Click **Open Perspective** to see a list of available perspectives. The perspectives list is similar to that available through the **Window > Perspective** menu selection.

Right-click an open perspective to see the context menu. While you can customize the perspective through the **Customize** menu option (see **Help > Help Contents > Workbench User Guide** for more information), you can also customize a perspective by dragging views and opening and closing views. These changes are persistent and survive closing and reopening a perspective. Click **Reset** to restore the perspective to its default settings.



Not all functions available through the Launcher perspective are relevant to developing for all target devices. The **Developing for ...** pages highlight the key pieces for each device category.

Welcome and Device Tabs

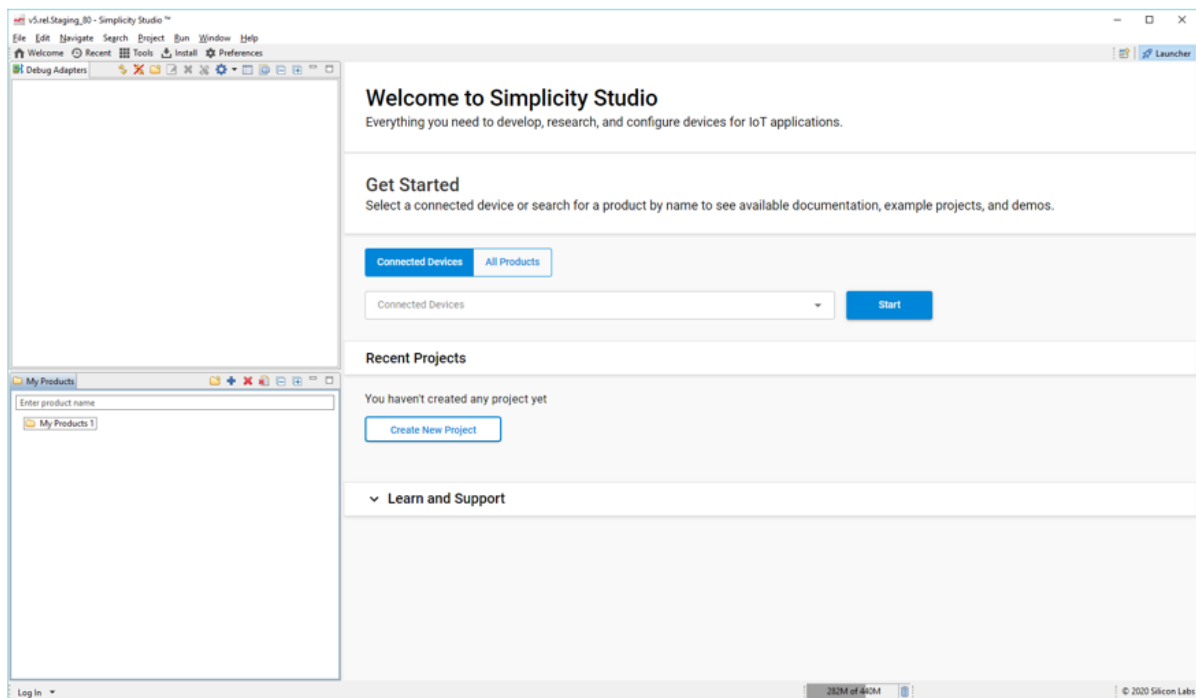
Welcome and Device Tabs

This page describes the functionality available on the [Welcome page](#) and the [tabbed interface](#) that is displayed once you connect or selected a devices. Tabs include:

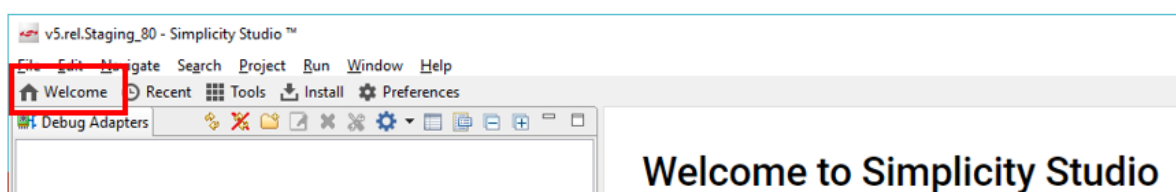
- [Overview](#)
- [Example Projects & Demos](#)
- [Documentation](#)
- [Compatible Tools](#)

Welcome

Simplicity Studio® 5 (SSv5) opens to a Welcome page.



To return to the Welcome page at any time, click **Welcome** on the tool bar.



On the Welcome Page you can:

- [Select a target device](#)
- [Start a new project](#)
- [Access educational and support resources](#)

Select a Target Device

SSv5's purpose is to provide a development environment directed toward a specific target device. Therefore, one of the first things to do is to define that target device. Once a target device is selected, a tabbed interface to features specific to that device is available, starting on the [Overview tab](#). The device can be a physical piece of hardware, or a virtual part.

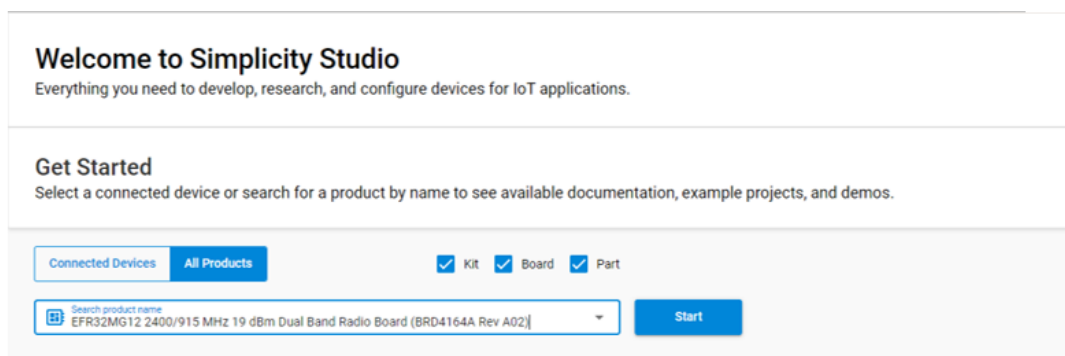
Physical If you have one or more devices physically connected, either on a development kit or on customer hardware with a supported debug adapter, they are displayed in the [Debug Adapters](#) view, where you can get started simply by clicking a device to selected it.

They are also displayed in the Get Started area's **Connected Devices** drop down. Clicking a device to select it, then click **Start**.

Virtual If you do not have a physical device, but would like to explore some of SSv5's functions, or get started with developing for a part you will receive later, select a virtual device either in the My Products view or in the Get Started area.

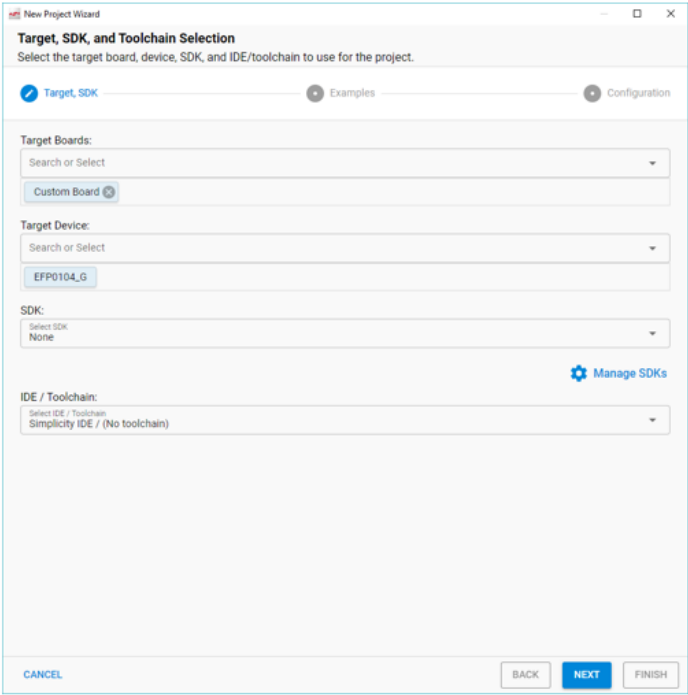
In the [My Products](#) view, start typing a product name and select the product of interest.

Under Get Started, click **All Products**. Use the checkboxes to limit the search list to kits, boards, or parts. Click in the search products field and start typing. When you see the target, select it and click **Start**. The next time you return to the Welcome page, that device will be shown in the My Products view.



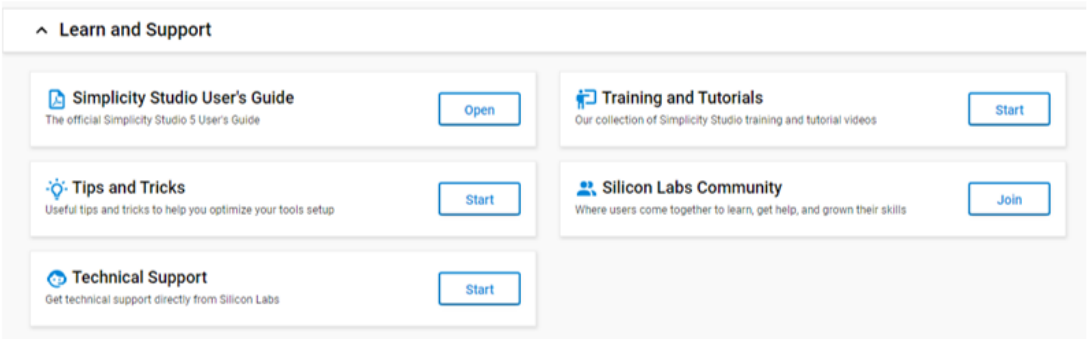
Start a New Project

You can start a new project from the Welcome page, but you must immediately select a target device. See [Start a Project](#) for more information.



Learn and Support

Expand the Learn and Support section for access to a variety of resources related to developing for a Silicon Labs target.



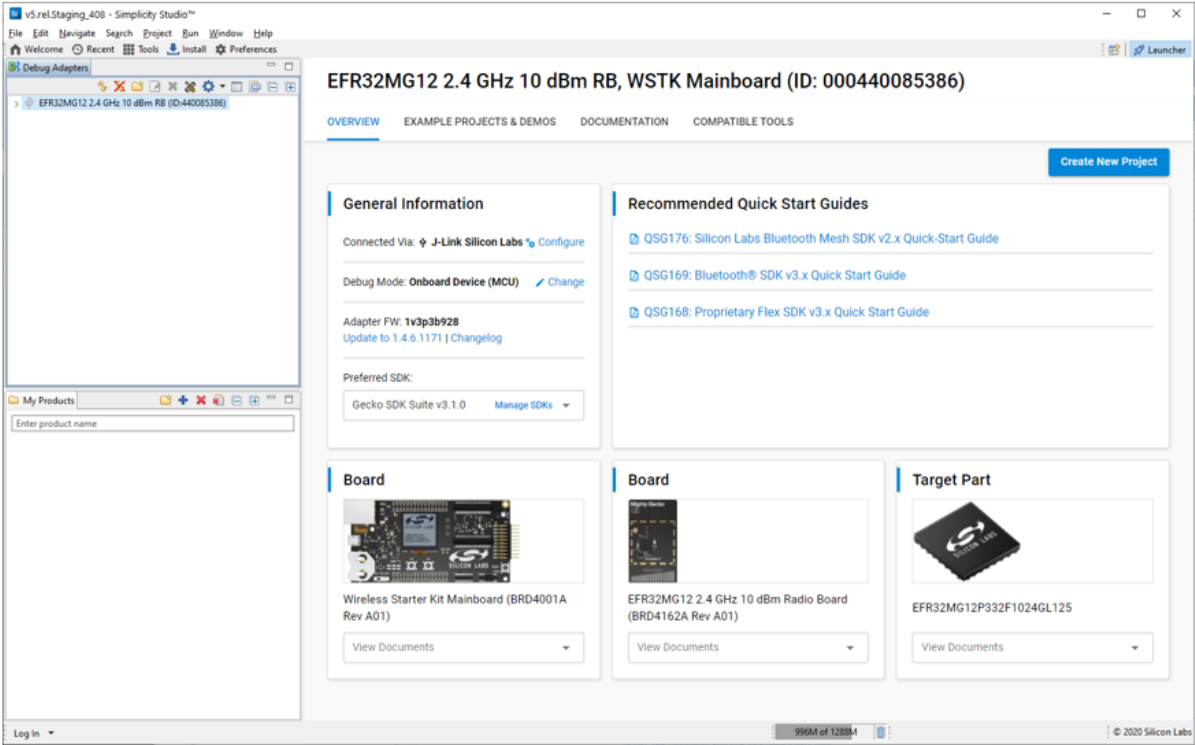
Device-Specific Tabs

Device-Specific tabs include:

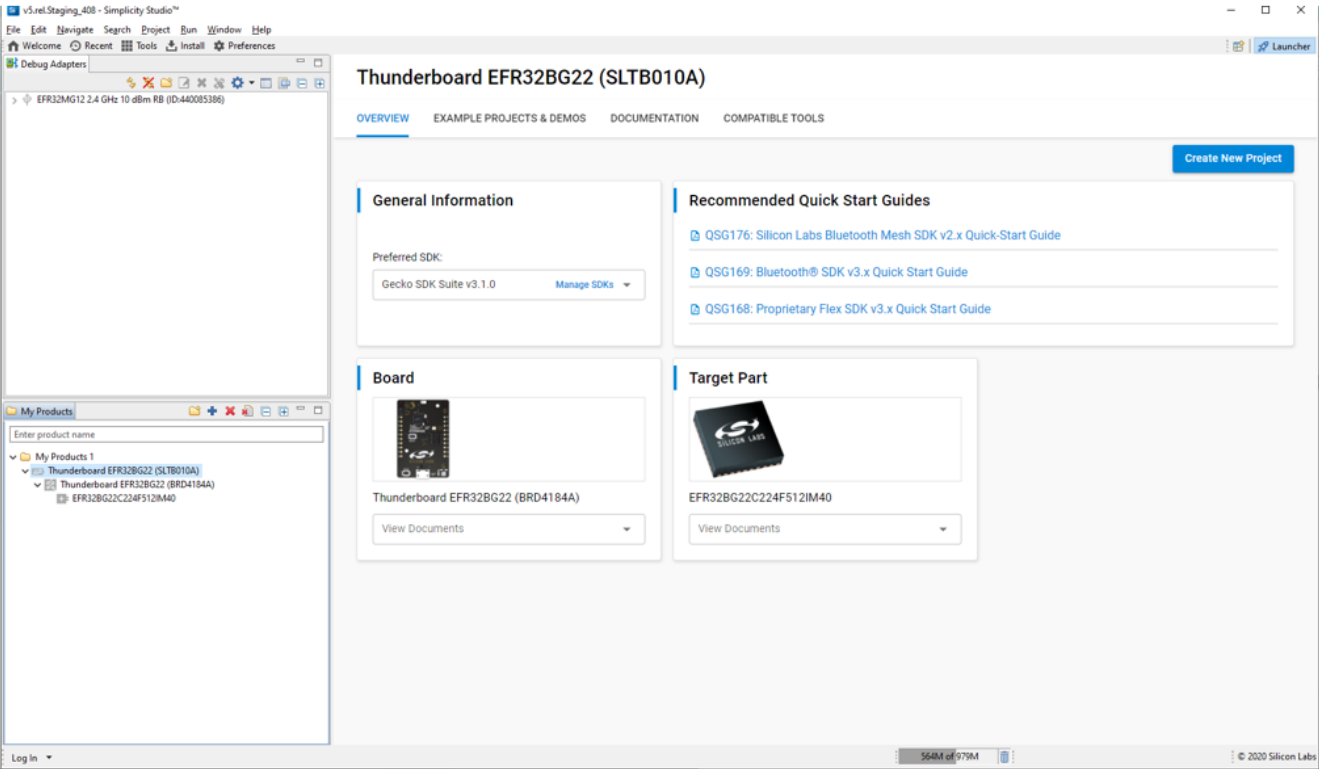
- [Overview](#)
- [Example Projects](#)
- [Documentation](#)
- [Compatible Tools](#)

Overview Tab

Once you have selected a target device, the Launcher perspective editor area changes to the OVERVIEW tab specific to that part. For a physically-connected device you have [general device information](#), as well as details about the hardware components. Each hardware component is pictured in a card and has a **View Documents** drop down where you can see related hardware documentation. Finally, links to recommended quick start guides from compatible protocol SDKs are provided.



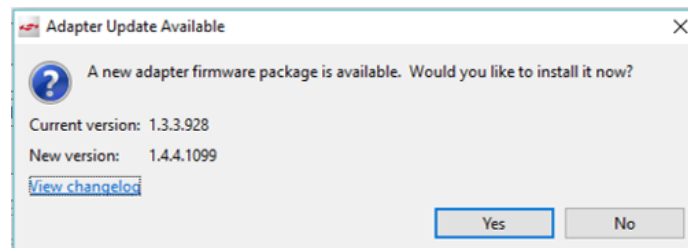
SSv5 displays similar information for virtual devices (selected in the My Products view) and devices connected to a supported debug adapter (for example, SEGGER J-Link or a Wireless Starter Kit mainboard in debug OUT mode). The settings in the General Information card vary depending on the target device.



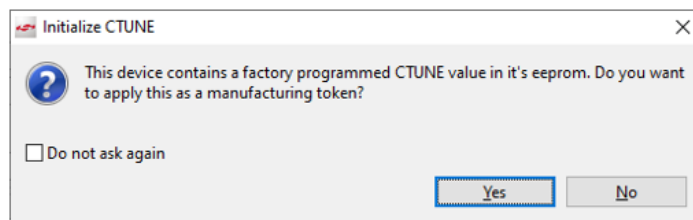
General Device Information

Configure Connection

Device Connection shows how the device is connected to SSv5. Click **Configure** to explore or modify connection parameters. If your device firmware is not up to date, you will be invited to update it.



If you are targeting an EFR32-based Silicon Labs kit, you will almost certainly also see the following question:



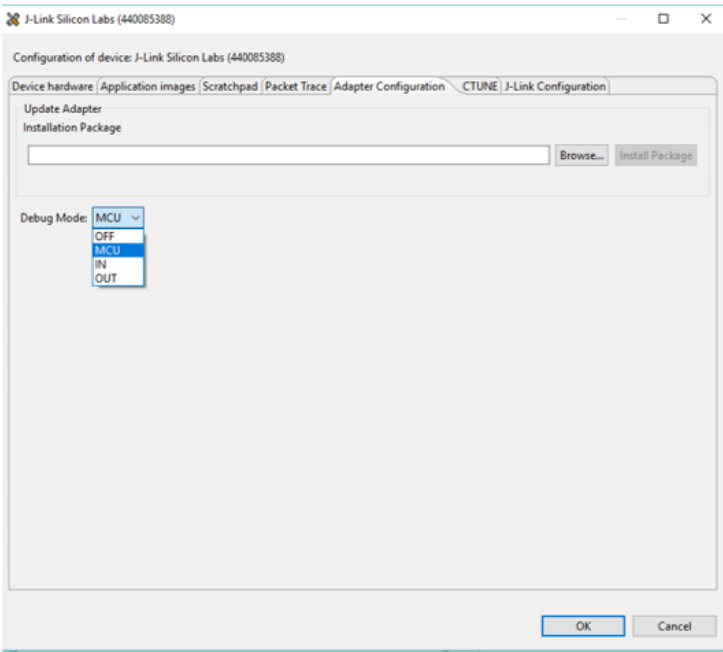
The CTUNE value is used to tune the external crystal capacitors to hit the exact frequency they are intended to hit. Because this varies from board to board, in production Silicon Labs measures it during board tests and programs a unique CTUNE value for each board into the EEPROM. Each SDK also has a default CTUNE value programmed in a manufacturing token. This message asks if you want to overwrite the default CTUNE value with the one found in the EEPROM. Because the EEPROM value is more accurate, Silicon Labs recommends you click **Yes**. The default CTUNE value will also work, but could under some circumstances, such as temperature extremes, bring the radio frequency out of spec.

Debug Mode

The Debug Mode controls the interface to the wireless starter kit mainboard onboard debugger. Changing Debug Mode opens the Adapter Configuration tab of the J-Link Configuration tool. The debug modes are:

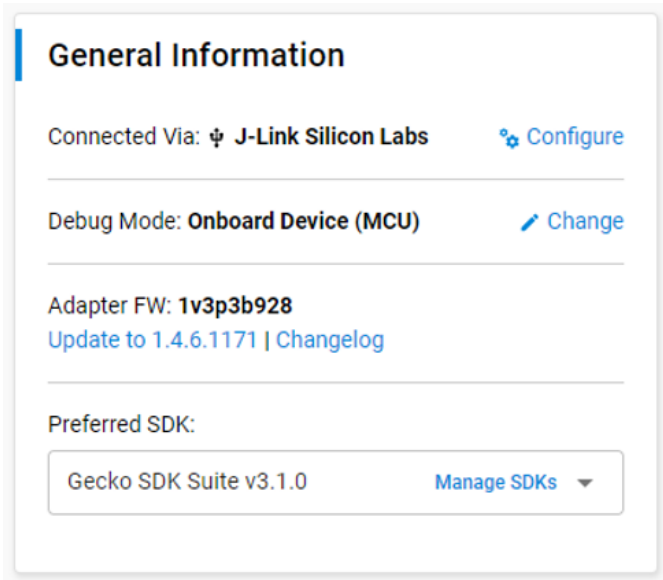
- **Onboard Device (MCU)** (default): The debugger built into the development board is connected to the on-board target device.
- **External Device (OUT)**: The on-board debugger is configured for connection to an external device such as your custom hardware.
- **External Debugger (IN)**: An external debugger is connected to the device on the development board.

See your kit's User's Guide for more information on the debug modes available.

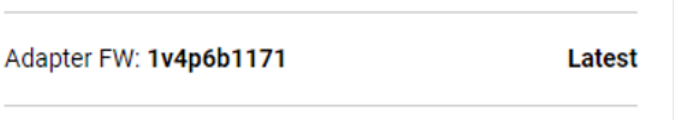


Adapter Firmware

This shows the firmware version running on the debug controller of your Silicon Labs development kit and whether or not an update is available. Silicon Labs strongly recommends that you update adapter firmware to the current version. The Changelog shows the firmware release notes.

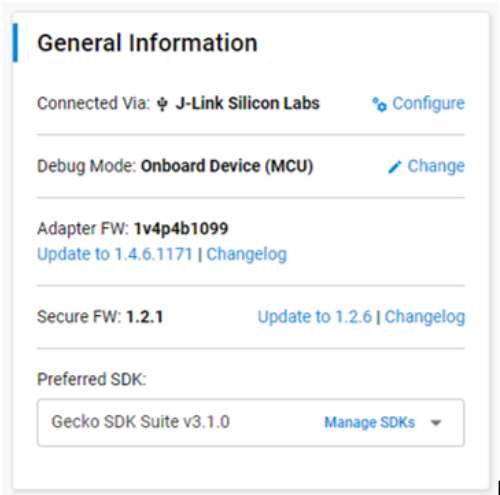


When you update adapter firmware SSv5 will ask you to confirm before proceeding. When firmware is up to date the interface says **Latest**.

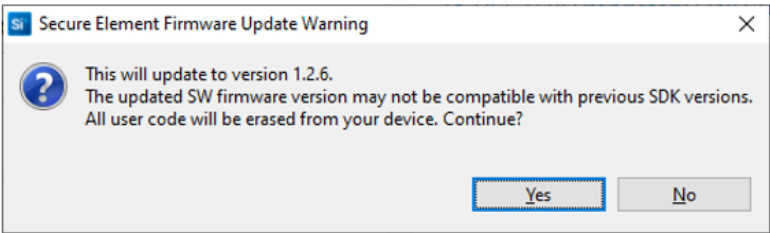


Secure Firmware

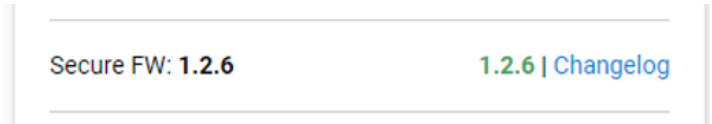
Series 2 devices contain a Secure Element, a tamper-resistant component used to securely store sensitive data and keys, and to execute cryptographic functions and secure services. The Secure Element firmware can also be updated. When you have a Series 2 device connected, the General Information card includes a **Secure FW** line. This shows the firmware version running on the Secure Element and whether or not an update is available. Silicon Labs strongly recommends that you update firmware to the current version. The Changelog shows the firmware release notes.



When you update, you are warned that user software, including any factory-installed applications such as RangeTest, will be deleted.

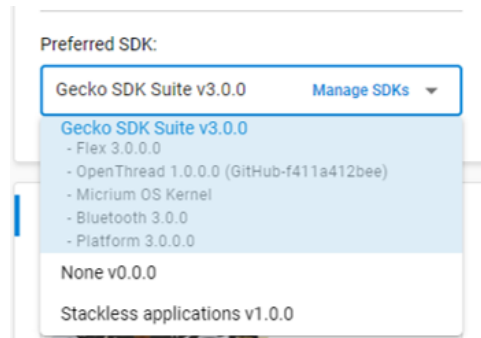


After upgrade, the installed and available versions are the same.

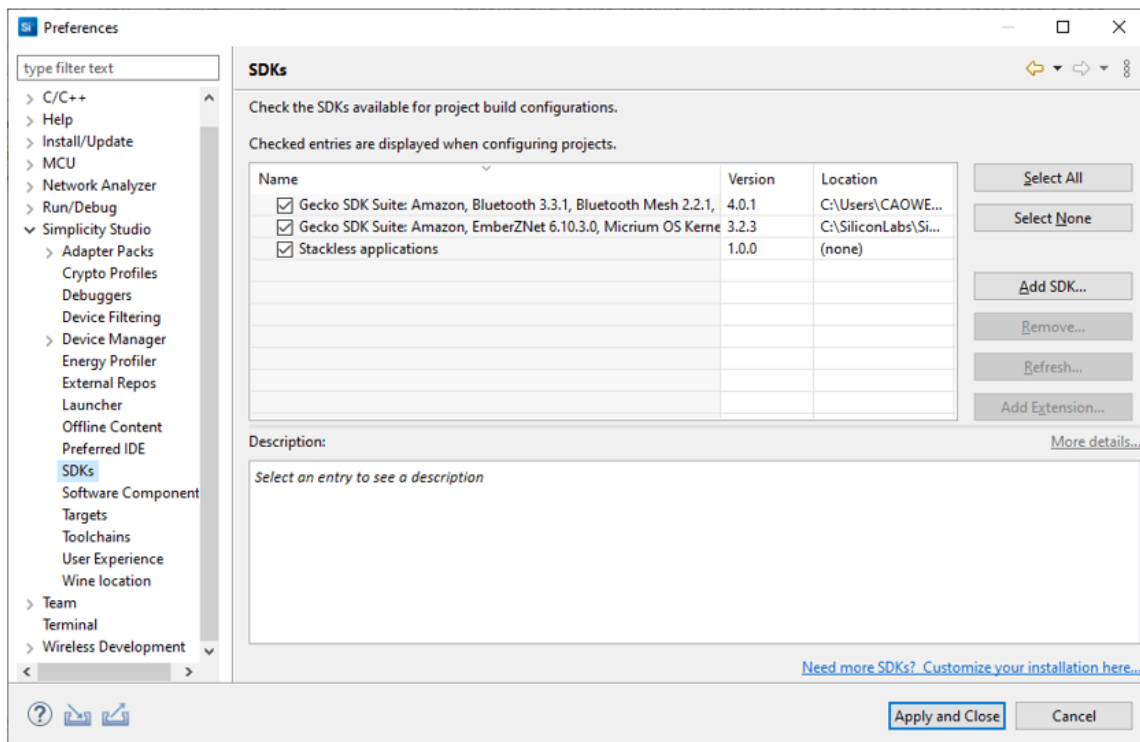


Preferred SDK

Some developers may have more than one GSDK version installed. The preferred SDK shows the currently selected SDK. Click **Manage SDKs** to see other options.



The options shown are those selected in Preferences > Simplicity Studio > SDKs. To add an installed SDK to the list, click **Add SDK** and browse to the installed location. SSV5 autodetects SDKs in the location folder. Select the SDK to add, and click **OK**. Make sure the new SDK is selected in the list, and click **Apply and Close**.

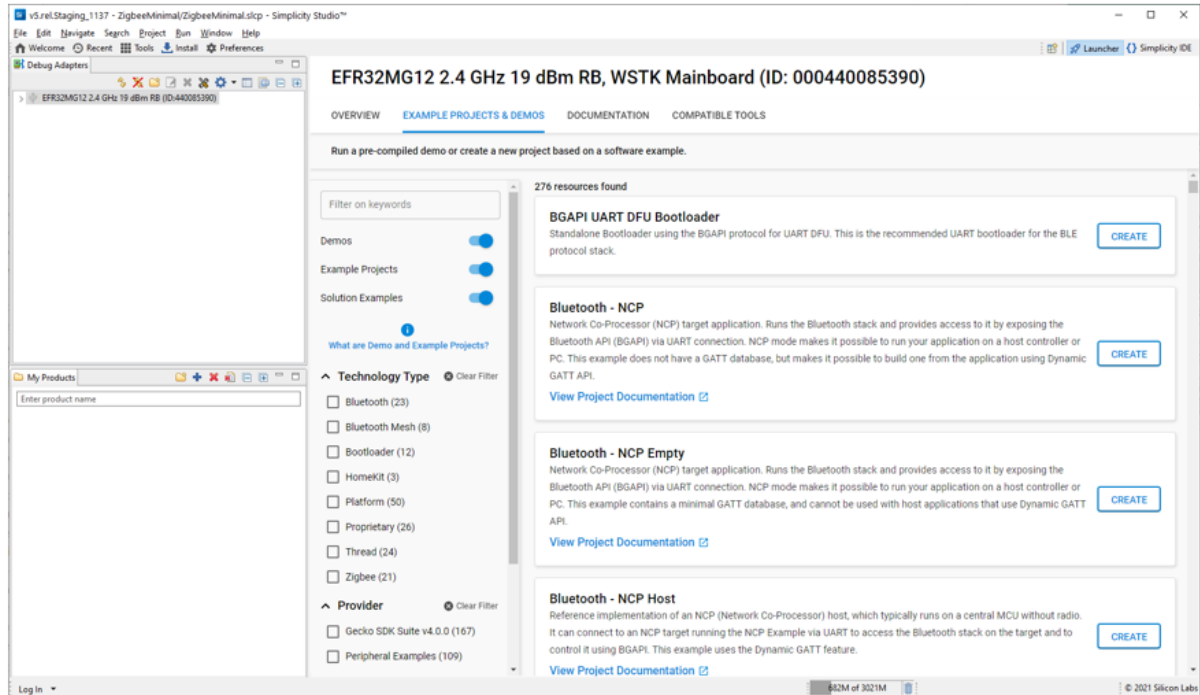


You should now be able to select it in the Preferred SDK list.

Example Projects & Demos Tab

The EXAMPLE PROJECTS & DEMOS tab shows a list of example projects and demos compatible with the selected device. A demo is a prebuilt software example that can be loaded into a compatible device and used to show and test application functionality. Every demo comes with an associated example project. See the Quick Start Guide for your SDK for more information about the examples and demos provided.

Click **RUN** on any demo to install it on a target device. Click **CREATE** on any project to create it. This is equivalent to creating a project from the OVERVIEW tab, except that the project is already selected. By default, the tab enables showing both demos and examples. Demos have a blue tag in the upper left of the card. To see only one type of file, disable the other type.

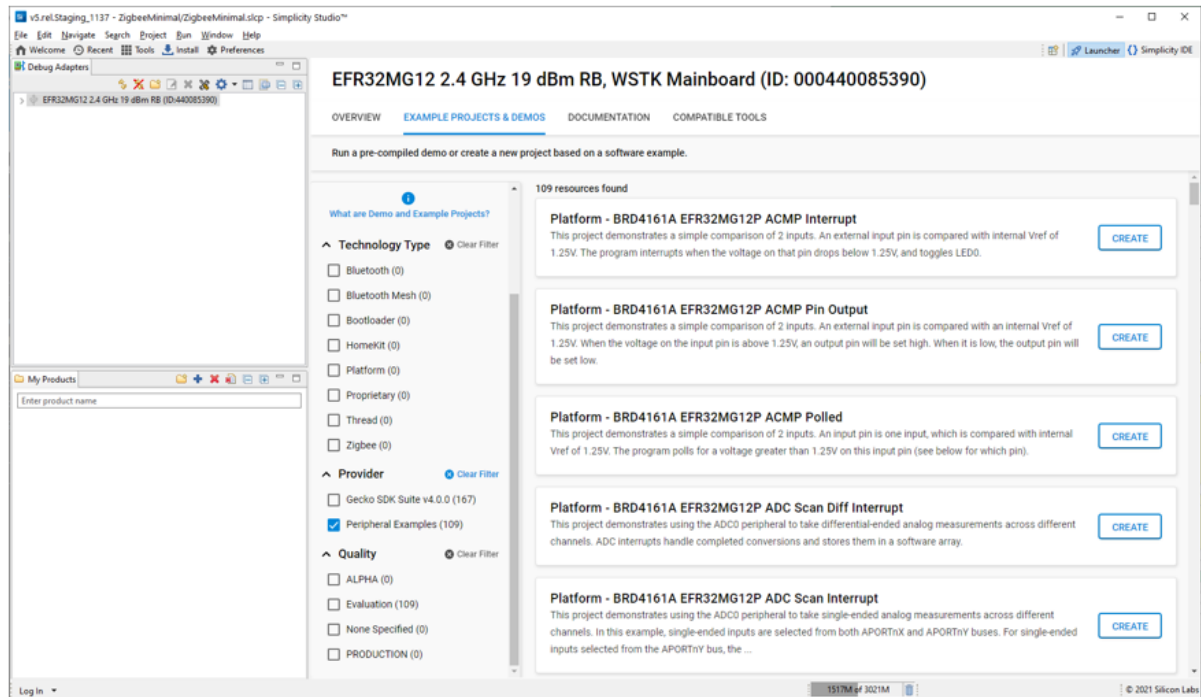


Use the switches, checkboxes and search box to filter the list. Note: Solutions are combinations of projects on which certain operations can be performed at the same time. This is a new feature and support is still being added for it. No example solutions are provided in this release, but you can create your own. See [Solutions](#) for more information.

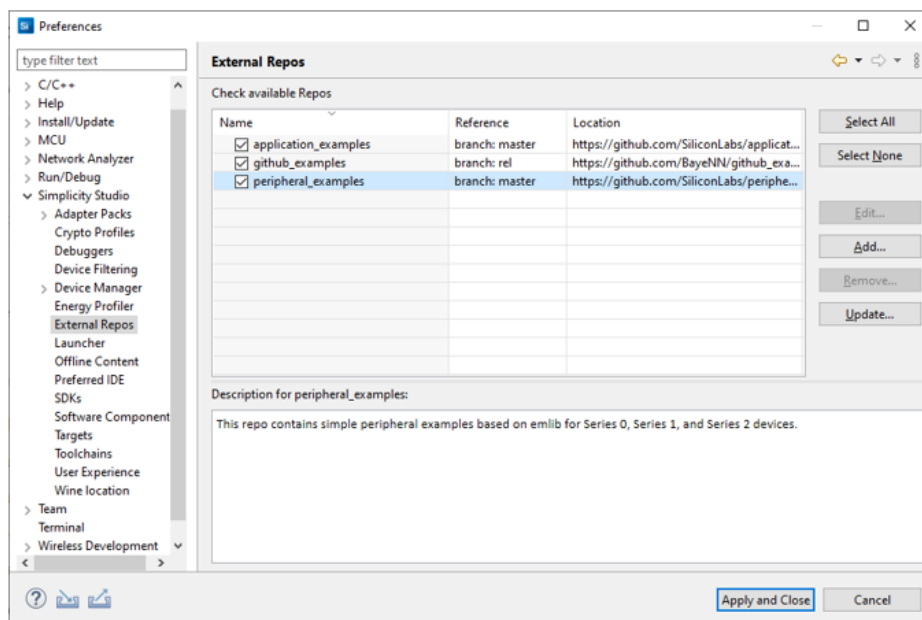
Checkboxes include:

- Technology Type
- Provider
- Quality

Provider allows you to filter on example sources. **Peripheral Examples**, provided from the Silicon Labs GitHub repository **peripheral-examples**, are specific to your connected or selected board, and allow you to exercise various peripheral functions.



SSv5 allows you to add other GitHub repositories containing examples. To add a GitHub repository, go to **Preferences > Simplicity Studio > External Repos**. Here you can add, edit, and delete repos, and select from repos that are already added. Adding a repo is done in two steps: cloning and then selecting the branch, tag, or commit to add. The default branch is Master. **application_examples** and **peripheral_examples** are official Silicon Labs repos and may not be edited or deleted.

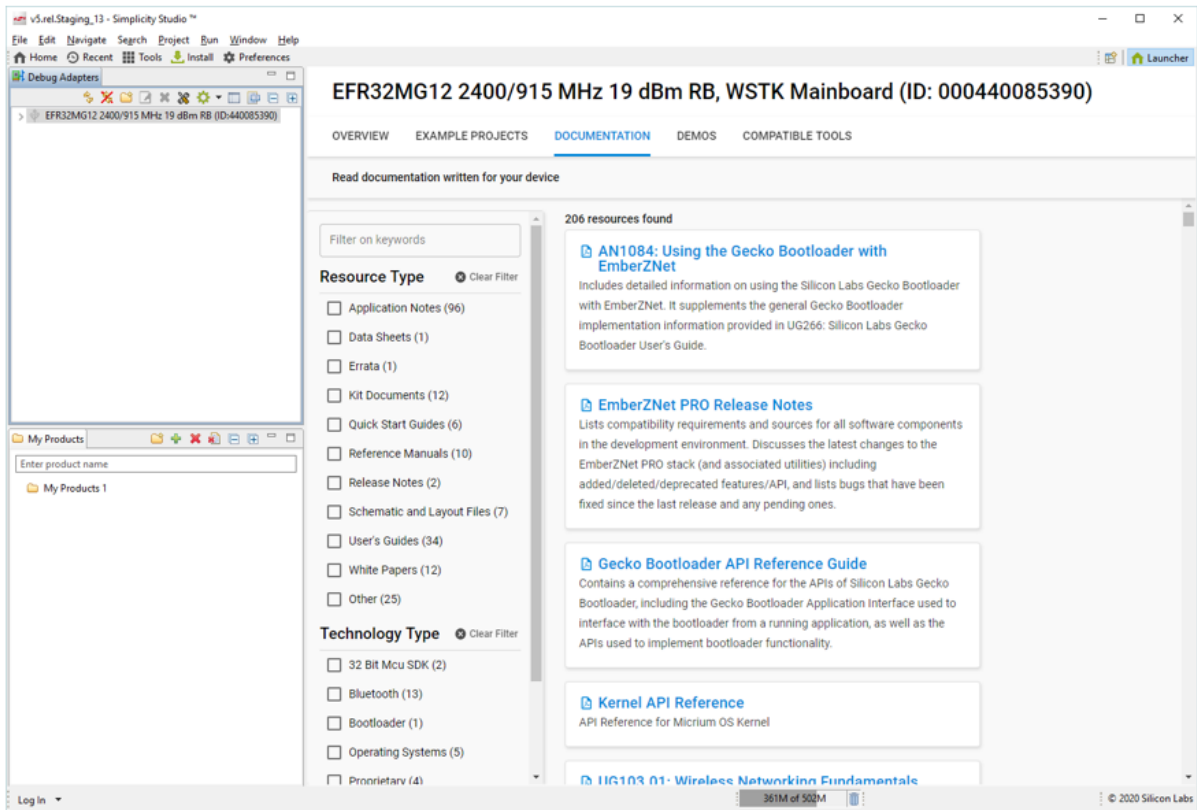


You must be connected to the Internet to create a project from an example in a remote GitHub repository. Projects created from GitHub repositories are created in the location specified in the project creation dialog. The cloned project does not have any Git-related information in it. You cannot sync/checkout/pull code from Git.

If you specify a repository installed locally, SSv5 will not synchronize the repo and all Git-related interface items will not be presented.

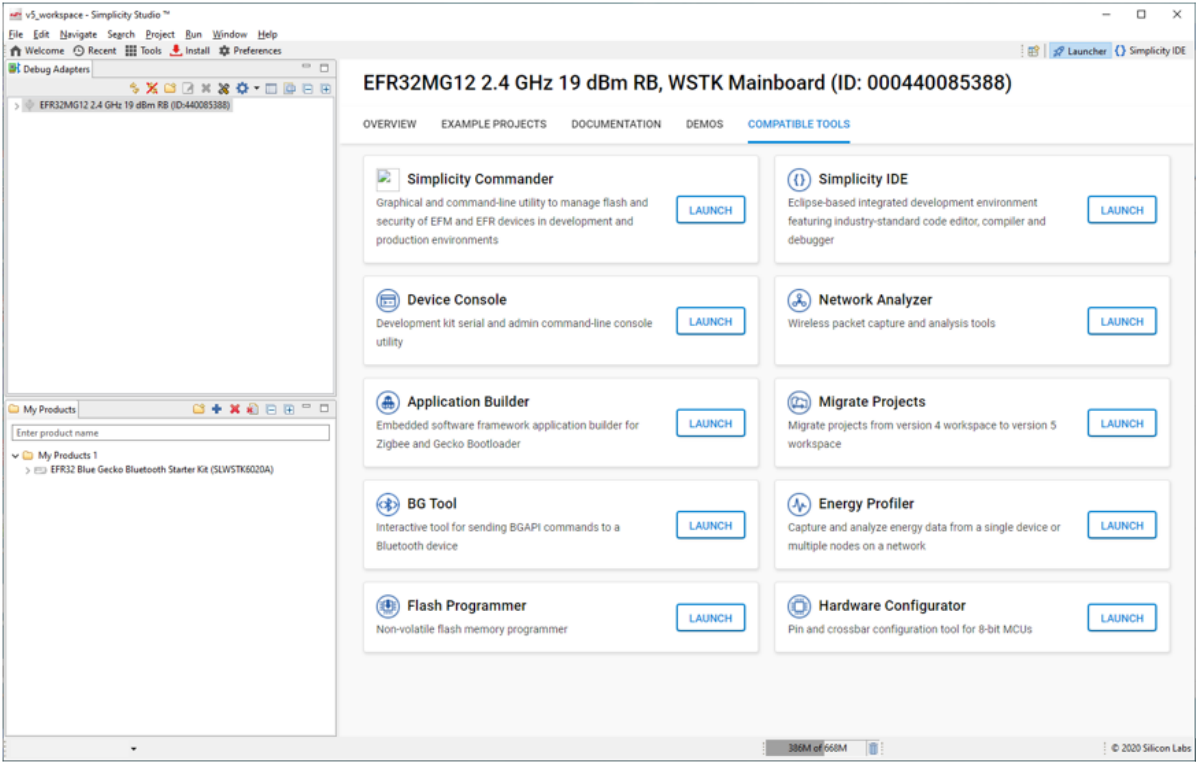
Documentation Tab

The DOCUMENTATION tab shows all documentation compatible with the selected part. Use the checkboxes or text filter field to find a resource of interest. The technology filter corresponding to your development environment will show you most software documents relevant to that environment.



Compatible Tools Tab

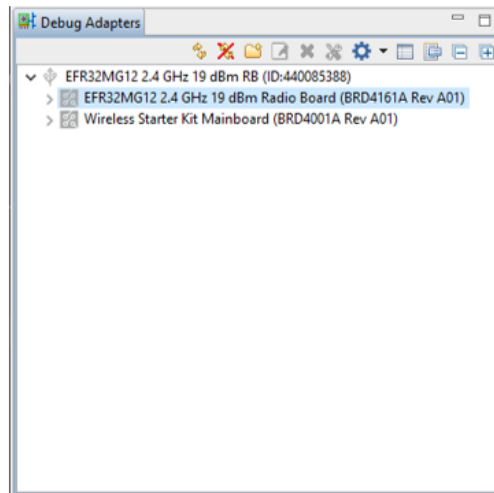
The COMPATIBLE TOOLS tab shows the tools compatible with the selected product. The Tools button on the toolbar shows all tools unfiltered.



Debug Adapters

Debug Adapters

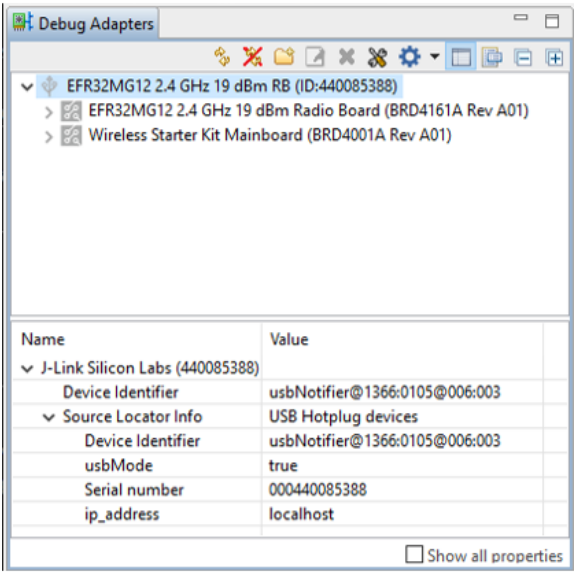
The Simplicity Studio® 5 (SSv5) Debug Adapters view shows connected hardware adapters and displays kits, board, and devices.



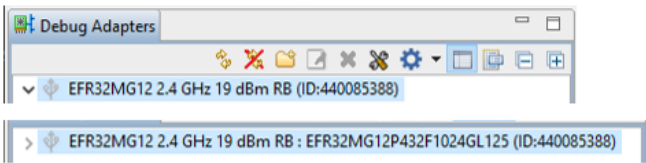
The Debug Adapters view menu functions are:



- Refresh the list of detected kits and debuggers
- Clear and refresh the list of detected kits and debuggers
- Create a group to help organize multiple adapters
- Rename a group
- Delete a group
- Device Configuration (equivalent to [Configure Connection](#))
- Preferences (provides shortcuts to three of the options available in Preferences from the toolbar or **Window > Preferences**.
 - Device Manager (Simplicity Studio > Device Manager)
 - Discovery (Simplicity Studio > Device Manager > TCP/IP Adapters)
 - Stack (Network Analyzer > Decoding > Stack Versions)
- Toggle properties (shows or hides the adapter properties)

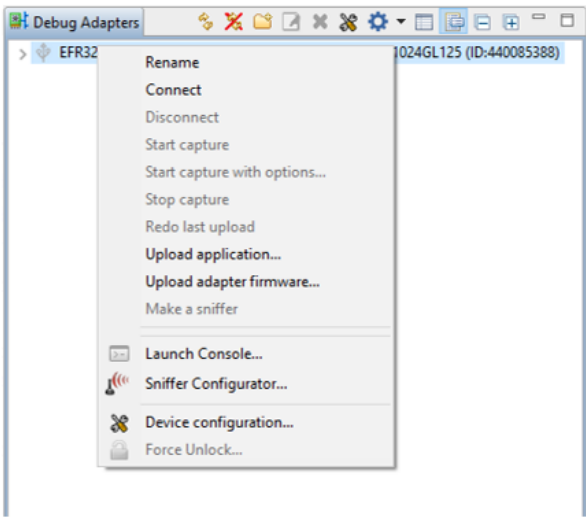


- Toggle device label detail



- Collapse all
- Expand all

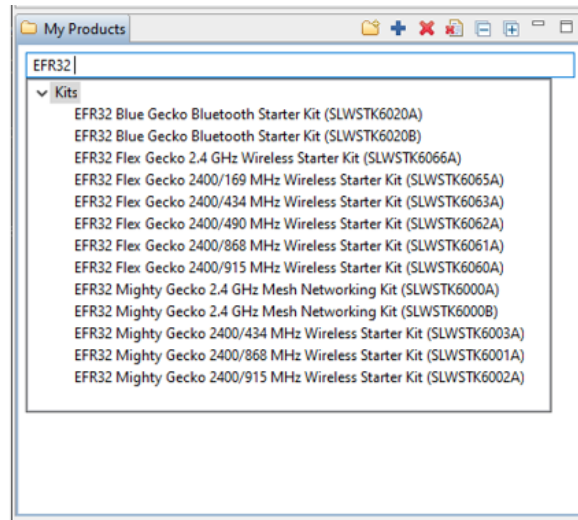
Finally, right-clicking on a debug adapter brings up a menu of functions. The availability varies depending on the context.



My Products

My Products

The Simplicity Studio® 5 (SSv5) My Products view provides you with a convenient way to save and organize a list of kits, boards, and devices for quick access. Use the search function to locate and add products to the view. Products selected here set the target device context and allow you to explore the relevant resources and to start projects.

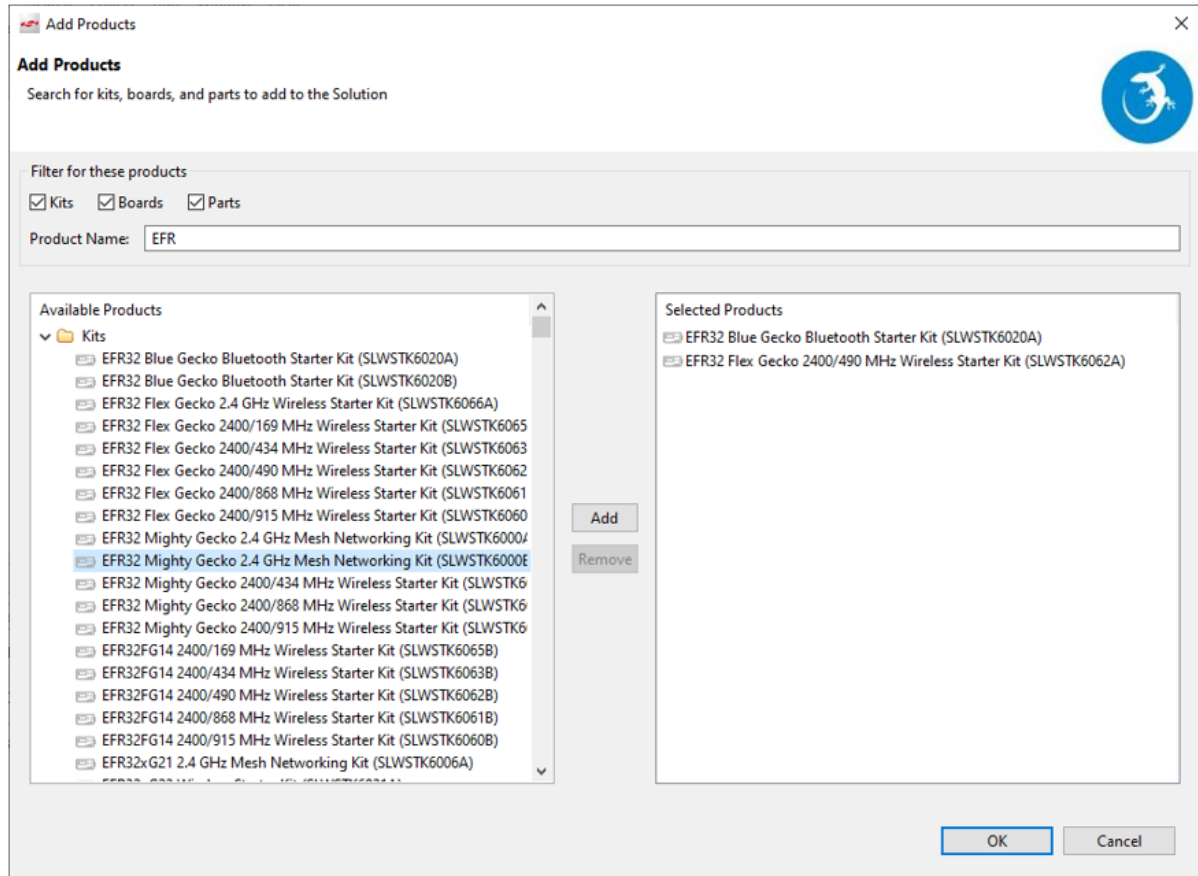


Start typing a part number or key word to see kits, boards, and parts. Once you select an item, it is added to a folder called 'My Products 1'.

The My Products view menu provides functions to help manage parts selected in this view.



- Make a new folder (rename a folder by right-clicking it)
- Add a product (opens a dialog where you can add and remove more than one part at a time)

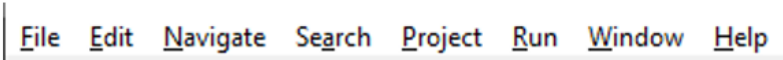


- Remove the selected part
- Remove all content
- Collapse all
- Expand all



Menu

The perspective menu is available on all Simplicity Studio® 5 (SSv5) perspectives. The options available under each vary depending on the context.



Toolbar

Toolbar

The Simplicity Studio toolbar contains functions that are generally useful throughout Simplicity Studio® 5 (SSv5).

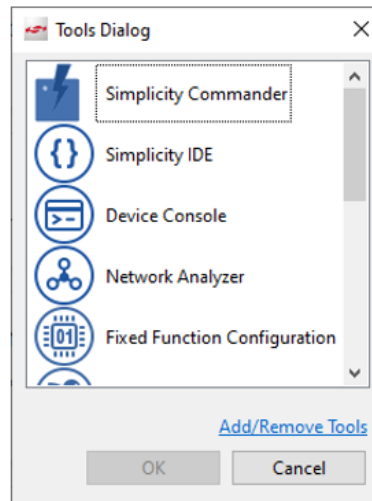


- Welcome returns you to the Launcher Welcome configuration.
- Recent shows you a list of recent projects. Select one to go to that project in the Simplicity IDE Project Explorer view.
- [Tools](#) provides a list of available tools. This list may have more selections than are available in the Launcher perspective Tools tab.
- [Install](#) brings you to a menu where you can install or uninstall software packages and review available updates.
- [Preferences](#) is a shortcut to the list of preferences also available through the menu selection Window > Preferences.

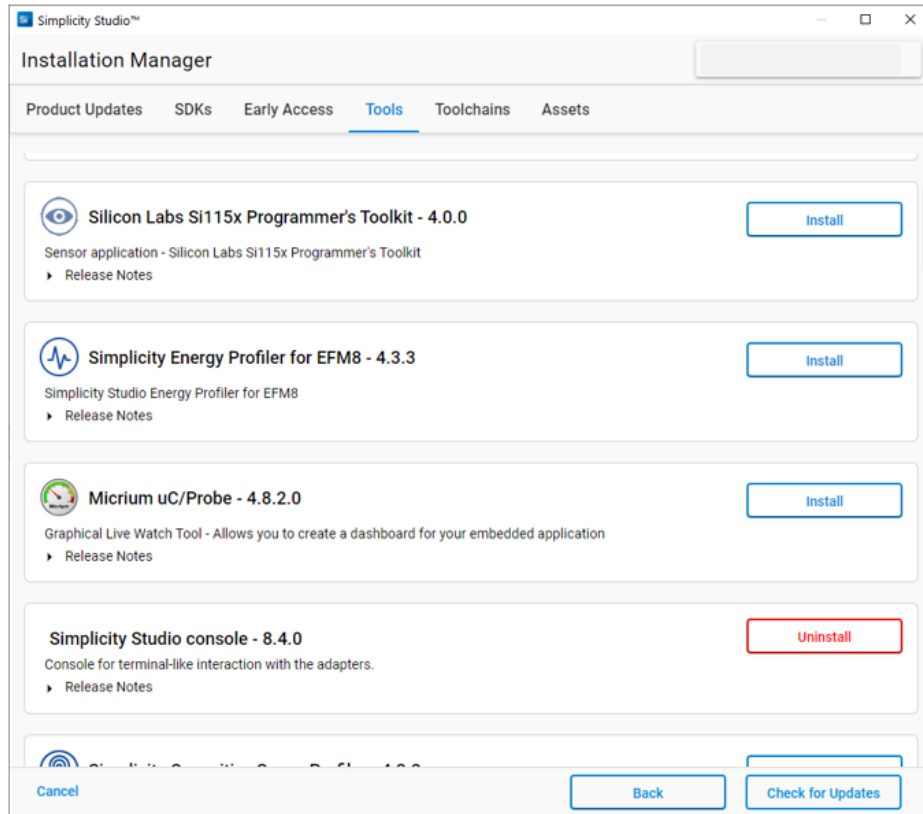
In addition, the section [About Update Frequency](#) describes how to manage the frequency with which Simplicity Studio checks for updates.

Tools

The Tools button opens a dialog where you can select a tool to open it, and also add and remove tools.

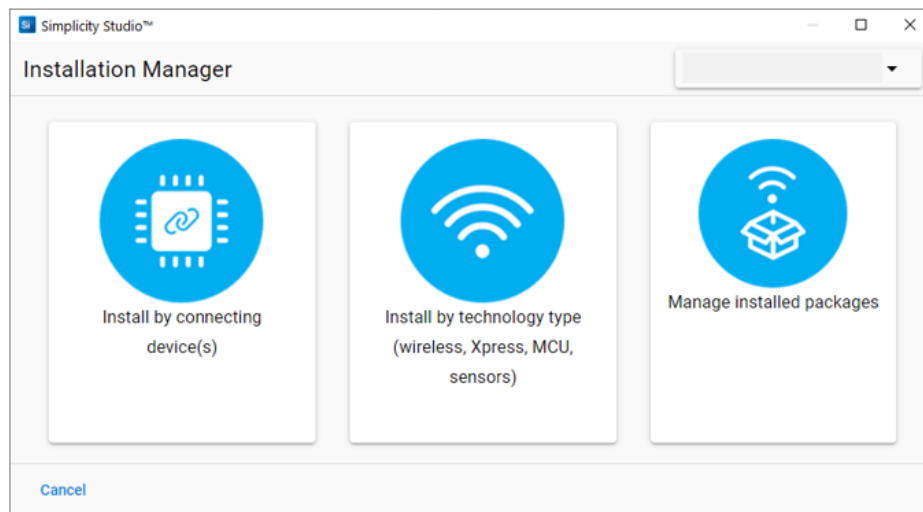


The Add/Remove Tools link opens the Installation Manager. Click **Manage Installed Packages** and go to the Tools tab, where you can add and remove tools.



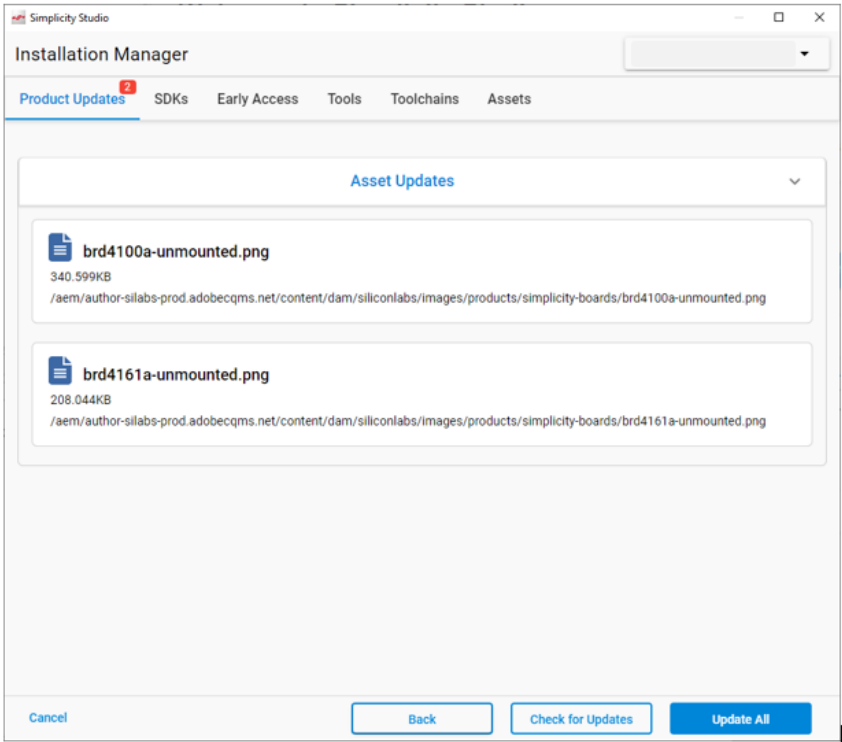
Install

The Install button (red when updates are available) opens the Installation Manager.



Because available items are often controlled through your Silicon Labs account, it is recommended that you be logged in while using the Installation Manager. **Install by connecting device(s)** and **Install by technology type** are both described in [Install SSv5 and Software](#). This section describes the **Manage installed packages** functionality.

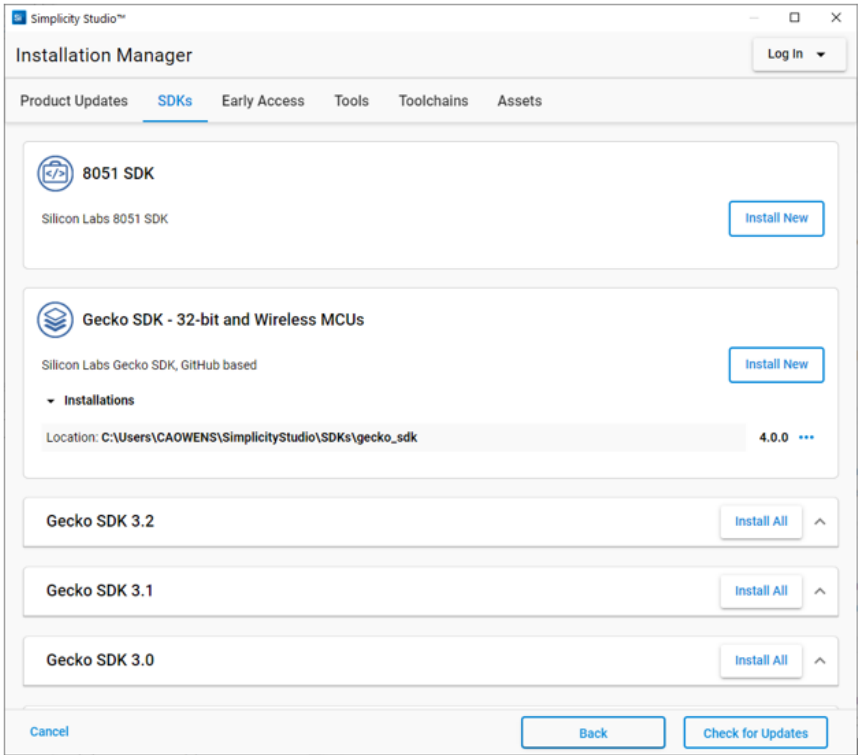
Click **Manage installed packages** to open a tabbed interface where you can install and uninstall a variety of SSv5 components. The interface opens on the Updates tab. Updates are grouped by type.



The SDKs tab supports installing and uninstalling SDKs and supporting packages. Summary release notes are provided. Filters across the top of the dialog allow you to control the items displayed.

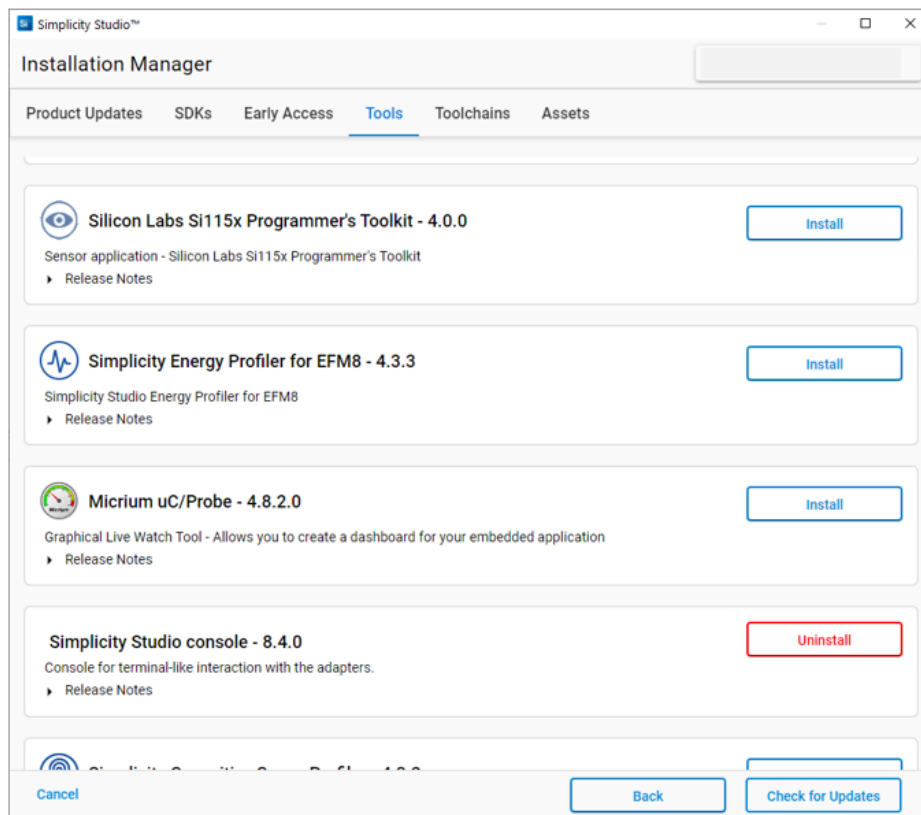
Note: The default Version filter is 'Latest'. To see and install earlier versions, change this to 'All'.

If you have access to the item Access Granted is noted in green, and the item has an **Install** control. If you do not have access, the item has a **Request Access** control that opens a web page where you can contact sales. Installed items have an **Uninstall** control in red. Some installed items cannot be uninstalled because other items are dependent on them.

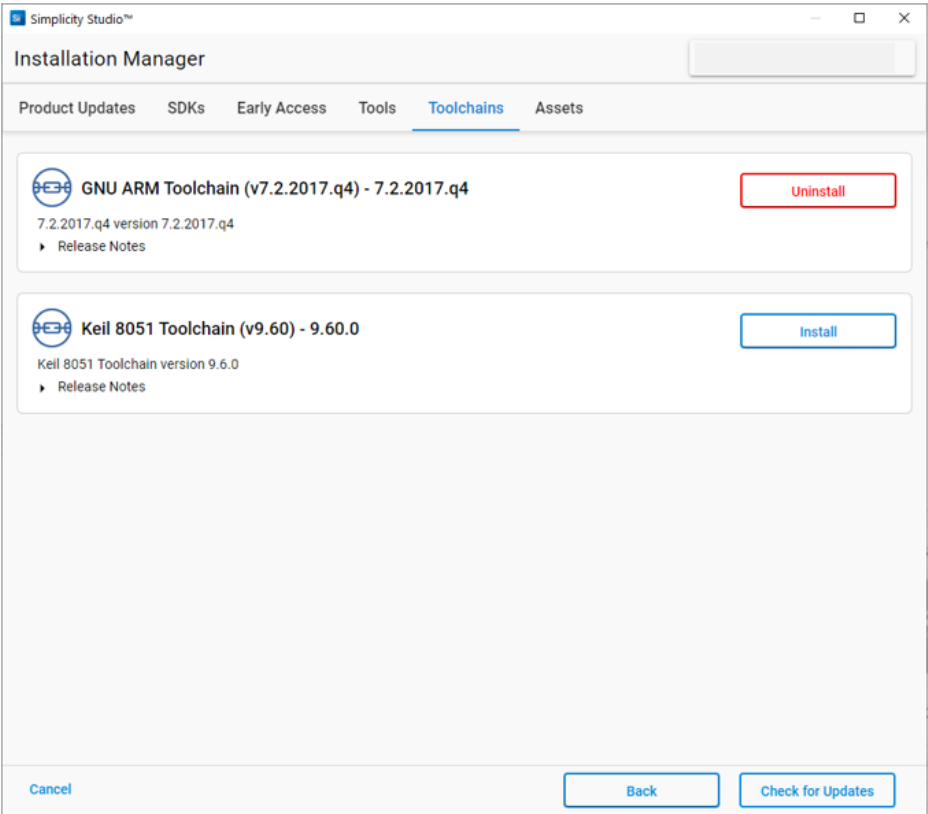


The Early Access tab is used to provide limited access for some customers, usually for beta testing.

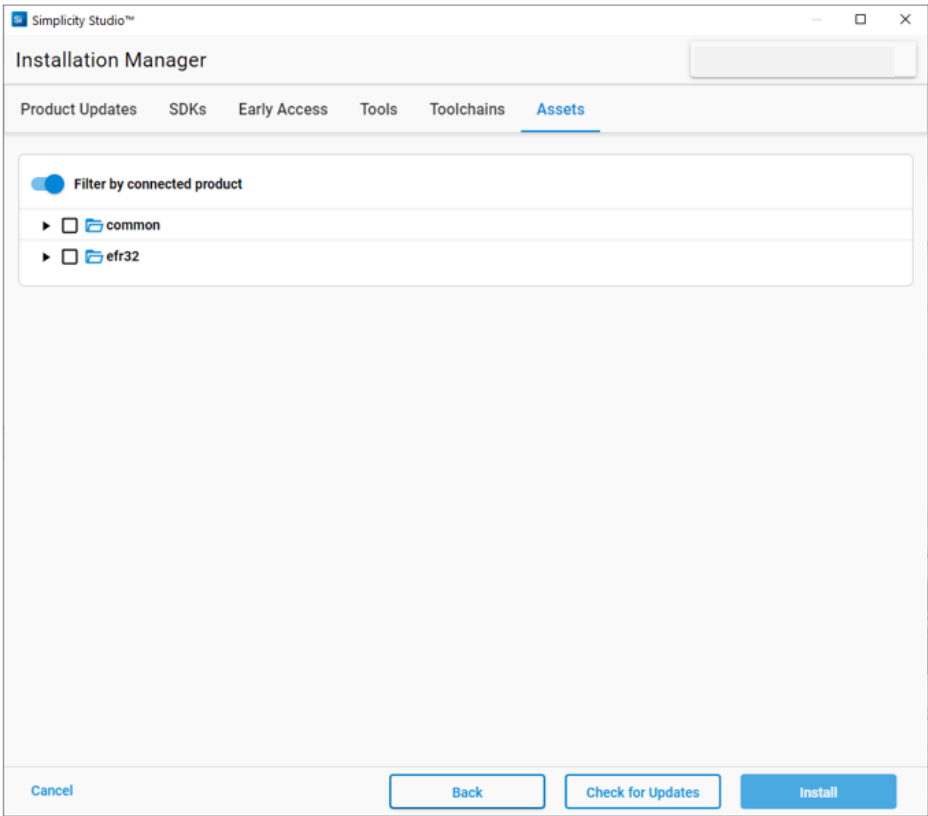
The Tools tab shows available and installed tools, regardless of your connected or selected hardware. Summary release notes are provided.



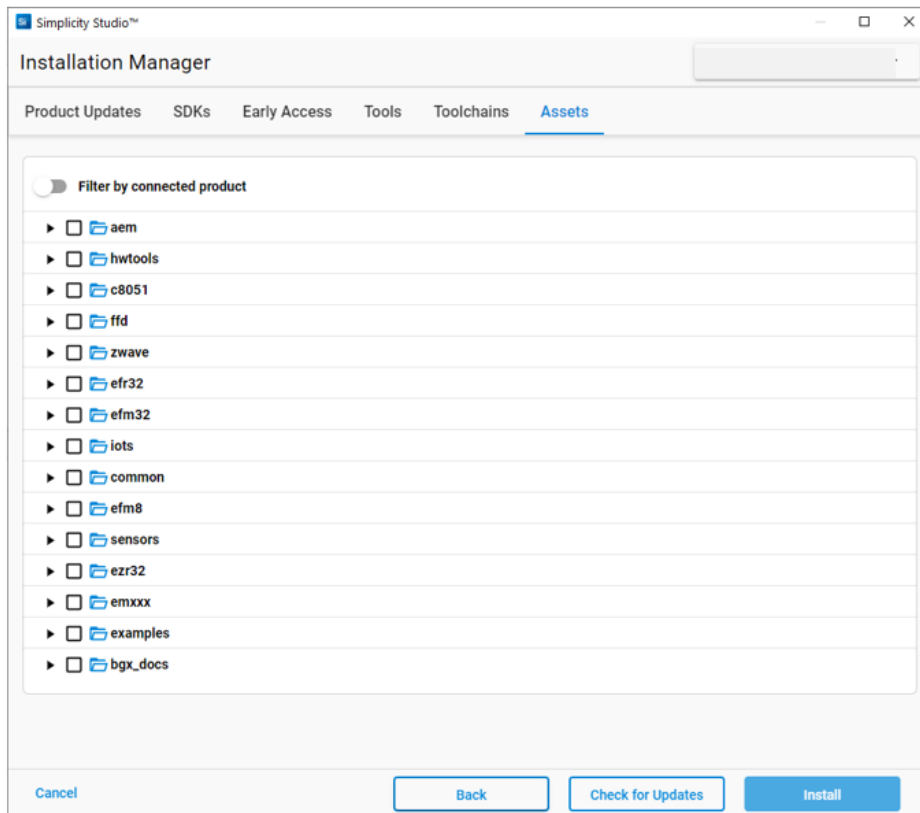
The Toolchains tab shows available and installed toolchains.



The Assets tab shows available assets. Assets include items such as documents, photographs, code, and so on. Check the item(s) of interest and click **Install**. The default view is filtered by connected product.



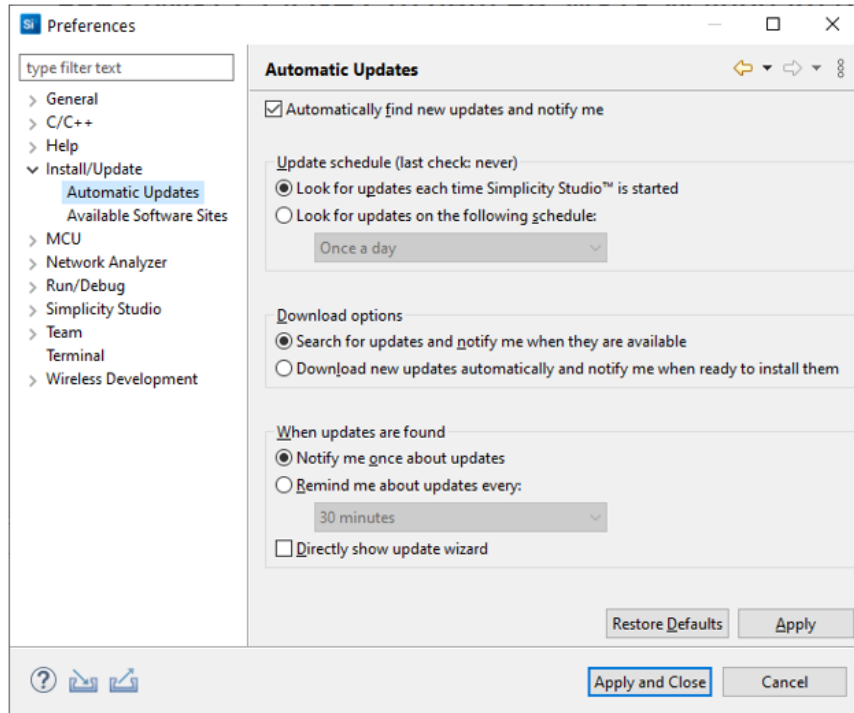
The unfiltered view provides a much larger set of options.



After you install or uninstall items, for example as a result of an update or because you want to manage your SDK installations, SSv5 determines if a restart is required.

About Update Frequency

By default, SSv5 checks for updates when you first open it. You can manage update frequency through Preferences > Install/Update > Automatic Updates.

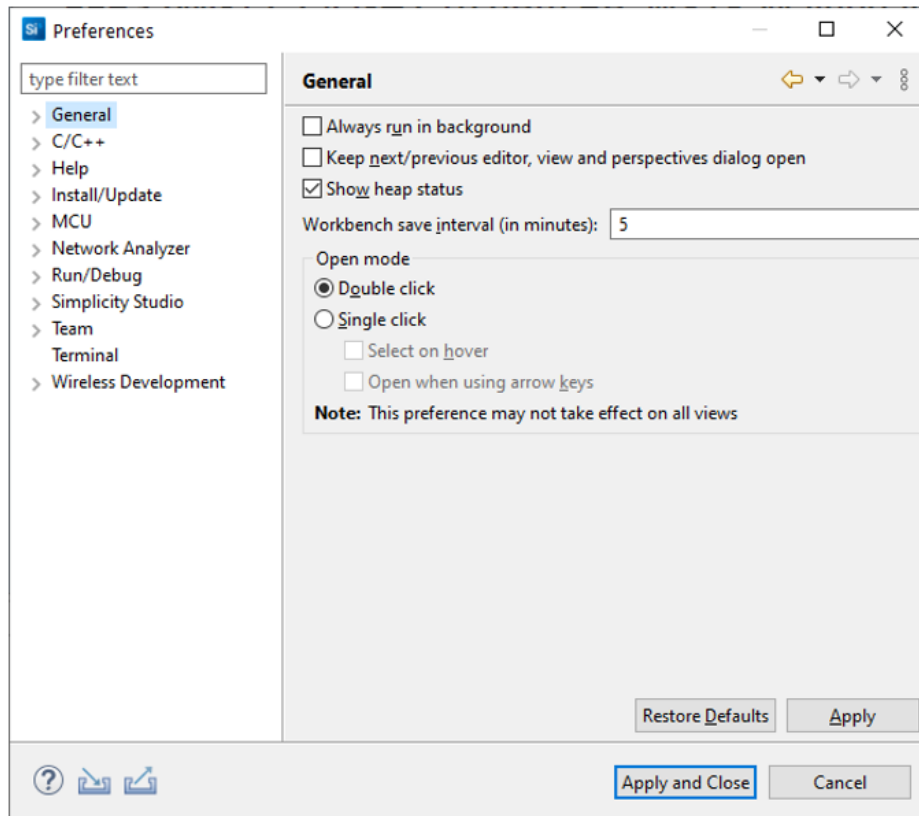


- Automatically find new updates and notify me (default: On): When selected, SSv5 automatically searches for update, as defined by the update schedule.
- Update schedule (default: On startup): Look for updates on each startup, or once a day or some day a week, at a predefined time.
- Download options (default: Search and Notify): Choose if SSv5 will search for updates and notify you of them once they are available or automatically download new updates and ask you to install them.
- When updates are found (default: Once): Choose to be notified about new updates only once, or to receive reminders until the updates are installed.

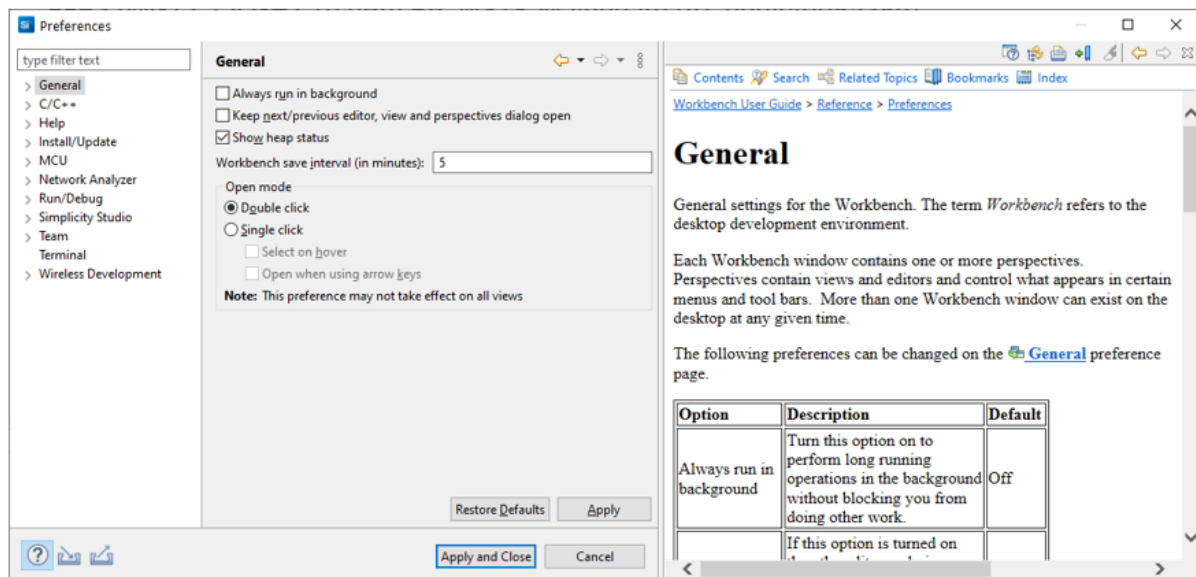
If you have turned automatic updates off, you can check for updates by clicking **Install** on the toolbar, then **Manage Installed Packages**, and then **Check for Updates** on the Product Updates tab.

Preferences

The Preferences button is a shortcut to the Windows > Preferences dialog (App menu on macOS).



Frequently used preferences are discussed in context of their use cases. Context-sensitive help is available for most preferences.



The arrow controls in the upper-right enable navigation through previously viewed pages. To return to a page after viewing several pages, click the drop-down arrow to display a list of recently viewed pages.

If you have made changes in preferences and wish to move them to a different installation, use the Import and Export controls in the lower left.

About the Simplicity IDE

About the Simplicity IDE

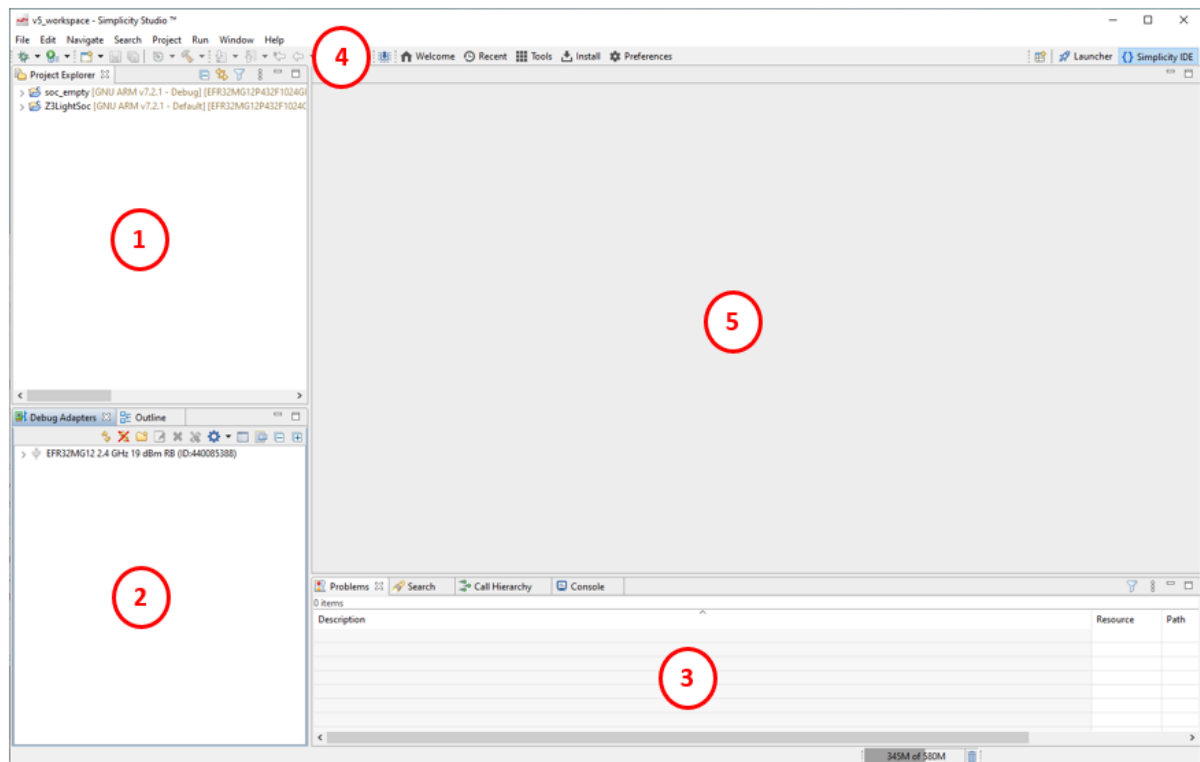
The Simplicity Studio® 5 (SSv5) **Simplicity Integrated Development Environment (IDE)** perspective is designed to support code editing, downloading, and debugging for EFR32 devices and modules and EFM32, EFM8, and 8051 devices.

These pages review the [Simplicity IDE User Interface](#), discuss how to [import and export projects](#), and explore the features supporting [code editing](#).

User Interface Review

User Interface Review

The Simplicity IDE perspective is made up of three views areas, the editor area, and a toolbar.

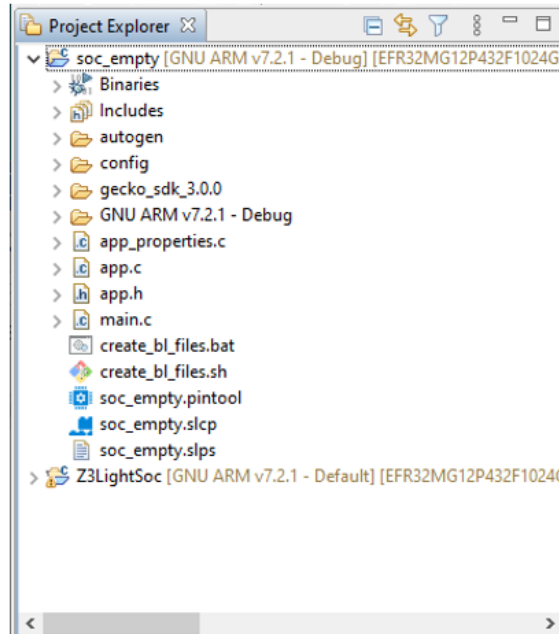


1. [Project Explorer View](#)
2. [Debug Adapters View](#)
3. [Other Views](#)
4. [Toolbar](#)
5. Editor area

The Editor area is populated with whatever tool is appropriate for the device and project, such as [Project Configurator](#), [AppBuilder](#), or the 8-bit device [Hardware Configurator](#).

Project Explorer View

The Project Explorer view shows project files in the current workspace.

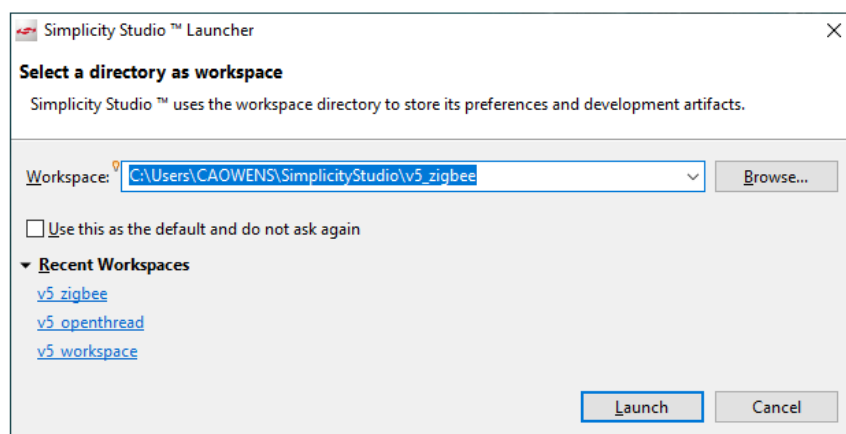


A workspace is a directory that includes some hidden metadata, and must be created through SSv5. The default Windows workspace is:

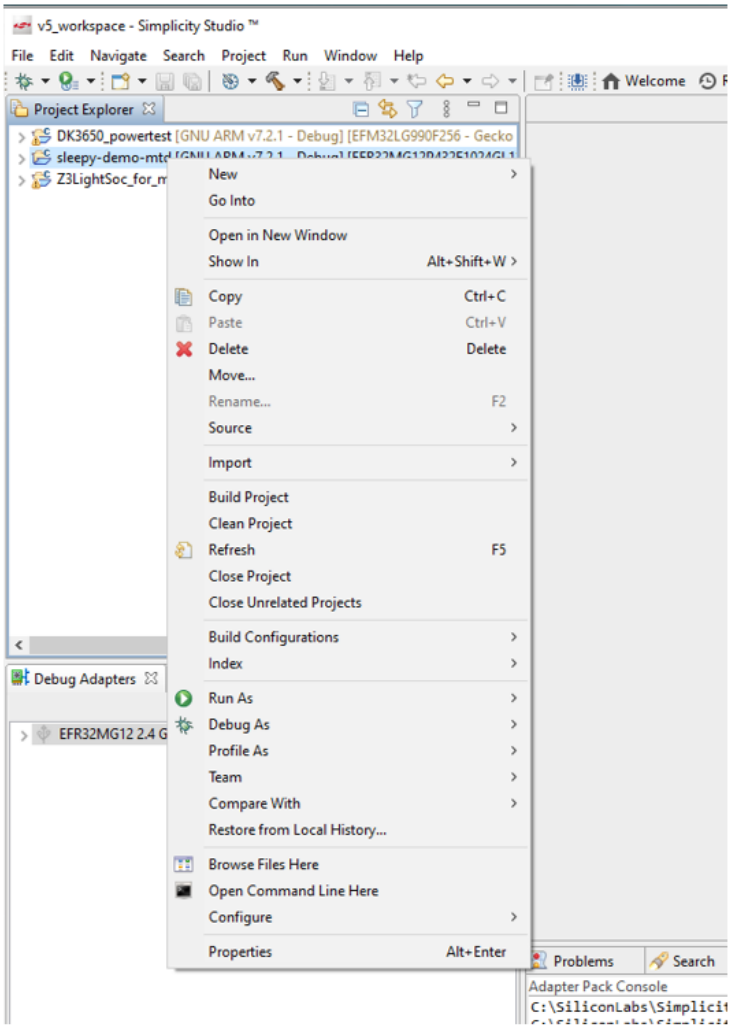
`\Users\<username>\SimplicityStudio\v5_workspace\`

Maintaining separate workspaces for different GSDK versions or compiler versions may be necessary in some cases or may help improve SSv5 Performance. See [Tips and Tricks](#) for more information.

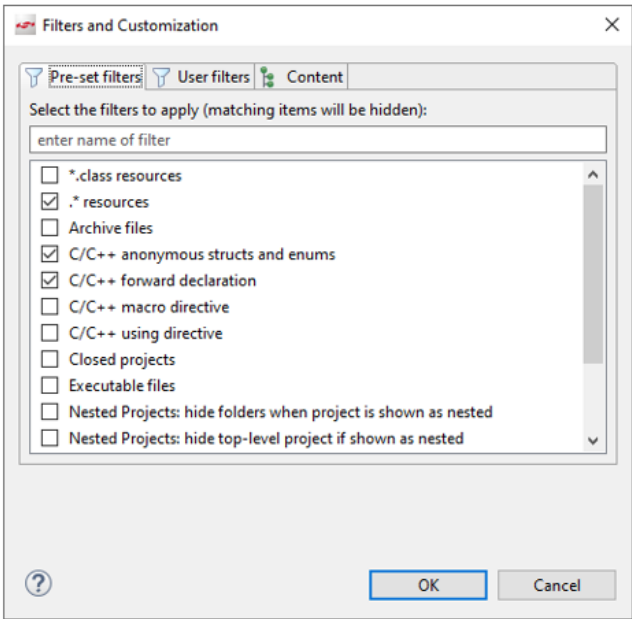
Each SSv5 session has a single default workspace. To change workspaces or to create a new workspace, use the **File > Switch Workspace** function. To create a new workspace click **Browse** and add a new directory. After you add or switch, SSv5 restarts.



Right-click a project directory for a context menu of project-level functions.

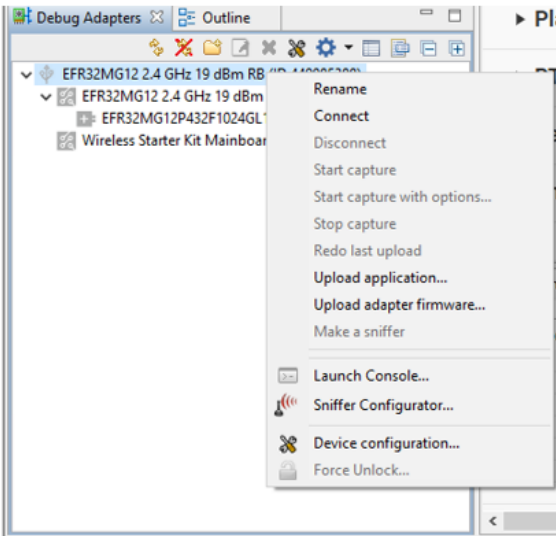


The Filter functionality available through the view toolbar can be used to limit the files shown.

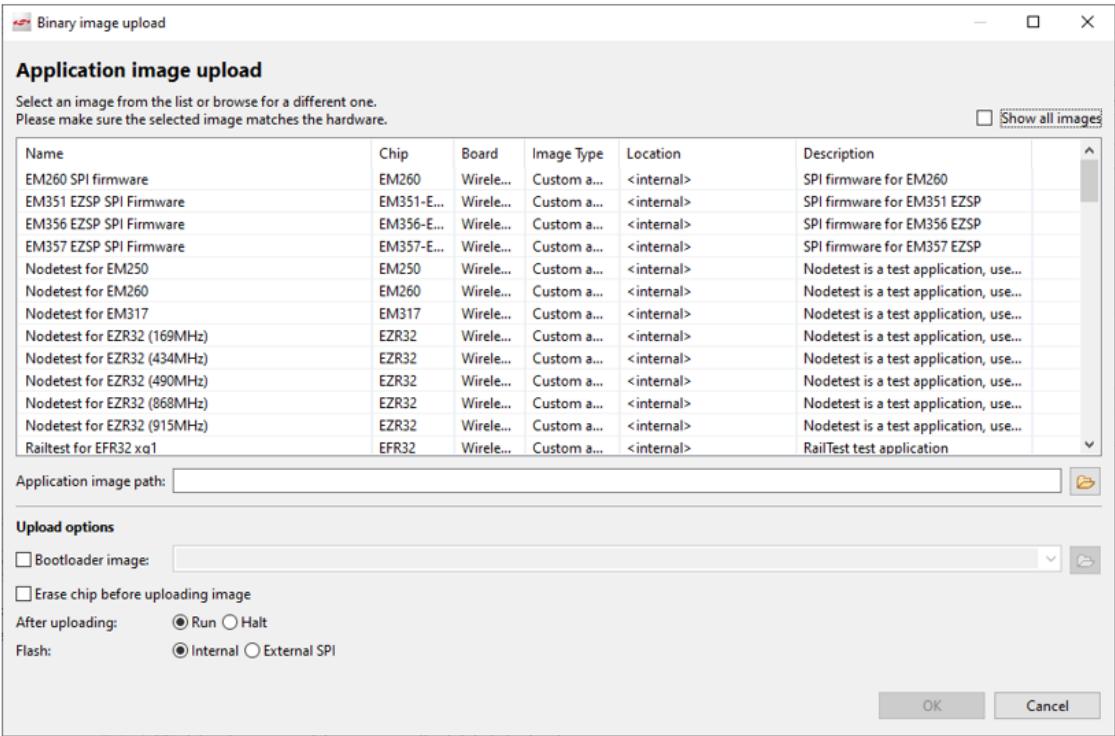


Debug Adapters View

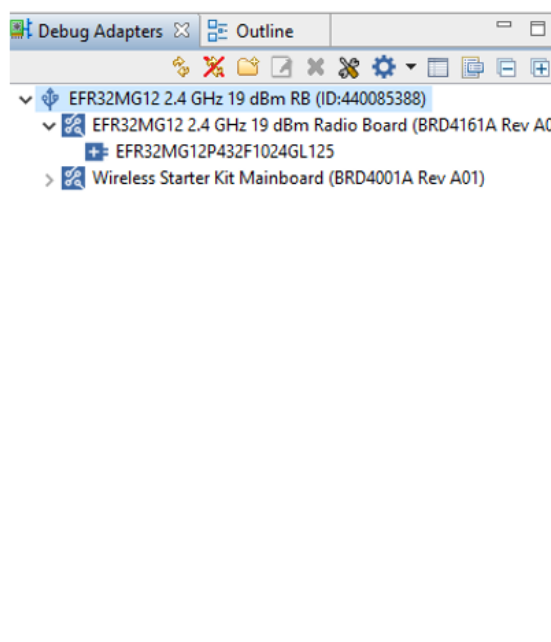
The debug adapters tab in this view is the same as that in the Launcher perspective.



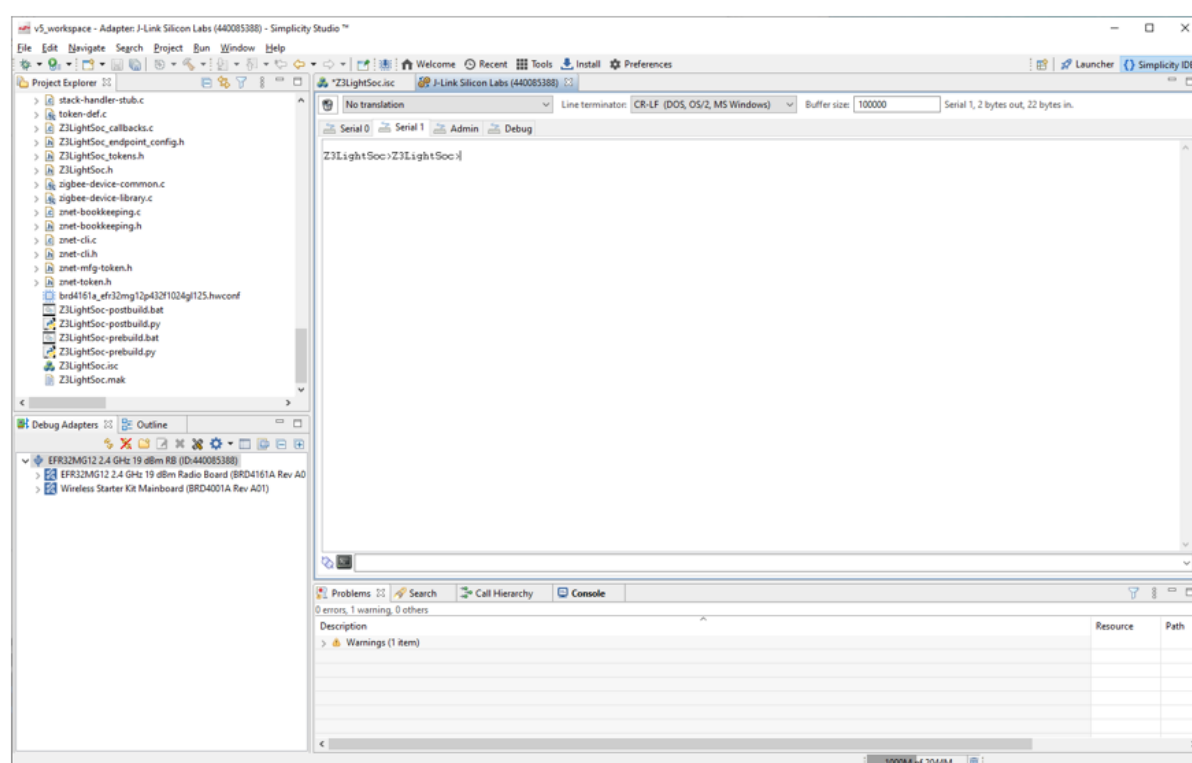
When the adapter is disconnected, an **Upload application** option is available. This has the advantage of allowing you to flash both an application image and a bootloader image at the same time, and also to see the various pre-compiled images available based on the installed SDKs, along with their compatible hardware.



When you connect to an adapter, the icons turn blue.

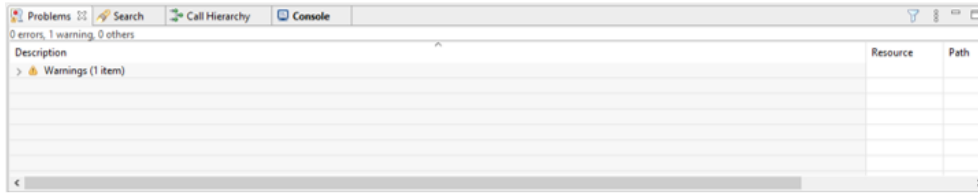


Once you have connected, **Start capture** and **Start capture with options** open the Network Analyzer interface for that device. For many devices, **Launch console** opens up a console in the editor area, where you can interact with the device. This option is not available with EFM8 / C8051 starter or development kits (STKs or DKs).



Other Views

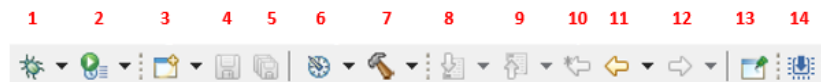
Other views are available in the pane below the editor area.



- **Problems** shows any problems detected in an open file or a process.
- **Search** shows the results of the most recent search. The toolbar allows you to retrieve previous searches.
- **Call Hierarchy** shows the results of Open Call Hierarchy when using the IDE for [code development](#).
- **Console** shows activity such as flashing an image to the device and build results.

Toolbar

The Simplicity IDE toolbar offers debug and other code and file options.



- 1 Debug** builds an image in debug mode, flashes it, and opens the [debugger](#).
 - 2 Profile as** opens the [Energy Profiler](#).
 - 3 New** opens a menu where you can create a variety of items, including a new project (equivalent to **File > New > Project**).
 - 4 Save** saves a changed file.
 - 5 Save all** saves all changed files.
 - 6 Mode** allows change between debug and release mode for the applicable toolchain.
 - 7 Build** builds the selected project file in the default mode (debug or release).
- When working with code files, **8 Next** and **9 Previous annotation** allow you to select the type of annotation and move to them.
- 10 Edit last location** opens the last file you had selected.
 - 11 Back** and **12 Forward to file** allow you to move to the previous or next file, or to select a file from a list.
 - 13 Pin editor** links the selection in the Project Explorer view to its editor tab.
 - 14 Flash programmer** opens the [Flash programmer](#) tool, also available through the Tools menu.

Import and Export

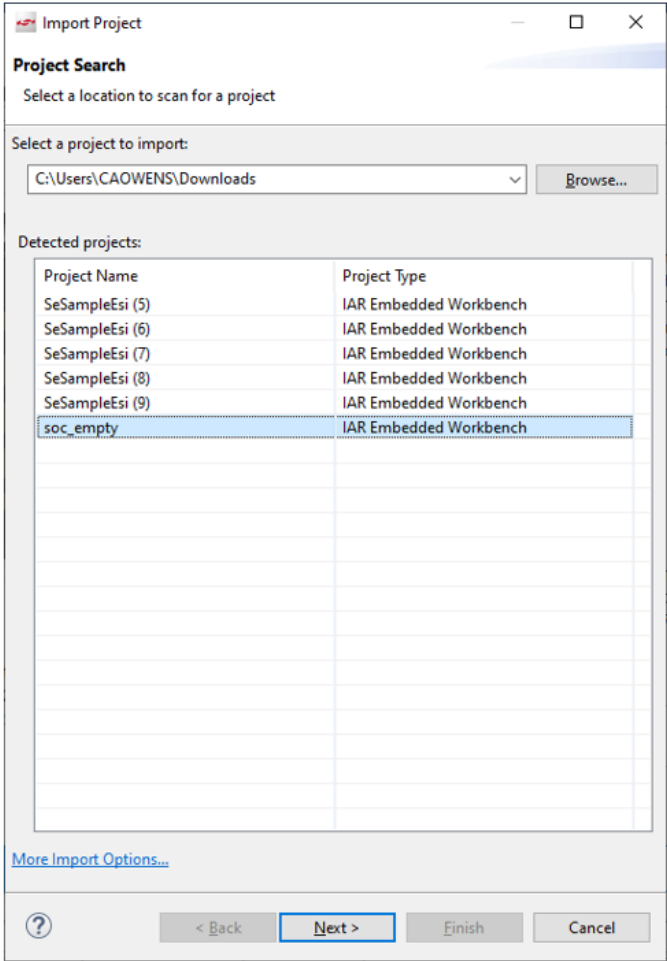
Import and Export

Simplicity Studio® 5 (SSv5) [File > Import](#) allows you to import a project from Keil® µVision4®, IAR Embedded Workbench, or the 8-bit Silicon Labs IDE into Simplicity IDE. You can also import a Silicon Labs Configurator project (.slcp) file to create a project in the Simplicity IDE, or a Silicon Labs export (.sls) file to import a project or a solution.

[File > Export](#) allows you to export a project or solution in a variety of formats.

Import

- Place the file to be imported in a folder.
- Select **File > Import**, and locate the folder with the project or solution to be imported.



Select the project and click **Next**. If anything about the project is unresolved you can resolve it.

Import Project

Build Configurations of the Project

Device part of the build configuration cannot be resolved.

Build configurations to import. Select each to examine its detail.

Default

[Manage Targets...](#)

Build Configuration Detail

Board:

Part:

mcu.arm.efr32.mg12.efr32mg12p432f1024gl125 mcu.arm.*

SDK:

unknown

Toolchain:

unknown

Build Artifact:

Executable

No build configuration is resolved in current installation/configuration of Studio.
Click "Next" to set or change the parameters and reconstruct the build configuration(s).

?

< Back

Next >

Finish

Cancel

Import Project

Reconstruct Build Configurations

Set parameters (part, SDK, etc.) to reconstruct build configurations

Boards:

Search

EFR32MG12 2.4 GHz 19 dBm Radio Board (BRD4161A Rev A01) ×

Wireless Starter Kit Mainboard (BRD4001A Rev A01) ×

Part:

Search

EFR32MG12P432F1024GL125

SDK:

Gecko SDK Suite: Bluetooth 3.0.0.1, EmberZNet 6.8.0.1, Flex 3.0.0.1, MCU 5.10.0.1, Micrium

Manage SDKs...

Toolchain:

GNU ARM v7.2.1

Manage toolchains...

Build Artifact:

Executable

Converted configurations:

Normal (active)

Manage Targets...

?

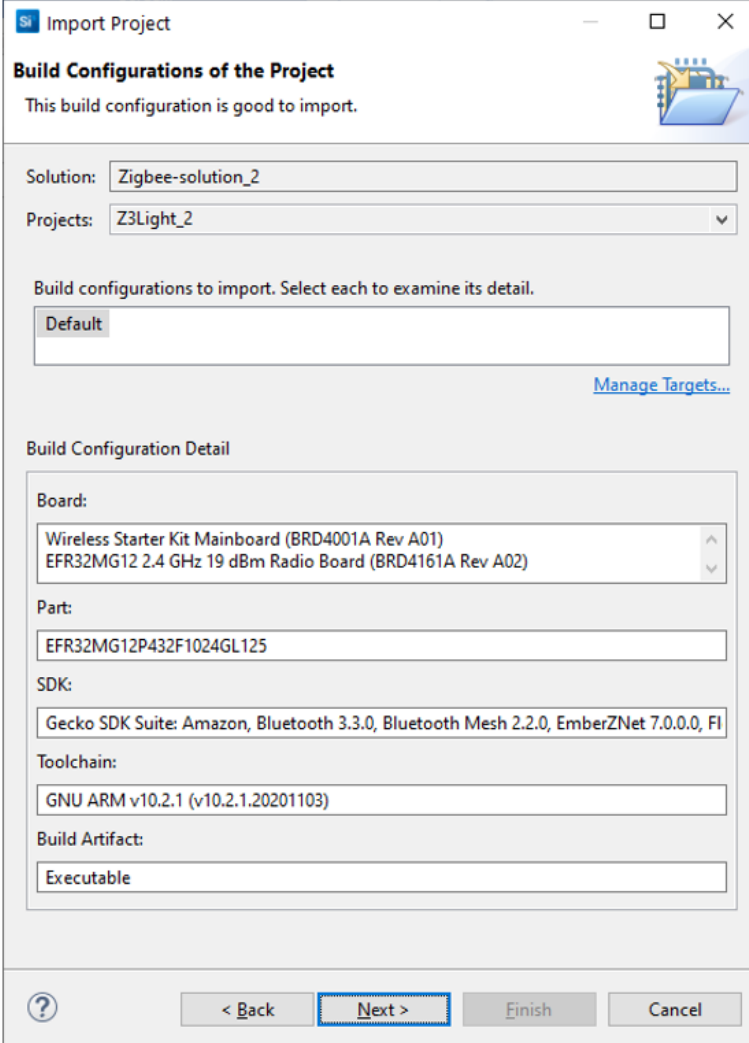
< Back

Next >

Finish

Cancel

If you are importing a solution, you can see the projects that are included in the solution.



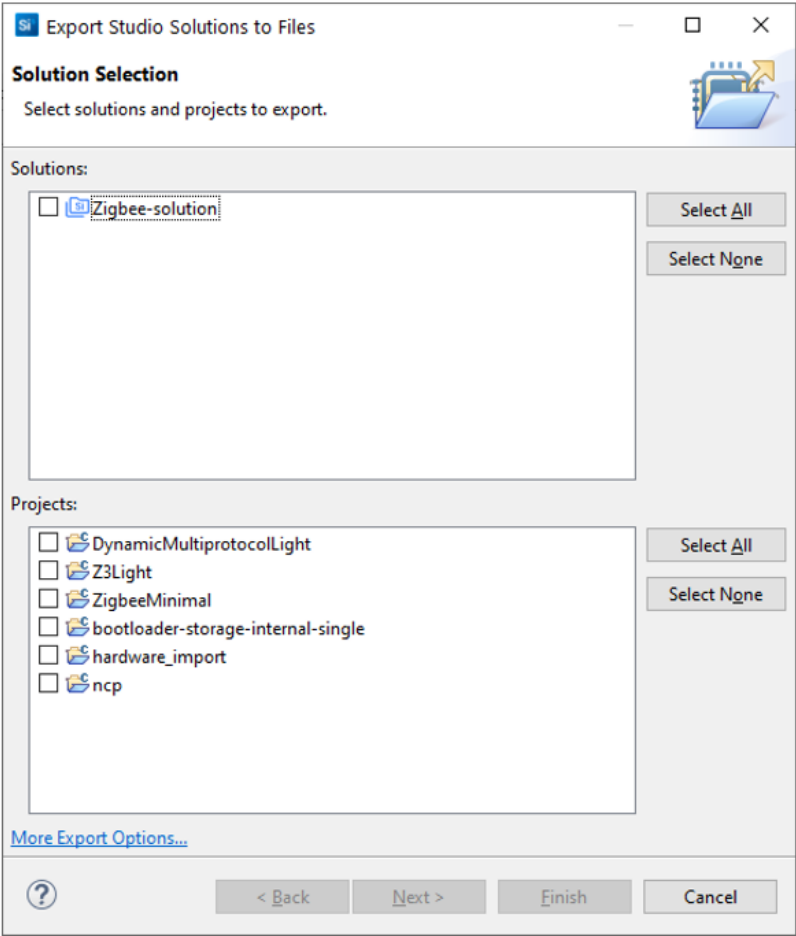
The 'Import Project' dialog box is titled 'Import Project' and contains the following sections:

- Build Configurations of the Project**: A message states 'This build configuration is good to import.' with a folder icon.
- Solution**: A text field containing 'Zigbee-solution_2'.
- Projects**: A dropdown menu showing 'Z3Light_2'.
- Build configurations to import. Select each to examine its detail.**: A list box containing 'Default'.
- Manage Targets...**: A blue hyperlink.
- Build Configuration Detail**: A section with several fields:
 - Board**: A list box showing 'Wireless Starter Kit Mainboard (BRD4001A Rev A01)' and 'EFR32MG12 2.4 GHz 19 dBm Radio Board (BRD4161A Rev A02)'.
 - Part**: A text field containing 'EFR32MG12P432F1024GL125'.
 - SDK**: A text field containing 'Gecko SDK Suite: Amazon, Bluetooth 3.3.0, Bluetooth Mesh 2.2.0, EmberZNet 7.0.0.0, FI'.
 - Toolchain**: A text field containing 'GNU ARM v10.2.1 (v10.2.1.20201103)'.
 - Build Artifact**: A text field containing 'Executable'.
- Navigation**: A row of buttons at the bottom: a help icon (?), '< Back', 'Next >' (highlighted with a blue border), 'Finish', and 'Cancel'.

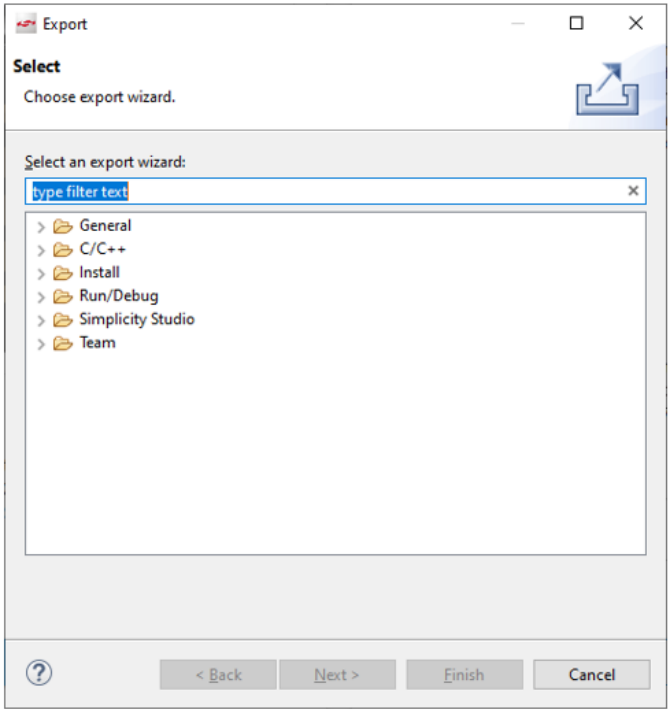
Click **Next**. Name the project or solution and click **Finish**.

Export

Select **File > Export**, and select the file(s) and/or solution(s) to be exported.



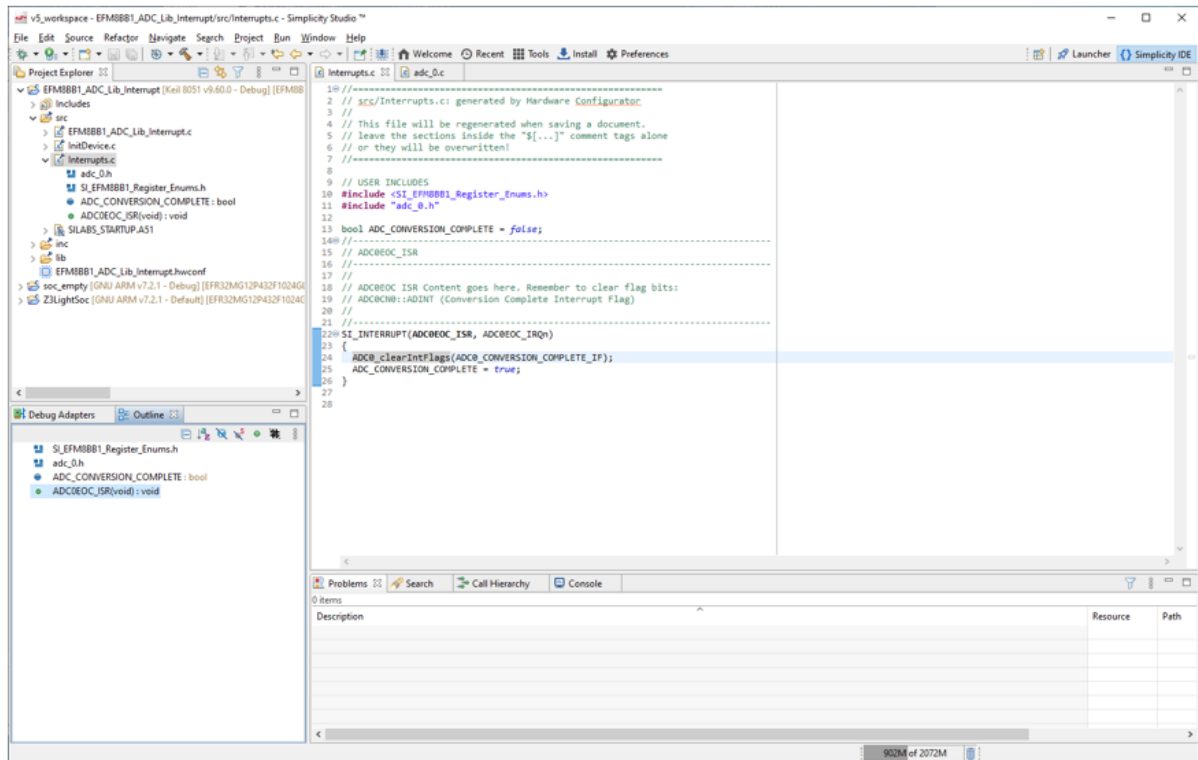
The default export format is an .sls file, which can easily be re-imported into SSv5. However, other options are available. Click **More export options...** and select a wizard.



Code Editing

Code Editing

Simplicity Studio® 5 (SSv5)'s Simplicity IDE is a code editing and development environment. The editor includes context highlighting, reference searching, and standard features found in any modern editor.



Note that the Outline view tab in the Debug Adapters area provides a code outline and a toolbar to control what shows in the Outline view.

This page includes information on:

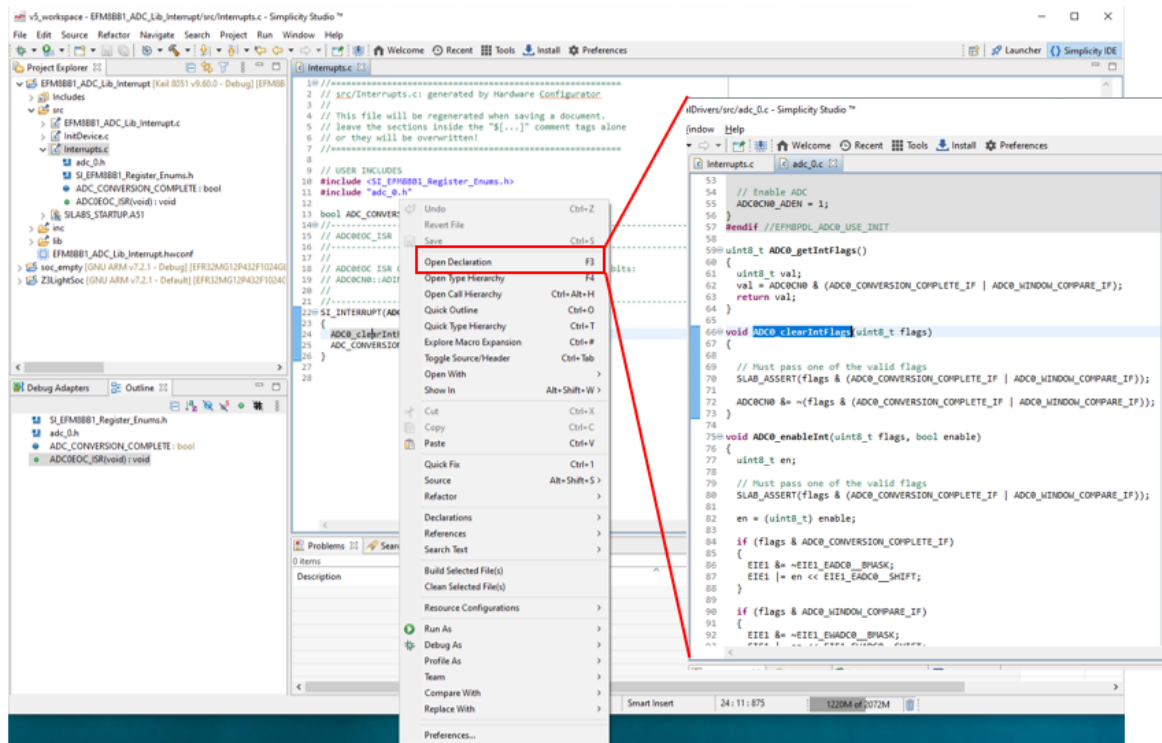
- [Open Declaration](#)
- [Content Assist](#)
- [Link with Editor](#)
- [Symbol Expansion](#)
- [Task View](#)
- [Quick-Access Console](#)
- [Call Hierarchy](#)

Open Declaration

In addition to the basic features, Simplicity IDE supports many advanced code-editing features. For example, the IDE automatically indexes all code within the project to support symbol lookup. The code does not have to build completely for the indexer to work, though certain features may not be available if, for example, the `main()` routine is not declared.

In this example, the **Open Declaration** (F3 shortcut) feature quickly finds symbol declarations.

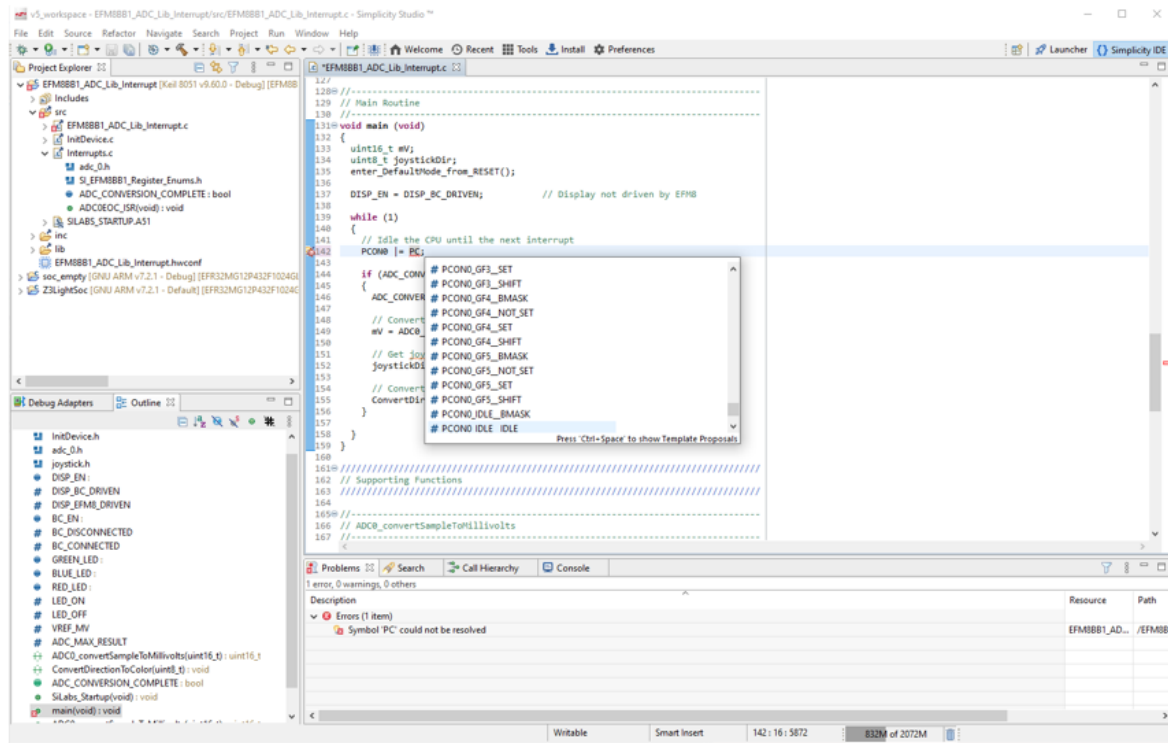
1. Open the file of interest by double-clicking it in the Project Explorer view.
2. Right-click the desired symbol to display the context menu.
3. Click **Open Declaration** to quickly navigate to the definition of the symbol.
4. SSV5 automatically opens the file and highlights the line containing the declaration of the symbol.



Content Assist

Simplicity Studio also supports code completion, a feature called **Content Assist**. Content Assist requires that the appropriate header files be included in the file so that the symbols are available. To use Content Assist, type the first few letters of a symbol or include file and press **Ctrl+Space** to display a list of symbols that match. For example, to use [Content Assist] to display a list of symbols starting with the characters PC:

1. Type `PC` and press **Ctrl+Space** to display the Content Assist list.
2. Use the arrow keys or page up and down keys to look through the list of matching symbols.
3. Press **Enter** to replace the typed characters with the selected symbol.

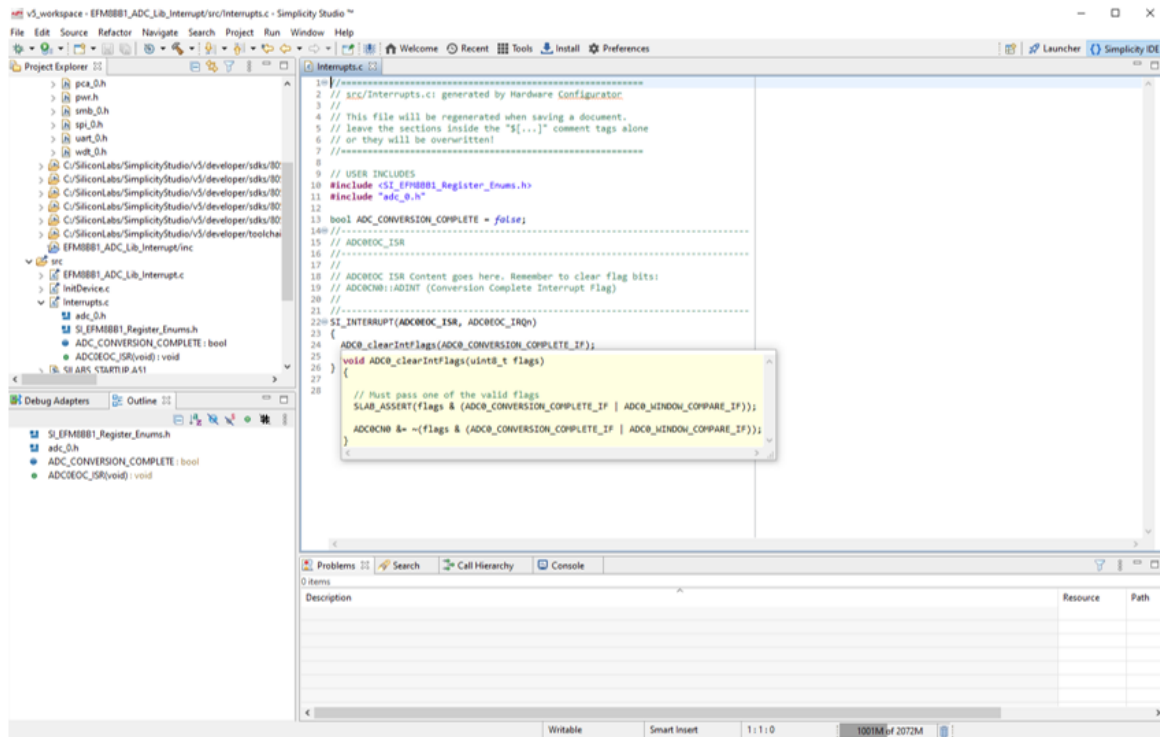


Link with Editor

In the Project Explorer view, click **Link with Editor** in the toolbar. Then, if you have multiple files open, selecting a file in Project Explorer makes the associated editor tab active.

Symbol Expansion

Hover over a function or macro in the editor to display a hover window with expanded information.

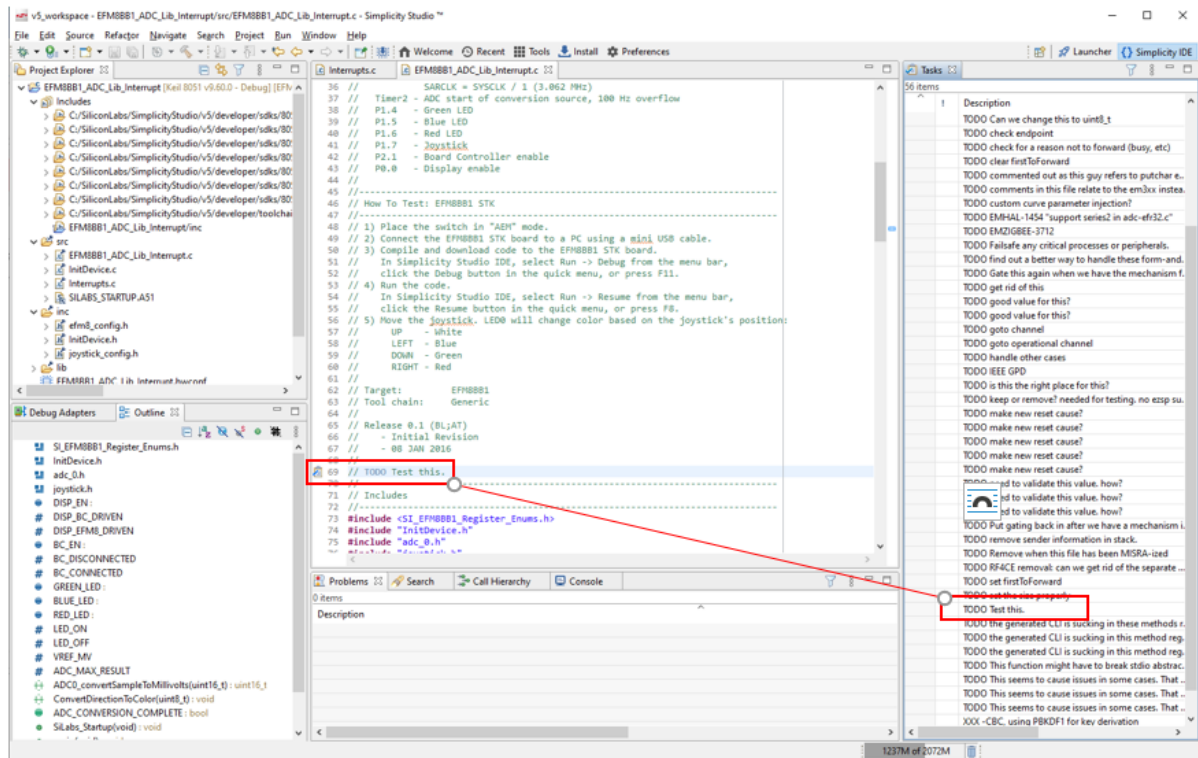


Task View

The Tasks view automatically picks up any comments with **TODO** or **FIXME** in the line. For example:

1. Type **TODO** in a comment line with the desired text and save the file
2. Select **Window > Show View > Other**, type **Tasks**, and press **Open**.

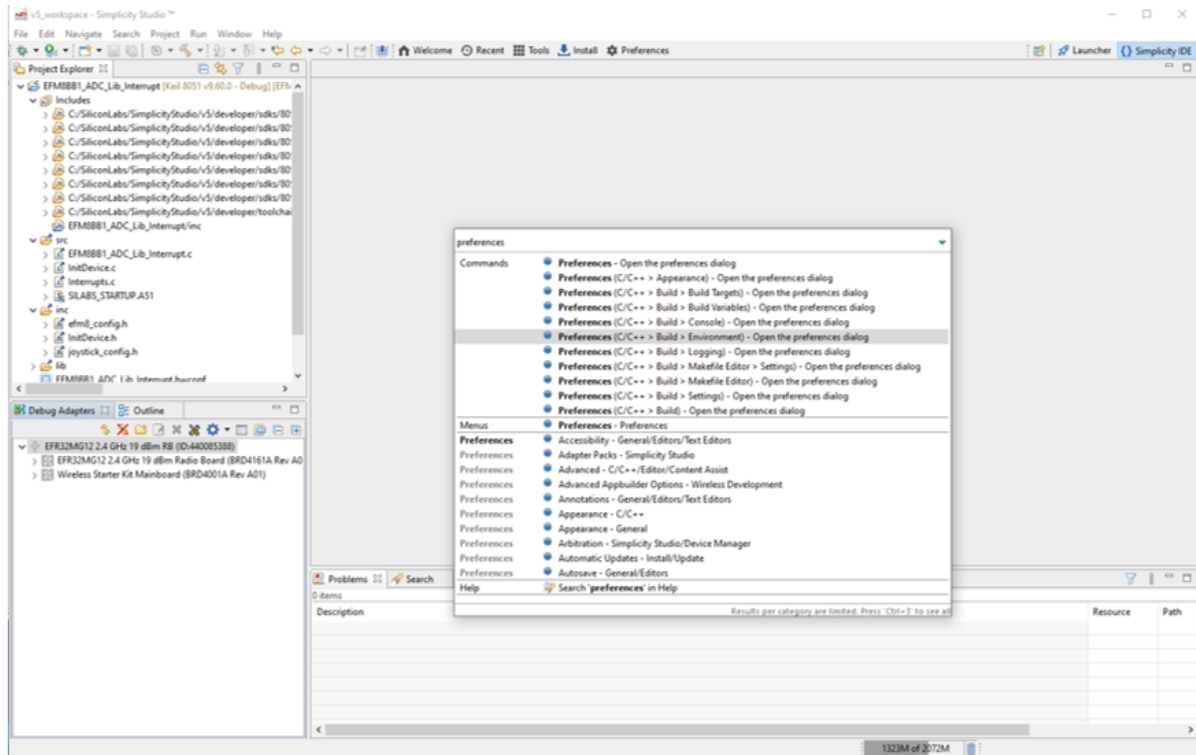
The TODO or FIXME lines are highlighted by a clipboard icon to the left of the line in the editor. Double-click on a line in the Tasks view to open the relevant file with that line selected.



Note: To reset the perspective to its original layout, right-click the perspective button in the toolbar and select **Reset**.

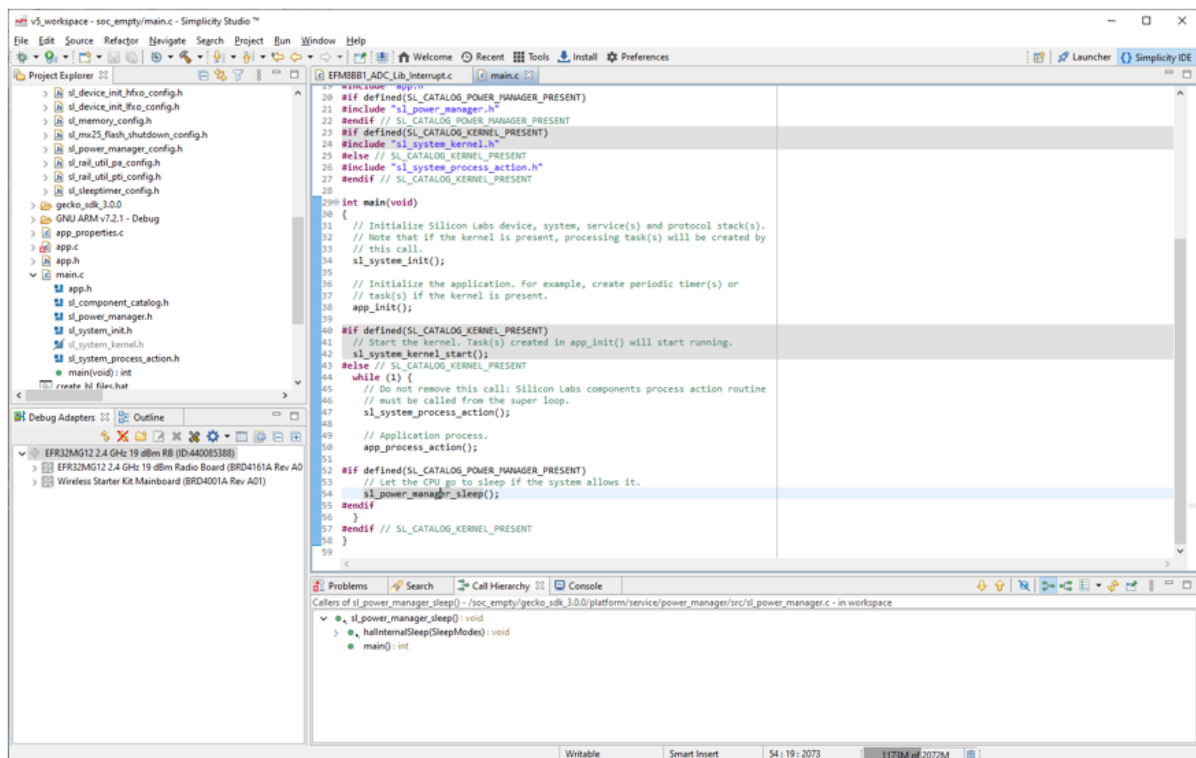
Quick-Access Console

Press **Ctrl+3** to open a quick-access console for locating any menu or view within the IDE. For example, press **Ctrl+3** and type **Preferences**. This lists all of the Preferences menus available within SSV5. Then, select an option to open the menu.



Call Hierarchy

The IDE includes a call hierarchy that can help find where functions are called. To find the call hierarchy for a function in development mode, right-click the function and select **Open Call Hierarchy**.



Overview

Developing For 32-Bit Devices - Overview

These pages describe how to customize projects developed in Simplicity Studio® 5 (SSv5) for 32-bit target devices.

If you have not yet installed SSv5 or are not familiar with its features, [Getting Started](#) guides you through installing SSv5 and your Silicon Labs protocol software development kit (SDK). This section assumes you have installed studio, have your development hardware connected, and are generally familiar with the SSv5 [Launcher Perspective](#) and with the [Simplicity IDE](#).

Each Silicon Labs SDK comes with example projects. The easiest way to start development is to modify the configuration of an example project. The various paths to creating a project based on an example are described in [Start a Project](#).

The development tools you will use depend on the example chosen as a starting point, as described in [Developing with Project Configurator](#) and [Developing with AppBuilder](#). In general, Project Configurator is used with Gecko Bootloader and all other protocol projects created with GSDK version 4.0 and higher, as well as Bluetooth, Bluetooth Mesh, OpenThread, Wi-SUN, and Proprietary applications created with Gecko SDK 3.x. These projects share a common infrastructure, called Silicon Labs Configurator (SLC). As of SSv5 version 5.3, AppBuilder is only used with Zigbee EmberZNet and Gecko Bootloader projects that were created with GSDKs version 3.2 and lower.

After you have created your project files, compile an application image and flash it to your device as described in [Building and Flashing](#).

When you are ready to test your project, whether on Silicon Labs hardware or your own custom device, SSv5 provides a number of tools to help with testing and debugging. An overview is provided in [Testing and Debugging](#).

Developing with Project Configurator

Developing with Project Configurator

Simplicity Studio® 5 (SSv5) introduced new and improved tools for configuring project code, designed to work on the project's component-based architecture. SSv5 includes project configuration tools that provide an enhanced level of software component discoverability, configurability, and dependency management. These include:

- [Project Configurator](#) to install and uninstall components,
- [Component Editor](#) to change component parameters,
- [Pin Tool](#) to configure peripherals.

Other tools are protocol-specific:

- For Bluetooth and Bluetooth Mesh projects, use the [Bluetooth GATT Configurator](#) to customize the Bluetooth GATT database.
- For Bluetooth Mesh projects, use the [Bluetooth Mesh Configurator](#) to customize a node's Device Configuration Data (DCD).
- For Proprietary RAIL projects, use the [Radio Configurator](#) to define and manage proprietary radio protocols and channel groups
- For Zigbee projects, use the [Zigbee Cluster Configurator](#) to manage and configure endpoints.

Once you have finishing customizing your project, [build and flash it](#), and then [test and debug it](#).

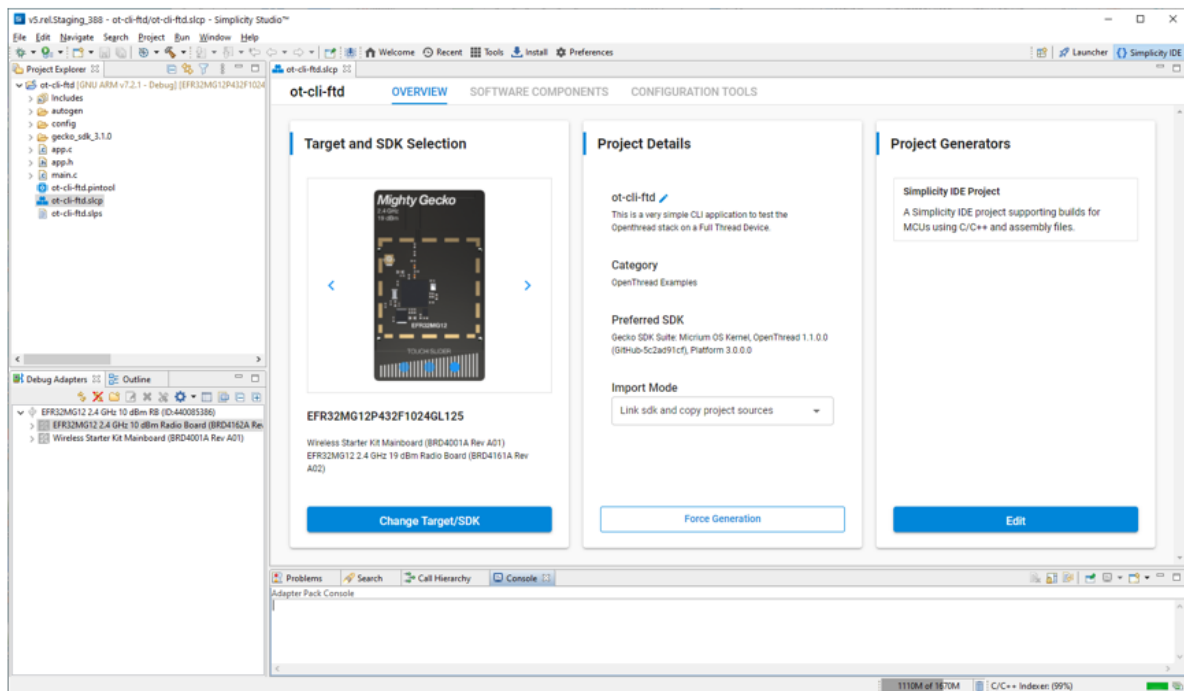
Beginning with Simplicity Studio 5.3, you can combine projects into [solutions](#). Solutions can be built, debugged, and flashed together.

Project Configurator

Project Configurator

When you create a component-based project (.slcp), the Project Configurator automatically opens an [OVERVIEW](#) tab in the Editor area of the Simplicity IDE perspective. A [SOFTWARE COMPONENTS](#) tab provides access to a library of software components and their configuration functions. A [CONFIGURATION TOOLS](#) tab allows for quick access to project-specific tools.

Open the Project Configurator for an existing project by double-clicking the `<project>.slcp` file in the Project Explorer view.



Overview Tab

The OVERVIEW tab has three cards:

- [Target and SDK selection](#), where you can change your development target and SDK.
- [Project Details](#), where you can change the Import mode and, in rare cases, force generation.
- [Project Generators](#), where you can change the files SSV5 generates for your project.

Target and SDK Selection

Click **Change Target/SDK** to change the device for which the project is developed, or the SDK version to be used in development. Changes made here do not apply to the project until you save changes.

Target and SDK Selection

Select the board, part and SDK for the project.

BOARDS

Search or Select

Wireless Starter Kit Mainboard (BRD4001A ...)

EFR32MG12 2.4 GHz 19 dBm Radio Board (...)

PART

Search or Select

EFR32MG12P432F1024GL125

CHANGE SDK

Select SDK

Gecko SDK Suite: Bluetooth 3.0.0.1, Mi...

Manage SDKs

CancelSave

Search for target hardware by part number. If you select a different part, it replaces the part already selected, or you can delete the part and then add a new one.

If you have more than one Gecko SDK Suite (GSDK) version installed, you can select it here. If you do not see a version that you expect to see, click **Manage SDKs** to open the SDK Preferences.

Preferences

type filter text

> General

> C/C++

> Help

> Install/Update

> Network Analyzer

> Run/Debug

> Simplicity Studio

- > Adapter Packs
- Crypto Profiles
- Device Filtering
- > Device Manager
- Energy Profiler
- Launcher
- Offline Content
- Preferred IDE
- SDKs
- Targets
- Toolchains
- Universal Config
- User Experience
- Wine location

> Team

> Wireless Development

SDKs

Check the SDKs available for project build configurations.

Checked entries are displayed when configuring projects.

Name	Version	Location
<input checked="" type="checkbox"/> Gecko SDK Suite: Bl...	3.0.0	C:\SiliconLab...
<input checked="" type="checkbox"/> Stackless application	1.0.0	(none)

Select All

Select None

Add...

Remove...

Description for Gecko SDK Suite: Bluetooth 3.0.0.1, Micrium OS **h** More details...

Name: Gecko SDK Suite: Bluetooth 3.0.0.1, Micrium OS Kernel, Platform 3.0.0.0

Version: 3.0.0

Location: C:\SiliconLabs\SimplicityStudio\v5\developer\sdk\gecko_sdk_suite\v3.0\

Supports parts:

- None

Need more SDKs? Customize your installation here...

?

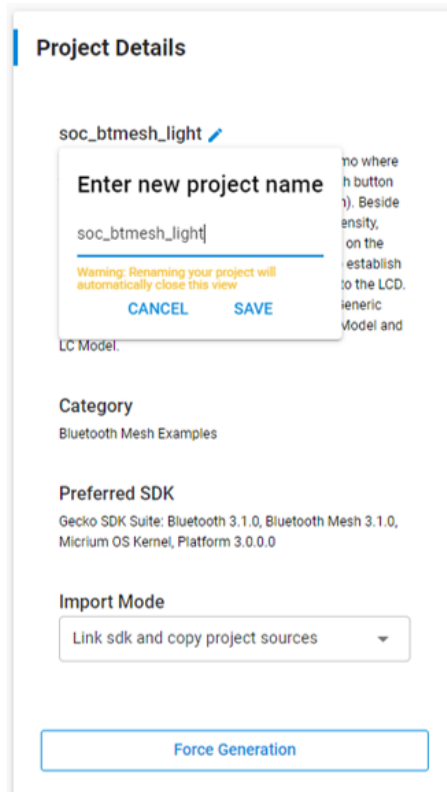
Apply and Close

Cancel


Here you can search for SDKs that might be installed outside of SSv5. Note that, if you have more than one SDK protocol installed in the same GSDK version, for example Bluetooth and Zigbee, you cannot change between them. You can only choose among GSDK versions.

Project Details

Project details include a description of the example on which the project is based, the category of the example, the versions of SDK included in the currently selected GSDK version, and the import mode. Here you can edit the project name, and change the import mode.



Project Details

soc_btmesh_light 

Enter new project name

soc_btmesh_light

Warning: Renaming your project will automatically close this view

CANCEL SAVE

LC Model.

Category
Bluetooth Mesh Examples

Preferred SDK
Gecko SDK Suite: Bluetooth 3.1.0, Bluetooth Mesh 3.1.0,
Micrium OS Kernel, Platform 3.0.0.0

Import Mode
Link sdk and copy project sources ▼

Force Generation

The import mode determines what resources are copied into your project and what are linked. If you change the import mode, the change is autosaved and your project files are regenerated.

- **Link to sources** means all project and SDK resources are linked. Only generated files are saved with the project.
- **Link SDK and copy project sources** (default) means that all the example project sources are copied, but SDK libraries are linked. If you update the SDK and regenerate the project files, the project will change.
- **Copy contents** means that all resources are copied with the project. You can update SDK or load an updated example project and your project will not change.

Force Generation is used only in rare cases when autogeneration is not triggered, usually because of some change made outside of SSv5. It will run all available generators (slcp, radio config, gatt, and so on).

Note for Simplicity Studio 4/AppBuilder users: Because many project configurator files are autogenerated, Project Configurator does not include a **Generate** control like the one in AppBuilder. **Force Generation** is not a replacement for that control.

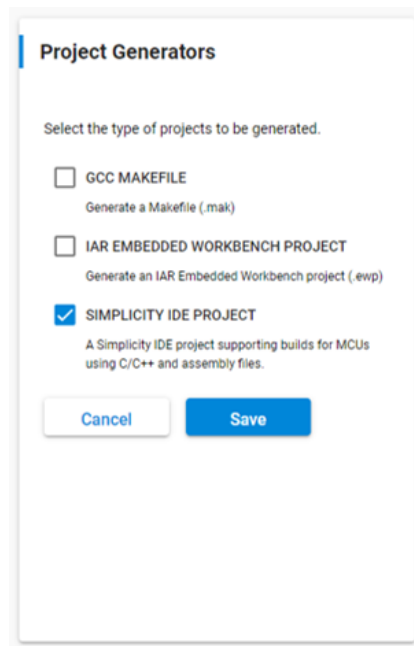
Project Generators

Click **Edit** to change the files that are generated by Project Configurator. Changes take effect when the selection is saved. The options are:

- GCC Makefile
- IAR Embedded Workbench Project
- Simplicity IDE project

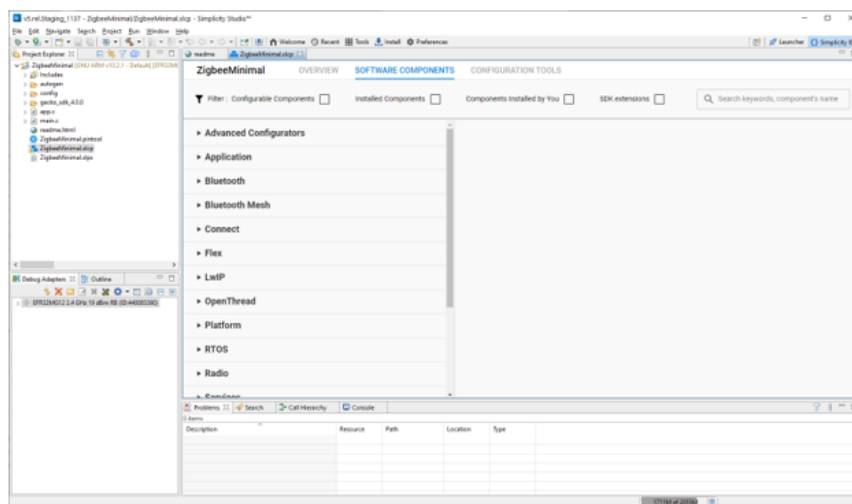
The options that are available for selection and the default vary depending on the SDK and toolchain you selected when you created the project.

Note that changing the project generator does not change the project toolchain.

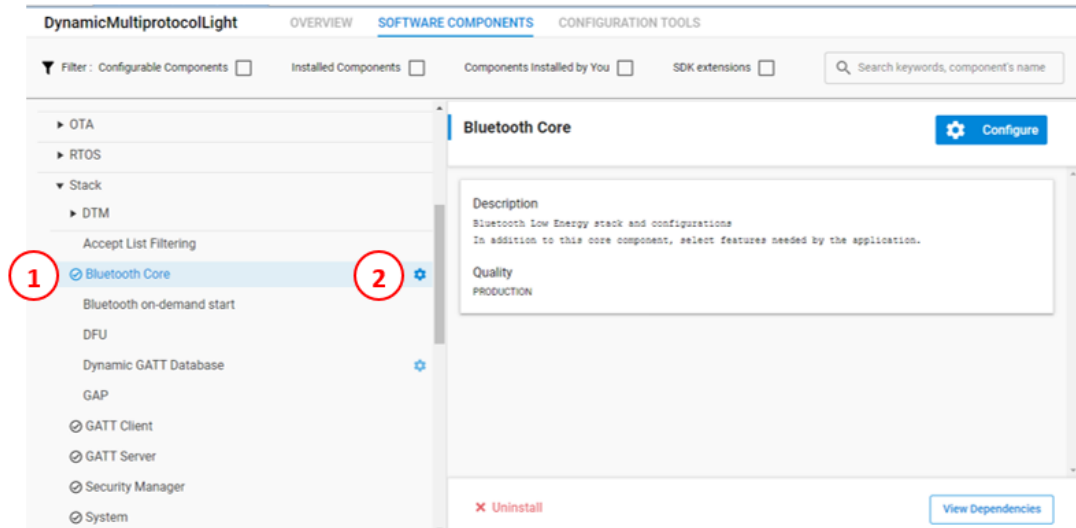


Software Components Tab

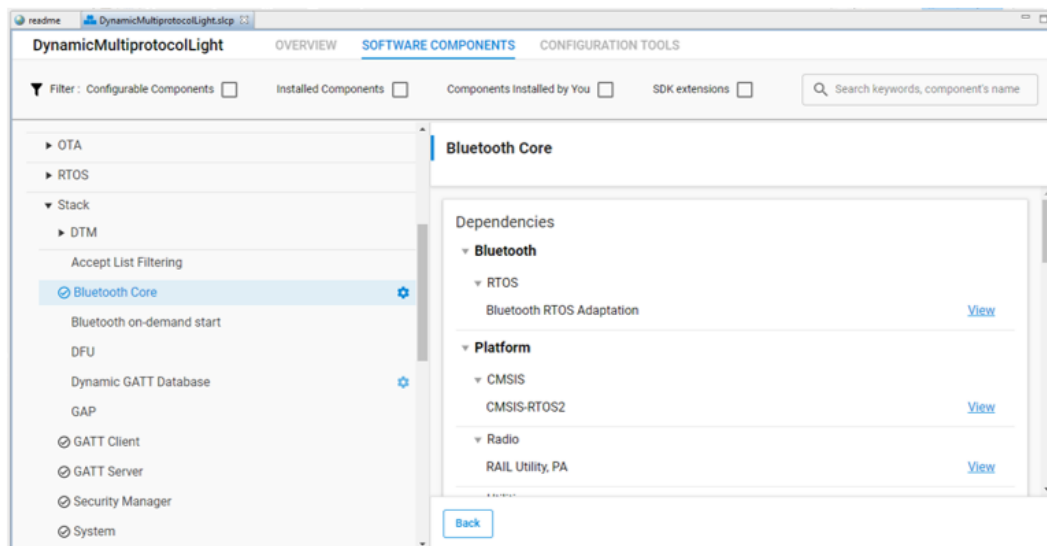
Projects are configured by installing and uninstalling components, and configuring installed components. The SOFTWARE COMPONENTS tab displays categories of components on the left, and details about the selected component on the right.



A number of filters as well as a keyword search are available to help you explore the various component categories. Note that components for all installed SDKs are presented. Expand a component category/subcategory to see individual components. Select a component to see its details. Components that were included in the original project or installed by the user are checked (1), and can be uninstalled. Configurable components are indicated by a gear symbol (2). Configurable components must be installed before their configuration can be changed.



Click **View Dependencies** to see the components on which this component depends, and components dependent on it.



When you install a component, the installation process will:

1. Copy the corresponding SDK files from the SDK folder into the project folder.
2. Copy all the dependencies of the given component into the project folder.
3. Add new include directories to the project settings.
4. Copy the configurations files into the /config folder.
5. Modify the corresponding auto-generated files (in the *autogen* folder) to integrate the component into the application.

Additionally, "init" type software components will implement the initialization code for a given component, utilizing their corresponding configuration file as input. Some software components will fully integrate into the application to perform a specific task without the need of any additional code, while other components provide an API to be used in the application.

Configuration Tools Tab

This tab provides an easy way to open a tool when the tool's tab is not open. The tab shows configuration tools relevant to the project type. A Bluetooth Mesh project shows a number of tools, while an OpenThread project might only show the Pin Tool. Click

Open on the tool's card to open it in a separate tab.

ncp_btmesh_empty

OVERVIEW

SOFTWARE COMPONENTS

CONFIGURATION TOOLS

Bluetooth Mesh Configurator

Open

Description

Bluetooth Mesh Configurator is a tool for customizing the Composition Data (CD) state in your Bluetooth Mesh project. The CD contains information about your Node's elements and supported models, it also gives you an oversight of the Capabilities of your Node. You can manually select a set of standard Models and Elements in Mesh Configurator for your project and write your preferred application code for handling them or you can add Bluetooth Mesh components from Simplicity Studio's Component Browser which populates the CD in Mesh Configurator and it also automatically adds source code for handling the Models. With the help of this tool any standard CD can be constructed which complies with the BT Mesh specification.

Bluetooth GATT Configurator

Open

Description

The GATT database is the heart of your Bluetooth application. It exposes profiles, services and characteristics to be accessed by remote devices. The GATT Configurator is a simple-to-use tool to help you build your own GATT database with an intuitive GUI instead of coding. It provides the possibility of adding profiles/services/characteristics defined by the Bluetooth SIG as well as defining custom ones. For detailed description see UG438: GATT Configurator User's Guide for Bluetooth® SDK v3.x.

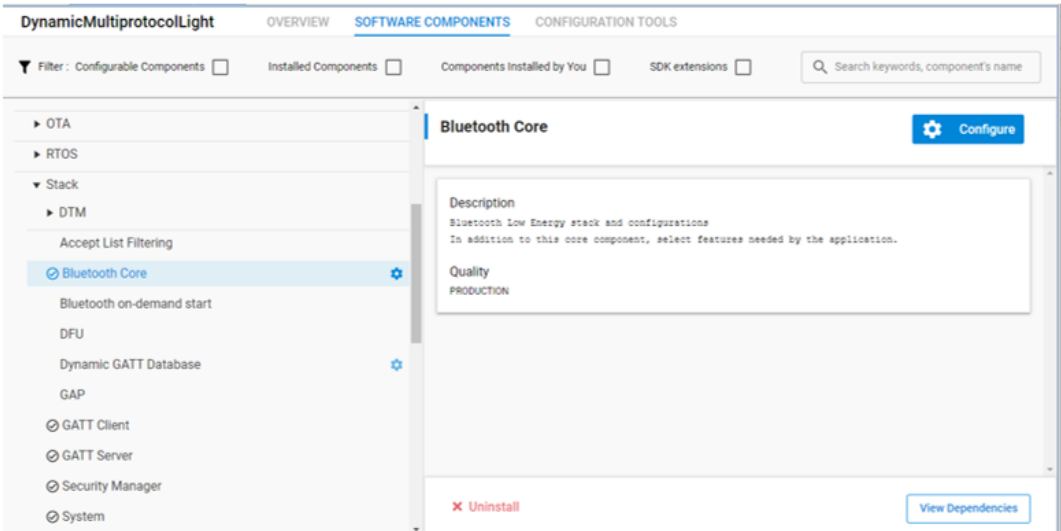
Pin Tool

Open

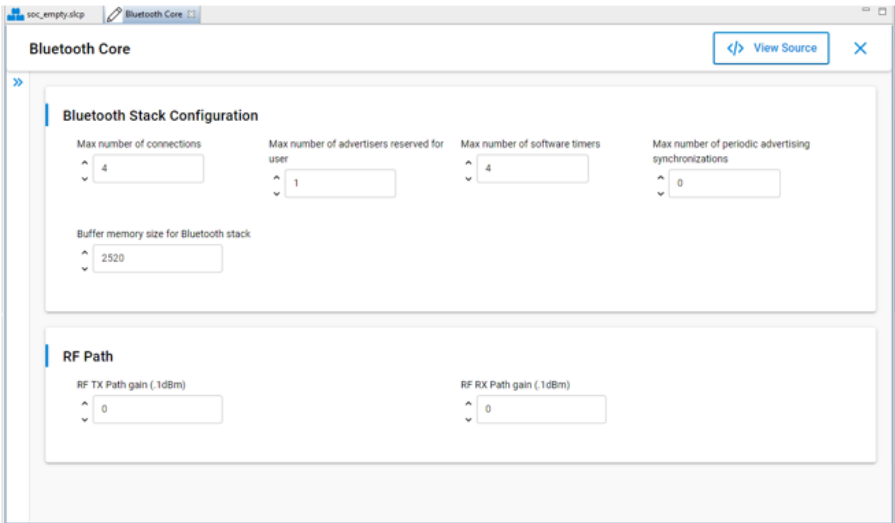
Component Editor

Component Editor

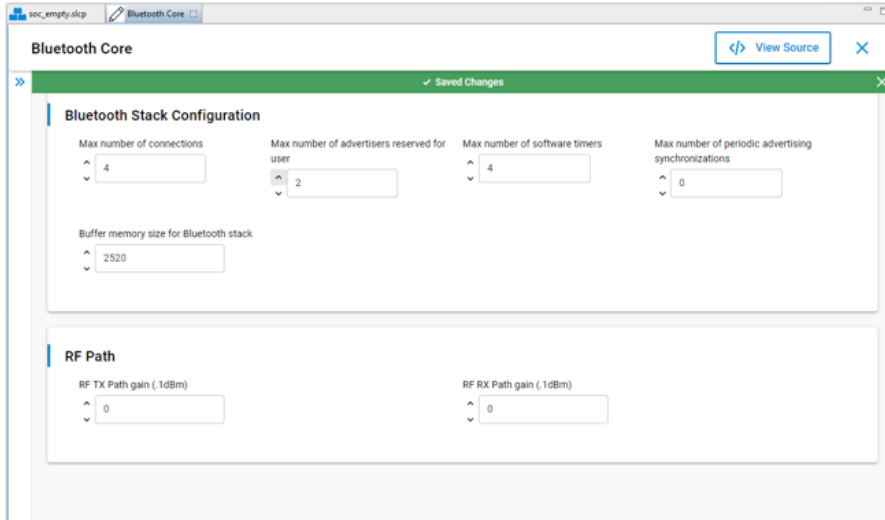
Click the gear symbol next to an installed configurable component name, or **Configure** on the component description to open the Component Editor.



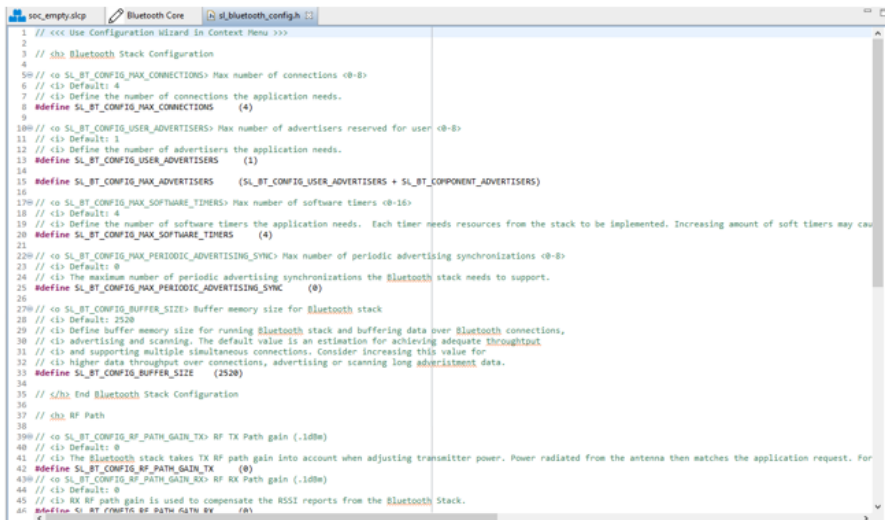
The Component Editor opens in a new tab. The changes you can make depend on the component.



Changes made here are autosaved in native source format in the associated source files.



Click **View Source** to open an editor on the configuration file. If a component has multiple configuration files, the control is **View Source Files**

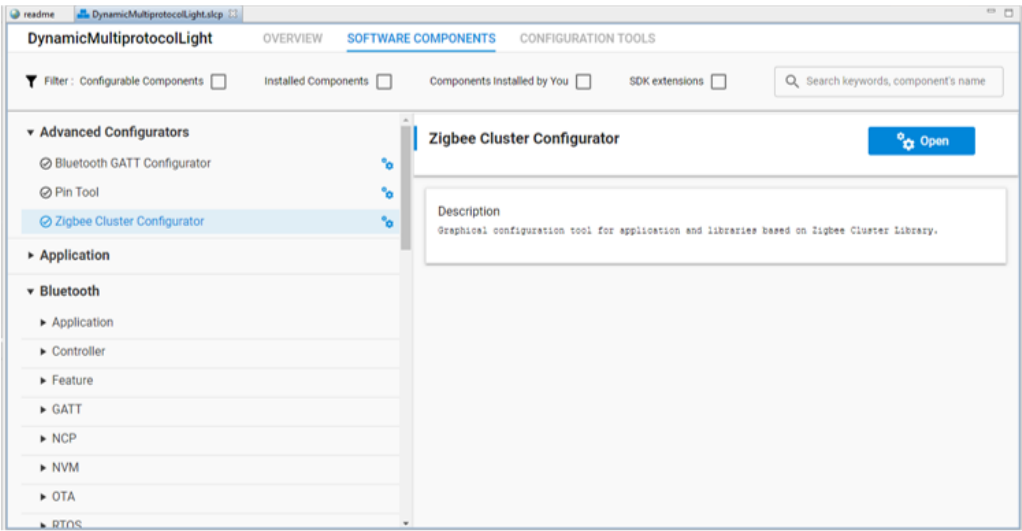


```

1 // <<< Use Configuration Wizard in Context Menu >>>
2
3 // <h> Bluetooth Stack Configuration
4
5 // <h> SL_BT_CONFIG_MAX_CONNECTIONS: Max number of connections <0-8>
6 // <i> Default: 4
7 // <i> Define the number of connections the application needs.
8 #define SL_BT_CONFIG_MAX_CONNECTIONS (4)
9
10 // <h> SL_BT_CONFIG_MAX_ADVERTISERS: Max number of advertisers reserved for user <0-8>
11 // <i> Default: 1
12 // <i> Define the number of advertisers the application needs.
13 #define SL_BT_CONFIG_MAX_ADVERTISERS (1)
14
15 #define SL_BT_CONFIG_MAX_ADVERTISERS (SL_BT_CONFIG_MAX_CONNECTIONS + SL_BT_CONFIG_MAX_ADVERTISERS)
16
17 // <h> SL_BT_CONFIG_MAX_SOFTWARE_TIMERS: Max number of software timers <0-16>
18 // <i> Default: 4
19 // <i> Define the number of software timers the application needs. Each timer needs resources from the stack to be implemented. Increasing amount of soft timers may cause stack to run out of memory.
20 #define SL_BT_CONFIG_MAX_SOFTWARE_TIMERS (4)
21
22 // <h> SL_BT_CONFIG_MAX_PERIODIC_ADVERTISING_SYNC: Max number of periodic advertising synchronizations <0-8>
23 // <i> Default: 0
24 // <i> The maximum number of periodic advertising synchronizations the Bluetooth stack needs to support.
25 #define SL_BT_CONFIG_MAX_PERIODIC_ADVERTISING_SYNC (0)
26
27 // <h> SL_BT_CONFIG_BUFFER_SIZE: Buffer memory size for Bluetooth stack
28 // <i> Default: 2520
29 // <i> Define buffer memory size for running Bluetooth stack and buffering data over Bluetooth connections,
30 // <i> advertising and scanning. The default value is an estimation for achieving adequate throughput
31 // <i> and supporting multiple simultaneous connections. Consider increasing this value for
32 // <i> higher data throughput over connections, advertising or scanning long advertisement data.
33 #define SL_BT_CONFIG_BUFFER_SIZE (2520)
34
35 // <h> End Bluetooth Stack Configuration
36
37 // <h> RF Path
38
39 // <h> SL_BT_CONFIG_RF_PATH_GAIN_TX: RF TX Path gain (1dBm)
40 // <i> Default: 0
41 // <i> The Bluetooth stack takes TX RF path gain into account when adjusting transmitter power. Power radiated from the antenna then matches the application request. For
42 // <i> SL_BT_CONFIG_RF_PATH_GAIN_TX (0)
43 // <i> SL_BT_CONFIG_RF_PATH_GAIN_RX: RF RX Path gain (1dBm)
44 // <i> Default: 0
45 // <i> RX RF path gain is used to compensate the RSSI reports from the Bluetooth Stack.
46 #define SL_BT_CONFIG_RF_PATH_GAIN_RX (0)
47
48

```

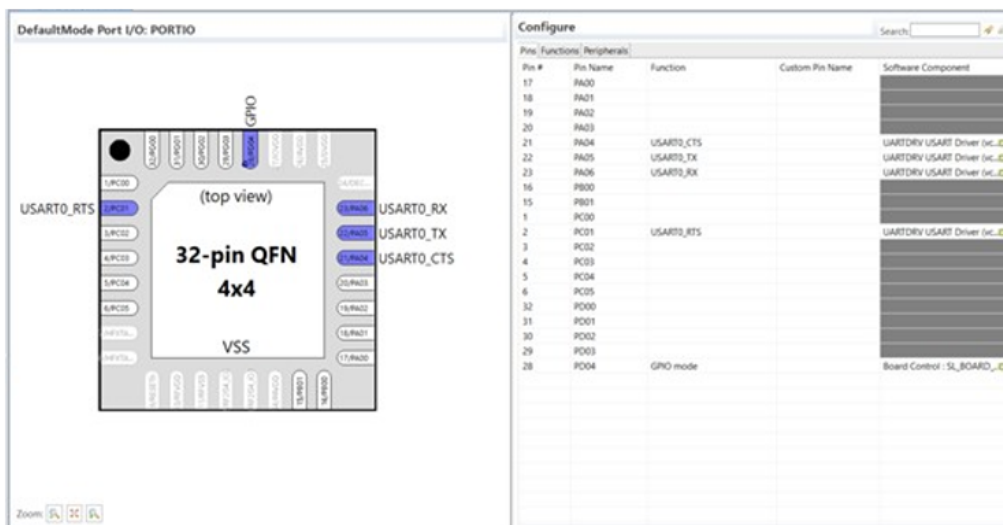
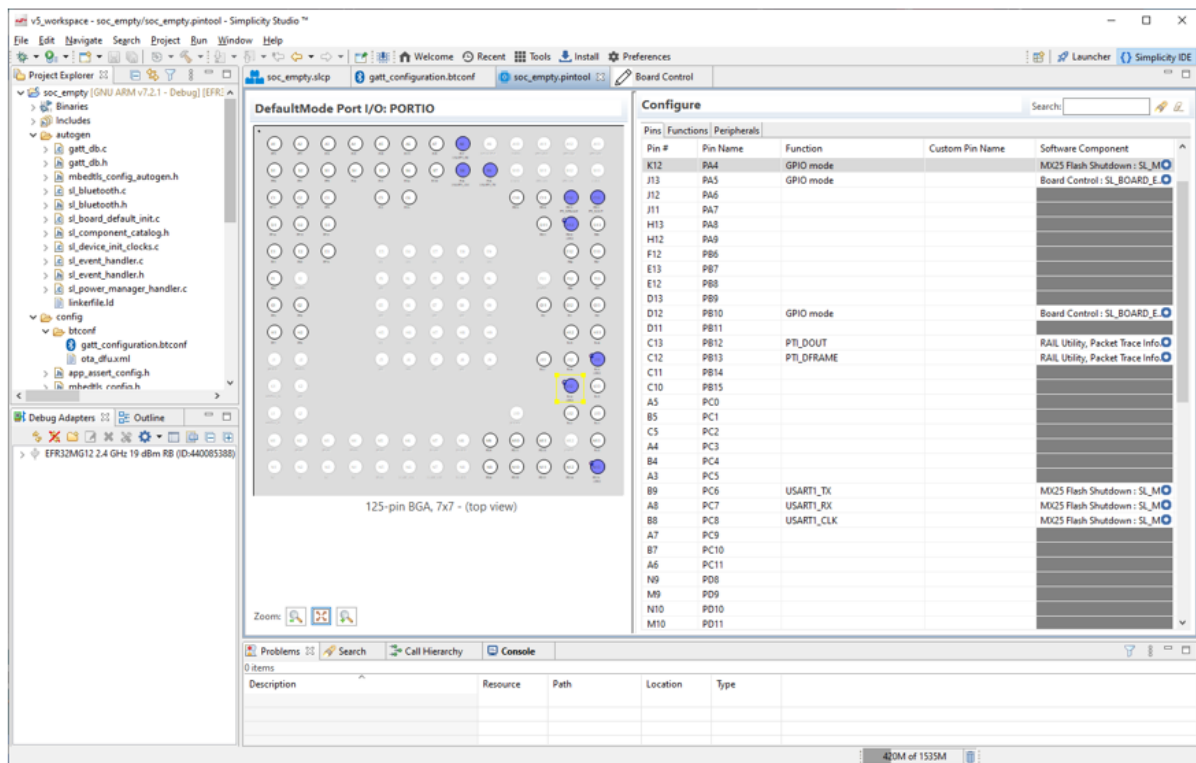
The top component category, Advanced Configurators, shows the same configurators as in the CONFIGURATION TOOLS tab.



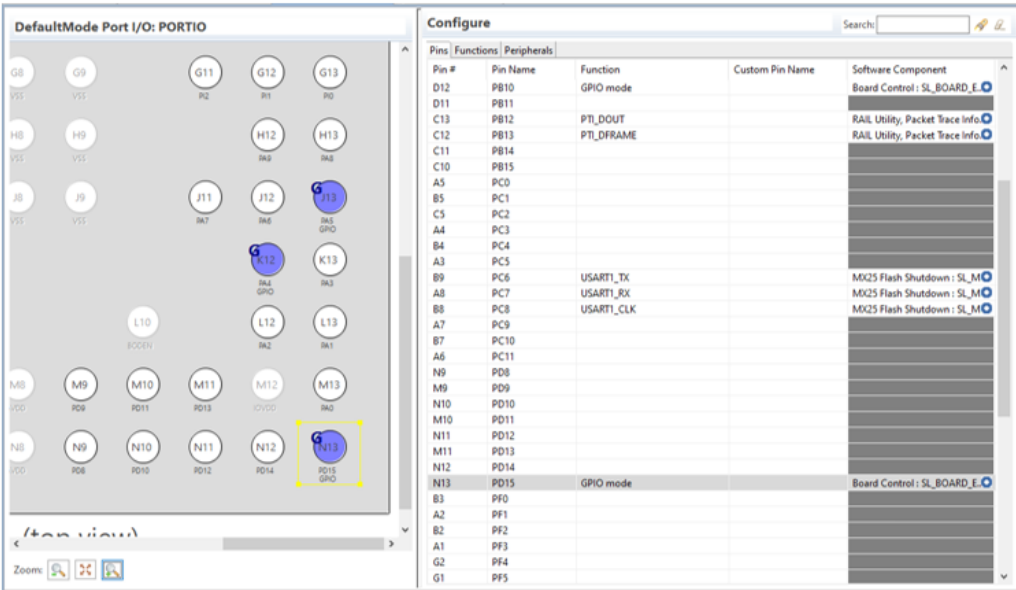
Pin Tool

Pin Tool

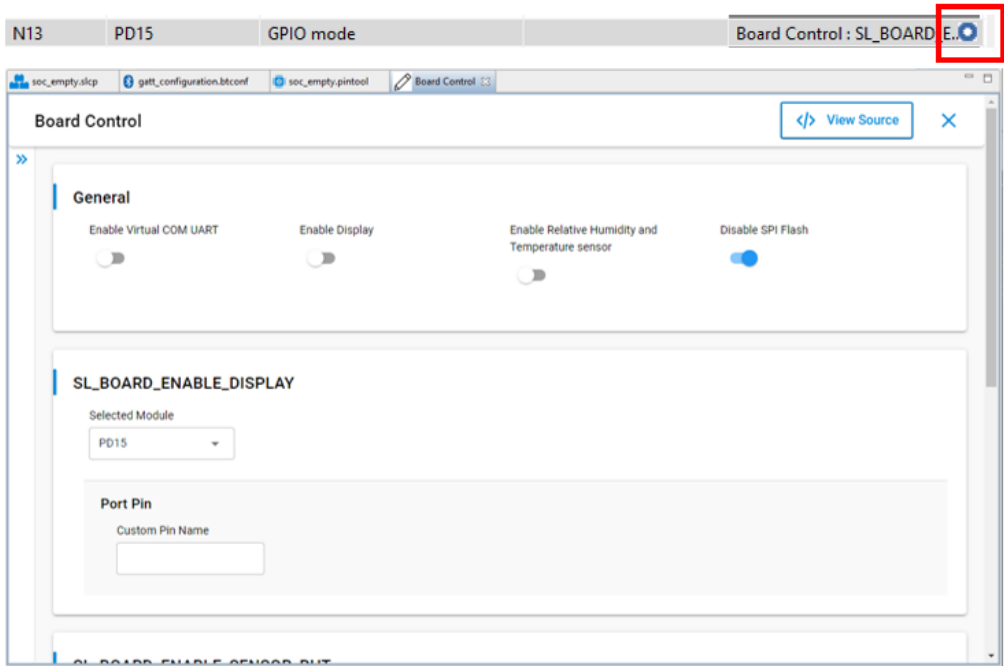
Simplicity Studio® 5 (SSv5) offers a Pin tool that allows you to easily configure new peripherals or change the properties of existing ones. In the Project Configurator SOFTWARE COMPONENTS tab, expand the Advanced Configurators group and open the Pin Tool. Alternatively, double-click the file <project>.pintool in the Project Explorer view. The graphical view differs based on the chip.



For more complex layouts, you can use the zoom controls in the lower left to see detail.



Click the Configure icon next to a component name to open the Component editor for the associated component.



The pin, function, and peripheral tabs in the configuration pane provide different modes of access. A search function at the top right is available to assist in finding an item.

DefaultMode Port I/O: PORTIO

A8

PC7

PTL_CLK

A9

DECOUPLE

A10

DVDD

A11

VREGVDD

A12

VREGSW

A13

VREGVSS

B8

PC8

USART1_TX

B9

PC8

USART1_TX

B10

IOVDD

B11

VREGVSS

B12

VREGVSS

B13

AVDD

C10

PE15

C11

PE14

C12

PE13

PTL_DFRAME

C13

PE12

PTL_DOUT

D11

PE11

D12

PE10

GND

D13

PE9

E8

VSS

E9

VSS

E12

PE8

E13

PE7

F8

VSS

F9

VSS

F11

IOVDD

F12

PE6

F13

PE5

G8

VSS

G9

VSS

G11

PE2

G12

PE1

G13

PE0

H8

VSS

H9

VSS

H12

PE12

H13

PE11

Zoom:

Configure

Search:

Pins

Functions

Peripherals

Pin #	Pin Name	Function	Custom Pin Name	Software Component
M13	PA0			
L13	PA1			
L12	PA2			
K13	PA3			
K12	PA4	GPIO mode		MX25 Flash Shutdown: SL_M
J13	PA5	GPIO mode		Board Control: SL_BOARD_E
J12	PA6			
J11	PA7			
H13	PA8			
H12	PA9			
F12	PB6			
E13	PB7			
E12	PB8			
D13	PB9			
D12	PB10	GPIO mode		Board Control: SL_BOARD_E
D11	PB11			
C13	PB12	PTL_DOUT		RAIL Utility, Packet Trace Info
C12	PB13	PTL_DFRAME		RAIL Utility, Packet Trace Info
C11	PB14			
C10	PB15			
A5	PC0			
B5	PC1			
C5	PC2			
A4	PC3			
B4	PC4			
A3	PC5			
B9	PC6	USART1_TX		MX25 Flash Shutdown: SL_M
A8	PC7	USART1_RX		MX25 Flash Shutdown: SL_M
B8	PC8	USART1_CLK		MX25 Flash Shutdown: SL_M
A7	PC9			
B7	PC10			
A6	PC11			

DefaultMode Port I/O: PORTIO

A8

PC7

PTL_CLK

A9

DECOUPLE

A10

DVDD

A11

VREGVDD

A12

VREGSW

A13

VREGVSS

B8

PC8

USART1_TX

B9

PC8

USART1_TX

B10

IOVDD

B11

VREGVSS

B12

VREGVSS

B13

AVDD

C10

PE15

C11

PE14

C12

PE13

PTL_DFRAME

C13

PE12

PTL_DOUT

D11

PE11

D12

PE10

GND

D13

PE9

E8

VSS

E9

VSS

E12

PE8

E13

PE7

F8

VSS

F9

VSS

F11

IOVDD

F12

PE6

F13

PE5

G8

VSS

G9

VSS

G11

PE2

G12

PE1

G13

PE0

H8

VSS

H9

VSS

H12

PE12

H13

PE11

Zoom:

Configure

Search:

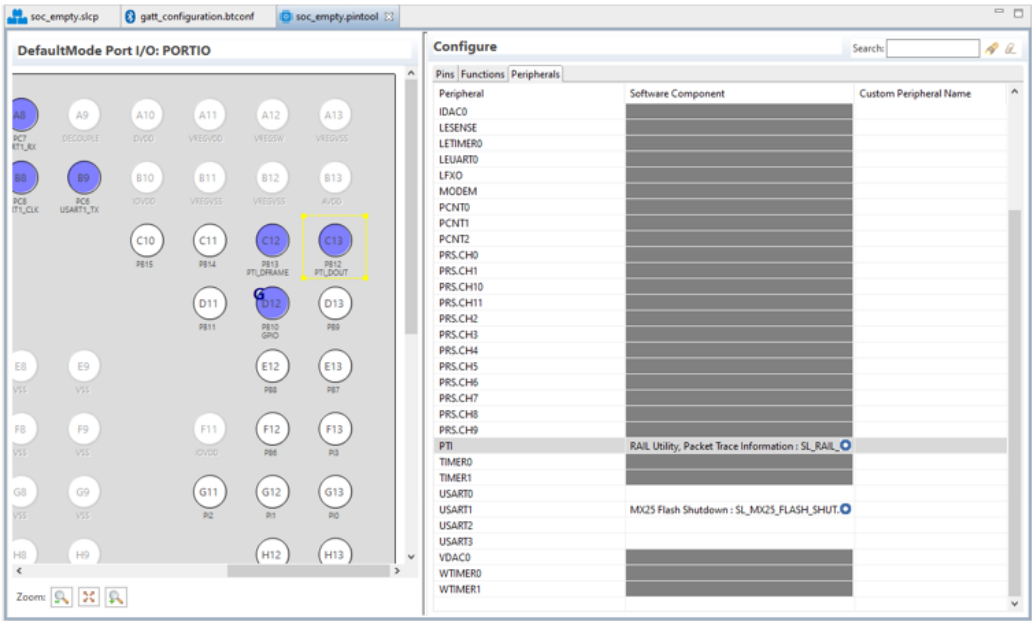
Pins

Functions

Peripherals

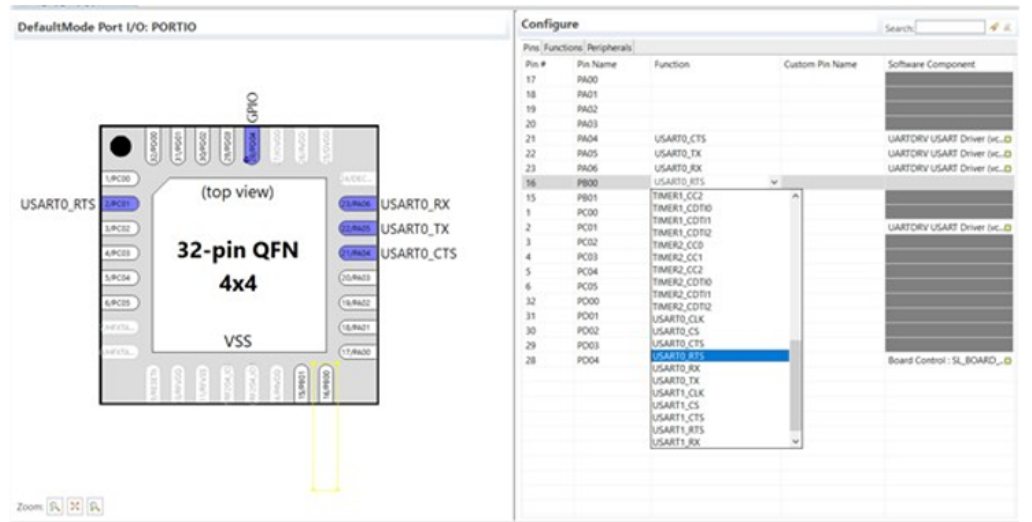
Function	Pin Name	Custom Pin Name	Software Component
PCNT0_S1IN	Disabled		
PCNT1_S0IN	Disabled		
PCNT1_S1IN	Disabled		
PCNT2_S0IN	Disabled		
PCNT2_S1IN	Disabled		
PRS Channel CH0_CH0	Disabled		
PRS Channel CH10_CH10	Disabled		
PRS Channel CH11_CH11	Disabled		
PRS Channel CH1_CH1	Disabled		
PRS Channel CH2_CH2	Disabled		
PRS Channel CH3_CH3	Disabled		
PRS Channel CH4_CH4	Disabled		
PRS Channel CH5_CH5	Disabled		
PRS Channel CH6_CH6	Disabled		
PRS Channel CH7_CH7	Disabled		
PRS Channel CH8_CH8	Disabled		
PRS Channel CH9_CH9	Disabled		
PTL_DCLK	Disabled		RAIL Utility, Packet Trace Informa
PTL_DFRAME	PB13		RAIL Utility, Packet Trace Informa
PTL_DOUT	PB12		RAIL Utility, Packet Trace Informa
TIMER0_CC0	Disabled		
TIMER0_CC1	Disabled		
TIMER0_CC2	Disabled		
TIMER0_COT0	Disabled		
TIMER0_COT1	Disabled		
TIMER0_COT2	Disabled		
TIMER1_CC0	Disabled		
TIMER1_CC1	Disabled		
TIMER1_CC2	Disabled		
TIMER1_CC3	Disabled		
USART0_CLK	Disabled		
USART0_CS	Disabled		

113/290

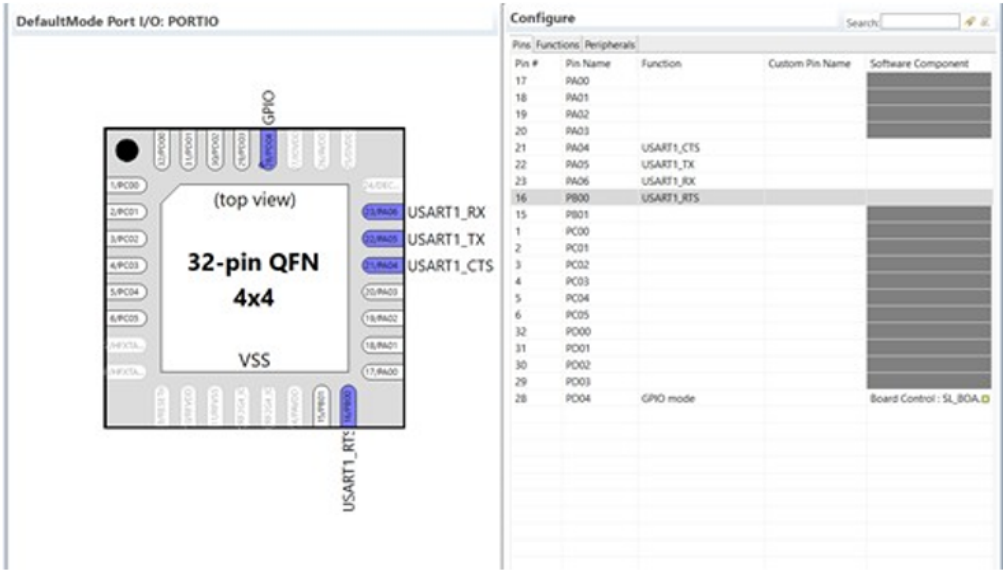


Modifying Pin Configurations

Use the Pin Tool to modify the pin configuration of the device. For example, you can reassign the pins used for USART communication to the appropriate layout for a custom board design by selecting the desired pin in the list and then selecting its functionality from the drop-down list.



After clicking the selected item, the layout will be updated. After saving the file, the configuration source codes will be automatically generated.

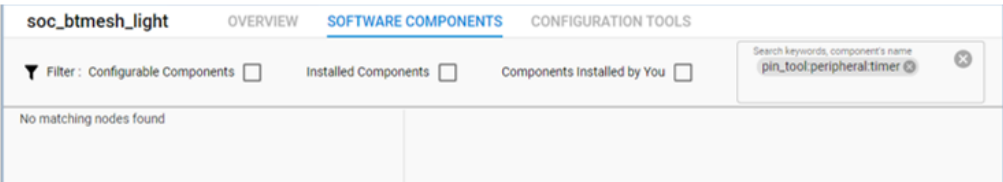


Adding Components

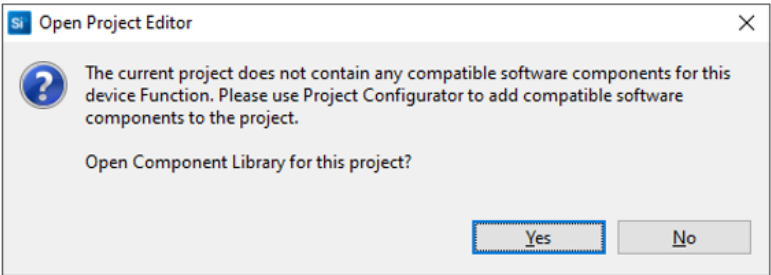
The Pin Tool shows the software components in the project currently associated with pins, functions, and peripherals. It also supports adding a component, by passing search criteria to the Project Configurator and optionally opening the Software Components tab.

To add a component to a pin in the Pins tab, first assign the pin a function, then click in the Software Components cell and select **Add Component**. If one or more compatible software components exist that match the search criteria passed by the Pin Tool, the active view changes to the Software Components tab with those components showing.

If compatible components exist but do not match the search criteria, the Software Components tab opens with the message "No matching nodes found."



If no compatible components exist in the project, the user can optionally add one.



Similar functionality is provided in the both the Functions and Peripherals tabs.

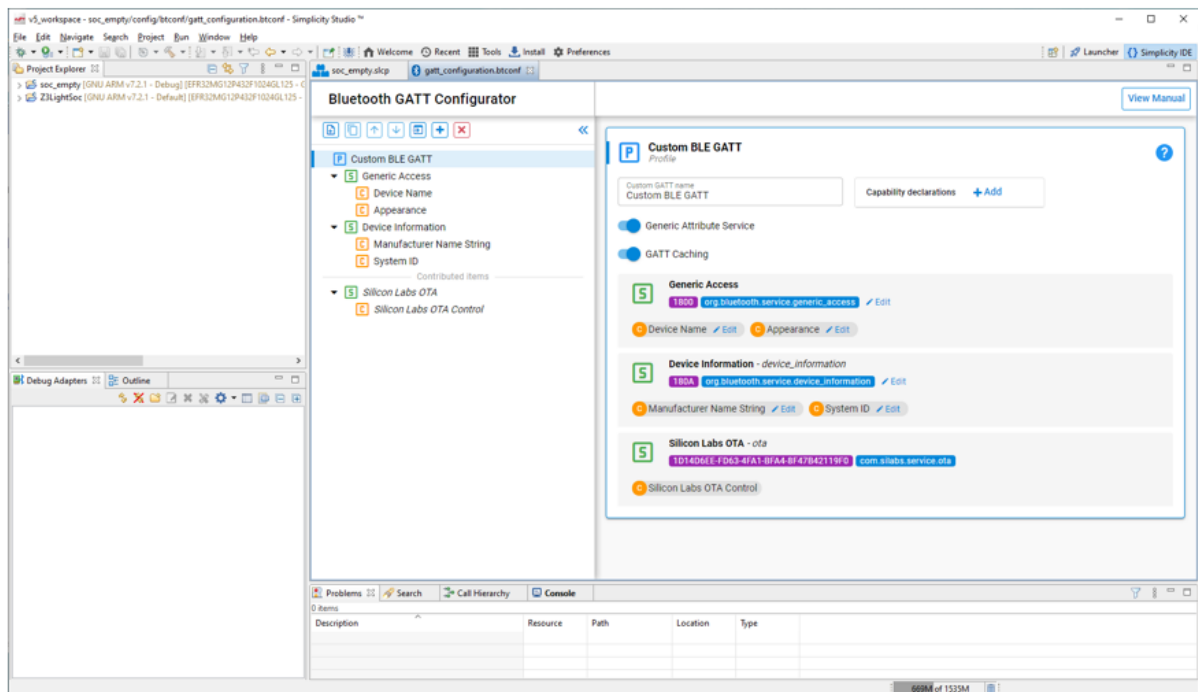
Bluetooth GATT Configurator

Bluetooth GATT Configurator

The Simplicity Studio® 5 (SSv5) Bluetooth GATT Configurator is a simple-to-use tool to help build a customized Bluetooth GATT database for Bluetooth projects. It is accessed through the Advanced Configurators software component group on the Project Configurator SOFTWARE COMPONENTS tab, or by double-clicking the project file *config > btconf > gatt_configuration.btconf*.

The Bluetooth GATT Configurator is composed of a Custom GATT editor on the left, showing a list of project Profiles/Services/Characteristics/Descriptors, and a Settings editor on the right. A SIG selector allows you to add standard elements to the profile. An options menu is provided at the top of the Custom GATT editor.

The Custom GATT editor is always visible, and the Settings editor opens by default.



The Bluetooth GATT Configurator menu is:

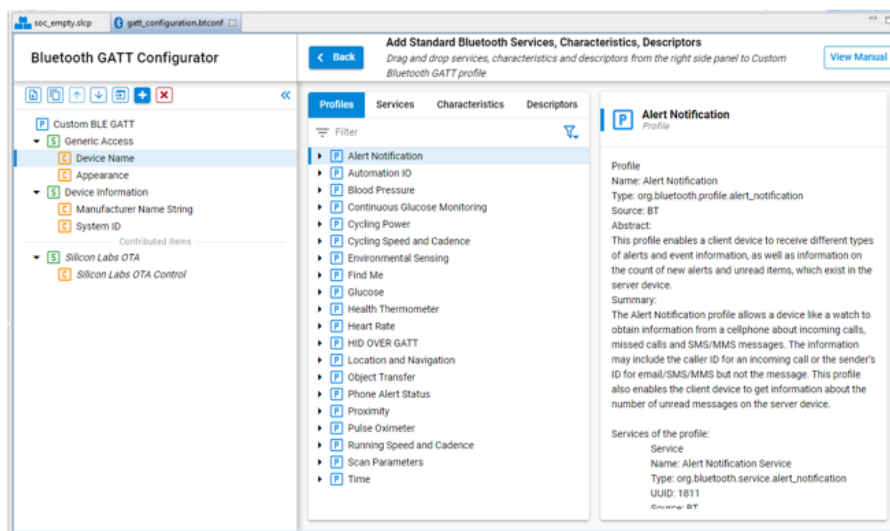


1. Add an item.
2. Duplicate the selected item.
3. Move the selected item up.
4. Move the selected item down.

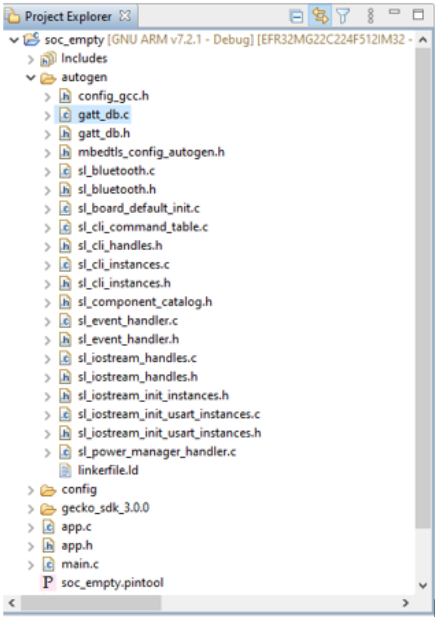
5. Import a Bluetooth GATT database.
6. Add Predefined (opens the SIG editor).
7. Delete the selected item.

SIG Selector

Click the Add Predefined menu button (6) to open the SIG selector. The SIG Selector displays a list of predefined Profiles, Services, Characteristics, and Descriptors. These items can be filtered, using the filter pane. Tabs allow you to switch between different lists. As shown in the following figure, the pane on the right side of the list displays textual information about the latest selection. To add an item to the Custom GATT editor, mouse over it and click **+** on the right. The item can then be edited in the Settings section. The selected SIG service/characteristic/descriptor will be added under the highlighted profile/service/characteristic. Click **< BACK** to return to the Setting Editor. Click **View Manual** to see more information about Bluetooth GATT database items.

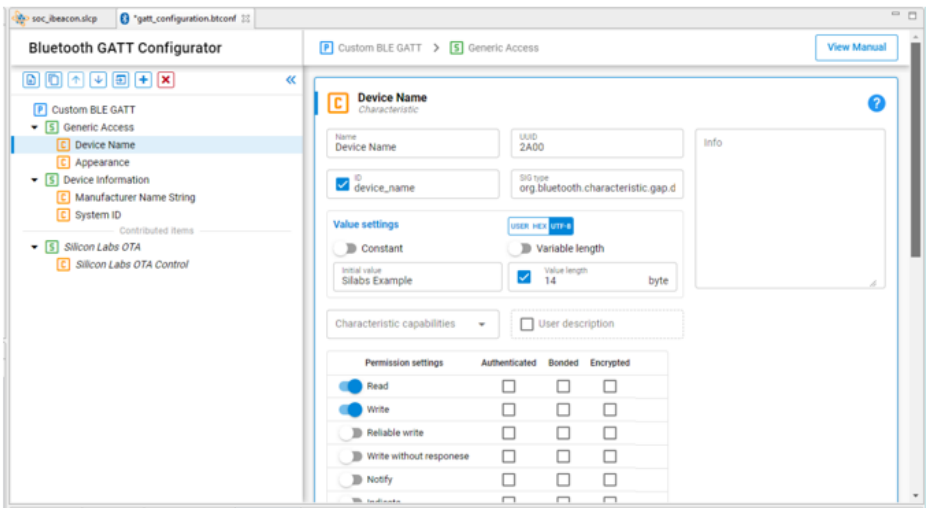


The GATT Configurator does not automatically save changes. An asterisk next to the configuration file name indicates unsaved changes in the configuration. Database generation happens automatically when the configuration is saved. The generated source files can be found in the *autogen* directory:

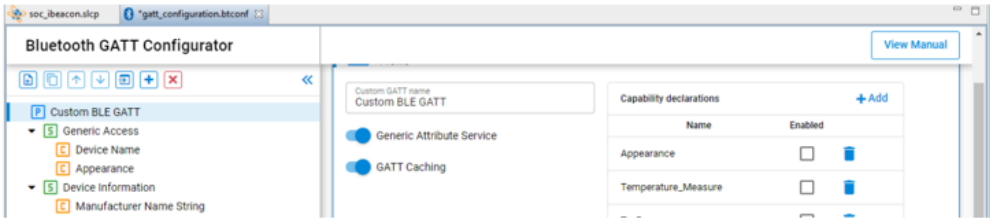


Custom GATT Editor

The Custom GATT Editor in the right pane of the GATT Configurator displays the items present in the current configuration file. This includes a Custom GATT Profile, Services, Characteristics, and Descriptors displayed as a hierarchical list. The order of items shown reflects the order in which they exist in the GATT database. When the Settings Editor is open, you can select an item to see its properties and configuration.



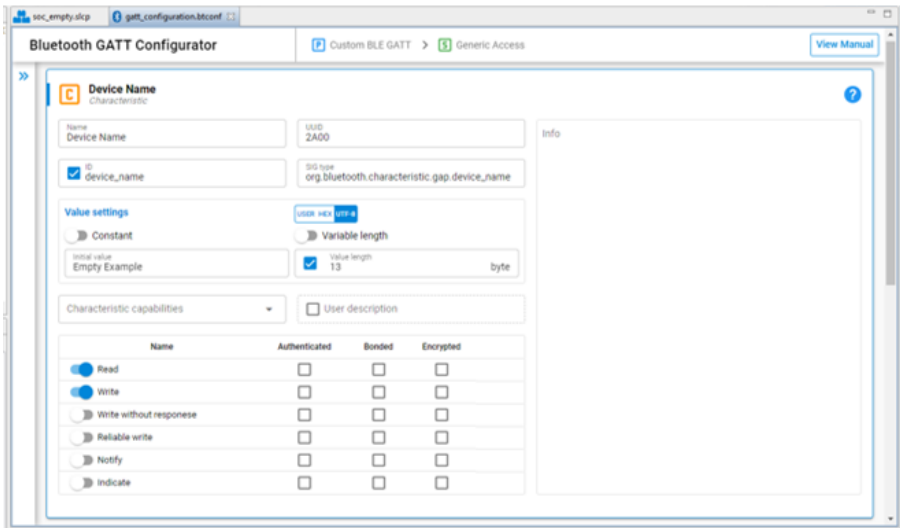
Note: The Generic Attribute Service is not listed in the Custom GATT database structure. This is a special service that is maintained by the stack, and can be added by enabling the Generic Attribute Service slider in the settings of the Custom BLE GATT profile. Once enabled, the service will be part of the database. It still will not appear in the Custom GATT database structure or on iOS devices, as iOS hides this service, but you may see it on Android devices for example.



Some services are listed in the configurator as "contributed items". This means that their content is defined in other components, and they cannot be edited from this view.

Settings Editor

The Settings editor allows you to configure the properties of items such as Profiles, Services, Characteristics and Descriptors that are present in the Custom GATT editor. Selecting an item populates the relevant configuration options such as the name, ID, properties and capabilities. Any changes made in this section are reflected immediately for the selected item. You can minimize the Custom GATT editor while working in the Settings editor, as shown in the following figure. All Characteristics for a Service are included in the same Settings editor pane.



Additional Information

For more information on specific use cases in the GATT Configurator, see *UG438: GATT Configurator User's Guide in Bluetooth SDK 3.x*.

Bluetooth Mesh Configurator

Bluetooth Mesh Configurator

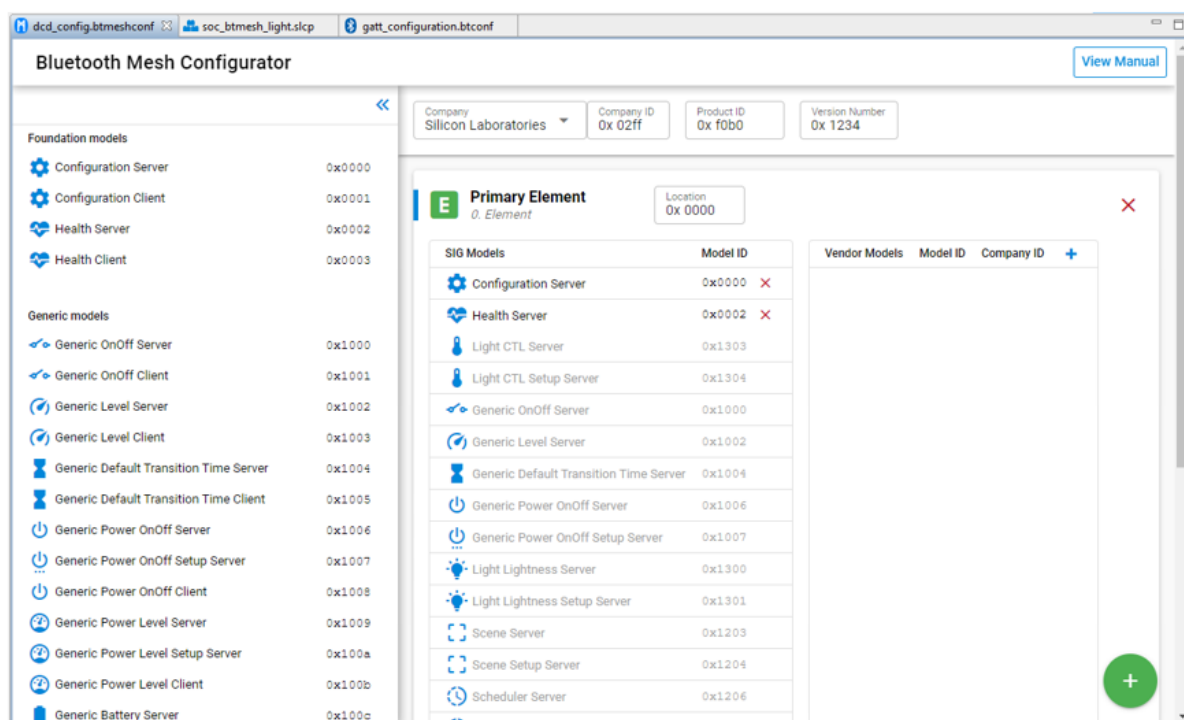
The Bluetooth Mesh Configurator provides access to a Bluetooth Mesh node's Device Composition Data (DCD). This contains information about the elements it includes and the supported models. DCD exposes the node information to a configuration client so that it knows the potential functionalities the node supports and, based on that, can configure the node.

Configuring DCD through the Bluetooth Mesh Configurator is only one part of configuring a Bluetooth Mesh node. For details see *UG472: Bluetooth® Mesh Node Configurator User's Guide for SDK v2.x*.

When you create a Bluetooth Mesh project in Simplicity Studio 5, three tabs open automatically: the [GATT Configurator](#) (gatt_configuration.btconf), the slcp or [Project Configurator](#) (<projectname>.slcp, and the Bluetooth Mesh Configurator (dcd_config.btmeshconf). If the example has documentation, the project opens on a readme tab.



Click the dcd_config.btmeshconf tab to open the Bluetooth Mesh Configurator. If the tab is closed, you can open it from the Project Configurator's CONFIGURATION TOOLS tab. The Device Composition Data is presented in three areas: device information, elements, and models.



Device Information

The device information card contains four fields. Changing the Company changes the next three fields.

Company
Silicon Laboratories

Company ID
0x 02ff

Product ID
0x f0b0

Version Number
0x 1234

Device configuration information includes:

- Company: Selected from a list of company names.
- Company ID: 16-bit company identifier assigned by the Bluetooth SIG. A list of companies and their identifiers may be found on the [Bluetooth SIG site](#).
- Product ID: 16-bit vendor-assigned product identifier, vendor-specific.
- Version Number: 16-bit vendor-assigned product version identifier, vendor-specific.

Elements

An element is an addressable entity within a node. Each node can have one or more elements, the first called the primary element and the others called secondary elements. Each element is assigned a unicast address during provisioning so that it can be used to identify which node is transmitting or receiving a message. The primary element is addressed using the first unicast address assigned to the node, and the secondary elements are addressed using the subsequent addresses. Both primary and secondary elements have a dedicated card, such as that shown in the following figure, through which they can be configured. Click the green plus symbol to add an element or select an element and click the red X symbol to remove it.

E

Primary Element

0. Element

Location
0x 0000

X

SIG Models	Model ID
Configuration Server	0x0000 X
Health Server	0x0002 X
Light CTL Server	0x1303
Light CTL Setup Server	0x1304
Generic OnOff Server	0x1000
Generic Level Server	0x1002
Generic Default Transition Time Server	0x1004
Generic Power OnOff Server	0x1006
Generic Power OnOff Setup Server	0x1007
Light Lightness Server	0x1300
Light Lightness Setup Server	0x1301
Scene Server	0x1203
Scene Setup Server	0x1204
Scheduler Server	0x1206
Scheduler Setup Server	0x1207
Time Server	0x1200

Vendor Models	Model ID	Company ID	+
---------------	----------	------------	---

+

X

Models

A model defines the basic functionality of a node, and a node may include multiple models. A model defines the required states, the messages that act upon those states, and any associated behaviors.

Models may be defined and adopted by the Bluetooth SIG and may also be defined by vendors. Models defined by the Bluetooth SIG are known as SIG-adopted models, and models defined by vendors are known as vendor models. SIG-adopted models are identified by a 16-bit model identifier and vendor models are identified by a 16-bit vendor identifier and a 16-bit model identifier.

Model specifications are designed to be very small and self-contained. At specification definition time, a model can require other models that must also be instantiated within the same node. This is called extending, which means a model adds functionality on top of other models.

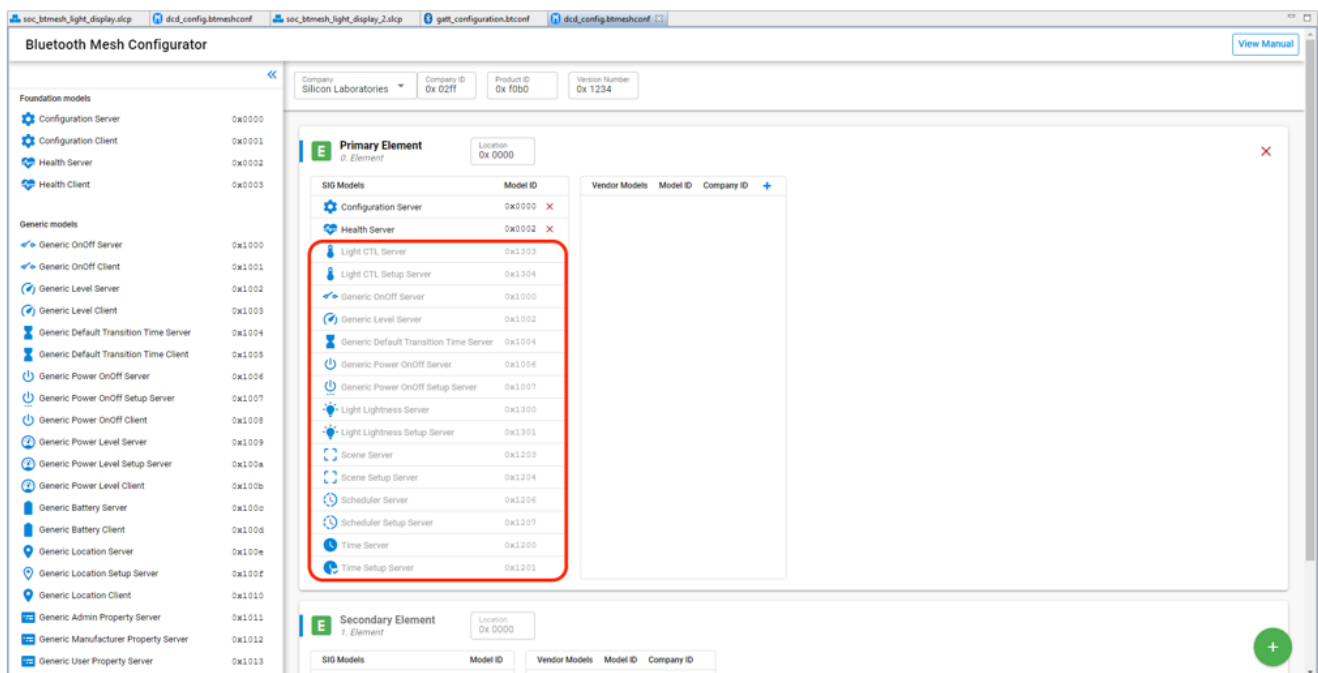
Models that do not extend other models are referred to as root models. Model specifications are immutable. In other words, it is not possible to remove or add behavior to a model, whether the desired behavior is optional behavior or mandatory. Models are not versioned and have no feature bits. If additional behavior is required in a model, then a new extended model is defined that exposes the required behavior and can be implemented alongside the original model.

Therefore, knowledge of the models supported by an element determines the exact behavior exposed by that element.

The Bluetooth Mesh Configurator supports configuring both SIG-adopted models and vendor models through separate editors.

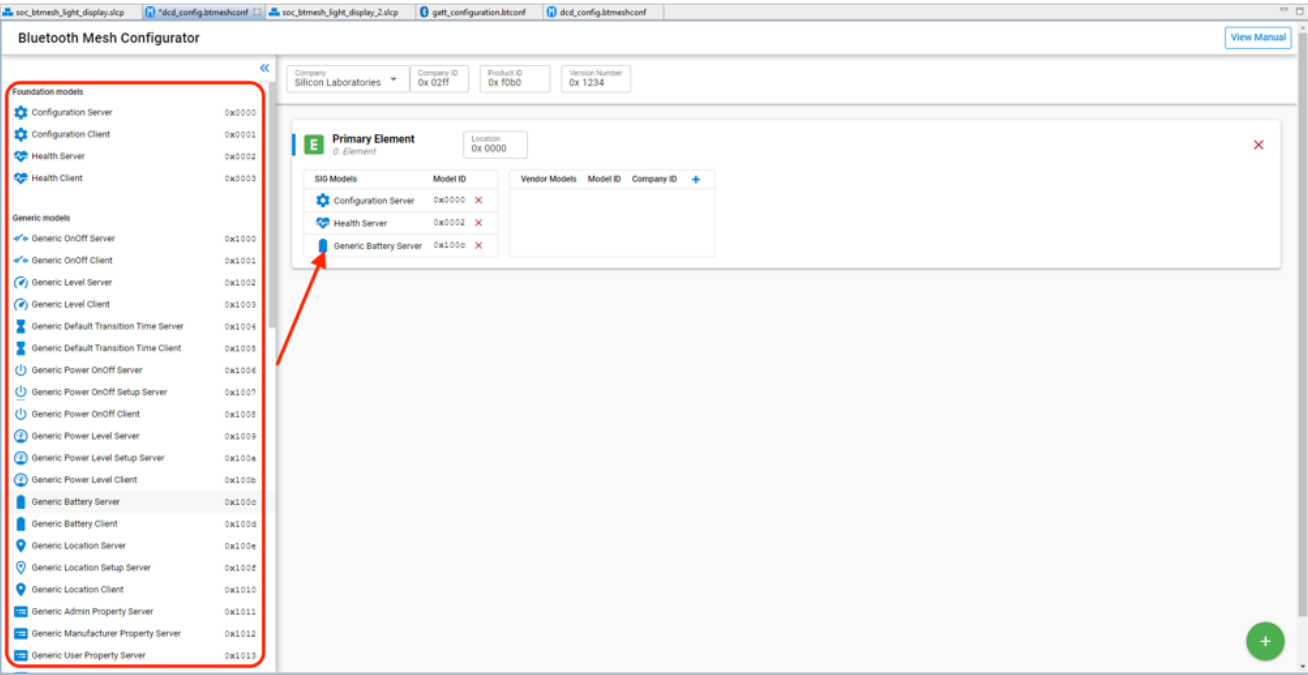
SIG-Adopted Model Editor

If you are using the provided model components that automatically bring in the source/header files, libraries, and configurations to the project, and also contribute the model to the DCD, you cannot edit or delete the model from the DCD manually. The model is greyed out, as shown in the following figure. In this case, all the model implementations will be generated to the project. You can modify the callbacks to adjust the application to your use case.



The drawback to using components is that you cannot edit the DCD and model information, because the models added by components are greyed out. If you want to build the DCD from scratch, for example to add a specific model to an element, uninstall all the model components. Then you can edit the DCD manually.





To delete a model, select it and click the red X symbol. To add a SIG-adopted model, drag the model from the left model pool to the SIG Models table in the correct element. A list of all the SIG-adopted models is displayed, and you can choose the one you want, as shown in the following figure. Note that, although all the SIG-adopted models are listed, not all of them are currently supported by the Bluetooth Mesh SDK. For the information on the supported models, see the SDK release notes.



Due to the extension mechanism of models mentioned above, attention is needed when adding models to your project. See *UG472: Bluetooth® Mesh Node Configurator User's Guide for SDK v2.x* for more information.

Vendor Models Editor

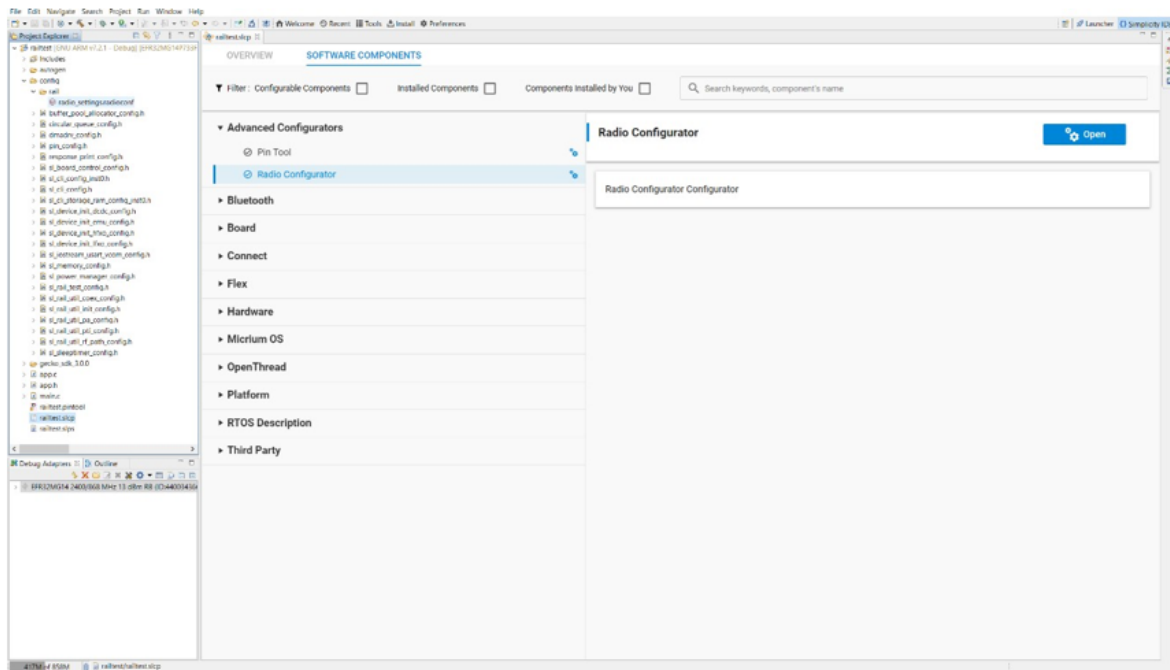
Vendor models give you more flexibility when developing products not covered by the SIG-adopted models. Vendors can define their own specification in these vendor models, including states, messages, and the associated behaviors. The vendor model editor is shown in the following figure. The ID field contains the 32-bit vendor identifier and model identifier. The two least significant bytes of the ID are the vendor ID and the two most significant bytes are the model ID. In the following figure, 0x02FF is the vendor ID for Silicon Labs, and 0x0021 and 0x0022 is the model ID. Click the plus symbol to add a vendor model, or select a model and click the red X symbol to remove it.

Vendor Models	Model ID	Company ID	+
 My Vendor Model 1	0x0021	0x02ff	
 My Vendor Model 2	0x0022	0x02ff	

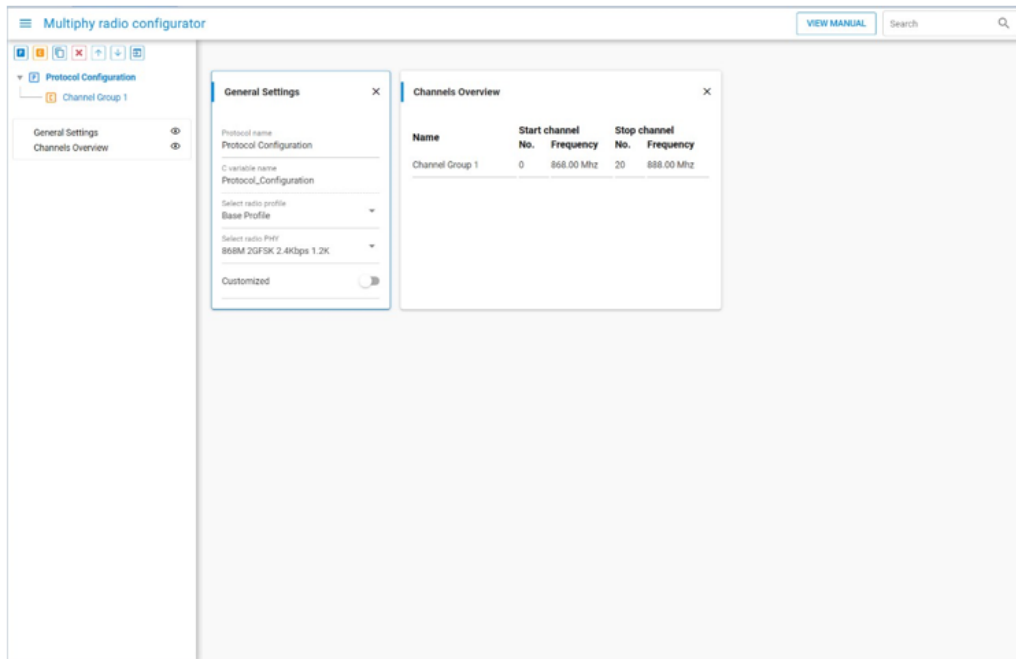
Proprietary Radio Configurator

Proprietary Radio Configurator

The Simplicity Studio® 5 (SSv5) Radio Configurator is provided as part of the Proprietary SDK. Use the Radio Configurator to create standard or custom radio configurations for your RAIL-based radio applications. The Radio Configurator is accessed through the Advanced Configurators software component group on the Project Configurator SOFTWARE COMPONENTS tab. (For some examples, the Radio Configurator might open on project creation). All radio configurator settings are stored in `config/rail/radio_settings.radioconf`. Changes made with Radio Configurator are not automatically saved.



Radio configuration information is organized by profile, where a profile is a high-level view of the parameter set valid for and describing a given radio link. All the parameters in the Radio Configurator are arranged in tiles, some of which are grouped together. Each card contains entries that logically go together. Different radio profiles (as described under [Protocol](#)) offer different views and parameter sets.



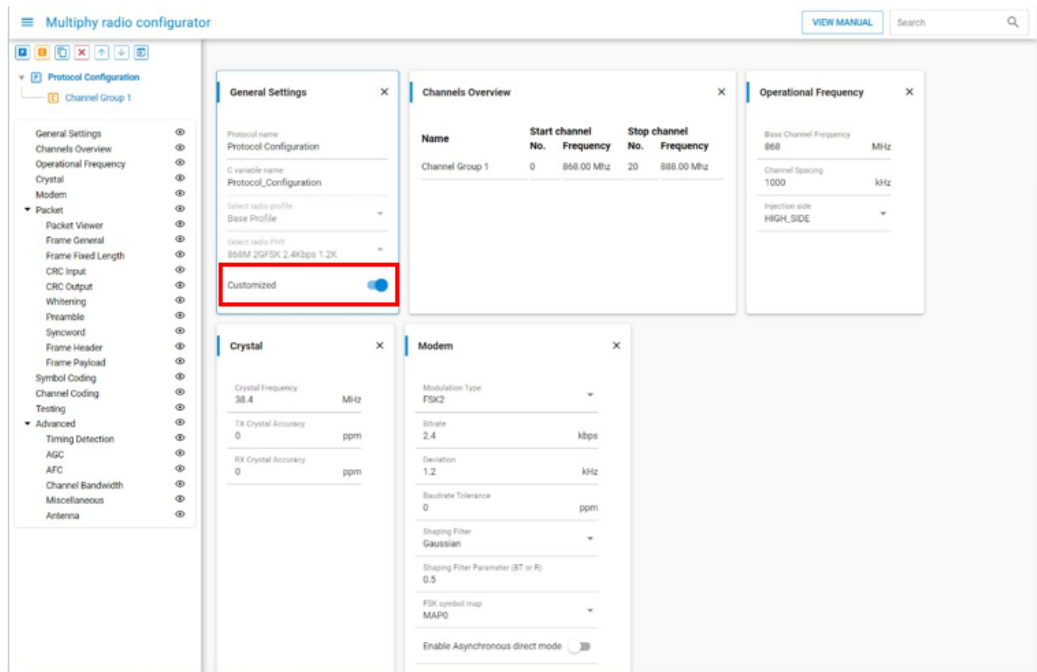
A radio configuration has two hierarchical levels: Protocol level and Channel Group level. A radio configuration can contain multiple protocols and a protocol can have multiple channel groups defined.

Protocol

Protocols are complete radio configurations that can be switched using the `RAIL_ConfigChannels()` API, or can be used in Dynamic Multiprotocol applications. For Channel Group definitions see [Channel Groups](#).

To configure a protocol, first select a predefined PHY configuration, then customize it to meet your needs.

1. In the General Settings card, select a radio profile in the **Select radio profile** drop-down menu. A radio profile may be any supported radio link technology. These technologies can be bound by standards (for example the Sigfox or WMBus protocols) or can be fully customized. The fully customizable profile is called the "Base Profile".
2. Select a radio PHY (radio configuration) in the **Select a radio PHY** dropdown list. Each profile has "built-in" configurations ready to use.
3. Review and update the profile options. By default, no changes are allowed; fields are grayed out. To enable customization, use the **Customized** switch on the General Settings card. This allows access to all the parameters defined by the profile.



Important notes:

1. If you select a "built-in" PHY, and then switch to "Customized", the Radio Configurator retains the property values of the "built-in" PHY. You can edit the values, but can also revert to the defaults.
2. If you switch to "Customized" mode, Silicon Labs recommends unchecking all "Advanced" properties, as those are fine-tuned for the "built-in" PHY, and may not be the optimal choice for the modified PHY. This way those parameters get auto-calculated, and you can experiment with the fine tuning starting with the calculated values. To keep the improved performance achieved by the original optimization, only minor changes should be made. For example, <100 MHz change in carrier frequency, or a different frame length configuration.
3. If you switch customization off, your modifications will revert to the property values of the "built-in" PHY.
4. Each menu item in the Navigation pane (on the left) is represented by a card in the main editor panel (on the right). Cards can be hidden by clicking the corresponding "eye" icon on the Navigation panel.

Based on the selected radio profile, customizable options may be restricted. For example, if a radio profile is selected that is bound by a standard, the profile options only allow users to set the base frequency. All other options are preset according to the standard.

Channel Groups

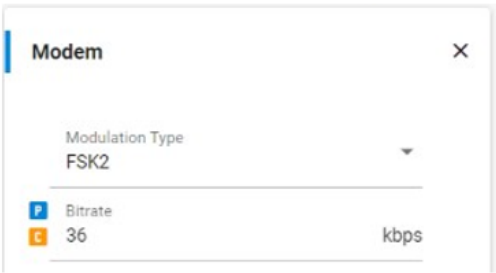
Each protocol configuration includes one or more channel group configurations. Channel groups define one or more (sequential) channels, with a constant channel spacing between them. Channel groups can differ in the radio configuration both from each other and from the parent protocol. By default, a channel group configuration includes only the General Settings and Channel Configuration tiles. Additional parameters defined by the Protocol can be accessed for customization on a channel group basis by sliding the Customized switch on the corresponding card.

RAIL automatically detects when hopping to a new channel requires hopping between channel groups. The configured property values defined by the channel group will be applied automatically for the new channel. This enables users to define virtual channels to the same physical frequency, but with different configuration settings. The order of the channel groups will be the same in the `RAIL_ChannelConfigEntry_t` array as shown in the Radio Configurator. Channel group order can be used to override channels in channel groups, as RAIL will always load the channel from the first channel group in which it is defined.

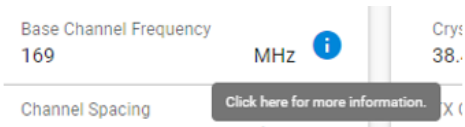
For more on Multi-PHY configuration, see the example in *AN1253: EFR32 Radio Configurator Guide for Simplicity Studio 5*.

Finalizing a Configuration

When a parameter is modified from its pre-loaded value, small pictograms show up next to the property field on the card. These pictograms symbolize the differences against the originally selected PHY configurations. A "C" means a difference from the original Channel Group property, and a "P" means a difference from the original Protocol Configuration.



Each input field has an Information icon next to it, which opens the embedded version of *AN1253: EFR32 Radio Configurator Guide for Simplicity Studio 5* at the relevant section. You can also reach the documentation by clicking **View Manual** in the top right corner of the perspective.

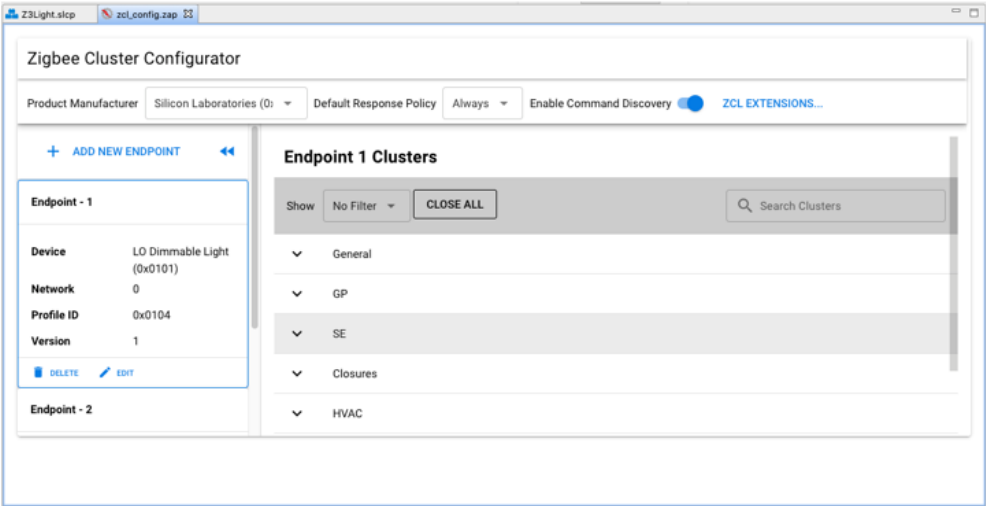


On save the Radio Configurator generates *rail_config.c* and *rail_config.h* in the project's *autogen* directory. These files are also generated when a project is created.

Zigbee Cluster Configurator

Zigbee Cluster Configurator

When you open Zigbee Cluster Configurator, it launches in a new tab next to the <project>.slcp tab, with the title 'zcl_config.zap'. A Zigbee application can have multiple endpoints. Each endpoint contains a device configuration made up of Clusters on that endpoint. Click **ADD NEW ENDPOINT** to add a new endpoint.



In the next dialog, select a device type for the endpoint, and optionally change the endpoint number. Click **CREATE** to create the endpoint.

Create New Endpoint

Endpoint

1

Profile ID

Device

Network

0

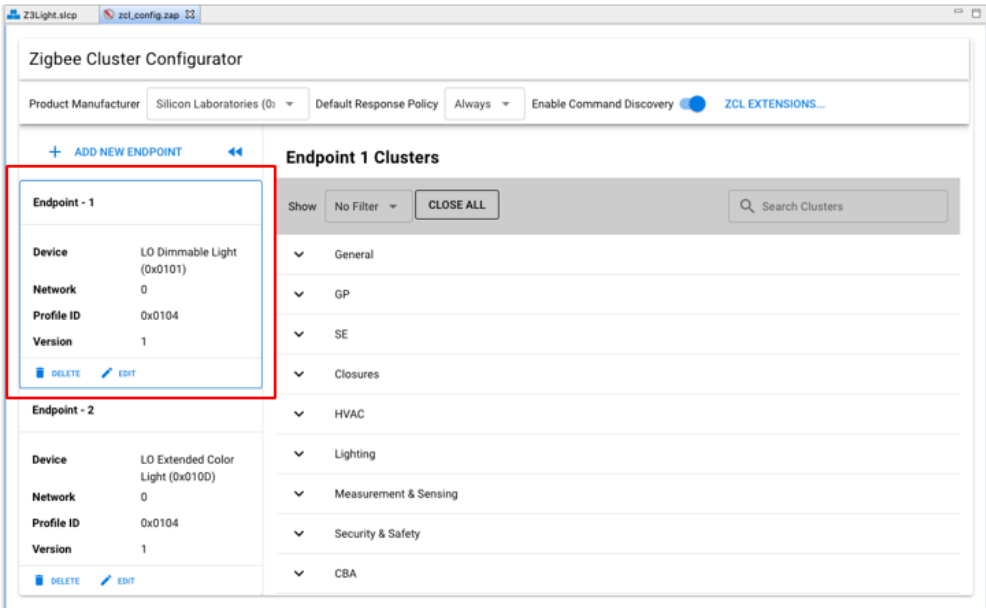
Version

1

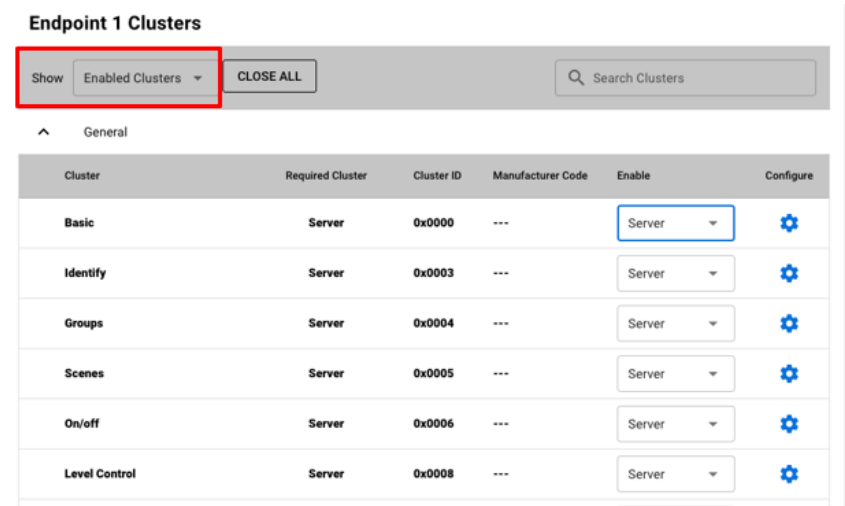
CANCEL

CREATE

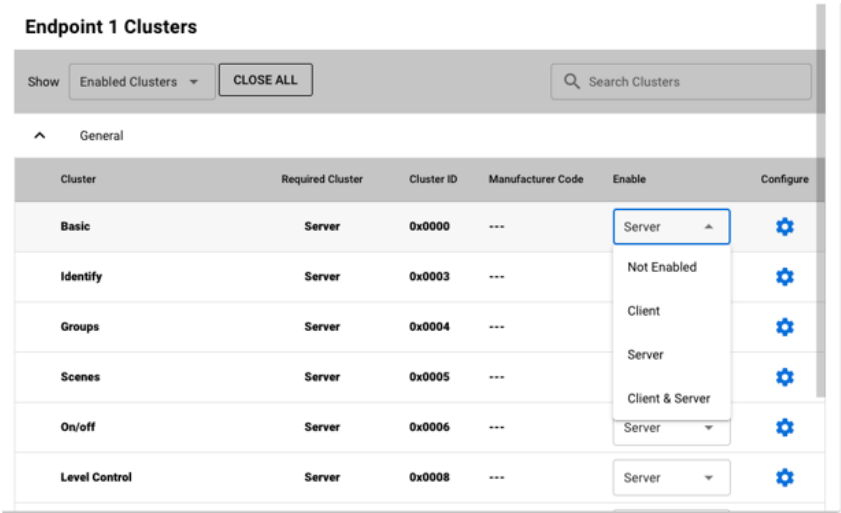
To modify an endpoint, select it in the left panel.



The **Show** dropdown filters the clusters shown. To see only clusters that are enabled on the endpoint, select 'Enabled Clusters'.

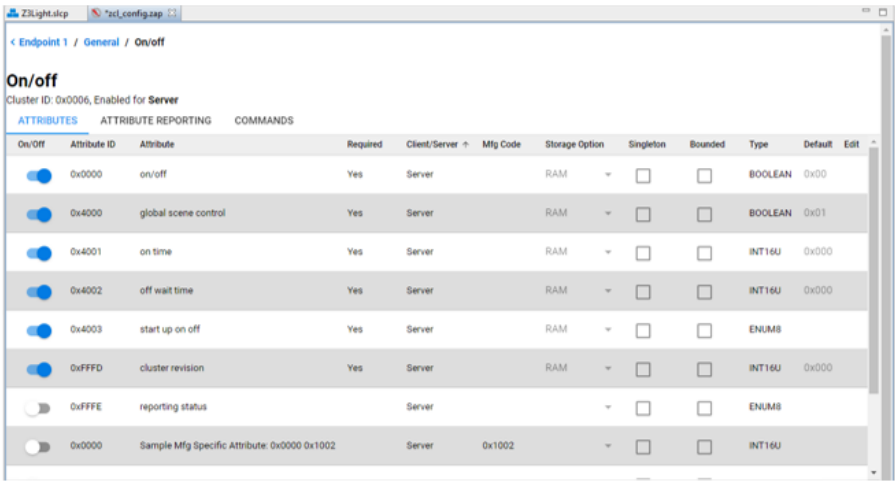


Settings in the Enable column enable either the Client or Server (or both) sides of a cluster. Depending on the changes you make, you may be notified that components have been added to your project. To remove the cluster entirely from the configuration, select 'Not Enabled'.



Click the Gear icon next to a cluster to enable or disable attributes, manage how they are stored, manage attribute reporting, and also manage the handling of commands on that cluster. The cluster configuration interface consists of three tabs:

- Attributes
- Attribute Reporting
- Commands



Configuration changes made through the Zigbee Cluster Configurator are saved to the `zcl_config.zap` file. The `.zap` file is the backing data file for the Zigbee Cluster Configurator configuration for your application. When you save the file, the Zigbee Cluster Configurator not only saves the `.zap` file into your project, but also automatically generates all the `.c` and `.h` files required by the Zigbee Application Framework for your Zigbee application. These files show up in two locations in your project. The `.zap` file is saved in the project's `config > zcl` folder. The files generated by the Zigbee Cluster Configurator for the application are placed in the project's `autogen` folder and all start with the 'zap' prefix.

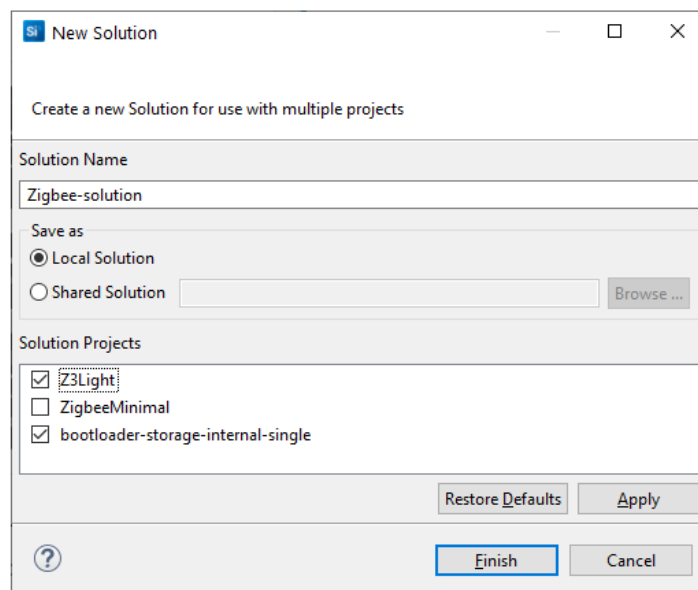
For additional details about cluster configuration and adding a custom cluster, see *AN1325: Zigbee Cluster Configurator User's Guide*.

Solutions

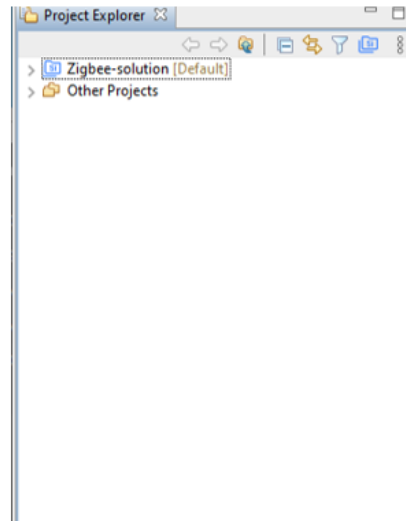
Solutions

Solutions are combinations of projects that can be compiled, debugged, and flashed together. This is a new feature, many aspects of which will be released in the future. At present it is most useful for debugging a bootloader and associated application at the same time.

Solutions can be created through **File > New > Solution** or **Projects > Manage Solutions > New**. The resulting dialog shows available projects in the current Workspace. Name the solution, select the projects to be included in it, and click **Finish**. Note: Shared solutions are not implemented in this release.

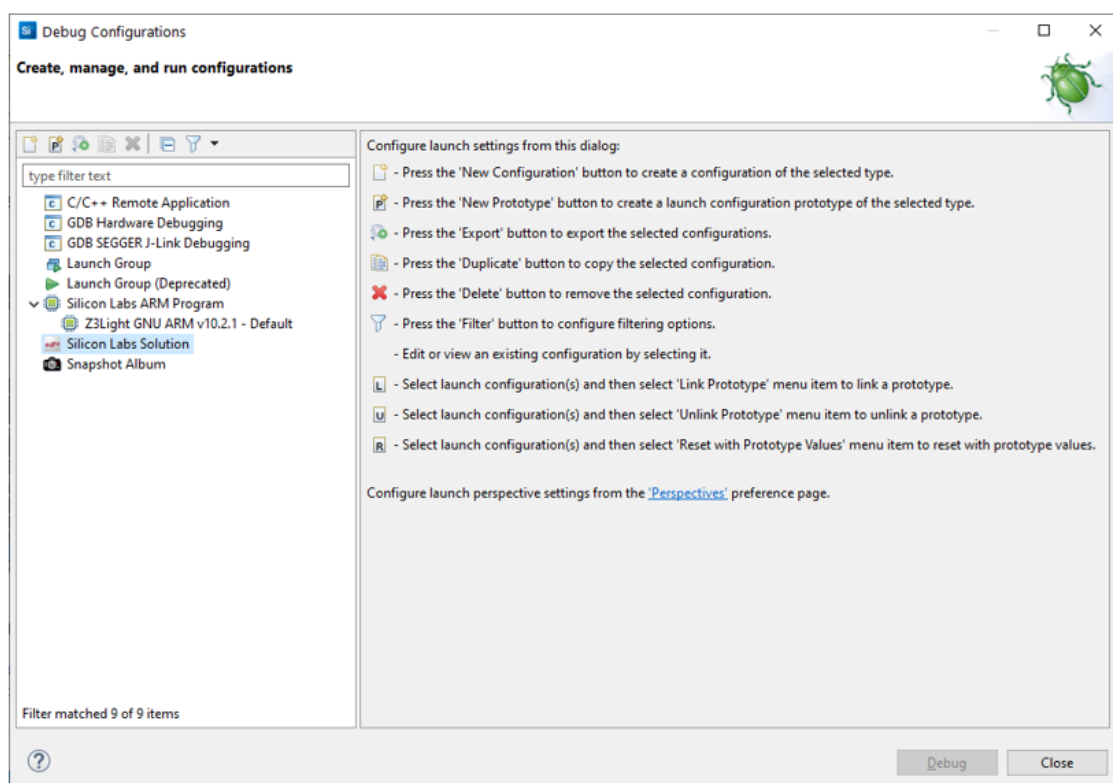


Once you have created a solution, Project Explorer view shows the solution as a separate folder, and projects that are not included in the solution as 'Other Projects'.

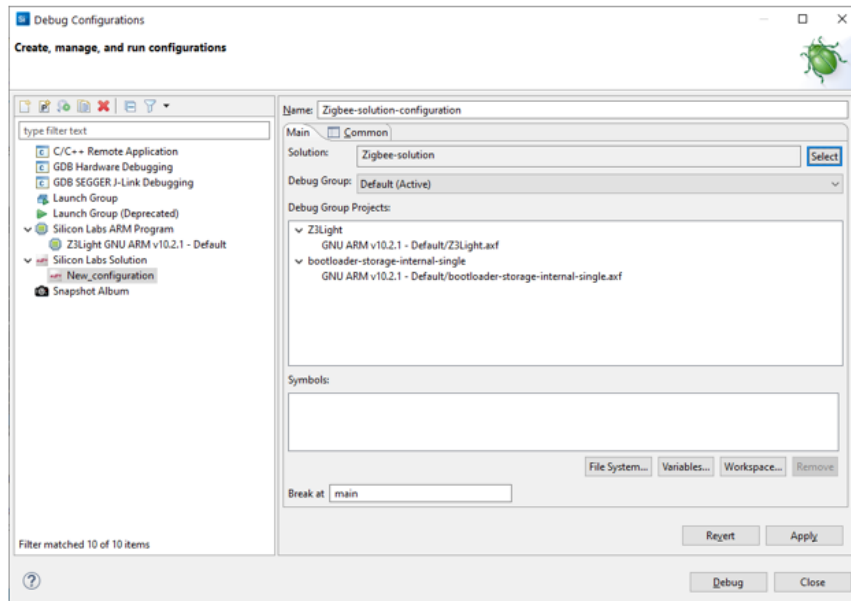


Select the solution and click **Build** to build all projects in the solution, or **Debug** to build all projects, download all projects, and start a debug session. Solution debug configurations do not honor automatic breakpoints in this release. You should set breakpoints in both the bootloader (Silicon Labs recommends setting a breakpoint at the start of the SystemInit2 function in btl_main.c) and the application.

Optionally, Solutions have a dedicated debug configuration type. Drop-down the Debug control menu and select **Debug Configurations** to see the available configuration types.



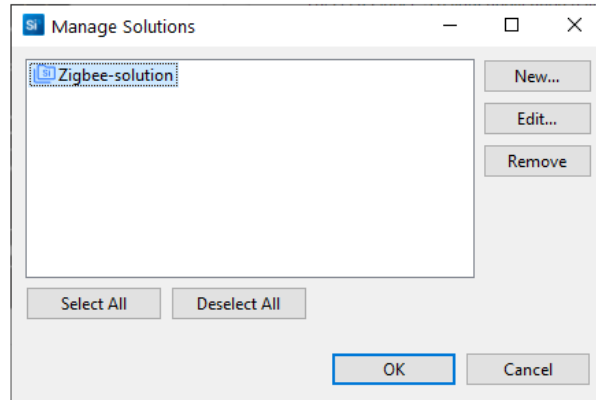
Right-click **Silicon Labs Solution** and select **New Configuration**. On the Main tab, provide a name and select the solution.



Click **Apply** to save changes.

Right-click the Solution in Project Explorer view, and click **Solutions** on the context menu to open the Manage Solutions dialog, set the active Configuration or sync solution configurations.

With **Manage Solutions** (also available on the Project menu) you can edit and remove solutions.



If the projects have multiple build configurations and the solution also has multiple build configurations, click **Sync Solution Configuration** to set the active build configuration of each project to match the solution's active build configuration.

Developing with AppBuilder

Developing with AppBuilder

Simplicity Studio® 5 (SSv5)'s AppBuilder is a graphical tool used to create configurations and build Application Framework files. The AppBuilder configuration files indicate which features and functions you would like for your compiled binary image. By using AppBuilder along with an application framework, you can quickly create an application that includes all of the required functionality for the image's purpose.

AppBuilder must be used in conjunction with one of the Silicon Labs application frameworks, which are shipped as part of the SDK. All of the code that will be compiled into the binary image is included in the SDK distribution. AppBuilder creates configuration and build files that tell the application framework which portions of the code to include in, and which to exclude from, the compiled binary image.

With the exception of a few header (.h) files, AppBuilder does not generate the C source code for the application. All of the source code that ultimately will be included in the binary image is provided in the Application Framework.

In general, to develop an application using AppBuilder:

1. Create an application based on one of the AppBuilder examples, such as Z3Switch.
2. Customize the application on the various AppBuilder tabs. Functions can be added by enabling and configuring plugins.
3. Click **Generate** to create application files.
4. Optionally, add your own code to the application.

Once you have finishing customizing your project, [build and flash it](#), and then [test and debug it](#).

Configuring a Project

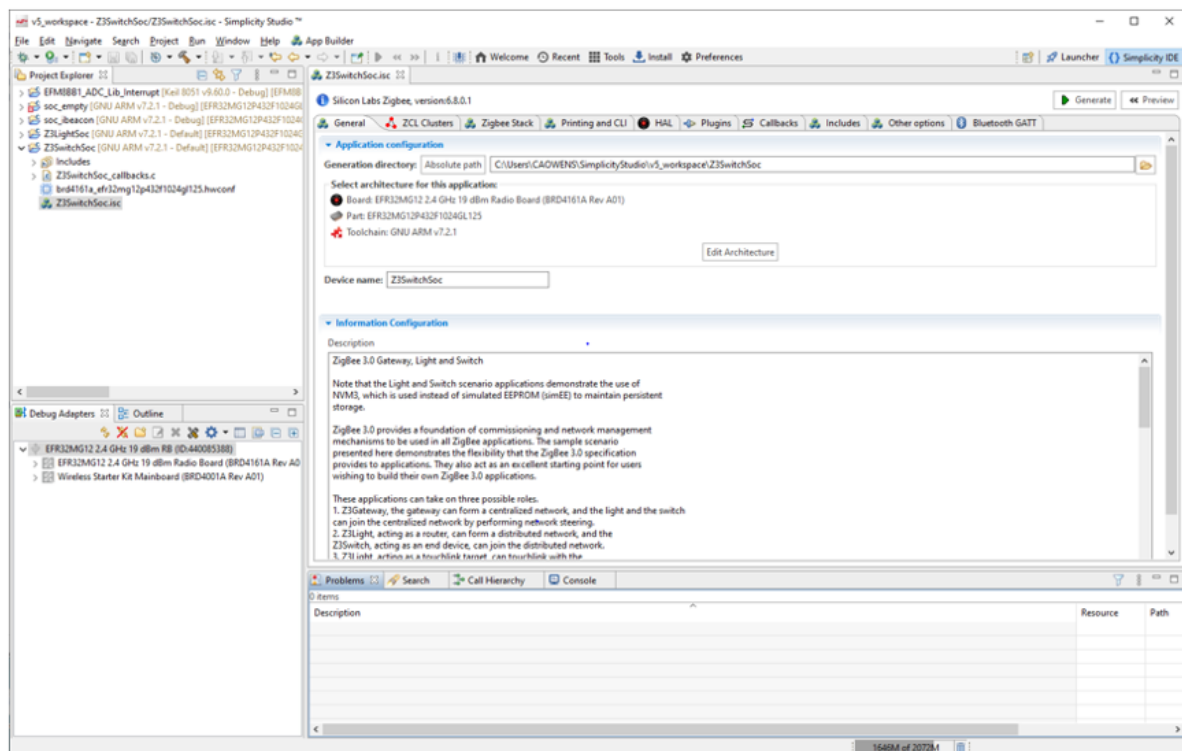
Configuring a Project

Simplicity Studio® 5 (SSv5)'s AppBuilder provides a tabbed interface. Each tab provides customization options.

- **General** - Configure global values for your application like the Device Name and Generation Directory
- **ZCL Clusters** - Choose the specific combination of clusters to include
- **Zigbee Stack** - Configure stack-specific settings
- **Printing and CLI** - Configure debug printing and CLI options
- **HAL** - Configure bootloader and board header file options, and access the Hardware Configurator tool to manage peripheral configurations
- **Plugins** - Include or exclude plugins, where a plugin is a specific implementation of a cluster or some other functionality
- **Callbacks** - Select from a set of predefined callbacks
- **Includes** - Include any external files into the generated project
- **Other Options** - Configure PHY support, plugin services, and other options
- **Bluetooth GATT** - For use with dynamic multiprotocol applications, provides a direct interface to the GATT configurator

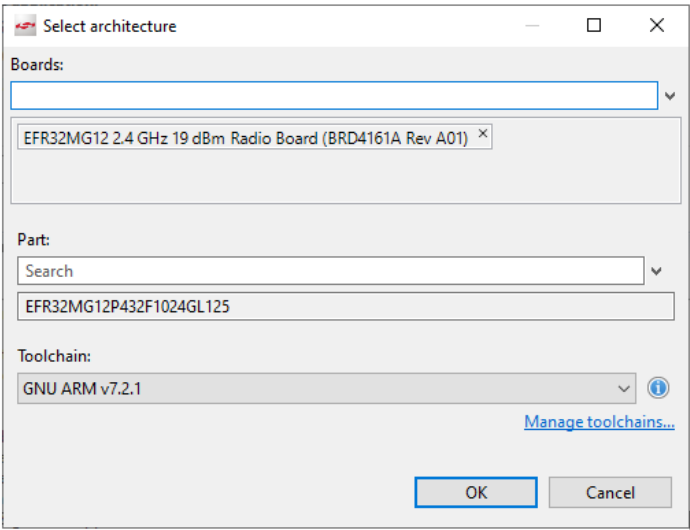
General

The General tab provides information about the example used as a foundation for the project, and lets you change project level information, such as the toolchain used.



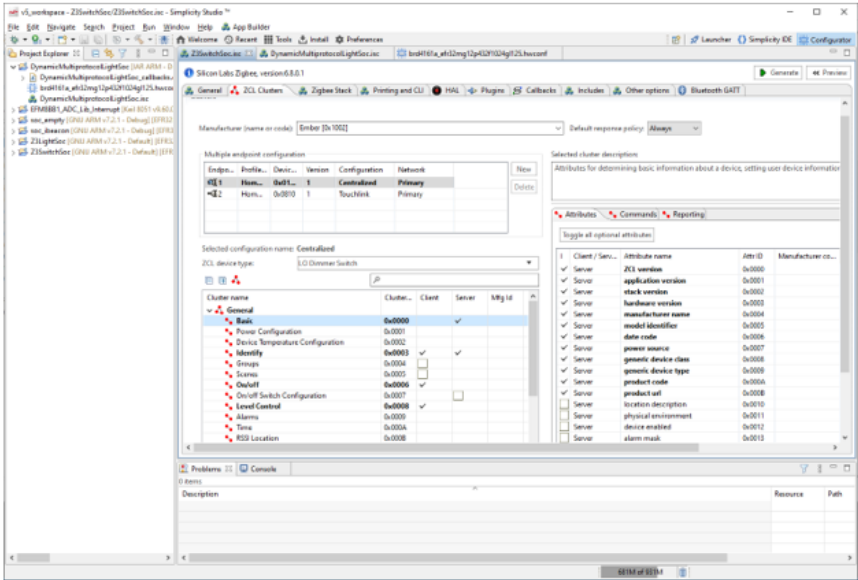
Generation directory shows where project files will be generated. By default this is a <project name> directory in the default SSV5 workspace.

Click **Edit Architecture** to change the target device or the toolchain.



ZCL Clusters

The ZCL Clusters tab provides functionality to manage endpoints and their cluster configuration.



Multiple Endpoint Configuration Table

The Multiple Endpoint Configuration Table allows you to configure the endpoints on your device. Click **New** to add an endpoint.

Endpoint: Change the endpoint on which your device will be hosted by clicking the number in the Endpoint column. The number field becomes editable. Change the endpoint to any of the valid Zigbee endpoints available.

Configuration: Each endpoint implements a specific configuration. The configuration is not a Zigbee construct. It is a name created for Simplicity Studio AppBuilder so that multiple endpoints that implement the same application can share the metadata associated with that application. This conserves the use of flash within the device. By default, each new endpoint will implement the configuration named "Primary." Change the configuration by selecting the endpoint row and then clicking on the "Configuration" column. A button appears to the right of the Configuration name. Click the button to launch the configuration dialog. Once you have created a new configuration, the application for that configuration can be implemented on as many endpoints as you like without using any more memory on your device for metadata storage. Each endpoint still needs to have its own attribute storage to contain the endpoint-specific values. AppBuilder and the application framework take care of this for you.

Network: By default, the first endpoint belongs to the network named "Primary." When new endpoints are created, they will belong to the same network as the first endpoint. On platforms that support multi-network, you may choose the network for a specific endpoint. New networks can be created and configured in the Zigbee Stack tab.

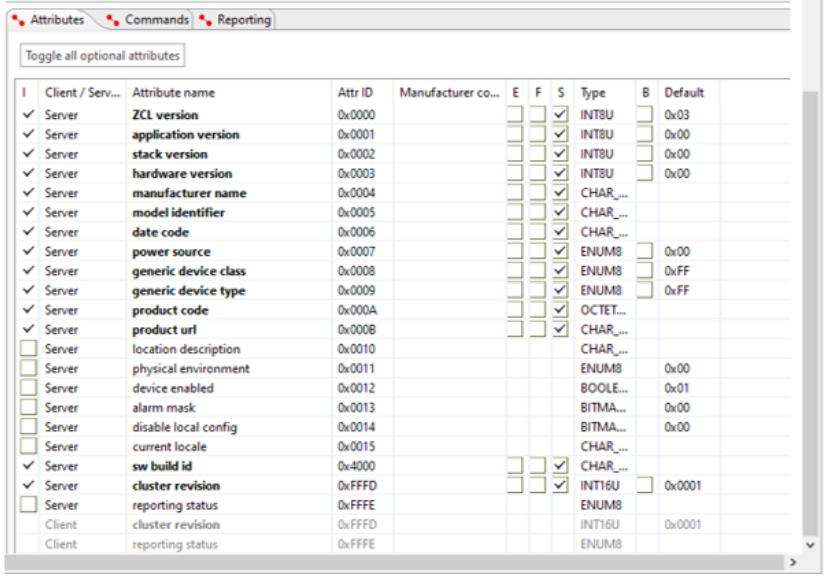
ZCL Device Type: Select from a set of pre-defined ZCL Device Types. AppBuilder then populates the cluster table with the clusters appropriate to that device type as defined by the Zigbee Cluster Library specification. In addition to these pre-defined device types, you also have the option to create a custom device type. With this option, you can choose from any of the available Zigbee clusters included within the Application Framework.

Cluster Table

The Cluster Table displays which clusters will be included as part of each endpoint type. In the case of a custom device implemented on any endpoint, you have the option to choose the clusters to include and their client/server role.

Attribute Table

When you click a specific cluster, its attributes display in the Attribute Table. Configure the device's behavior by configuring the attributes in this table.



	Client / Serv...	Attribute name	Attr ID	Manufacturer co...	E	F	S	Type	B	Default
<input checked="" type="checkbox"/>	Server	ZCL version	0x0000		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	INTBU	<input type="checkbox"/>	0x03
<input checked="" type="checkbox"/>	Server	application version	0x0001		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	INTBU	<input type="checkbox"/>	0x00
<input checked="" type="checkbox"/>	Server	stack version	0x0002		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	INTBU	<input type="checkbox"/>	0x00
<input checked="" type="checkbox"/>	Server	hardware version	0x0003		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	INTBU	<input type="checkbox"/>	0x00
<input checked="" type="checkbox"/>	Server	manufacturer name	0x0004		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	CHAR...		
<input checked="" type="checkbox"/>	Server	model identifier	0x0005		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	CHAR...		
<input checked="" type="checkbox"/>	Server	date code	0x0006		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	CHAR...		
<input checked="" type="checkbox"/>	Server	power source	0x0007		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	ENUM8	<input type="checkbox"/>	0x00
<input checked="" type="checkbox"/>	Server	generic device class	0x0008		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	ENUM8	<input type="checkbox"/>	0xFF
<input checked="" type="checkbox"/>	Server	generic device type	0x0009		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	ENUM8	<input type="checkbox"/>	0xFF
<input checked="" type="checkbox"/>	Server	product code	0x000A		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	OCTET...		
<input checked="" type="checkbox"/>	Server	product url	0x000B		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	CHAR...		
<input type="checkbox"/>	Server	location description	0x0010		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	CHAR...		
<input type="checkbox"/>	Server	physical environment	0x0011		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	ENUM8	<input type="checkbox"/>	0x00
<input type="checkbox"/>	Server	device enabled	0x0012		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	BOOLE...	<input type="checkbox"/>	0x01
<input type="checkbox"/>	Server	alarm mask	0x0013		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	BITMA...	<input type="checkbox"/>	0x00
<input type="checkbox"/>	Server	disable local config	0x0014		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	BITMA...	<input type="checkbox"/>	0x00
<input type="checkbox"/>	Server	current locale	0x0015		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	CHAR...		
<input checked="" type="checkbox"/>	Server	sw build id	0x4000		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	CHAR...		
<input checked="" type="checkbox"/>	Server	cluster revision	0xFFFD		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	INT16U	<input type="checkbox"/>	0x0001
<input type="checkbox"/>	Server	reporting status	0xFFFE		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	ENUM8		
<input type="checkbox"/>	Client	cluster revision	0xFFFD		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	INT16U		0x0001
<input type="checkbox"/>	Client	reporting status	0xFFFE		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	ENUM8		

External Attribute storage: By default, all attributes are stored in a RAM buffer provided by the application framework. Storing some attributes may not make sense, however, since they are either already stored somewhere else in the system or are not stored at all but read from some external piece of hardware. In this case you may indicate that the attribute is externally stored. When the application framework needs to interact with the attribute it will use the external attribute callbacks. By implementing these callbacks and marking the attribute as externally stored, the attribute storage is removed from the framework and placed into the domain of the application. The metadata used to represent the attribute on the network is still stored inside the framework so that the framework can respond to ZDO requests and so on.

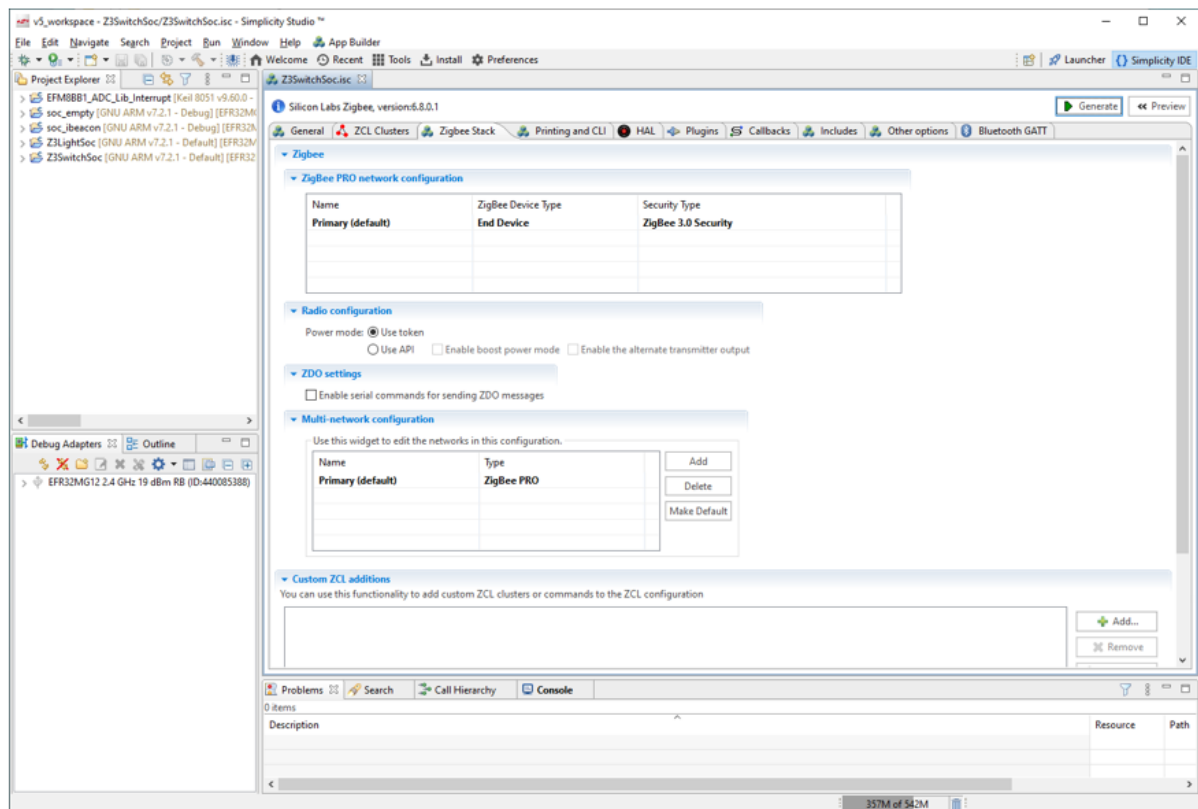
Persistent attribute storage: By default, all attributes are stored in RAM. As a result, attribute data does not survive a reboot of the device. If you want to maintain state for an attribute across reboots, the attribute must be stored in persistent memory on the device. To store a specific attribute in persistent memory, check the checkbox in the F column.

Singleton attribute storage: Most attributes are stored as a separate value for each endpoint on which they are implemented. This does not make sense for some attributes that may exist across endpoints. For instance, it makes little sense to store multiple copies of the Basic Cluster's ZCL Version since the version pertains to the entire application and not to each individual endpoint. Attribute values may be shared across endpoints by indicating that the attribute is a "singleton."

Bounding attributes to their Min and Max values: By default, the application framework allows you to write any value (within the limits of the size of the attribute) into the attribute table. However, you may request that the application framework reject any attribute value outside the Min and Max defined by the Zigbee specification by checking the checkbox in the B column. The application framework then stores the min and max values for the chosen attribute in the attribute table and rejects any write request, whether from the CLI or an external device, that is outside the attribute value range.

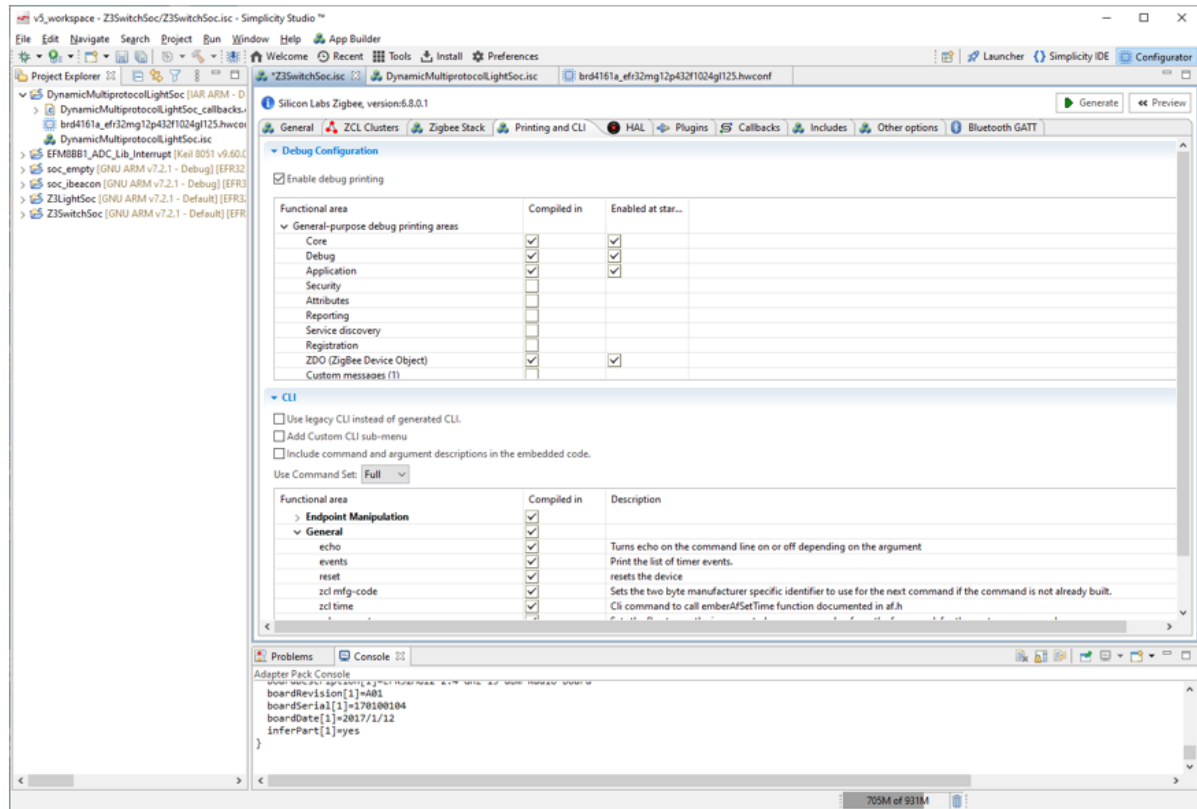
Zigbee Stack

Here you can configure networks and add custom clusters.



Printing and CLI

Here you can enable and configure debug printing, and enable/disable CLI functionality.



Debug printing

The application framework can output application and stack debug information over the serial port. To choose the information to include in the debug output, select from the serial printing checkboxes. If you are not concerned with debug output, and/or would prefer to conserve the flash and RAM associated with debugging, turn off the serial printing options by deselecting them.

Command Line Interface (CLI) Options

AppBuilder can output either a "Legacy" or "Generated" command line interface.

Use Legacy CLI: If checked, AppBuilder uses the hard coded CLI interface included in the application framework. Otherwise AppBuilder generates a Command Line Interface along with other generated files based on the CLI interface options selected in the CLI configuration window.

Add Custom CLI Sub-menu: Adds the ability to include user-defined CLI commands into the Command Line Interface.

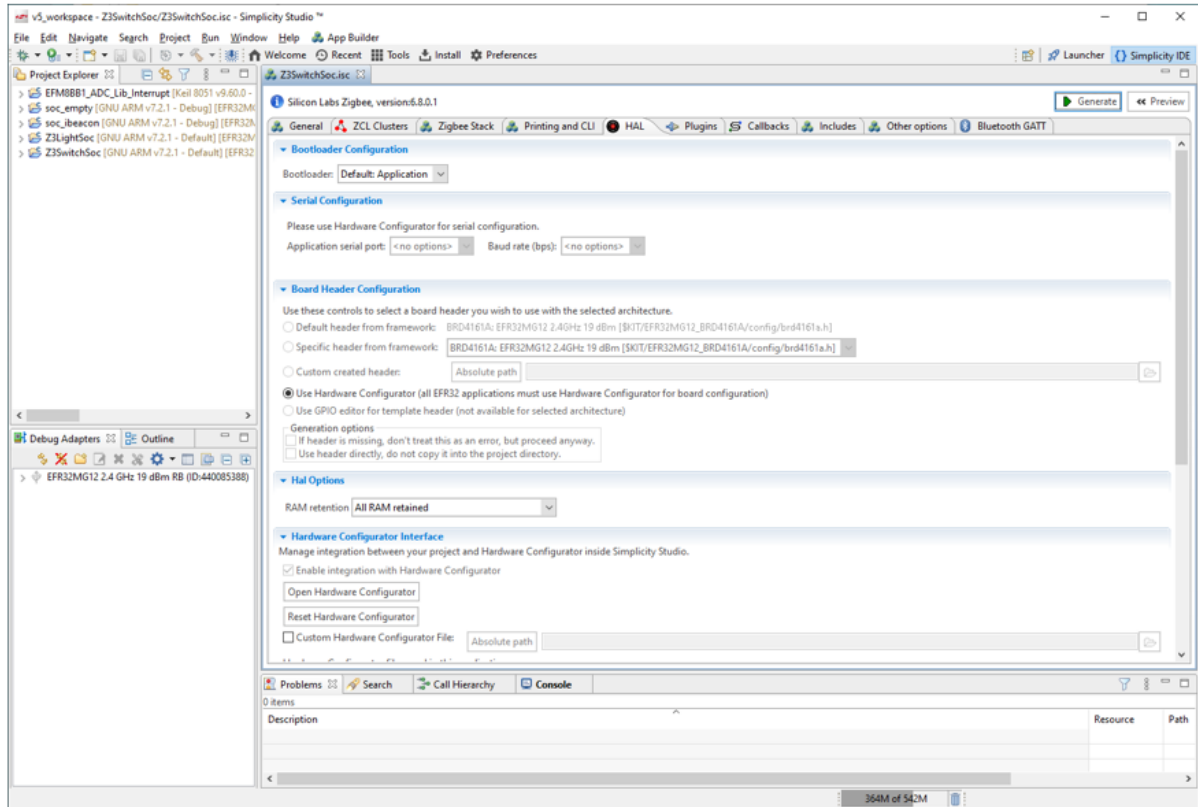
Include Command and ...: Includes a description for each command or argument into the Command Line Interface. Turning this on will increase the size of your application but will make it easier to use the Command Line Interface since all commands will be self-described when a command is not recognized by the application.

Use Command Set: Makes it possible to turn the command line interface on and off and choose a pre-defined subset of the CLI for use in your application

CLI Configuration Table: Select exactly what CLI commands are supported in the application. By default, the Full command line interface command set selects all General commands and all cluster and plugin commands supported by clusters and plugins included in the application.

HAL

Use the HAL tab to configure hardware-specific options for your device.

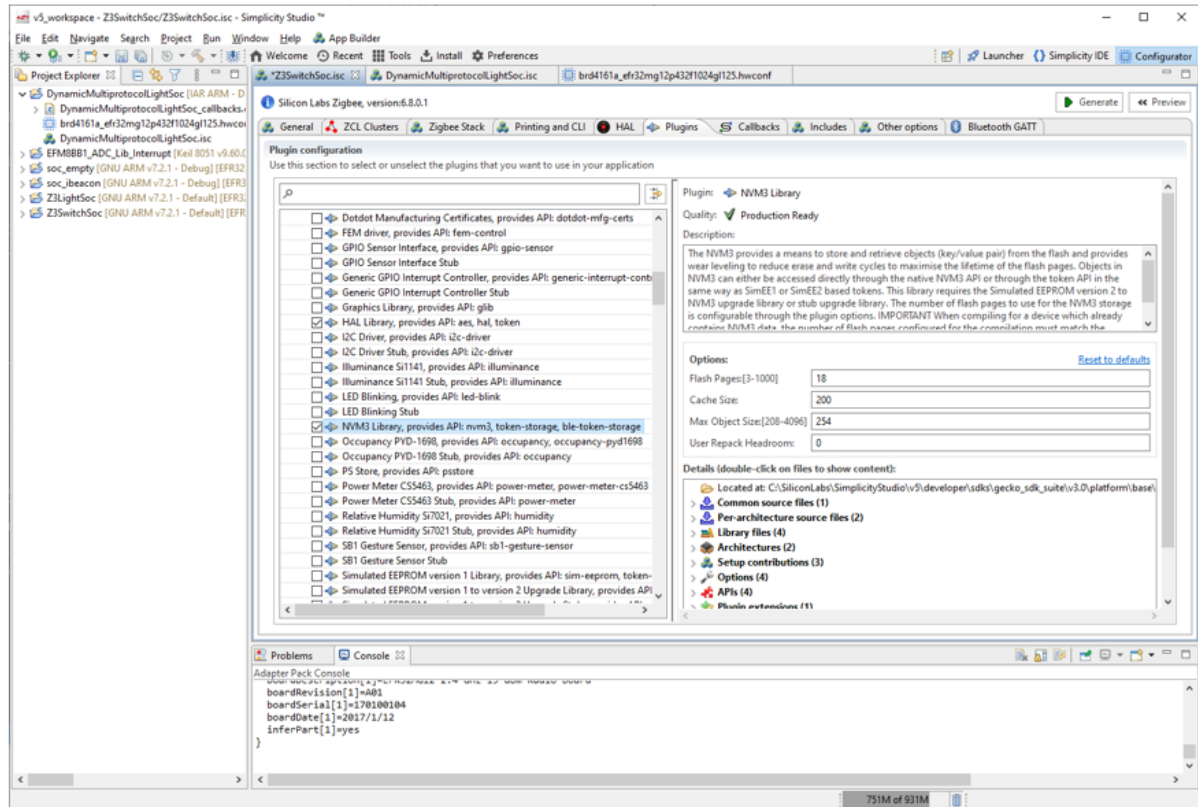


For EFR32 devices, most hardware configuration is done through the [Hardware Configurator](#). Under **Hardware Configurator Interface** click **Open Hardware Configurator**.

Bootloader - Select the type of bootloader to use. See [UG103.6: Bootloader Fundamentals](#) as a starting point to learn more about bootloaders.

Plugins

Use the Plugins tab to include, exclude, and configure the functional implementations called plugins.

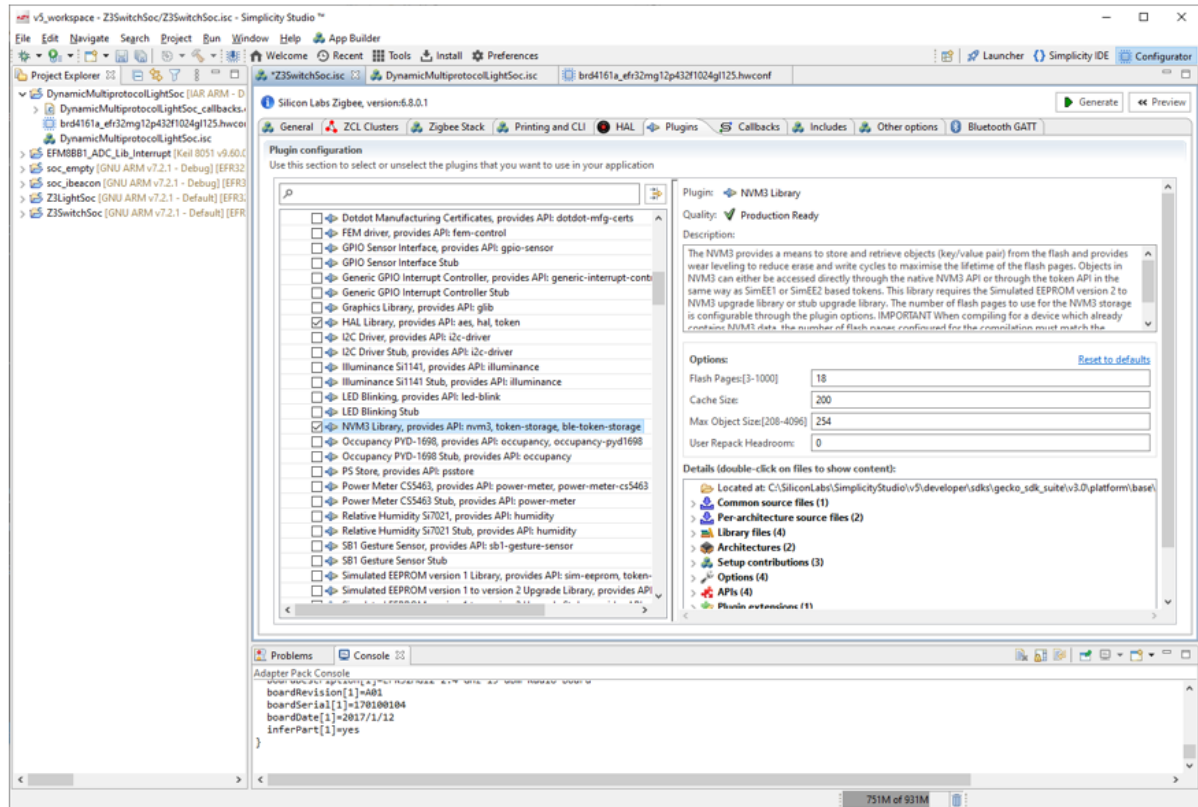


Include/exclude plugins by checking/unchecking them. Select a plugin to see information about it and configurable parameters, if any.

Some plugins provide access to the Hardware Configurator peripheral settings. These plugins have a Hardware Configurator Dependent Options pane. You may need to scroll down in that pane to see all options. Enabling/disabling plugins can also enable and disable Hardware Configurator modules and their dependent peripherals. When a plugin with Hardware Configurator dependencies is enabled/disabled, a pop-up dialog box shows which Hardware Configurator modules and peripherals are being enabled/disabled. Also, when a plugin that shares Hardware Configurator modules/peripherals with another plugin is enabled/disabled, a similar warning shows which peripherals are being affected behind the scenes in the Hardware Configurator. See [Configuring Peripherals](#) for information on using the Hardware Configurator directly. For more details on both plugin and tool access, see [AN1115: Configuring Peripherals for 32-Bit Devices using Hardware Configurator](#).

Callbacks

Use the Callbacks tab to add or remove callbacks, and to see the callbacks that are required by plugins or other code. Select a callback to see its code and other information about it.



Enabled callbacks must be implemented in application code, otherwise you will get linker errors.

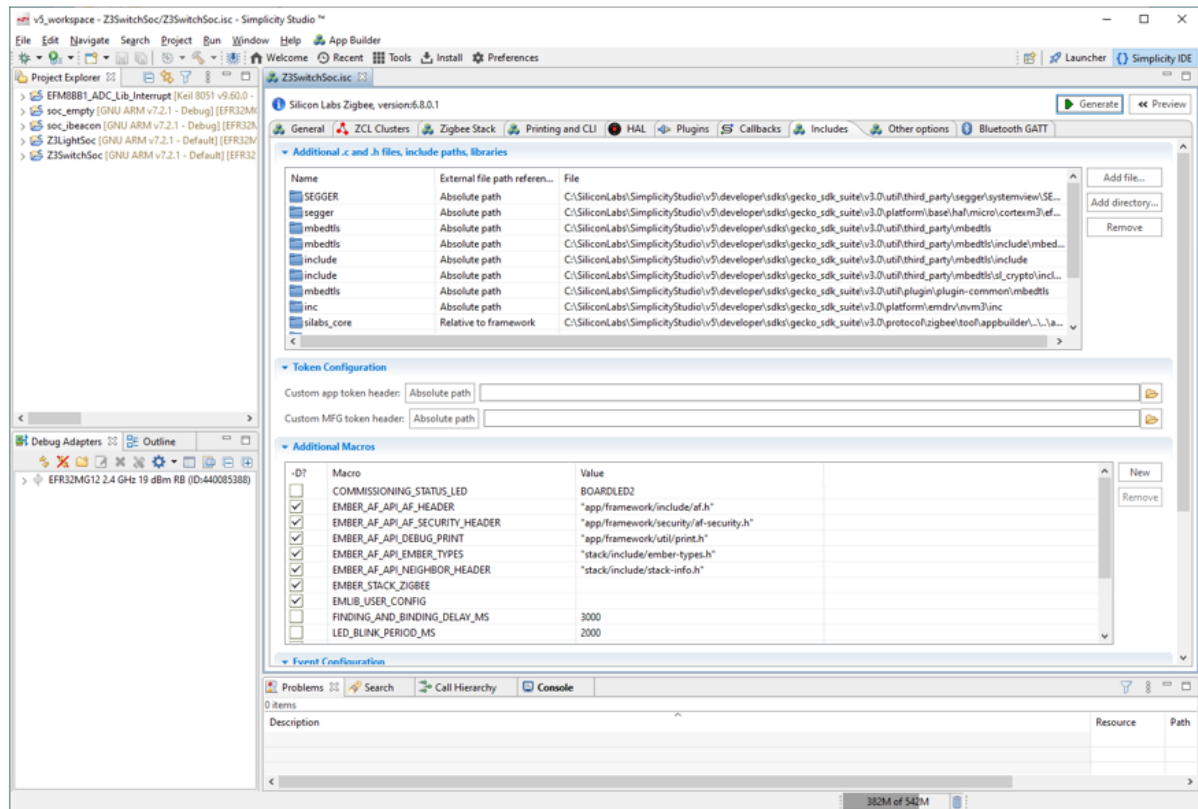
Callbacks are grouped into logical sections in the callbacks tab for ease of navigation. Callbacks implemented by an included plugin have the plug symbol. All of the custom application framework callbacks are included in the "Non-cluster related" section. All of the other callbacks are grouped by cluster. Many of the cluster-specific callbacks are intended for command handling.

When a command comes in, it is passed off to a cluster-specific callback for processing. If the callback returns TRUE then the internal handler for that command will not be called. Cluster-related callbacks are also only implemented for those client and server clusters that are included in the application. If a cluster is not included, the application is not expected to parse that cluster's commands. The application framework returns a default response of UNSUPPORTED_COMMAND.

Callback generation: The first time you generate your application from AppBuilder, it automatically generates a callbacks.c file with the name <project name>_callbacks.c. When you regenerate files in the future, AppBuilder protects your generated callbacks file from being overwritten by asking if you want to overwrite it. By default, AppBuilder will not overwrite any previously created callbacks file. If you choose to overwrite the file, AppBuilder backs up the previous version to the file <project name>_callbacks.bak.

Includes

Use the includes tab to manage information included in the application.



Additional .c and .h files

When you generate a project file from AppBuilder, you often need to modify the project to include your own source files into the application image. This is a problem if the project file needs to be re-generated, since the newly generated project file will overwrite the old one, thereby removing any files that have been included.

Any files that you would like to compile along with your application can be included in the file include table. To include a new file, click **New**. Navigate to the location of the file you wish to include and click **OK**. The file will be included inside the generated project file with an absolute path to the location of the file.

Token Configuration

To implement attributes in tokens, the application framework places its own token file into the generated APPLICATION_TOKEN_HEADER #define within the generated project file.

The application framework's token header file, located at app/framework/util/tokens.h, includes a spot where you may place a relative path to your own token header. The token header files are chained off one another with the application framework's token header at the top of the chain. To include your own token header within your application, provide absolute or relative path inside the appropriate Token Configuration path field.

Additional Macros

Much of the configuration for the application framework and the stack is done using macros documented within the API. Any additional macros that you wish to define, either for compile time or for run time, should be provided here.

Compile-time macros should include the "-D" option. These macros will be included in the compiler and linker definition sections in the generated project file. Any macros which do not include the "-D" option will be included in the generated application header file.

Event Configuration

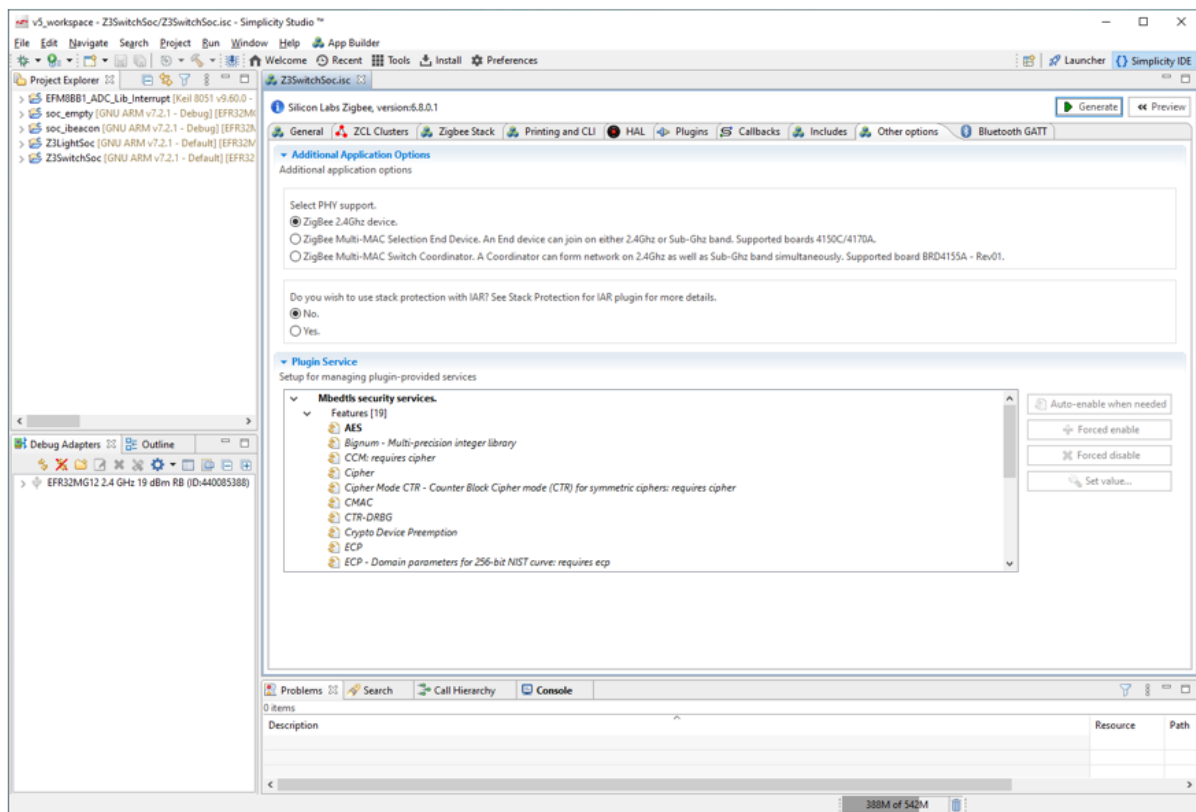
You can include custom application events into the application framework's event system. These events are run in the same manner as the application framework's own events as well as all cluster events implemented by the cluster plugins.

To include a custom event, click **Add New**. Your custom event will be automatically included in the event configuration section of the generated *endpoint_configuration.c* file. Stubs for your event function and event control will be generated into the *callbacks.c* file. You may also change the name of the generated event control value and function to whatever you desire.

For more information on how events work [UG391: Zigbee Application Framework Developer's Guide](#).

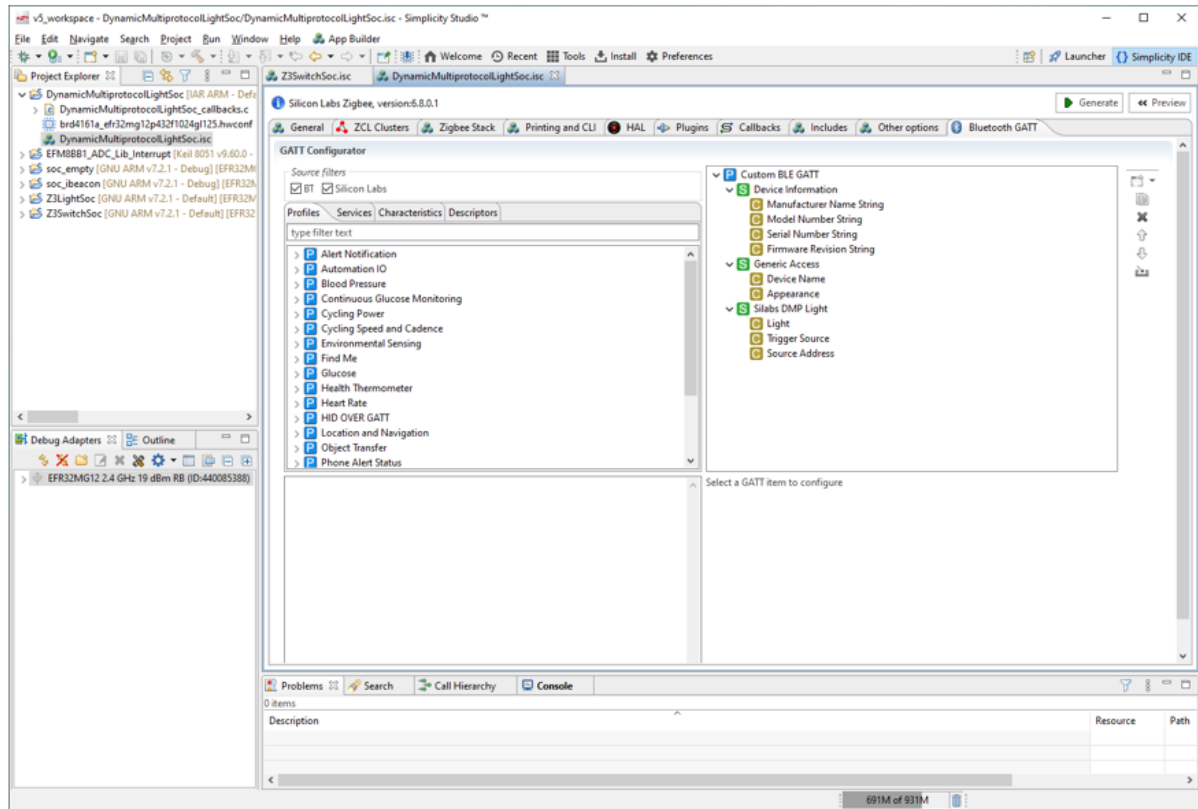
Other Options

Use the Other Options tab to configure PHY support, stack protection, and to manage plugin-provided services.



Bluetooth GATT

For Dynamic Multiprotocol applications, use the Bluetooth GATT tab to configure the GATT database for the Bluetooth application.



For more information about Bluetooth GATT database configuration see [UG365: GATT Configurator User's Guide for Bluetooth SDK v2.x](#).

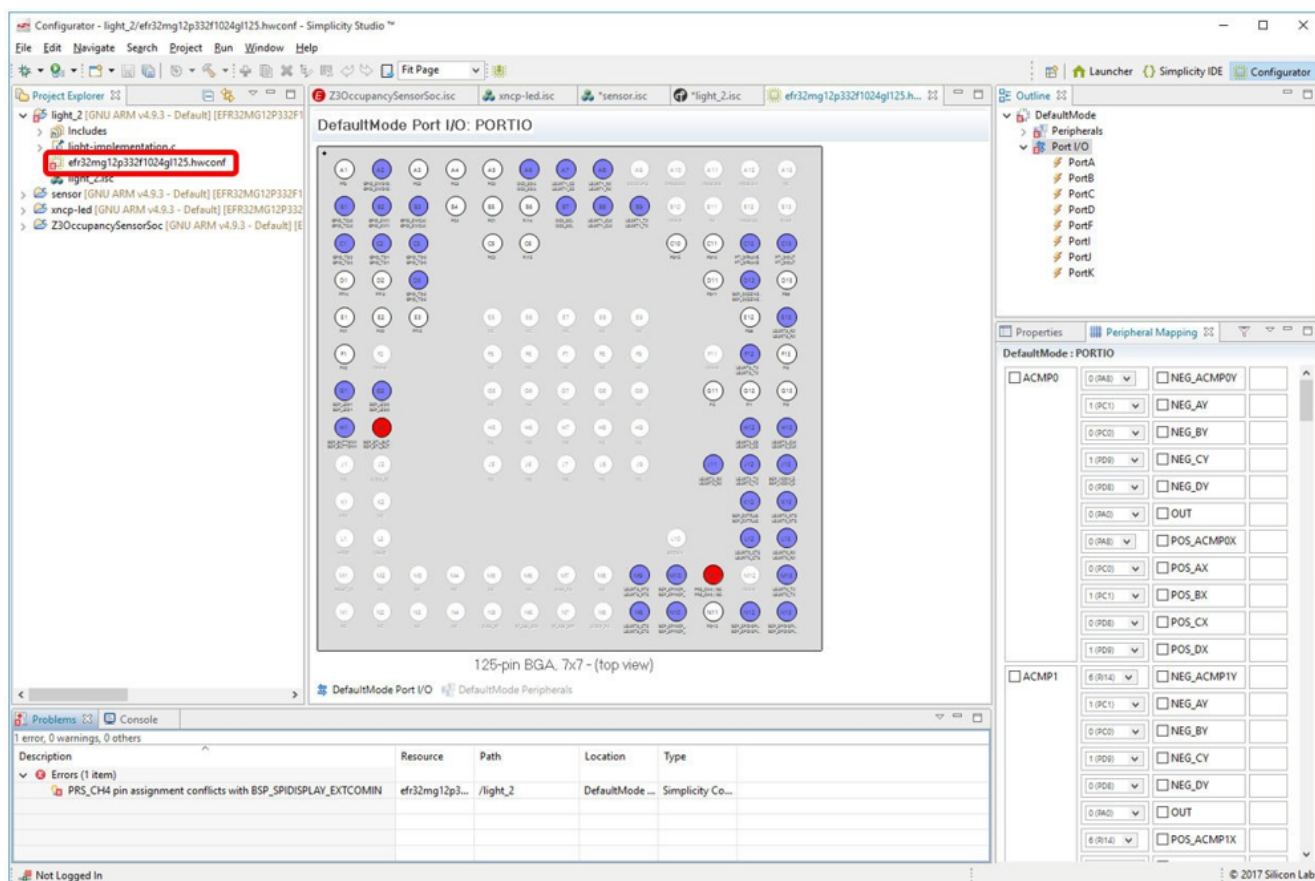
Configuring Peripherals

Configuring Peripherals

Simplicity Studio® 5 (SSv5)'s AppBuilder HAL tab provides access to a **Hardware Configurator** that you can use to configure pins and peripherals. Access to specific configuration options is also available through various peripheral [plugins](#).

To open the Hardware Configurator for an open project, double-click the `.hwconf` file in Project Explorer, click **Open Hardware Configurator** on the HAL tab, or select **Hardware Configurator** from the Tools menu and then select the target project. The Hardware Configurator has two views, accessed through the two DefaultMode tabs at the bottom of the center pane:

- **Port I/O**: Used to configure the pin locations and port pins
- **Peripherals**: Used to configure modules such as Timers, USARTs, and HAL peripherals. Most configuration changes can be made through this tab.



Port I/O

The Port I/O tab displays a package drawing for the selected device. This drawing updates to display changed pin assignments. Hover the cursor over a pin to see its definition. White = unused, blue = assigned, orange = two or more signals going to the pin, conflict allowed, and red = two or more signals going to the pin, conflict not allowed. While you can make some changes to the peripheral associated with a given pin, Silicon Labs recommends changing peripheral configuration through the Peripheral tab. Use this configuration for pin customizations such as renaming the pin.

Some changes must be made in both the Port I/O and Peripherals tab. For example:

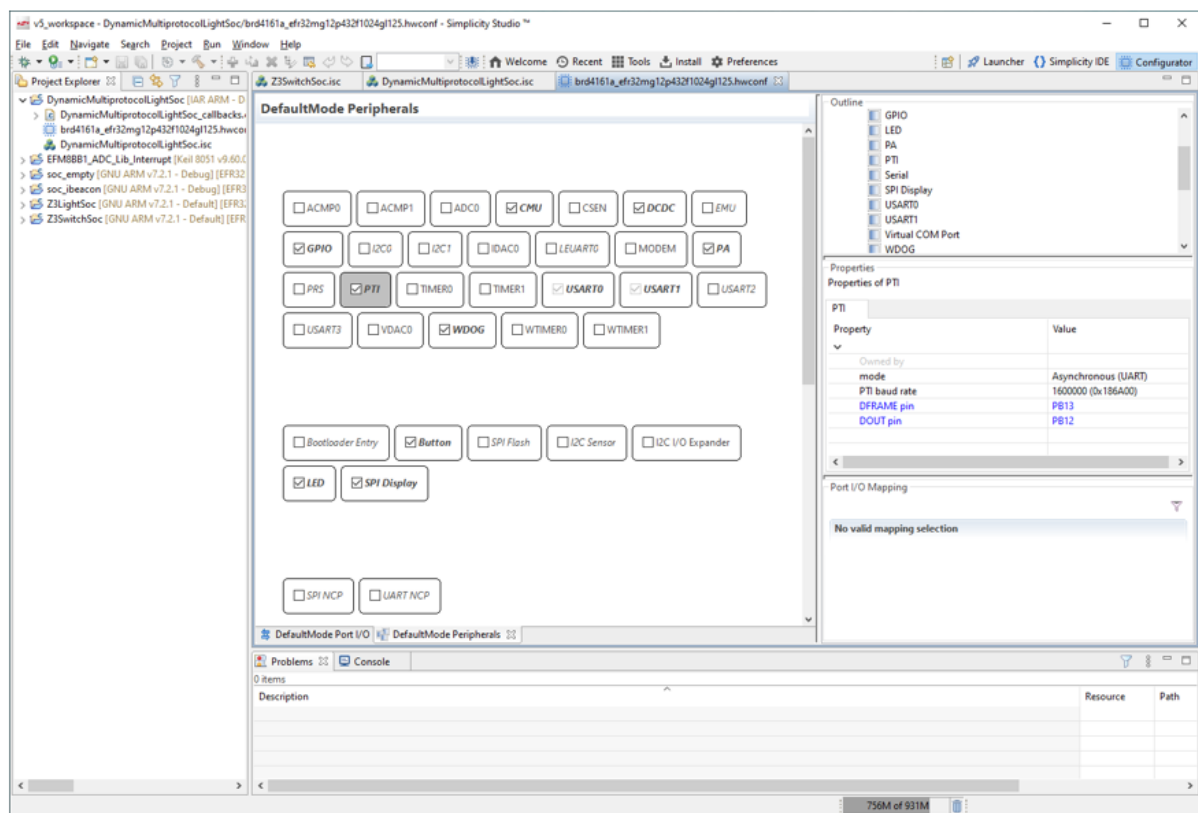
- A route can be selected in Port I/O and an APORT channel can be selected in the peripherals properties.
- ACMP output can be selected on the Port IO route selection and ACMP inputs can be configured in the Peripherals section.

A printable report can be generated by right-clicking on the pinout diagram and selecting Pin Configuration Report. This opens a report as a webpage in a browser that can be saved, printed, or archived. The Module Configuration Report option generates a similar set of tables organized by module rather than by pin order.

Note: To share information about the hardware configurations for a device Silicon Labs recommends sharing the .hwconf file itself.

Peripherals

The Peripherals tab contains boxes, each of which represents either a hardware peripheral or a software concept that is HAL-related but not physically on the chip. Peripheral boxes are organized into groups. Collapse or expand a group by clicking the arrow icon on the upper right of the group. Hover your cursor over a box to see information about the peripheral.



Click on a box to see its properties in the Properties pane. Properties can either have a drop-down menu with the available selections or a text input box for a numeric or text field. After making a selection for a property, click away from the property or press **Enter** to ensure the property value change occurs. If you cannot disable a peripheral it may be owned by another peripheral. Go to the settings for that peripheral to free up any dependent peripherals.

Note: The defines for the peripheral are only generated if the checkbox on the peripheral box is checked. For example, the interface for a project based on the Silicon Labs Zigbee Z3LightSoc example has a HAL group with a Button peripheral. Click on that peripheral to see its properties.

HAL

☐ Bootloader Entry

☒ Button

☐ SPI Flash

☐ I2C Sensor

☐ I2C I/O Expander

☒ LED

☐ SPI Display

NCP

☐ SPI NCP

☐ UART NCP

Radio

Properties

Properties of Button

Property	Value
Owned by	
Number of buttons available	2 (0x2)
Button 0	PF6
Button 1	PF7
DOUT register value of button	Low
MODE register value of button	Input
Number of buttons to enable	2 (0x2)
List of button indices to enable	0, 1

Developing for 8-Bit Devices

Developing for 8-Bit Devices

Hardware Configurator (Configurator) for 8-bit devices is part of Simplicity Studio® 5 (SSv5) and greatly simplifies EFM8 and C8051 MCU peripheral initialization by presenting peripherals and peripheral properties in a graphical user interface.

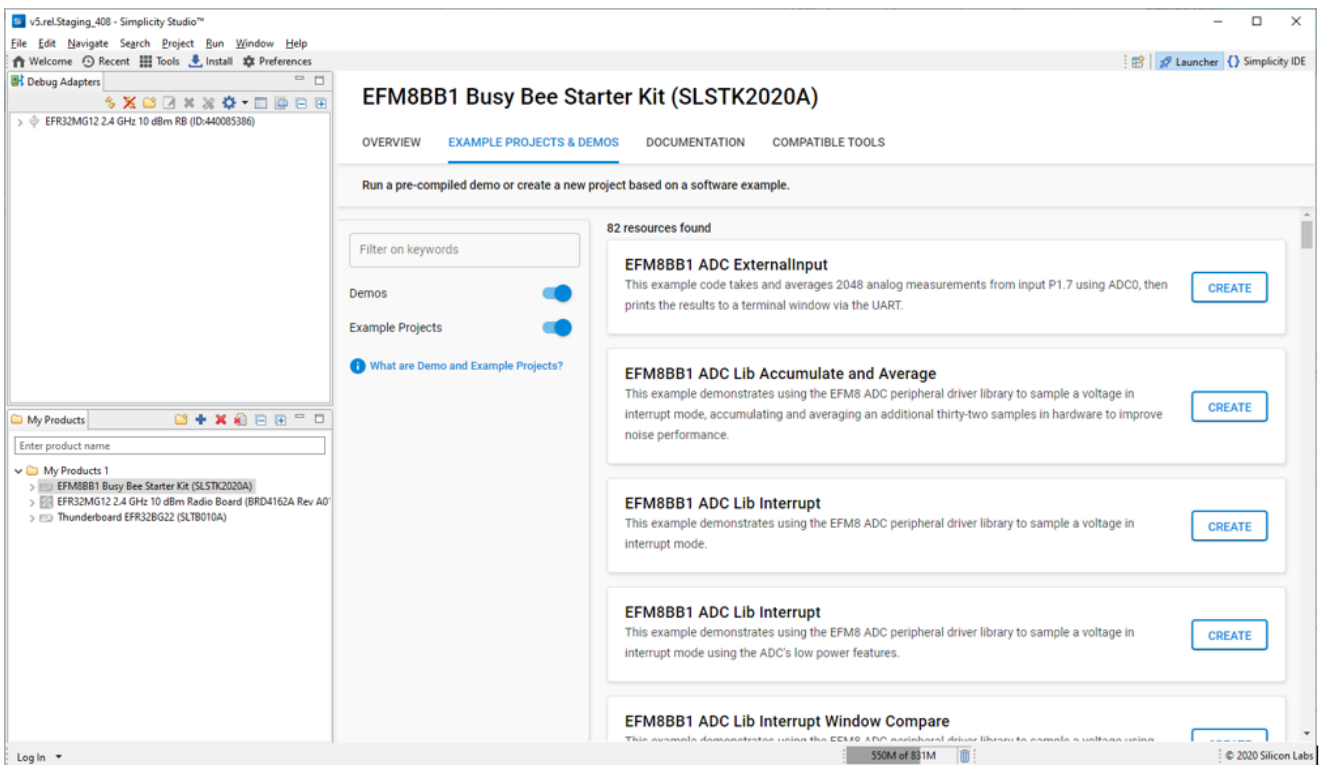
The 8051 SDK contains an extensive and nearly comprehensive set of examples for 8-bit MCU peripherals for each supported device family. These examples show simple use cases for each peripheral, and can be used as building blocks for larger systems incorporating multiple peripherals, or as a starting place for applications requiring each peripheral. Projects based on these examples are customized by changing code as described in [About Projects](#) and by updating peripheral configuration using the 8-bit [Hardware Configurator](#).

In Hardware Configurator, most of the initialization firmware can be generated by selecting peripherals and property values from combo boxes or entering register values in text boxes. Some peripherals provide calculators, such as baud rate, timer overflow rate, and SPI clock rate, that can be used to automatically confirm the necessary reload register value to generate the specified clock rate. Hardware Configurator also provides real-time property validation to ensure that a configuration is valid before downloading code to the MCU.

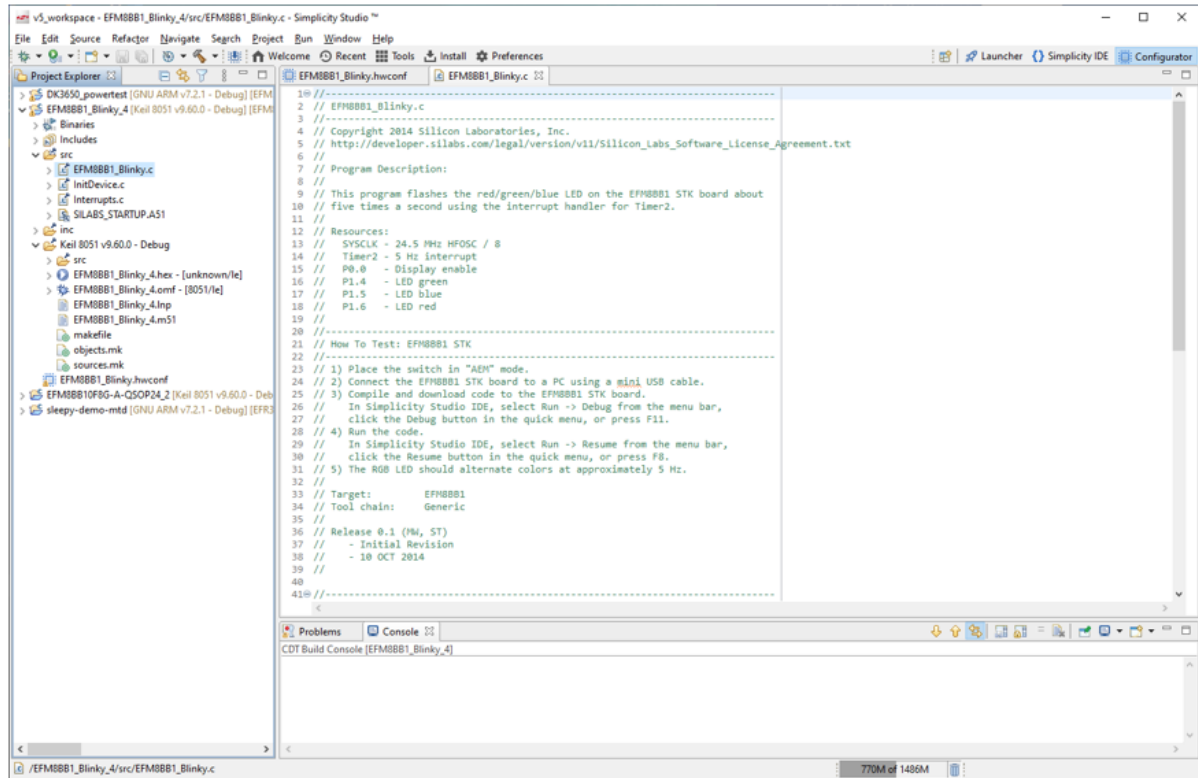
About Projects

About Projects

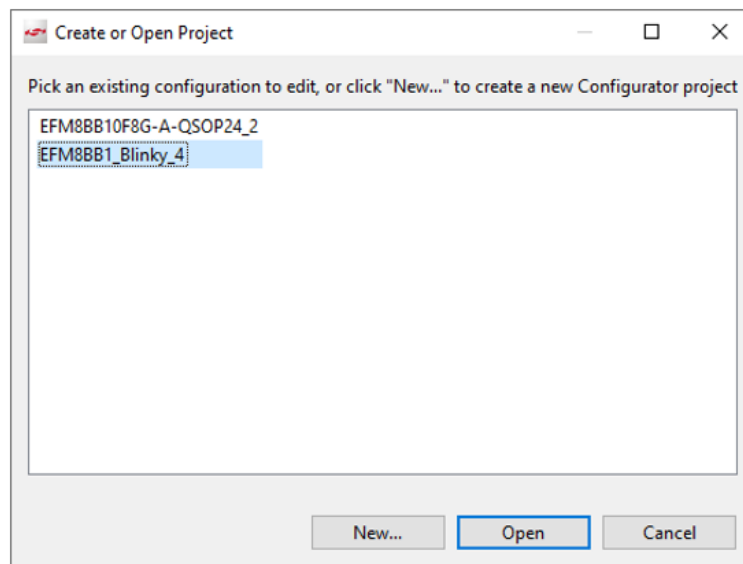
Create a Simplicity Studio® 5 (SSv5) project for an 8-bit target by selecting a target device, and then selecting an example, as described in [Project Creation](#). An extensive list of examples is provided for most Silicon Labs EFM8 and C8051 devices. These examples contain configurations specific to each target device.



The [Simplicity IDE perspective](#) opens with the project directory highlighted in Project Explorer view. Expand the directory and double-click the project source to see or modify the code.



Open Hardware Configurator by double-clicking the `.hwconf` file in Project Explorer, or by selecting **Hardware Configurator** from the Tools menu, and selecting the project.



Use Hardware Configurator to customize the configuration and functionality as desired. Modifications to the device configuration can be saved to the `.hwconf` file. Hardware Configurator generates output in the form of generated code in multiple files, as described in [Using Hardware Configurator](#).

Build and debug the application as described in [Building](#) and [Using the Debugger](#).

Using Hardware Configurator

Using Hardware Configurator

Simplicity Studio® 5 (SSv5)'s Hardware Configurator for 8-bit devices uses the **Configurator** perspective. This perspective is tailored specifically for use with Hardware Configurator to initialize MCU peripherals. Special views in this perspective allow peripheral registers to be configured.

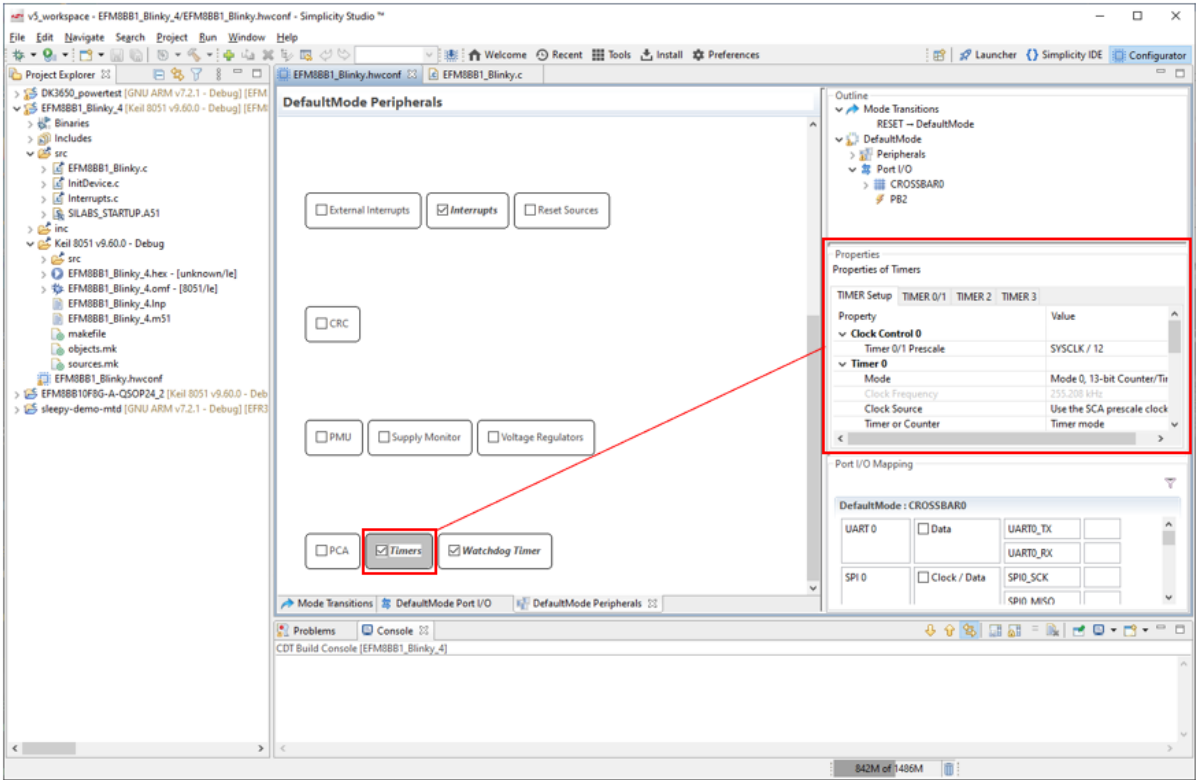
The available editors in a Configurator project are as follows:

- **Peripherals**: Used to configure hardware peripherals such as ADCs, Timers, LEUART, PCAs, and so on.
- **Port I/O**: Used to configure the pin locations, crossbar, and port pins. This editor is open by default for a new project.
- **Mode Transitions**: Used to define different MCU peripheral initialization states, such as DefaultMode, RESET, and other optional modes (example: LowPower mode). This editor can also be used to define transitions between states.

The Hardware Configurator automatically validates register configuration values. Occasionally changes to the configuration can cause [errors or warnings](#). These clear as soon as the cause is addressed.

Peripherals

Use the Peripherals tab to configure hardware peripherals like the ADC, comparators, or timers. To configure a peripheral, click the peripheral icon. This selects the peripheral and opens it in the Properties view. Properties can either have a drop-down menu with the available selections or a text input box for a numeric or text field. Properties that are grayed out are read-only. These properties typically provide more information about the configuration of a peripheral. After making a selection for a property, click away from the property or press **Enter** to ensure the property value change occurs.



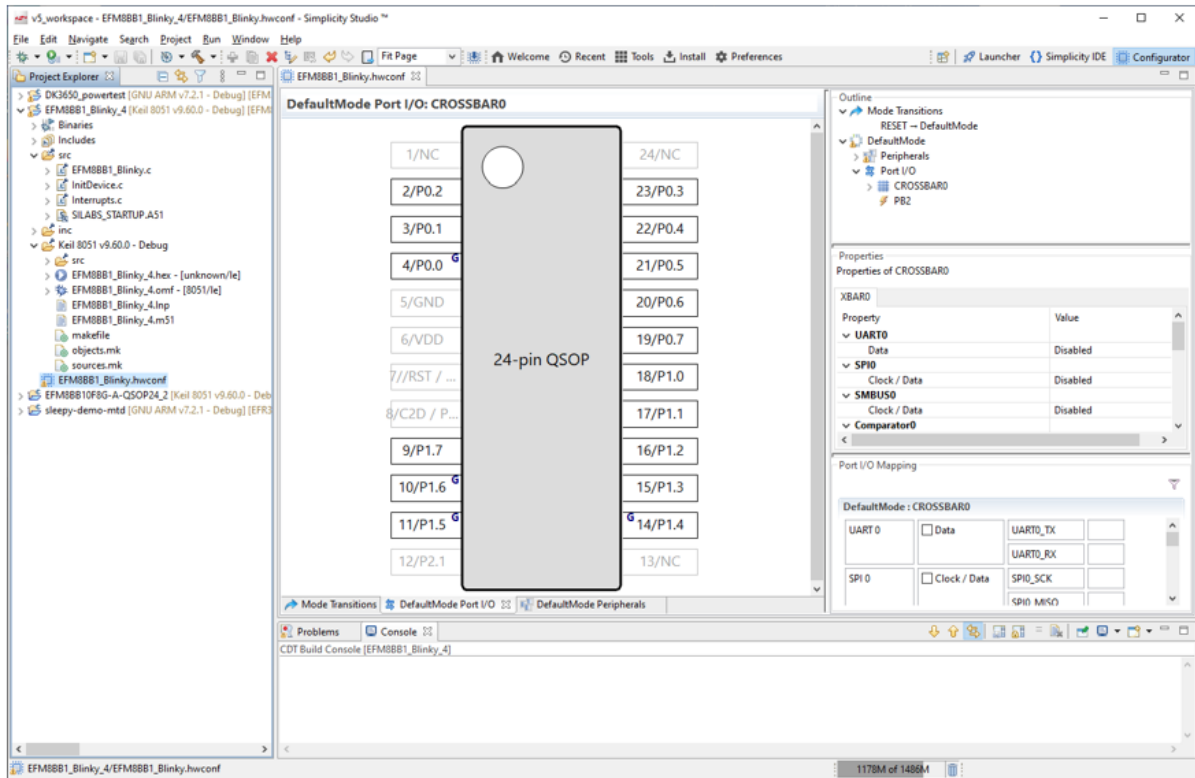
For example, click the Timers peripheral to display the timer properties in a tabbed view. The Timer 3 tab has several properties that can be modified, like **Clock Source**, **Mode**, and **Target Overflow Frequency**. Modifying any of these properties will update the **Timer Reload Overflow Period** and **Timer Reload Overflow Frequency** read-only properties, which display the calculated overflow time based on the **Target Overflow Frequency** and the **Clock Source** settings. These read-only fields and calculators depend on the Mode and Run Control state. Calculators for reload value are for auto-reload mode.

Properties of Timers	
TIMER Setup	TIMER 0/1 TIMER 2 TIMER 3
Property	Value
▼ Control	
Clock Source	SYSCLK / 12
Clock Source Frequency	255.208 kHz
Clock Source Period	3.918 us
Enable Low Byte Interrupt	Disabled
Mode	One timer, 16-bit auto-reload
Run Control	Stop
Timer Running State	Stopped
▼ Init and Reload Value	
Target Overflow Frequency	0.0
Timer Init Overflow After	256.794 ms
Timer Init Value	0 (0x0)
Timer Reload Overflow Frequency	3.894 Hz
Timer Reload Overflow Frequency(Low Byte)	996.906 Hz
Timer Reload Overflow Period	256.794 ms
Timer Reload Overflow Period(Low Byte)	1.003 ms
Timer Reload Value	0 (0x0)
▼ Timer Overflow for Peripherals Clock Source	
ADC0 Conversion Start Signal	3.894 Hz
SMBus0 SCL Low Timeout	256.794 ms

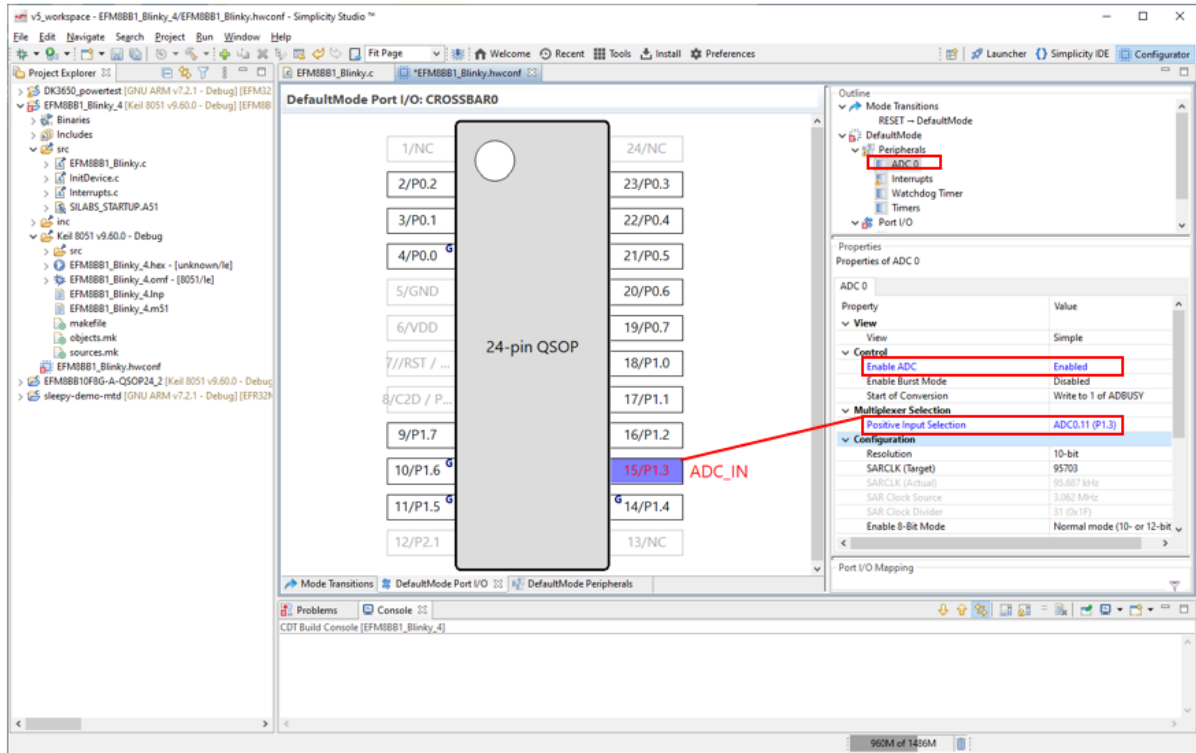
Note: Peripherals will not have [code generation](#) enabled unless the peripheral checkbox is checked.

Port I/O

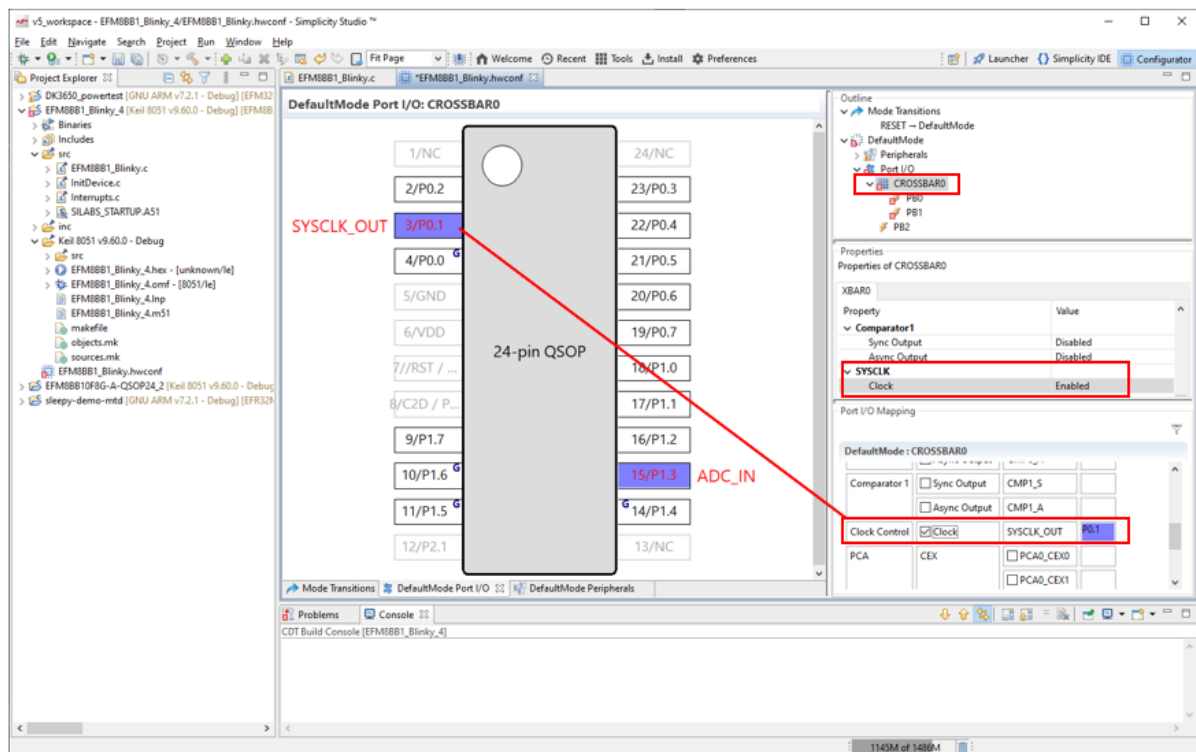
The Port I/O tab displays a package drawing for the selected device. This drawing updates to display pin assignments as peripherals are enabled on the crossbar or peripherals with fixed pin assignments are enabled. For fixed pin assignments, the associated peripheral must be enabled in order for the fixed pin function to appear on the Port I/O tab. Changes are shown in blue until the file is saved.



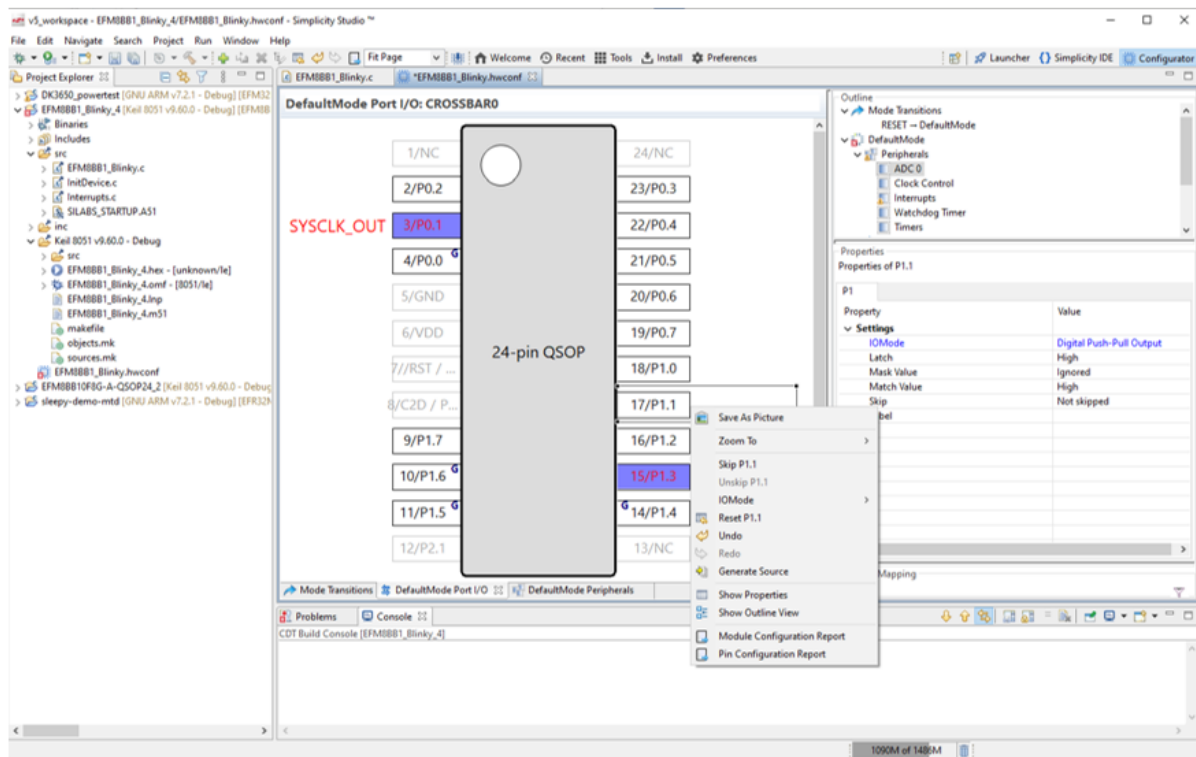
For example, on the Peripherals tab make sure the ADC0 module is checked. On the port I/O tab, in the Outline view select ADC0, in Properties change **Enable ADC** to **Enabled**, and select a **Positive Input pin** (in this example P1.3). This displays the ADC_IN fixed signal on the selected pin in the drawing.



To enable a peripheral on the crossbar, on the Peripherals tab enable a peripheral for code generation (in this case Clock Control). On the Port I/O tab, in the Outline view click CROSSBAR0, and in the Port I/O Mapping view check the corresponding signal. This changes the corresponding property to **Enabled**.



To configure a pin's properties, click the pin in the package drawing and select the desired pin property settings. If configuring a device with a crossbar, a pin can be skipped by right-clicking the pin and selecting **Skip** in the context menu or changing the Skip property setting.

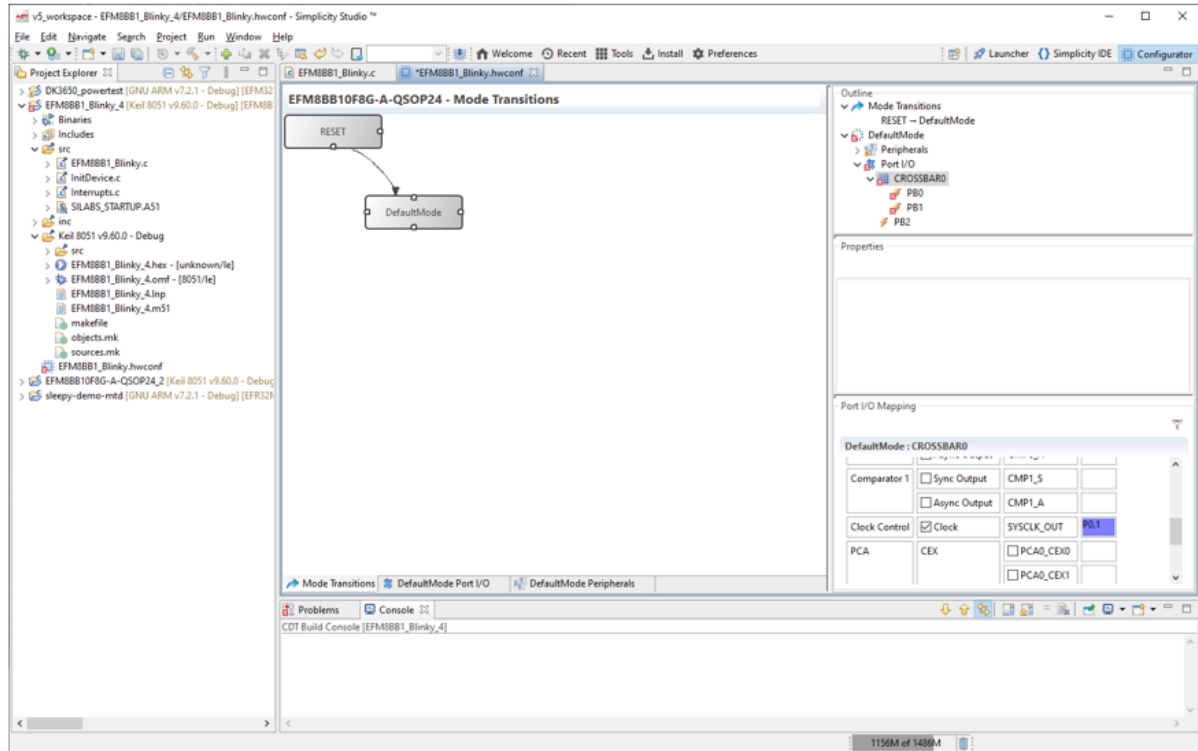


Similarly, I/O mode can be selected by right-clicking the pin and selecting **IO Mode** or changing the IO Mode property setting.

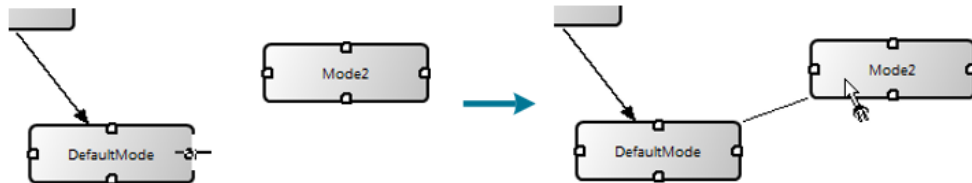
On all devices, multiple pins can be selected by holding Ctrl or Shift and selecting the desired pins or holding the left mouse button and dragging over a group of pins. With multiple pins selected, the property changes made in the Properties view or context menu apply to all pins. To reset a pin to its default state, right-click the pin and select **Reset**.

Mode Transitions

Modes define different states of peripheral configurations. For example, an application may use two configurations of the ADC and Timer 2 with different input pins and sampling rates. These two configurations can be treated as separate modes with separate initialization sequences. The movements between these modes are called transitions. By default, each project contains one **DefaultMode** mode. The reset state exists only to indicate the transition from RESET to DefaultMode and is not a full mode.



To add a new mode, right-click either the Mode Transitions tab or the Outline view and select **Create Mode from Reset**. Right-clicking an existing mode also enables cloning that mode with the **Clone Mode** option. To add a transition from one mode to another, hover over one of the four white handles on a mode until the mouse cursor changes, hold down left mouse button, and drag to the end mode of the transition. A Peripherals and Port I/O pair of tabs are added for each mode in the project.



After reset, call the mode transition `enter_DefaultMode_from_RESET()` to apply the DefaultMode settings. In most cases this will be the first transition in the application code.

Adding a transition generates a corresponding function that application firmware can call to initiate the transition between modes. For example, with DefaultMode as the originating mode going to Mode2:

```
enter_Mode2_from_DefaultMode(void)
```

This function then calls all of the functions that configure the peripherals for the mode. Hardware Configurator generates only the transitional code from peripheral to peripheral between modes. For example, if only the timer reload value and ADC input mux selection differ, then those are the only two properties touched by the transition code. To see the differences between two modes, right-click the mode transition and select **Show Differences**. This provides a report of all the different property values between the modes on a module-by-module basis.

Property	DefaultMode Value	Mode2 Value
▲ ADC 0		
Control : Timer 3 Overflow Frequency	3	1
Enabled	true	false
Control : Enable ADC	Enabled	Disabled
Control : Timer 2 Overflow Frequency	3	1
▲ CROSSBAR0		
SPI0 : Clock / Data	Enabled	Disabled
▲ Interrupts		
Enabled	true	false
▲ P0.0		
Settings : Skip	Skipped	Not skipped
▲ P0.5		
Settings : IOMode	Digital Push-Pull Output	Digital OpenDrain I/O
Settings : Output Mode	Push-pull	Open-drain
▲ P0.6		
Settings : Output Mode	Push-pull	Open-drain
Settings : IOMode	Digital Push-Pull Output	Digital OpenDrain I/O
▲ P0.7		
Settings : Output Mode	Push-pull	Open-drain
Settings : IOMode	Digital Push-Pull Output	Digital OpenDrain I/O
▲ P1.0		
Settings : Output Mode	Push-pull	Open-drain
Settings : IOMode	Digital Push-Pull Output	Digital OpenDrain I/O
Settings : Skip	Skipped	Not skipped
▲ P1.1		
Settings : Output Mode	Push-pull	Open-drain
Settings : IOMode	Digital Push-Pull Output	Digital OpenDrain I/O
▲ Reset Sources		
Enabled	true	false
▲ SPI 0		
Enabled	true	false
▲ TIMER2		
Timer Overflow for Peripherals Clock Source : SMBus0 SCK Frequency	1.298 Hz	0

Close Save Report... Collapse All Expand All

Transitions can be added in both directions using the same method as the original mode transition.

To delete a mode transition, select the arrow and press Delete or right-click the arrow and select **Delete transition**.

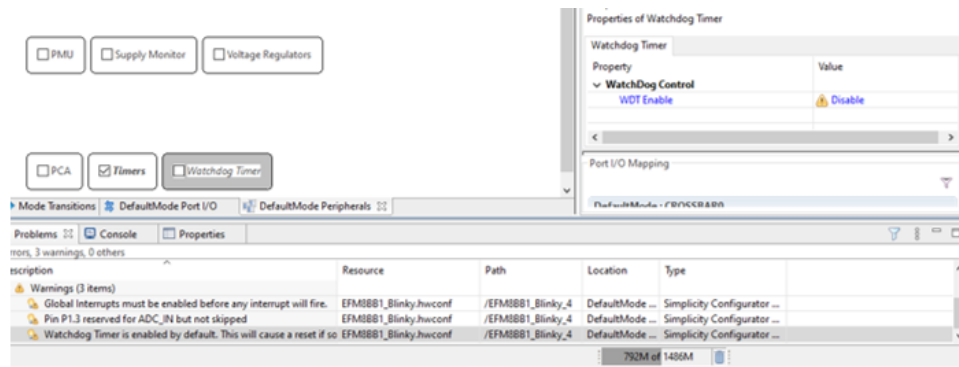
Transition functions will not modify the state of the global interrupt enable (EA) on EFM8 or C8051 devices. Transitions assume that interrupts are disabled (that is, global interrupt enable bit EA = 0) or that any enabled interrupts will not interact with any changes made during the transition. Transition functions do not clear interrupt flags, to ensure that no information is lost during reconfiguration. If having these flags set will cause an issue in firmware operation, firmware must clear these interrupt flags before calling the transition function.

Transition functions also assume that any peripherals being updated are not active. For example, firmware should stop a timer before calling a transition function that changes the timer configuration and restart the timer after the transition completes.

It is possible to change the configuration order of a set of peripherals by creating multiple modes with multiple transitions. For example, to configure Timer 2 before the ADC during a mode transition that would normally put the ADC first, create a mode to handle the Timer 2 changes and a mode to handle the ADC changes. Firmware can then call the Timer2 mode transition function first, followed by the ADC transition function.

Errors and Warnings

The Hardware Configurator automatically validates register configuration values and displays any errors, warnings, or information items in the Problems view. Double-clicking an entry displays the property that raised the problem in the Properties view. Any peripherals that contain a warning or error are highlighted in yellow (warning) or red (error), and the associated property has a corresponding warning or error icon.



Once the highlighted property is updated, the associated warning or error will disappear from the Problems view, indicating that the problem has been solved.

All newly created projects will have a warning regarding the Watchdog Timer, since it's enabled after a reset and must be handled in application code or disabled. If a warning or error doesn't apply to the project, it can be temporarily deleted from the project by right-clicking the entry in the Problems view and selecting **Delete**. Closing and reopening the *.hwconf* file regenerates any deleted warnings or errors.

Code Generation

To generate code for a peripheral, check the checkbox for that peripheral in the Peripherals tab. Saving the project automatically generates code for all selected peripherals and port pins. This code generates into the *InitDevice.c*, *InitDevice.h*, and *Interrupts.c* files.

Each hardware register has a section in the *InitDevice.c* file tagged with the register name and register description. For example, the P1 register area is as follows:

```
1 // $[P1 - Port 1 Pin Latch]
2 // [P1 - Port 1 Pin Latch]$
```

These tags indicate that everything in between is automatically generated, so any code added manually between these tags will be deleted on the next Hardware Configurator project save. Code can be added in between these tags, however, and this code will not be overwritten.

```
1 // $[P1 - Port 1 Pin Latch]
2 P1 = 0x00; // This code is not safe, and Configurator will overwrite it
3 // [P1 - Port 1 Pin Latch]$
4
5 P1 = 0x00; // This code is safe from Configurator automatic code generation
6
7 // $[P1MASK - Port 1 Mask]
8 // [P1MASK - Port 1 Mask]$
```

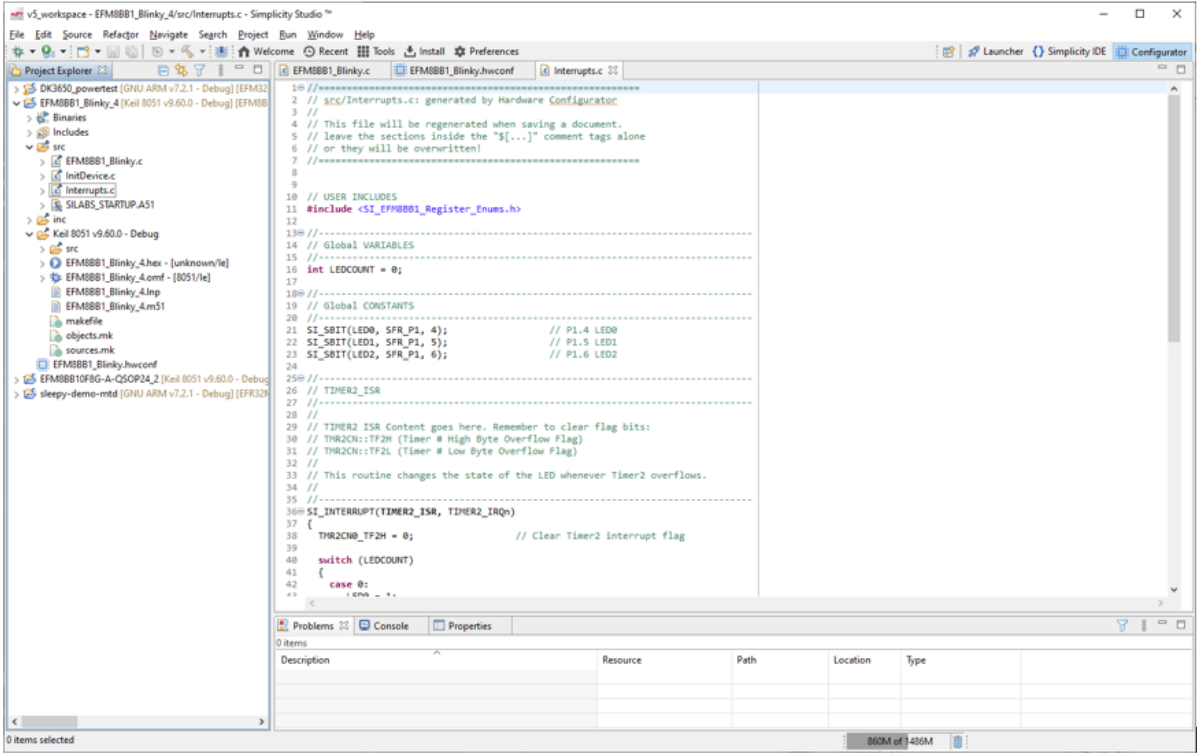
For registers that are modified from their reset value or the value in the previous mode, the tags include comments that update based on the settings for the register. For example, setting P1.0 to push-pull on an EFM8 or 8-bit MCU generates the following:

```
// $[P1MDOUT - Port 1 Output Mode]
/*
// B0 (Port 1 Bit 0 Output Mode) = PUSH_PULL
// (P1.0 output is push-pull.)
// B1 (Port 1 Bit 1 Output Mode) = OPEN_DRAIN
// (P1.1 output is open-drain.)
// B2 (Port 1 Bit 2 Output Mode) = OPEN_DRAIN
// (P1.2 output is open-drain.)
// B3 (Port 1 Bit 3 Output Mode) = OPEN_DRAIN
// (P1.3 output is open-drain.)
// B4 (Port 1 Bit 4 Output Mode) = OPEN_DRAIN
// (P1.4 output is open-drain.)
// B5 (Port 1 Bit 5 Output Mode) = OPEN_DRAIN
// (P1.5 output is open-drain.)
// B6 (Port 1 Bit 6 Output Mode) = OPEN_DRAIN
// (P1.6 output is open-drain.)
// B7 (Port 1 Bit 7 Output Mode) = OPEN_DRAIN
// (P1.7 output is open-drain.)
*/
P1MDOUT = P1MDOUT_B0 PUSH_PULL | P1MDOUT_B1 OPEN_DRAIN | P1MDOUT_B2 OPEN_DRAIN
          | P1MDOUT_B3 OPEN_DRAIN | P1MDOUT_B4 OPEN_DRAIN | P1MDOUT_B5 OPEN_DRAIN | P1MDOUT_B6 OPEN_DRAIN
```

```
1 | P1MDOUT_B7 OPEN_DRAIN; // [P1MDOUT - Port 1 Output Mode]$
2 |
```

Interrupts

The Hardware Configurator creates an *interrupts.c* file containing interrupt prototypes whenever interrupts are enabled and the project is saved. Hardware Configurator generates the prototype if it is not present, but does not overwrite existing prototypes. This protects any application code written in the prototypes from being accidentally modified or deleted. The comments above the prototypes list any flags in the modules that may need to be cleared by application code after the interrupt triggers.



Building and Flashing

Building and Flashing

These pages describes how to [compile or build](#) software into a binary image, and how to [load or flash](#) that application image onto a connected device.

Building

Building

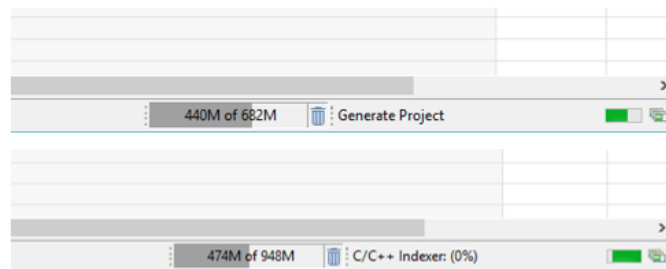
Simplicity Studio® 5 (SSv5) offers two convenient ways to compile or 'build' projects:

- [Simple build](#)
- [Debug build and flash](#)

Projects are built with the [toolchain](#) defined when the project was created, and using the active configuration. Project files must be generated before you can build the project.

- For [32-bit device development using AppBuilder](#), click **Generate** in the Simplicity IDE.
- Files are automatically generated if the project uses [Project Configurator](#).

Progress is shown in the lower right of the Simplicity IDE perspective.



Speed varies depending on your system, number of projects, and other factors. Be sure that generation and indexing complete before building the application image.

The result of the build is a compiled application known as a firmware image or binary. The binaries are physically located in a directory named for the compiler used to generate them, and are also shown as a 'binaries' group in project explorer. Right-click a binary for a context menu from which you can debug, flash, and perform other functions.

The binaries generated depend on both the SDK and the target device. For example, the Keil® 8051 compiler for an 8-bit device generates:

- *.hex (application image)
- *.omf (contains additional debug information)

The GNU ARM® compiler for a 32-bit device using the Zigbee EmberZNet SDK generates:

- *.axf (image that can be read on a Microsoft Windows device)
- *.bin (binary image file, can be flashed to any address)
- *.gbl (Gecko Bootloader file, specialized firmware file for use with the Gecko bootloader)
- *.hex (application image file)
- *.s37 (similar to a binary file but contains the target memory location to flash to - an application image or a bootloader image, but not both)

Note that if you need a .gbl file but do not see one in the binary directory, you can use Simplicity Commander to create one. Commands invoked from Simplicity Commander's CLI can be used to:

- Generate key files for signing and encryption
- Sign application images for Secure Boot

- Create GBL images (encrypted or unencrypted, signed or unsigned)
- Parse GBL images

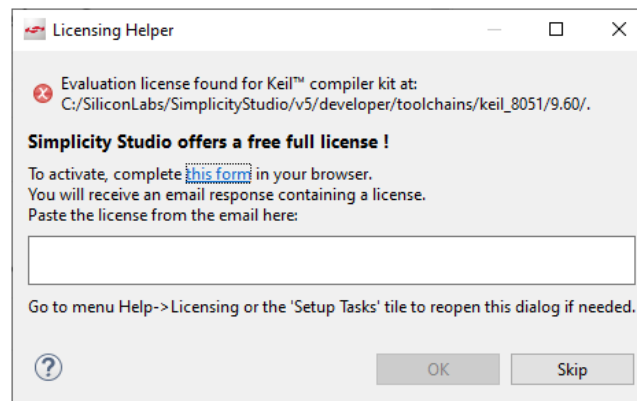
For details about using Simplicity Commander see [UG162: Simplicity Commander Reference Guide](#).

For details about using the Gecko Bootloader, including its enhanced security features, see [UG266: Silicon Labs Gecko Bootloader User's Guide](#).

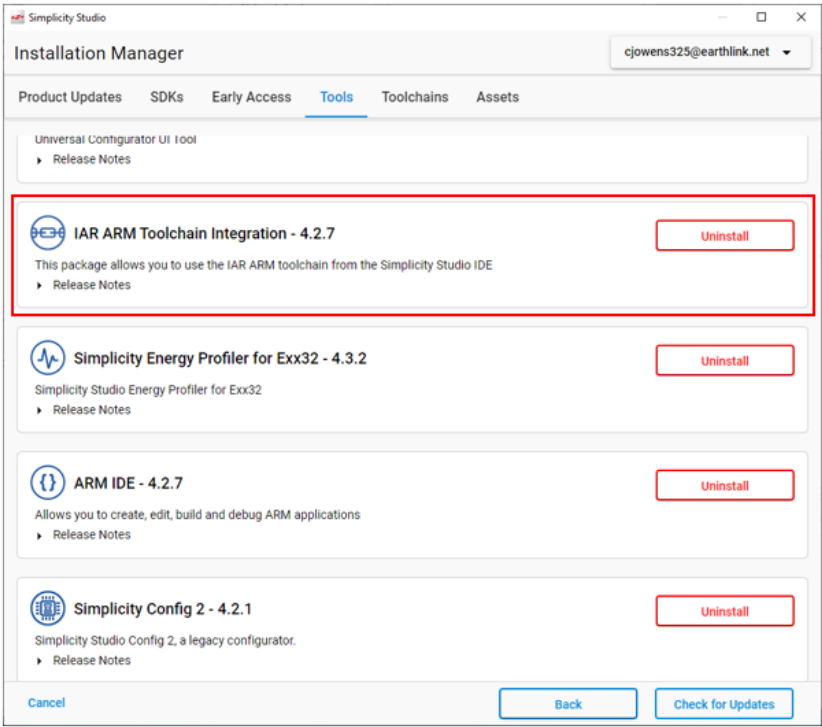
See your SDK's quick-start guide for more stack-specific information about building and flashing.

About Toolchains

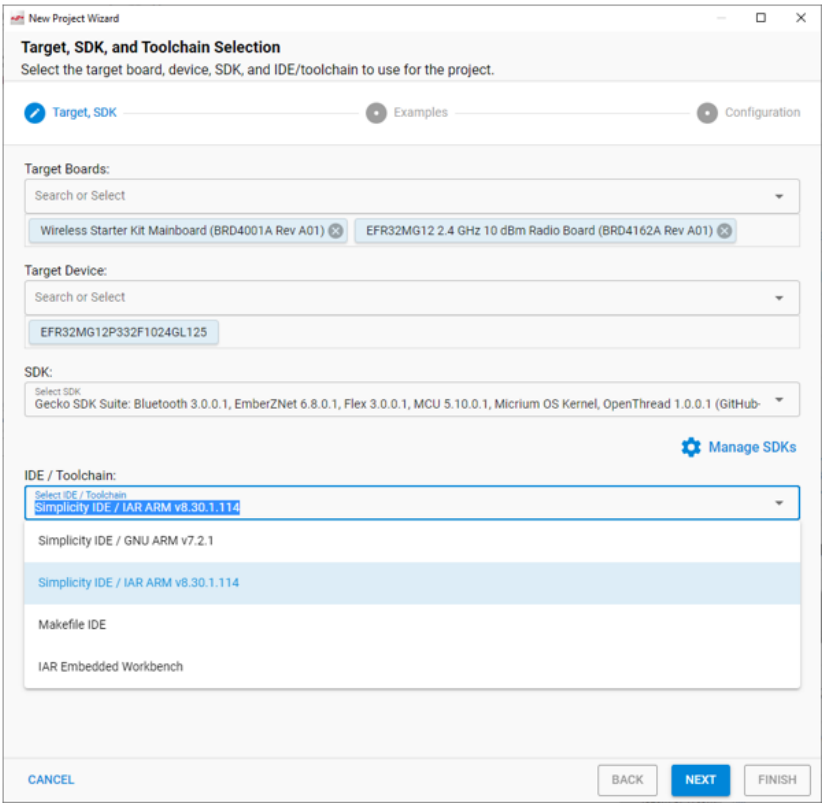
SSv5 provides a GNU ARM® toolchain to build projects for 32-bit devices and a 30-day evaluation license to the Keil® 8051 toolchain to build projects for 8-bit devices. You can apply for a free full license when you build an 8-bit project.



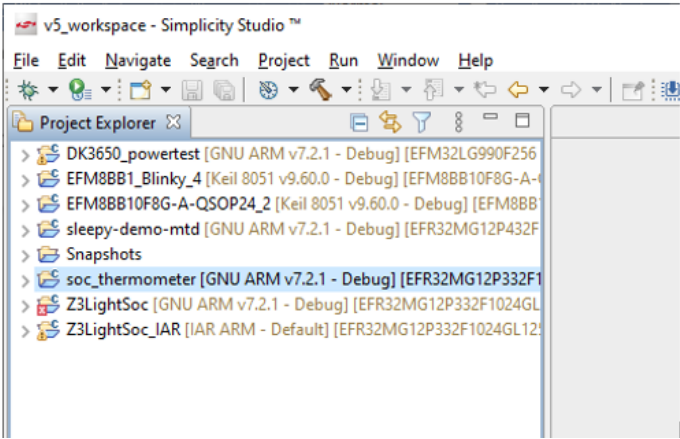
You can also add your own toolchain, for example IAR-EWARM. IAR is required for some projects, such as the Zigbee Dynamic Multiprotocol and Micrium OS examples. However, you must use the version specified in the SDK release notes front page under compatible tools. See your SDK's quick-start guide for information on how to load a compatible version and obtain a free evaluation license. SSv5 provides an integration package for IAR, so that you can use that tool within SSv5.



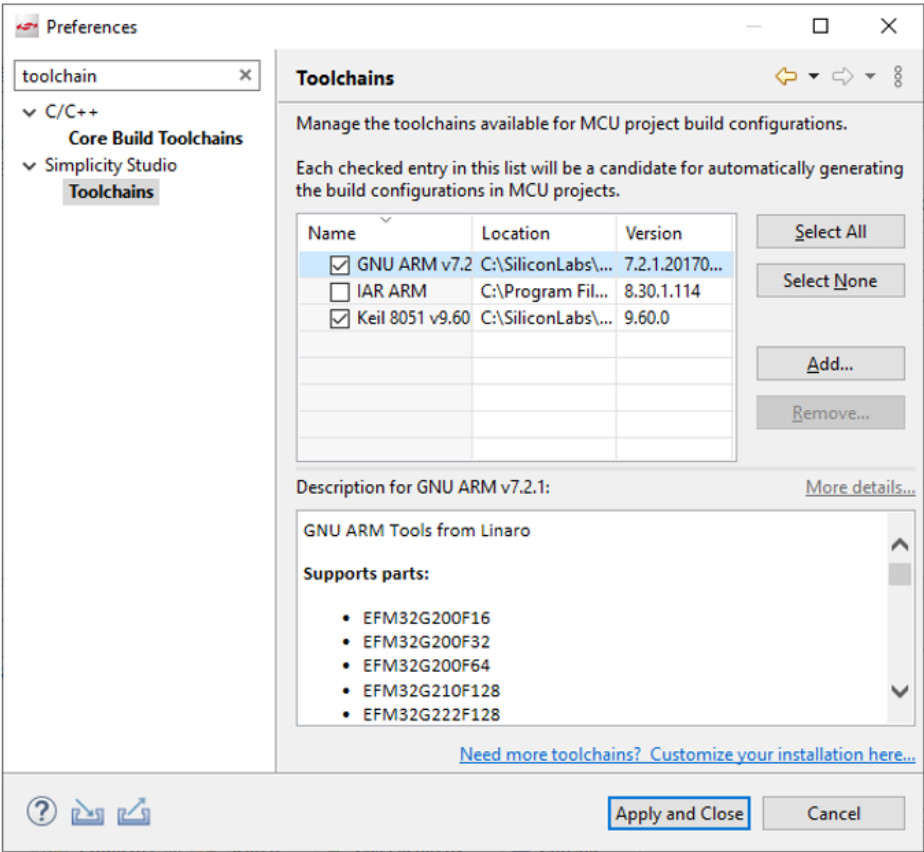
Projects use the toolchain selected at the time of project creation. The selection is available on the first of the three New Project Wizard dialogs.



The toolchain and build configuration are displayed in Project Explorer view with the project directory. The build configuration determines whether the image is built for debugging or release. Default is typically equivalent to a debug build.

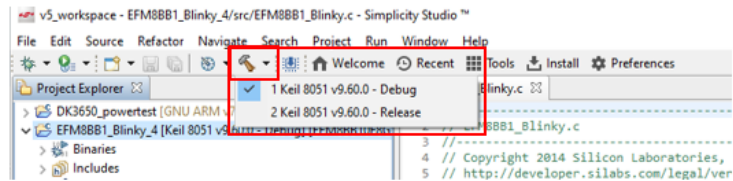


If more than one toolchain is available, you can configure which are presented as options when creating a new project. In the **Preferences** filter field type `toolchain`. Uncheck the ones you do not wish to display. You can also completely remove toolchains, or add new toolchains through this dialog.



Simple Build

Right-click the project directory and in the context menu select **Build**, or click the **Build (hammer)** button on the Simplicity IDE perspective toolbar to build a project with its toolchain and the active build configuration.

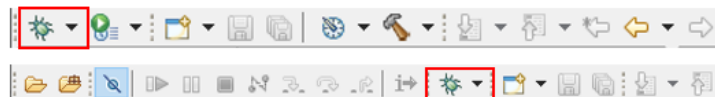


While the Build menu selection always uses the active configuration, the **Build** button's drop-down menu allows you to select a different configuration. This also changes the active configuration for the project to the one selected.

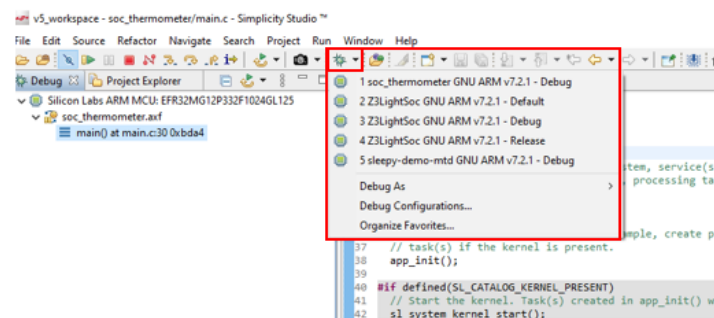
If the **Build** button is not enabled, make sure you have a project directory or file in the directory selected.

Debug Build and Flash

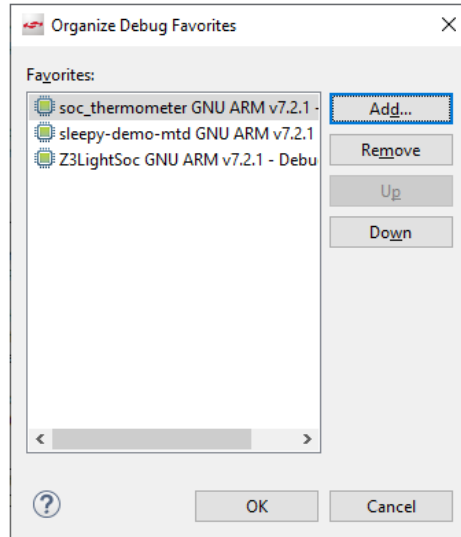
Click the **Debug (bug)** button in either the Simplicity IDE or Debug perspective to build an application image, flash it to the device, and open the Debug perspective (if it is not already open).



The **Debug** button's drop-down menu allows you to select the project in your workspace you want to debug.

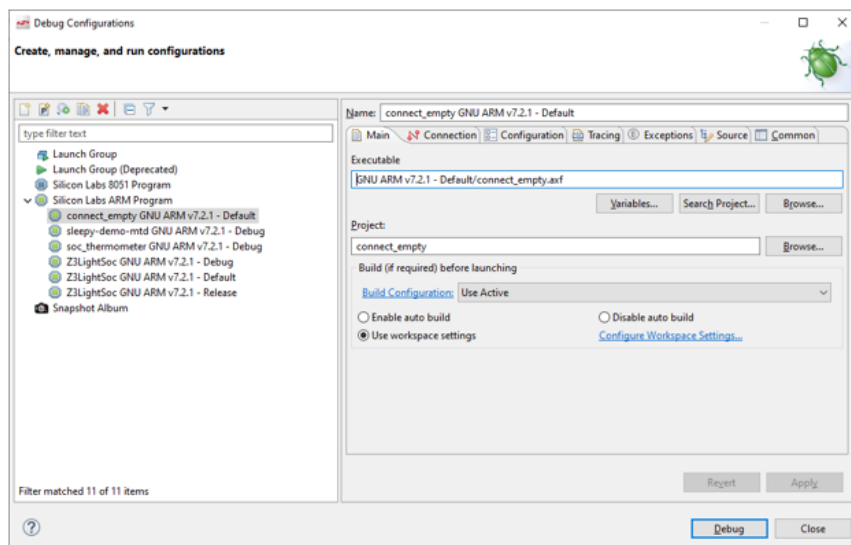


If you have a lot of projects use **Organize Favorites** to select favorites and organize them. These projects then appear at the top of the selection list with other projects below a demarcation line.



Select **Debug Configurations** to open a tabbed set of configuration option dialogs. If you click **Debug**, the build and flash process will proceed with the options you selected.

See [Using the Debugger](#) for more information.



Flashing

Flashing

Simplicity Studio® 5 (SSv5) offers several ways to load (flash) a firmware image to your device.

- With the **Debug** button (see [Debug build and flash](#))
- Through the debug adapter's context menu, [Upload Application...](#) selection
- Using the [Flash Programmer](#) tool

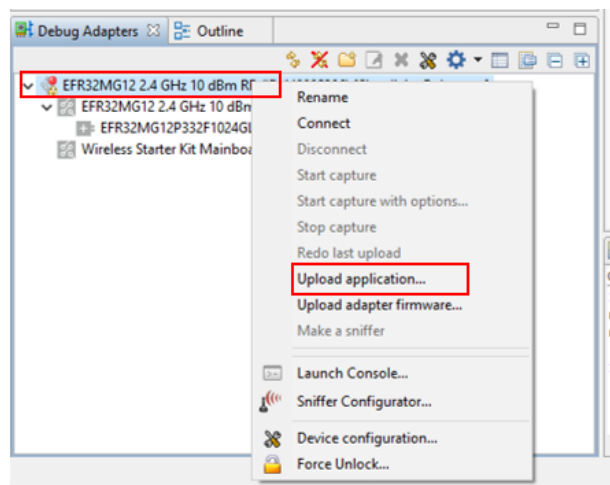
See your SDK's quick start guide for more stack-specific information about building and flashing.

Upload Application

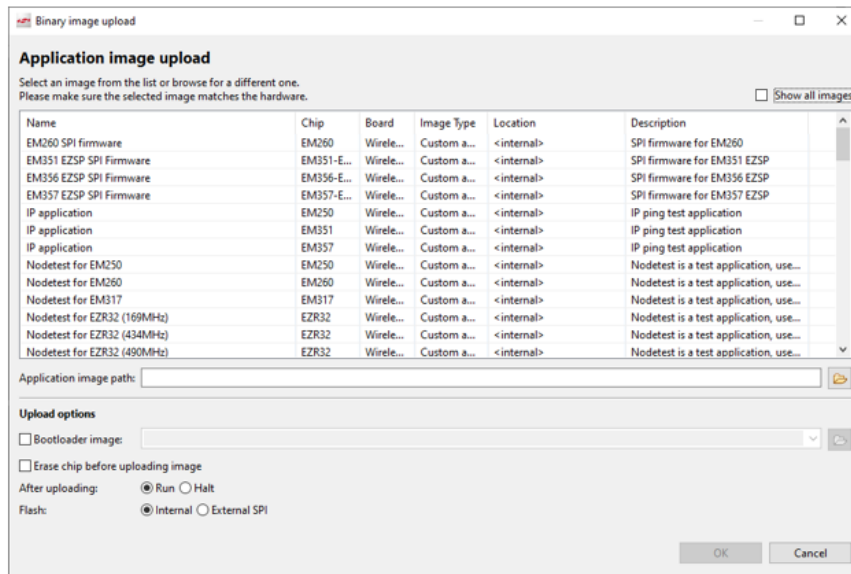
This option is useful if you want to load a bootloader image and an application image in a single step. To use this option, you will need to know the radio board part number (shown in the Debug Adapters view), and the location and name of the binary image you wish to load. The default workspace locations are:

Windows 10 workspace: C:\Users\<user>\SimplicityStudio Mac workspace: /Users/<user>/SimplicityStudio

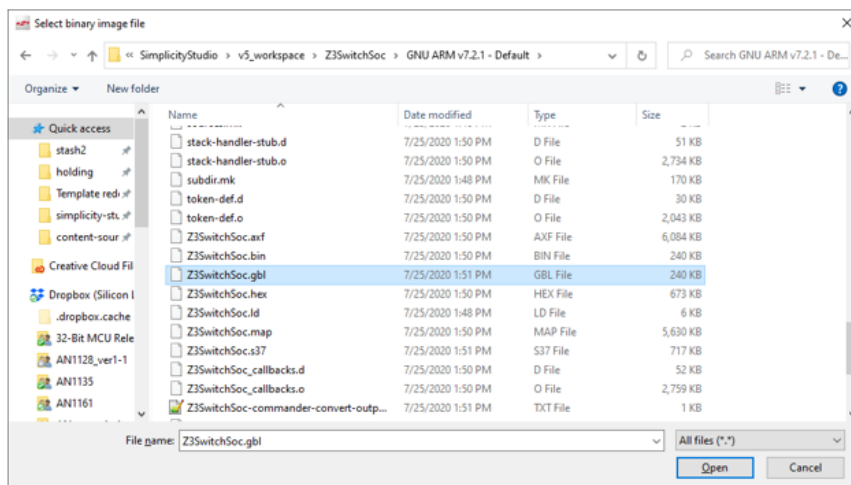
In the Debug Adapters view, right-click the adapter (top line) and select **Upload Application...** from the debug adapter context menu.



The Application Image Upload dialog is displayed.



Browse to the project directory, go to the directory corresponding to the compiler toolchain, and select an image file. This example uses the .GBL file, as it assumes you are also loading a Gecko Bootloader image. (Start with [UG103.6: Bootloader Fundamentals](#) if you are not familiar with bootloaders.) Click **Open**.



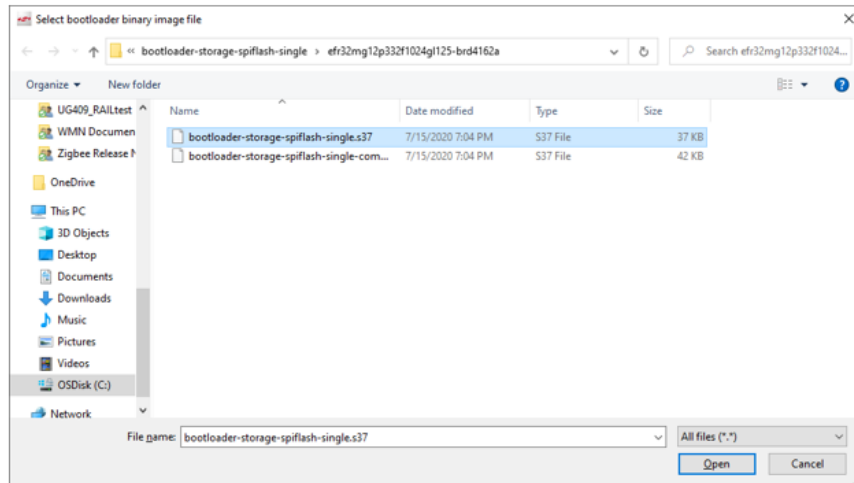
Check **Bootloader image**, then browse to the folder containing a prebuilt bootloader image. Images are located in the Simplicity Studio platform bootloader folder under sample apps. In this case open the SPI Flash Single folder, for example:

C:\SiliconLabs\SimplicityStudio\<version>\developer\sdk\gecko_sdk_suite\<version>\platform\bootloader\sample-apps\bootloader-storage-spiflash-single

Open the folder that corresponds to your board and part number and select the .s37 file, for example:

efr32mg12p332f1024gl125-brd4162a\bootloader-storage-spiflash-single-combined.s37

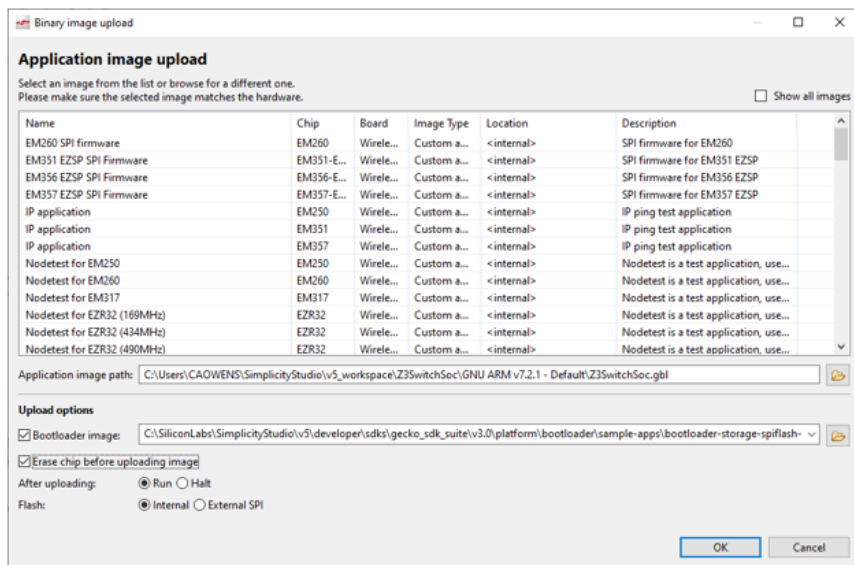
Click **Open**.



Now that both the application image and the bootloader are selected, check **Erase Chip**, to make sure that the main flash block is erased before your new image is uploaded. New users will typically always check this.

- The **After uploading** options are **Run** (begin executing the code immediately) and **Halt** (wait for an event, such as a debugger to connect or manual initiation of a boot sequence). During initial development you will typically leave this set to **Run**.
- The **Flash** options determine the storage location, and are Internal and External SPI. Leave the option set to **Internal**.

The completed dialog should resemble the following:



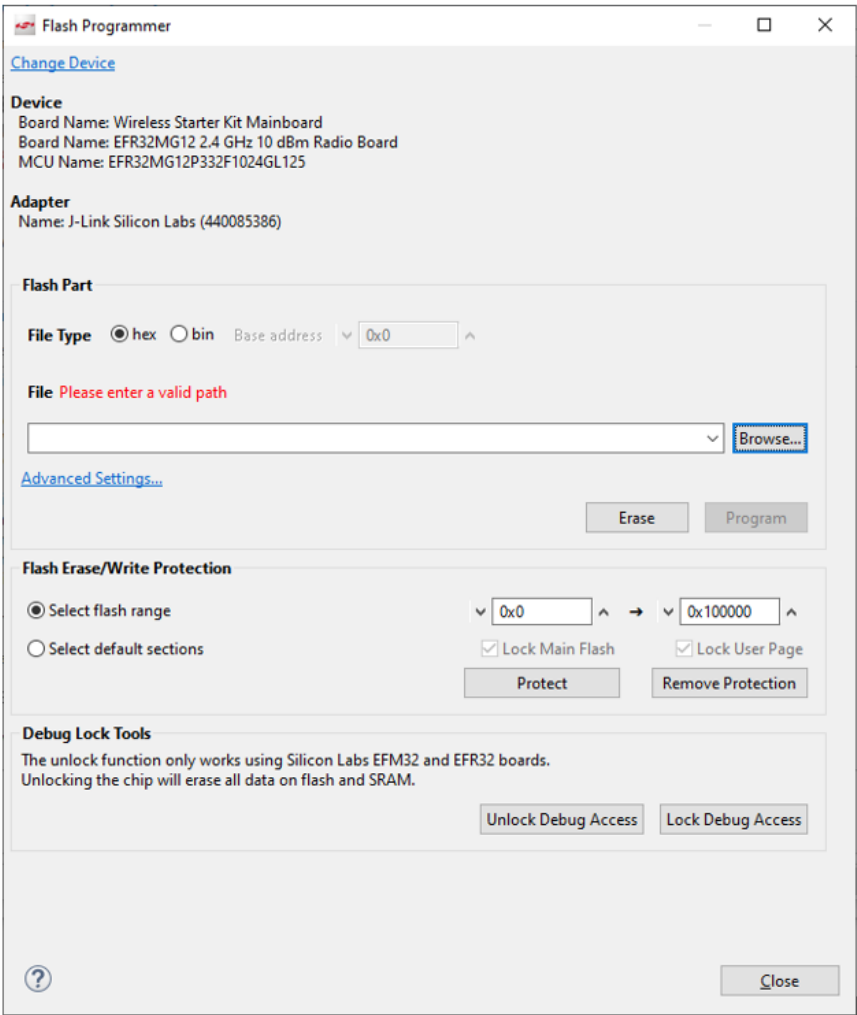
Click **OK**.

Flash Programmer

The Flash Programmer is a tool that provides a number of options for use when flashing images to a device. Select the Flash Programmer from the **Tools** button on the toolbar. Some perspectives have a button specifically for the Flash Programmer.

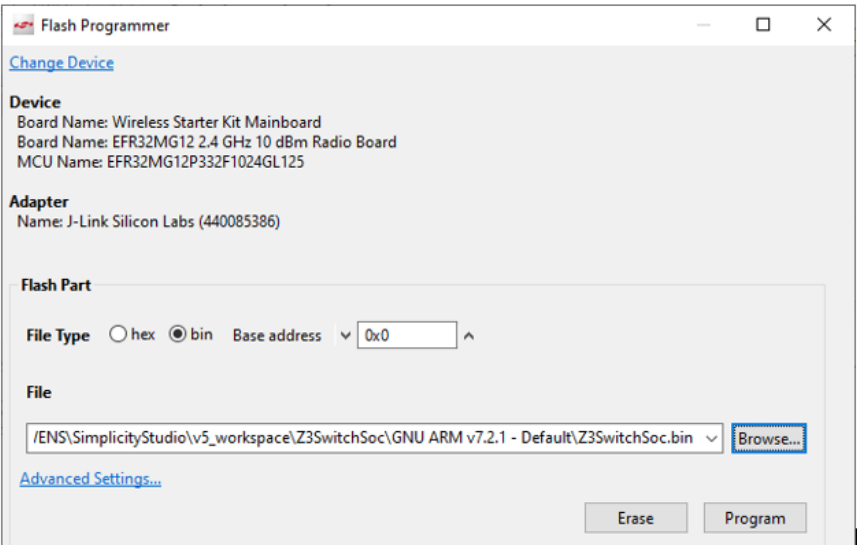


The Flash Programmer provides basic flash and erase functionality, but also allows you to lock parts of memory and enable or disable debug access.

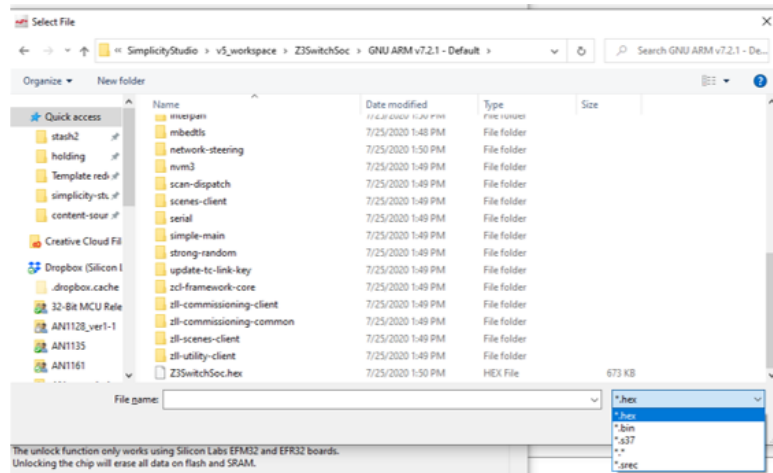


Flash Part

The Flash Programmer is configured to facilitate flashing .hex or .bin files.



To flash an image, browse to the image location. Note that the images you see are filtered by the extension drop-down to the right of the file name field.



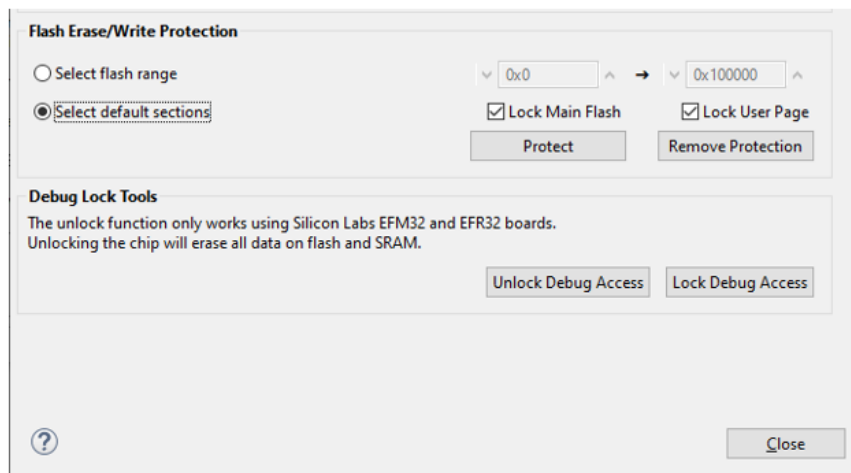
Click **Open** and then click **Program** to flash the image.

By default, the **Erase** function erases the main page. Click **Advanced Settings** to change what is erased.

Finally, if you have more than one device connected, click **Change Device** to select the target.

Flash Erase/Write Protection

Use these functions to protect or remove protection from a custom range, or default pages.



Debug Lock Tools

Use these functions to unlock or lock debug access.

Testing and Debugging

Testing and Debugging

This section provides information on testing and debugging application firmware.

- [Overview and Resources](#) reviews the tools that are available and additional documentation.
- [Using the Debugger](#) provides details on Simplicity Studio's built-in debuggers.

Overview and Resources

Resources

Simplicity Studio® 5 (SSv5) offers a number of tools that can be used to test and debug application functionality, power consumption, and network behavior.

Tools include:

- The built-in [debugger](#)
- [Network Analyzer](#)
- [Energy Profiler](#)

In addition, a number of SDKs provide example applications that can be used for testing, such as:

- NodeTest (Zigbee EmberZNet SDK) (See [AN1019: Using the NodeTest Application](#)) - Deprecated in Zigbee EmberZNet SDK 6.10.0.0
- RAILtest (Proprietary Flex SDK) (see [UG409: RAILtest User's Guide](#))

Finally, Silicon Labs provides a number of other documentation resources related to testing such as:

- [AN1267: Radio Frequency Physical Layer Evaluation in Bluetooth® SDK v3.x](#)
- [AN1142: Mesh Network Performance Comparison](#)
- [AN718: Manufacturing Test Overview](#)
- [UG104: Testing and Debugging Applications for the Silicon Labs EM35x and EFR32MG Platforms \(Zigbee\)](#)

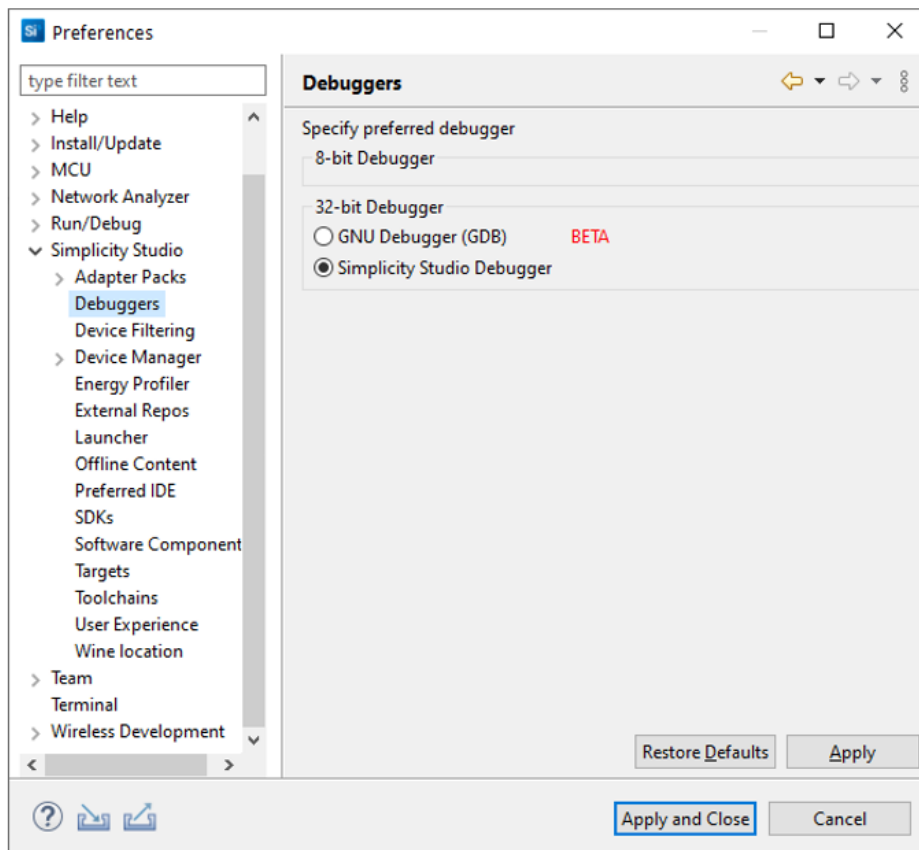
Using the Debugger

Using the Debuggers

Simplicity Studio® 5 (SSv5) supplies two debuggers:

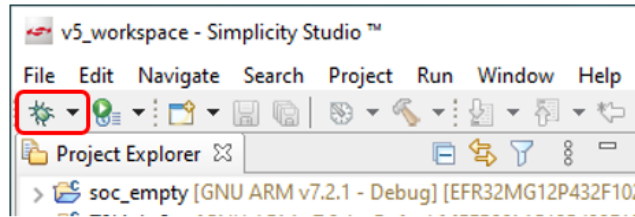
- The classic Simplicity Studio debugger is a full featured debugger that offers the ability to step through code, set breakpoints, examine memory, variables and registers. This is the default debugger.
- For 32-bit device users, Simplicity Studio 5.1 includes Beta-level support for a GNU Debugger (GDB) client and SEGGER's GDB server. The GNU Debugger (GDB) enables thread-aware debugging, and offers features such as unlimited flash breakpoints.

To change from the Simplicity Studio debugger, on the toolbar click Preferences and select **Simplicity Studio > Debuggers**. Select **GNU Debugger (GDB)** and click **Apply and Close**.



Silicon Labs supplies the debug models for each of their devices so that all of the registers can be examined and modified using either debugger.

The debugger runs in the **Debug** perspective. The debug perspective can be opened in a variety of ways, but most commonly by clicking the **Debug** button in the Simplicity IDE perspective once a project has reached a point where it will build and link correctly.



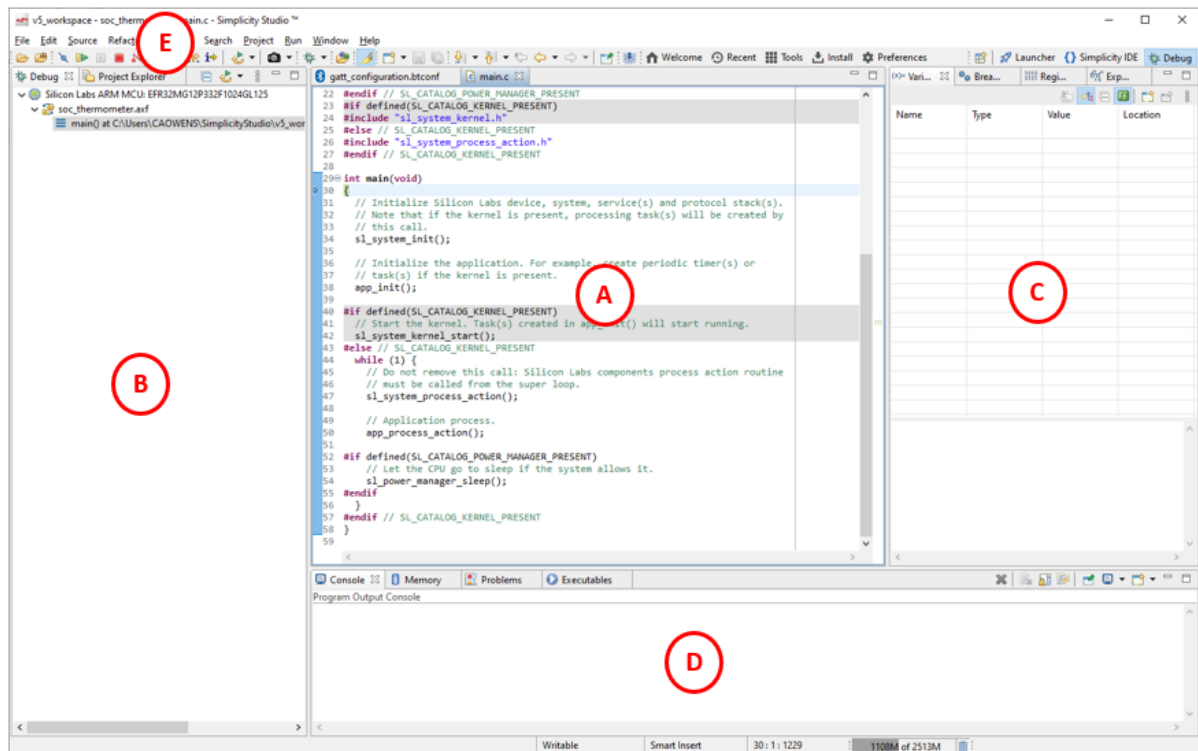
If a debug session has never been started before, a warning that a debug configuration does not exist might appear. Click the down arrow next to the debug icon, select **Debug as...** and then select either **Silicon Labs ARM Program** for 32-bit parts or **Silicon Labs 8051 Program** for EFM8 and C8051 parts.

If a single debug adapter is available, SSv5 automatically downloads the code to that device. If more than one debug adapter is available, SSv5 will prompt to select one.

With the Simplicity Studio debugger you can also save a [snapshot](#) of register values on a device, which can be used to compare the states of two different devices, or the state of the device at two different points in time.

Debug Perspective

The Debug Perspective by default is composed of the editor (A) and three tabbed view panes.



The Debug view (B) shows the call stack and call hierarchy that can help debug and find where functions are called. The Project Explorer view is available as a tab.

The right pane (C) and the bottom pane (D) contains tabbed views into data and consoles. These vary between the two debuggers. Depending on your actions, additional views may open in either the right or bottom pane.

Buttons in the Debug perspective toolbar (E) for the Simplicity Studio debugger and the GDB are shown below. The toolbar is similar for both debuggers.



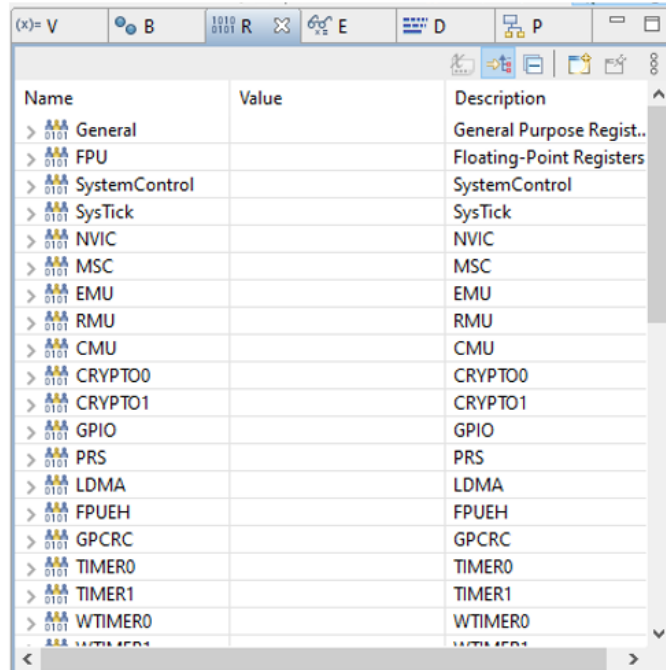
Number	Command	Description
1	Debug	Starts a new debug session. An active debug session must be disconnected before starting a new session using the same debug adapter.
2	Reset the device	Performs a hardware reset.
3	Create snapshot	(Simplicity Studio Debugger only) Creates a snapshot when clicked (default). Drop down the menu to select Create when Stopped or Create at Breakpoints . See About Snapshots for more information.
4	Skip	Skips all breakpoints.
5	Resume	Runs the application after reset or hitting a breakpoint.
6	Suspend	Halts the application.
7	Terminate	Terminates the session.
8	Disconnect	(Simplicity Studio Debugger only, gray for GDB) Terminates the session and disconnects the debug adapter. SSV5 automatically switches back to the Simplicity IDE perspective.
9	Step into	Single steps into the first line of a function.
10	Step over	Single steps over a function, executing the entire function.
11	Step return	Steps out of a function, executing the rest of the function.
12	Instruction Stepping Mode	Toggles assembly single stepping. When enabled, single stepping executes a single assembly instruction at a time. If clicked, opens a Disassembly view in the right pane that shows the assembly code corresponding to the source code at the current line of execution.
13	Restart	(Simplicity Studio debugger only) Restarts a process or target without terminating and relaunching
14	Open Element	Opens a dialog where you can see the qualified name and location for an element. Start typing to bring up a list of matching elements.
15	Toggle Mark Occurrences	Turns the mark occurrences function on and off.

A debug adapter can only support a single debug session at a time. An active debug session must be disconnected before code can be recompiled and a new debug session started.

To set a breakpoint, double-click in the blue bar to the left of the code editor or right-click on a line of code and select **Add Breakpoint**.

Simplicity Studio Debugger

This section describe the various views in the Simplicity Studio debugger.

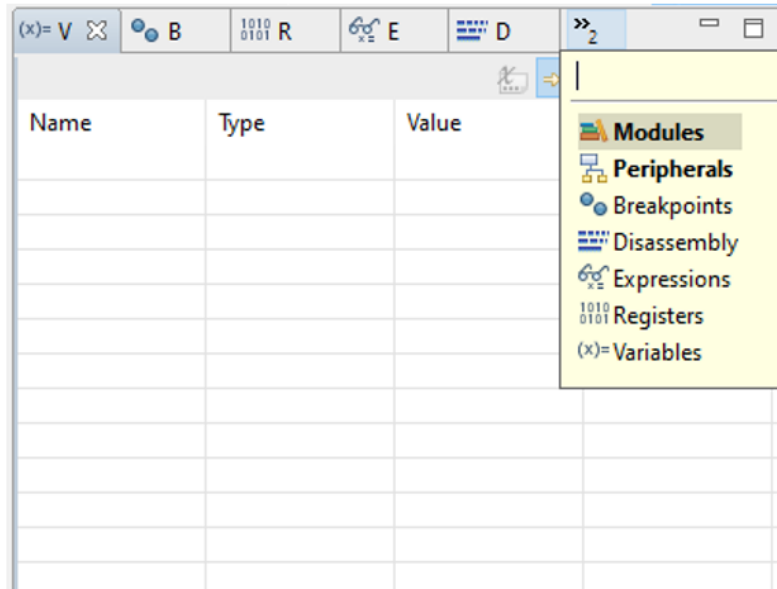


- The **Variables** view shows the values of variables.
- The **Breakpoints** view provides functionality to manage breakpoints.
- The **Registers** view displays and allows you to change register contents. Registers with bitfields are split into individual fields with the enumeration value decoded. Registers that have changed between breakpoints are highlighted in yellow.
- The **Expressions** view allows you to add and change expressions. If possible, SSv5 evaluates the expression and displays its current value when the application is halted. If an expression is out of scope, SSv5 cannot evaluate the expression until the application is halted in a section of code where the expression is in scope.
- The **Disassembly** view provides an interleaved display of the original source code with the assembler instructions use to execute the source code.

The Memory view in the bottom pane displays the contents of the CODE, RAM, and XRAM memory. To experiment, in the Monitors menu click **+**. Select **Enter memory space and address**, select a memory space such as CORE and enter an address to view, such as 0x0000. Click **OK**. A memory monitor is added to the Memory view that displays the contents of the space starting at the address you provided.

GDB

This section describe the various views in the GNU Debugger.



- The **Variables** view shows the values of variables.
- The **Breakpoints** view provides functionality to manage breakpoints.
- The **Registers** view displays and allows you to change general register contents. Registers that have changed between breakpoints are highlighted in yellow. To see other registers, select a peripheral in the Peripherals view.
- The **Expressions** view allows you to add and change expressions. If possible, SSv5 evaluates the expression and displays its current value when the application is halted. If an expression is out of scope, SSv5 cannot evaluate the expression until the application is halted in a section of code where the expression is in scope.
- The **Disassembly** view provides an interleaved display of the original source code with the assembler instructions used to execute the source code.
- The **Peripherals** view, after a short delay, shows peripherals with bitfields that are split into individual fields shown as a hex value. Their values cannot be modified. When a peripheral is selected, the **Memory** tab in the bottom pane shows associated registers and their values.

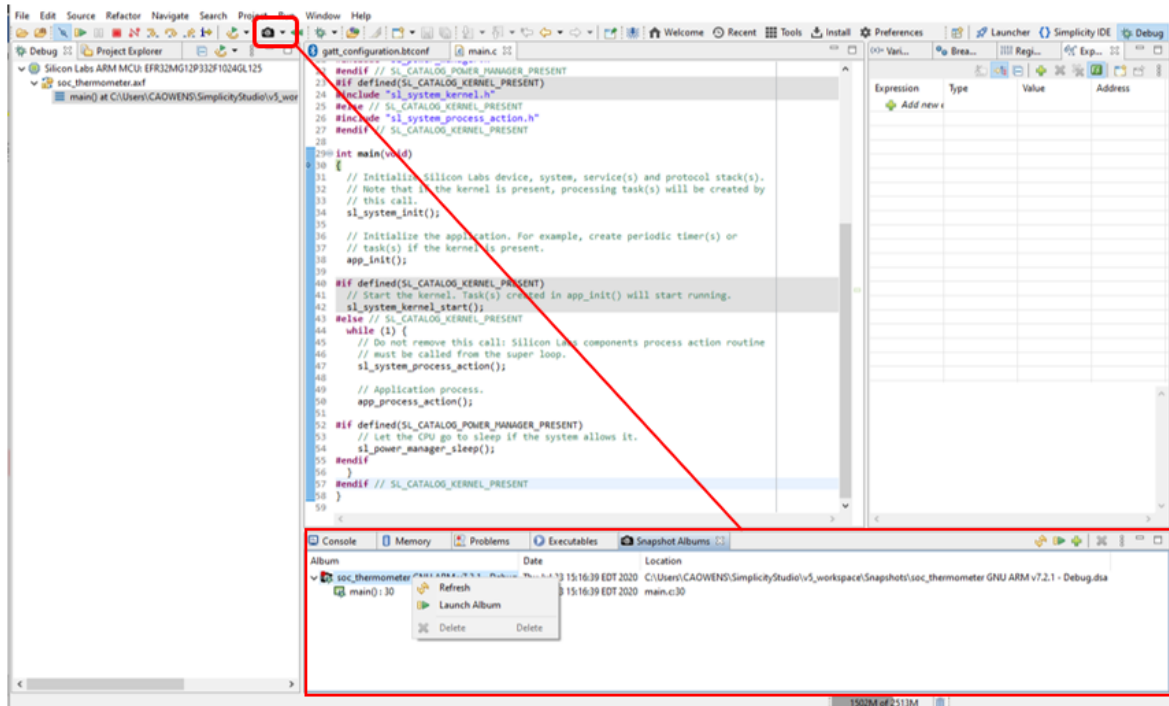
The Memory view in the bottom pane displays the contents of the CODE, RAM, and XRAM memory. To experiment, in the Monitors menu click **+** and enter an address or an expression to monitor. A monitor for that address or expression is added.

The bottom pane also includes a Debugger Console, with output specific to GDB Debug SEGGER J-Link Debugging.

About Snapshots

The Snapshot feature is available in the Simplicity Studio debugger only. A snapshot saves the values of the registers on a device at a particular point in time. This feature is useful when comparing the states of two systems next to each other or looking at the state of the hardware at separate points in time.

Once you take a snapshot, the Snapshot Album view opens in the bottom view pane.



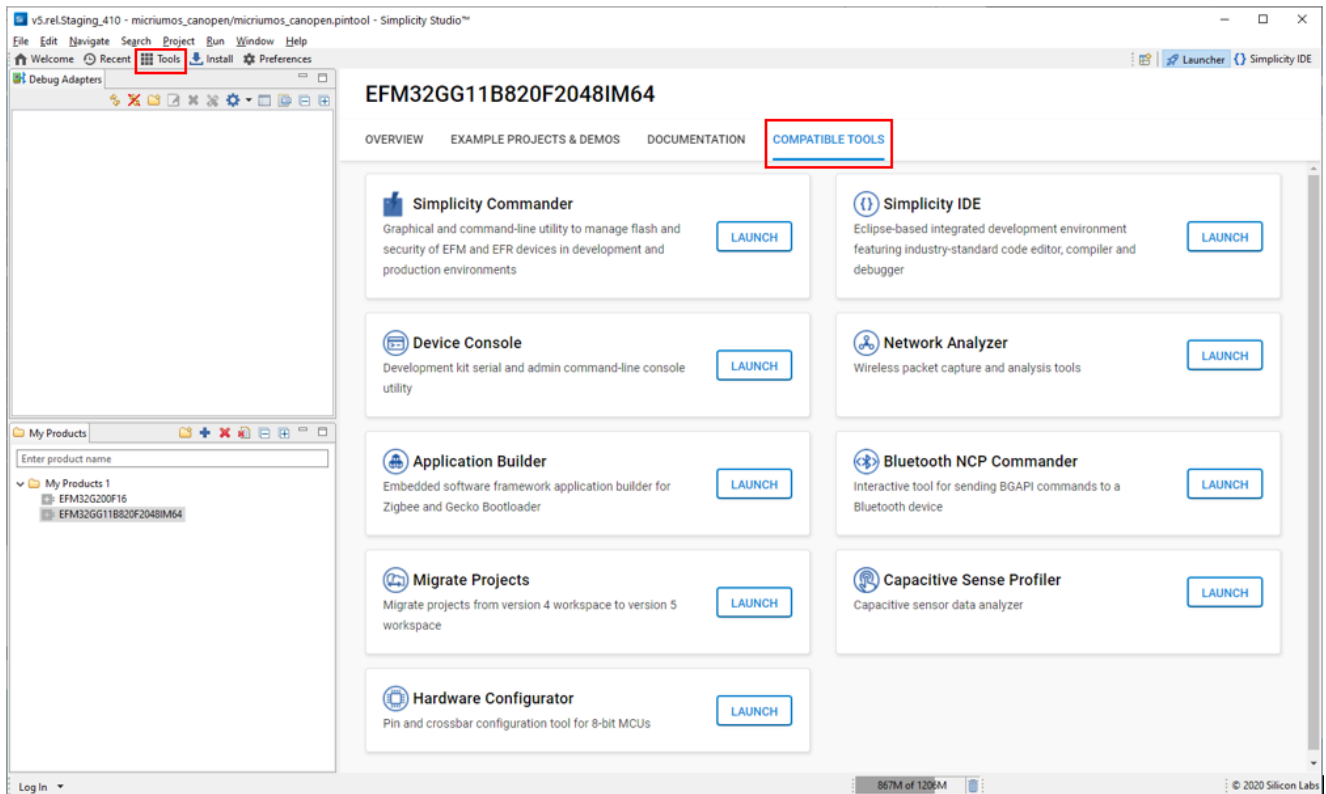
In the Debug perspective, if you do not see the Snapshot Album view, select **Window > Show View > Other > Snapshot Albums**.

To view a snapshot, right-click a snapshot in the list and select **Launch Snapshot**. This adds a debug session in the Debug window as it was at the time of the snapshot, with a Snapshot label at the start of the debug configuration. However, it is not an active debug session on hardware. To switch back to a debug session on hardware, select the Silicon Labs ARM debug configuration in the Debug window if a hardware debug session was active or else select **Run > Debug** if a session is not active.

Tools Overview

Using the Tools - Overview

Simplicity Studio® 5 (SSv5) provides a number of tools to assist with development activities. Use the **Tools** button to see a list of available tools. The Project COMPATIBLE TOOLS tab provides a list filtered by the project's target device.



Many of these tools are discussed on other pages in this guide, for example:

- [Simplicity IDE](#)
- [Application Builder](#)
- [Migrate Projects](#)
- [Flash Programmer](#)
- [Hardware Configurator](#)

These pages discuss:

- [Bluetooth NCP Commander](#)
- [Energy Profiler](#)
- [Network Analyzer](#)
- [Bluetooth Direction Finding tools suite](#)

More tools will be documented in future releases of the *Simplicity Studio 5 User's Guide*.

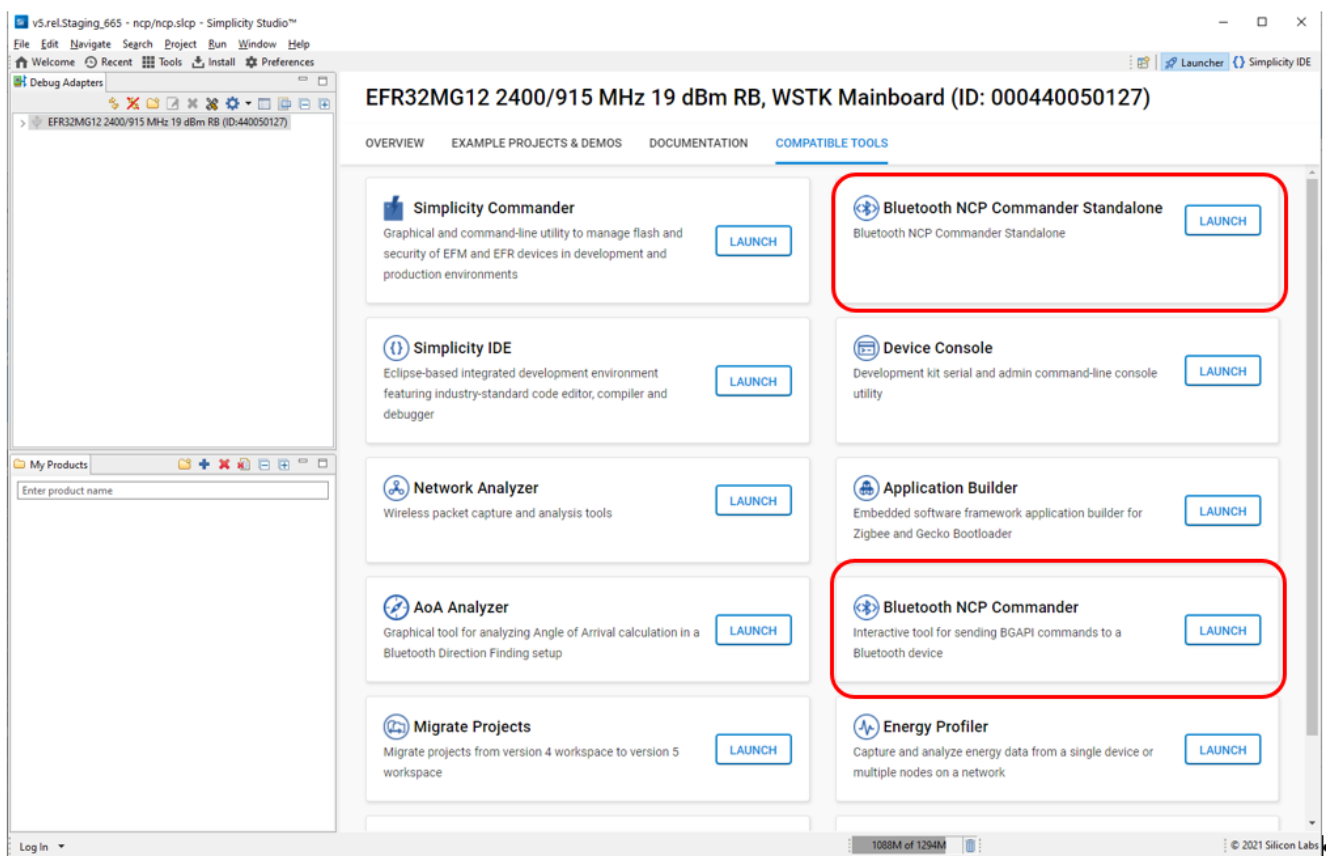
Bluetooth NCP Commander

Bluetooth NCP Commander

Bluetooth NCP Commander is a Simplicity Studio® 5 (SSv5) tool for sending BGAPI commands to an NCP target application during development.

Two versions of the tool are available in SSv5:

- Bluetooth NCP Commander Standalone
- Bluetooth NCP Commander



For detailed information about using NCP Commander and developing Bluetooth NCP-Host applications, see [AN1259: Using the Silicon Labs v3.x Bluetooth Stack in Network Co-Processor Mode](#).

Bluetooth NCP Commander Standalone

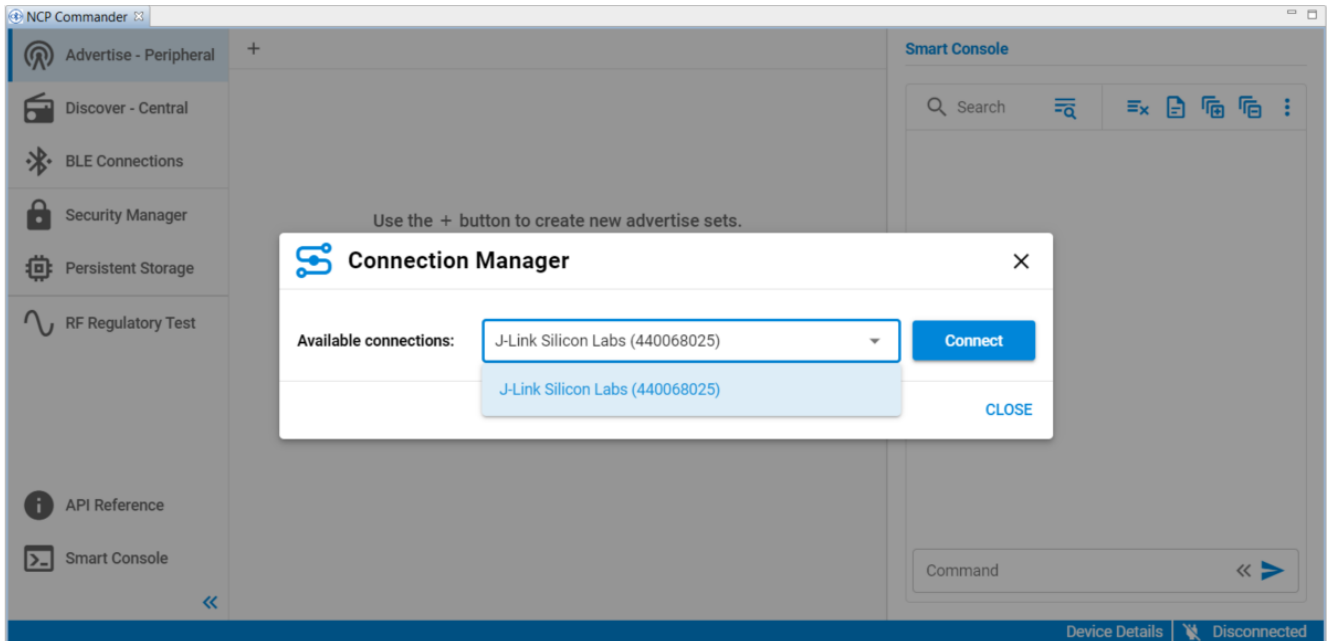
The Standalone version is provided for customers who need to control an NCP device on custom hardware. The Standalone version can access the system COM ports that are not exposed in SSv5. Users who wish to work outside of the SSv5 environment can do so by copying the directory <SSv5-install>/developer/adapters/ncp_commander.

The Standalone version cannot access parts over Ethernet, which the integrated SSv5 version can.

Bluetooth NCP Commander

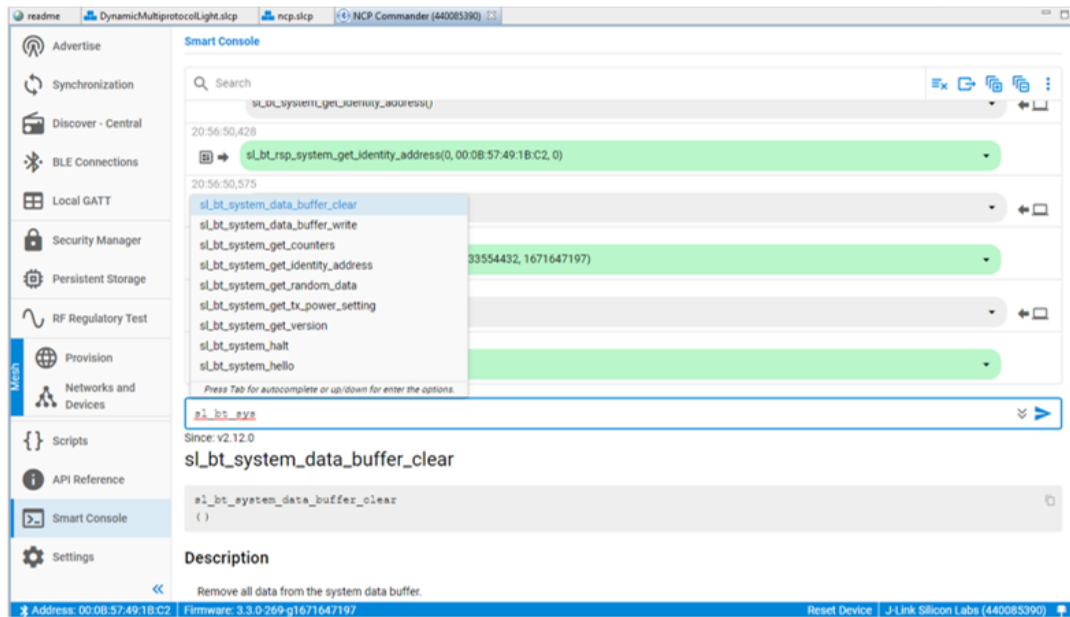
To open Bluetooth NCP Commander, make sure that the correct board is connected. If you are just getting started, build and flash a project based on **Bluetooth - NCP**.

In the Project Configurator COMPATIBLE TOOLS tab, click **Launch** on the Bluetooth NCP Commander card. In the Connection Manager dialog, select the target device and click **CONNECT**.



Once the UART connection to the mainboard is established, an Interactive view opens, which you can use to issue BGAPI commands. Note that the connected device is shown in the lower right. You can change target devices without leaving Bluetooth NCP Commander by clicking that area. It will show "Disconnected" if not connected to any device. Check the log for the NCP target response and status messages.

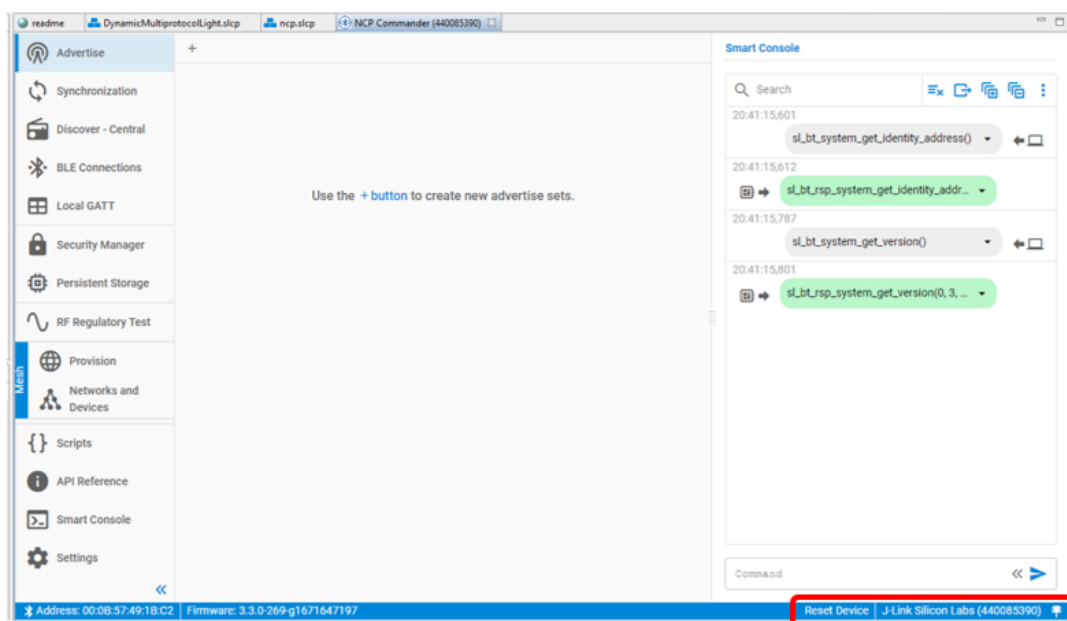
You can also issue commands manually. For example, you can issue the 'system hello' command at any time to verify that communication between the host and the device is working. The Smart Console provides auto completion and documentation for the possible commands.



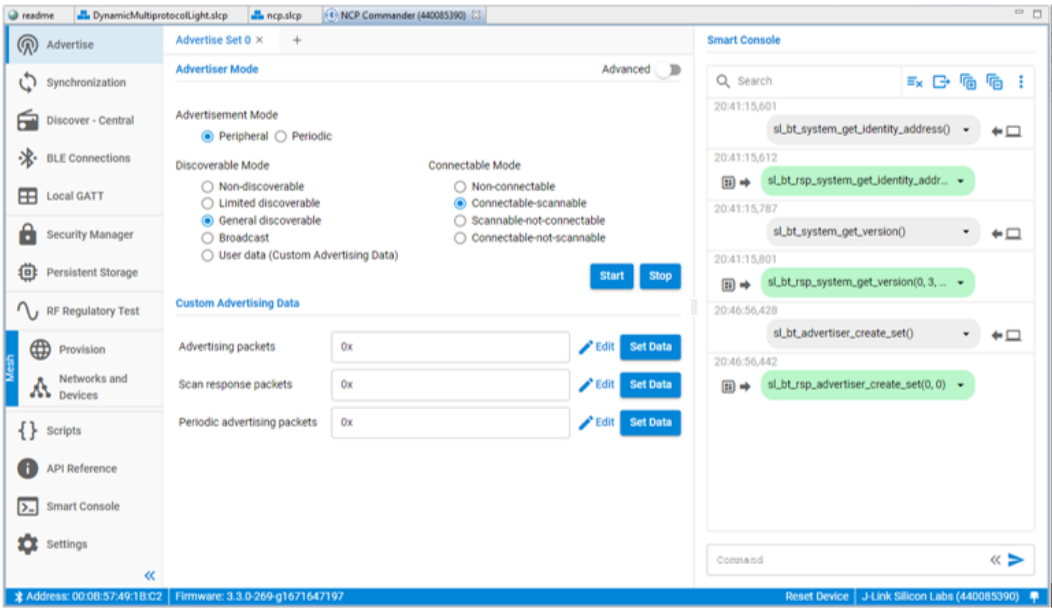
NCP Commander provides a simple scripting feature. Create or import an existing script using the controls in the top right corner. You can use any BGAPI commands in the script, but it has no additional features, such as branching or error handling. Click **Export** to save the commands sent through the console to a file that can be imported back as a script.

Advertising

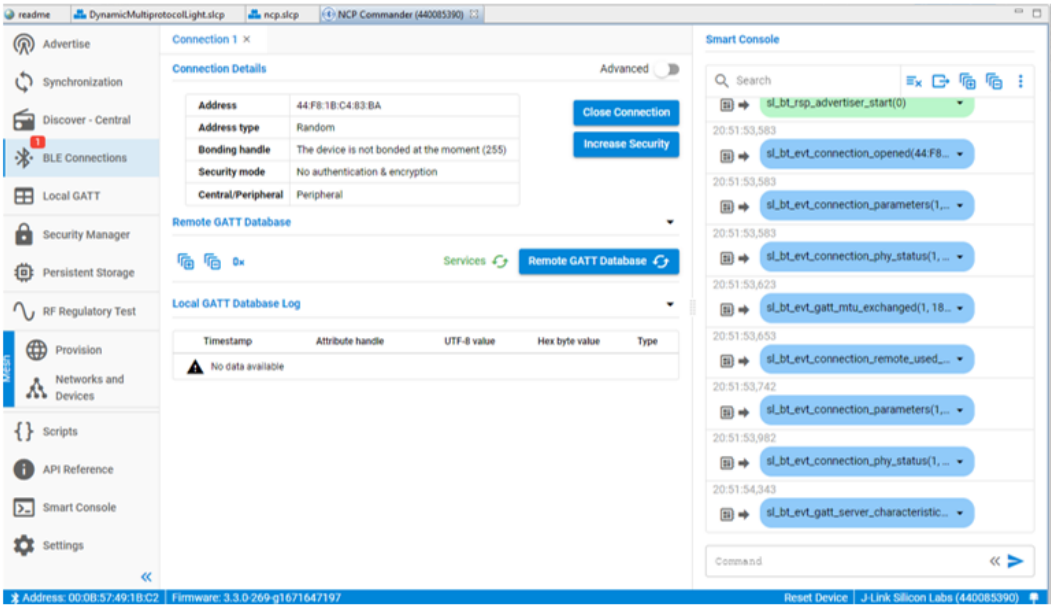
To start advertising, click "+" next to "Advertise – Peripheral" to create an advertiser set.



Select the desired advertising mode, create custom advertising packets if desired, and click **Start**.

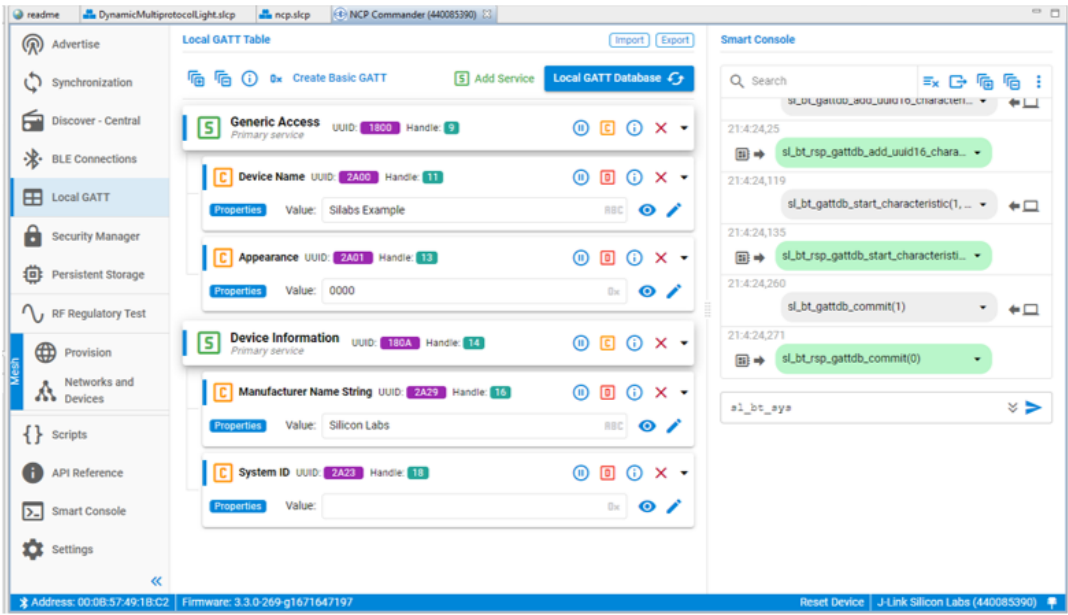


When advertising, the NCP target example accepts Bluetooth connections. If you connect to a WSTK or with another central device (for example with your phone), you can see the events and commands on the log.



GATT Database

NCP commander supports creating a GATT database. To generate a basic GATT database, open the Local GATT view, and click **Create Basic GATT**. The following database is generated.

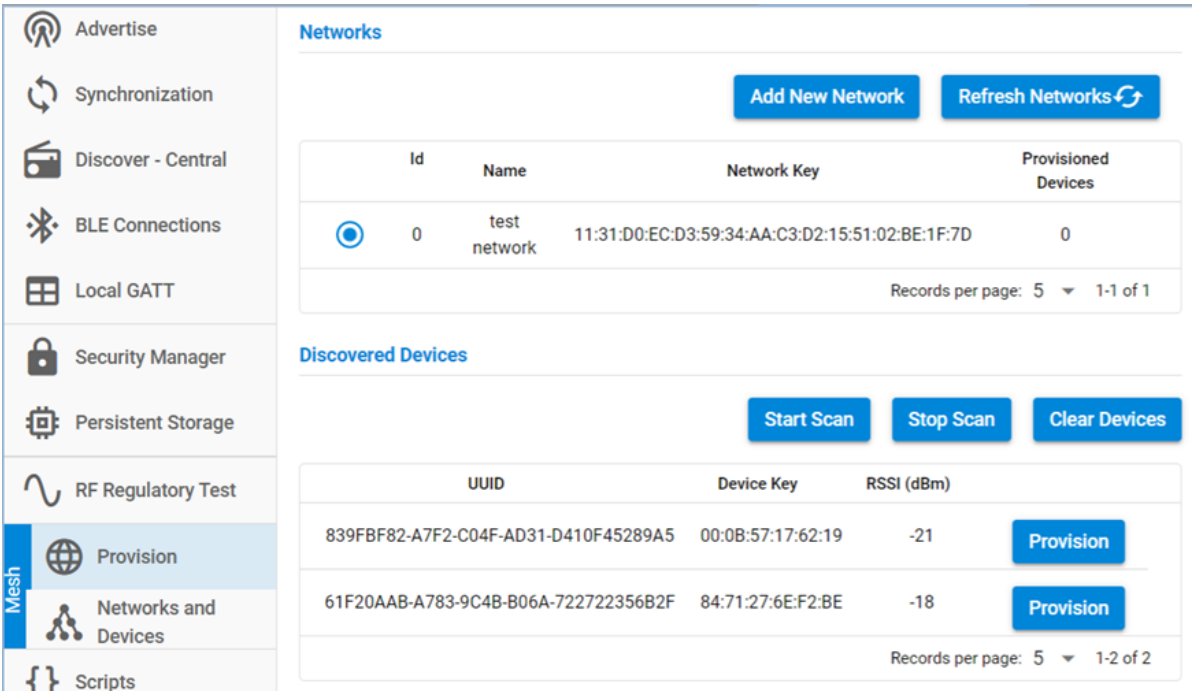


Here you can add services and characteristics. You can also read out the local GATT database from the device.

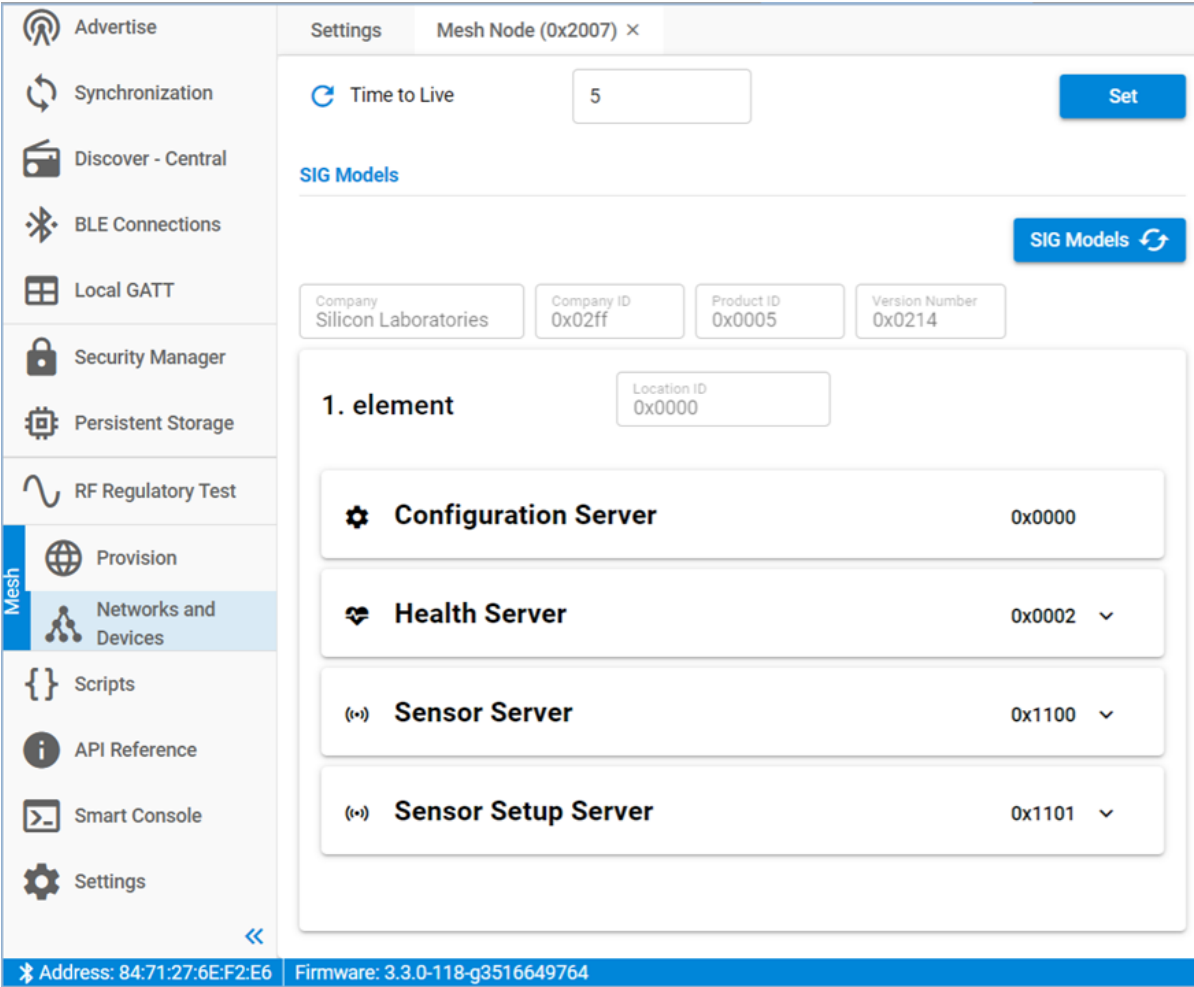
Bluetooth mesh

NCP Commander supports Bluetooth mesh features. You can issue Bluetooth mesh commands manually in the Smart Console, or use the interactive host provisioner feature to provision and configure mesh nodes and manage mesh networks, instead of using a Bluetooth mesh mobile application. To start using the host provisioner, select either **Provision** or **Networks and Devices** on the left menu, and click **Initialize for Provision**.

To provision devices, select **Provision** on the left menu, and click **Start Scan** in the right panel. The devices that are transmitting unprovisioned beacons are shown in the **Discovered Devices** section. Click **Provision** next to the device you want to provision.



To configure provisioned devices, select **Networks and Devices** on the left menu. Provisioned devices are shown in the **Provisioned Devices** section of the **Settings** tab. Click **Configure** to open a **Mesh Node** tab in which you can configure the device. In the Configurations section, you can configure Bluetooth mesh features and network settings. In the SIG Models section, click **SIG Models** to retrieve DCD from the device, and then you can configure the models.



Before configuring devices, you may need to create application keys and groups. Application keys, groups and other network settings can be managed in the **Settings** tab of the **Networks and Devices** menu item.

Energy Profiler

Energy Profiler

Simplicity Studio® 5 (SSv5)'s Energy Profiler enables you to visualize the energy consumption of individual devices, multiple devices on one target system, or a network of interacting wireless devices to analyze and improve the power performance of these systems. Real-time information on current consumption is correlated with the program counter providing advanced energy software monitoring capabilities. It also provides a basic level of integration with the Network Analyzer network analysis tool.

Energy saving and efficiency are at the top of developers' priorities for an ever-growing number of embedded systems applications. These constraints can be due to government regulations (for example, metering applications), a requirement to increase battery life, or simply a need to lower the electricity bill. In battery-operated systems, energy efficiency often plays the most important role. In cases where developers are satisfied with their system's battery life, increasing the energy efficiency means they can switch to a smaller and cheaper battery, which will lower the overall cost. There are also situations where the operating life must be extended to the absolute maximum, such as products where the battery cannot be replaced or replacement involves very high costs.

Having a low-power MCU by itself does not mean you will have lower energy consumption. The trick is to optimize your software not just in terms of functionality, but also with respect to energy efficiency. Having full control of the hardware surrounding the MCU and optimizing the overall software and peripheral usage are crucial factors for reducing system energy consumption. Software is not usually seen as an energy drain, yet every clock cycle consumes energy. Minimizing the number of clock cycles becomes a key challenge to reduce overall system consumption.

The Energy Profiler enables you to visualize the energy consumption of individual devices, multiple devices on one target system, or a network of interacting wireless devices to analyze and improve the power performance of these systems. Real-time information on current consumption is correlated with the program counter providing advanced energy software monitoring capabilities. It also provides a basic level of integration with the Network Analyzer network analysis tool.

In these pages the following terms will be used:

AEM: Advanced Energy Monitor

ISD: The file extension used with Multi-Node Energy Profiler and Network Analyzer files.

PTI: Packet Trace Information

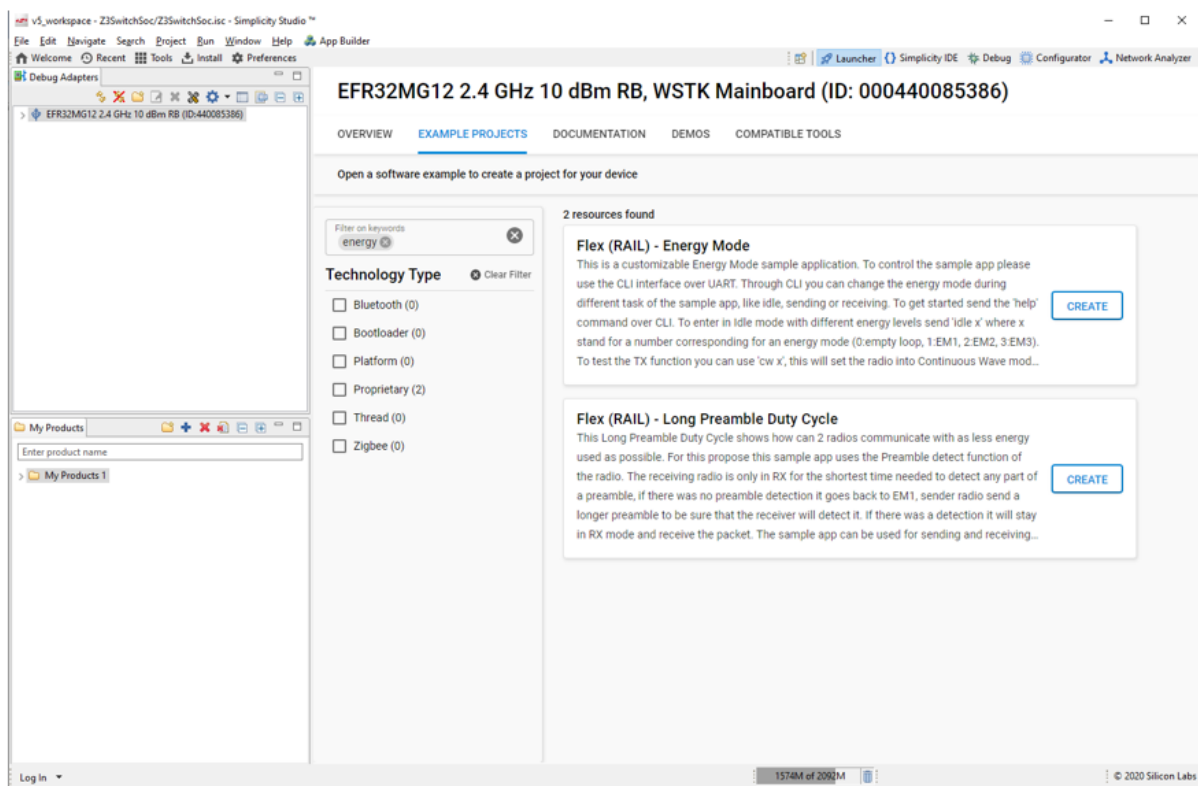
Starting an Energy Analysis Session

Starting an Energy Analysis Session

An energy analysis session can be started from either the [Simplicity IDE Perspective](#) or from the [Energy Profiler](#).

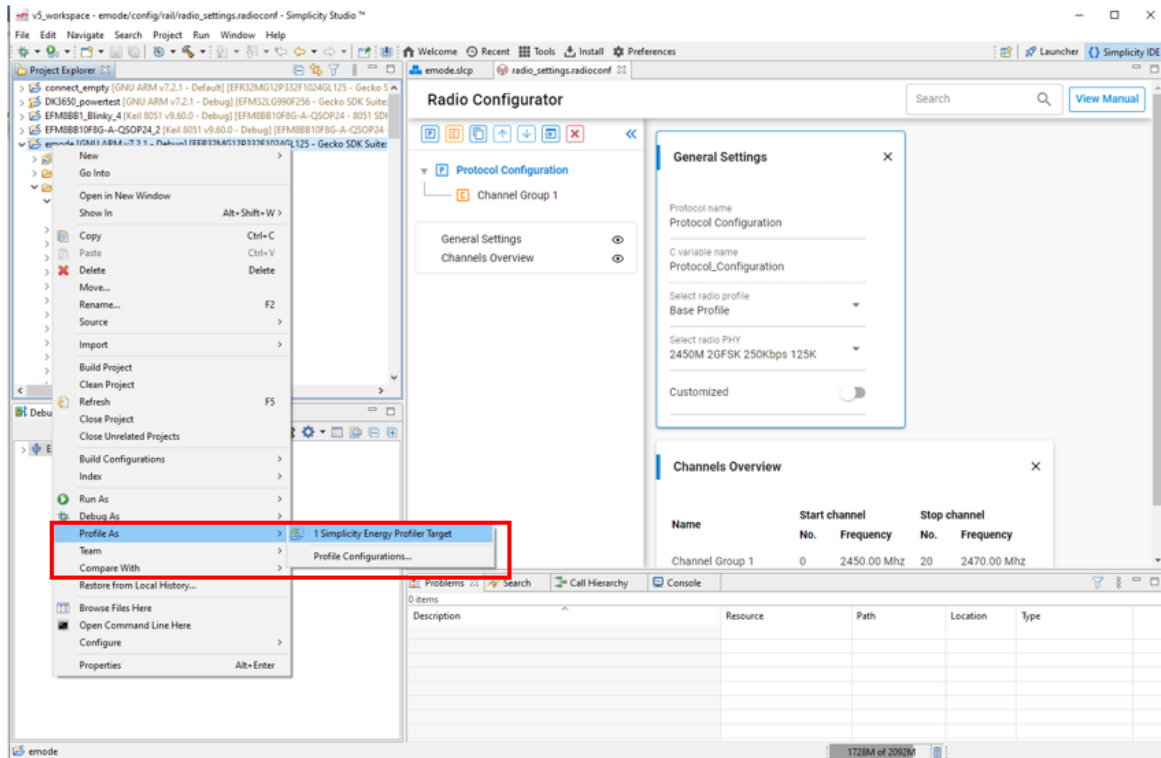
From the Simplicity IDE Perspective

Some Silicon Labs SDKs contain examples that are pre-configured to deliver energy profiling data to the Energy Profiler. In the Simplicity Studio Launcher perspective, you can find example titles such as "Powertest" or "Energy modes" or "Emode" for many development kits. In the figure below, the selected device is an EFR32 development kit. The Flex SDK has been installed.



Create an example (in this case **Flex(RAIL) - Energy Mode**). Because this is a RAIL example, the Simplicity IDE perspective opens with the [Radio Configurator](#) open. If this is an AppBuilder project, click **Generate**.

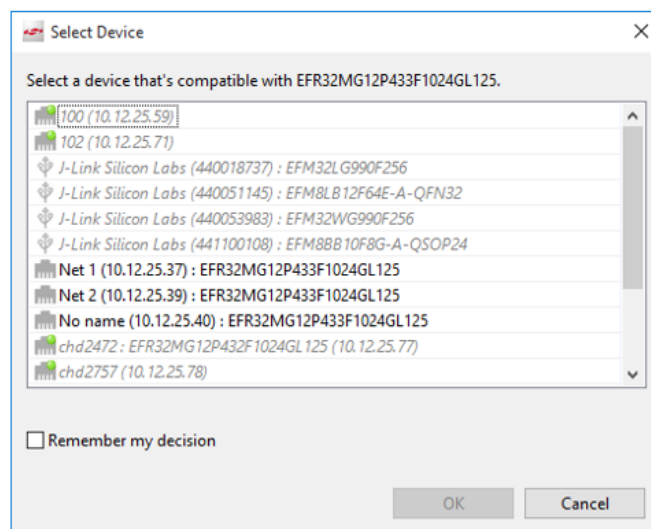
Right-click the project directory. In the context menu select **Profile As > Simplicity Energy Profiler Target**.



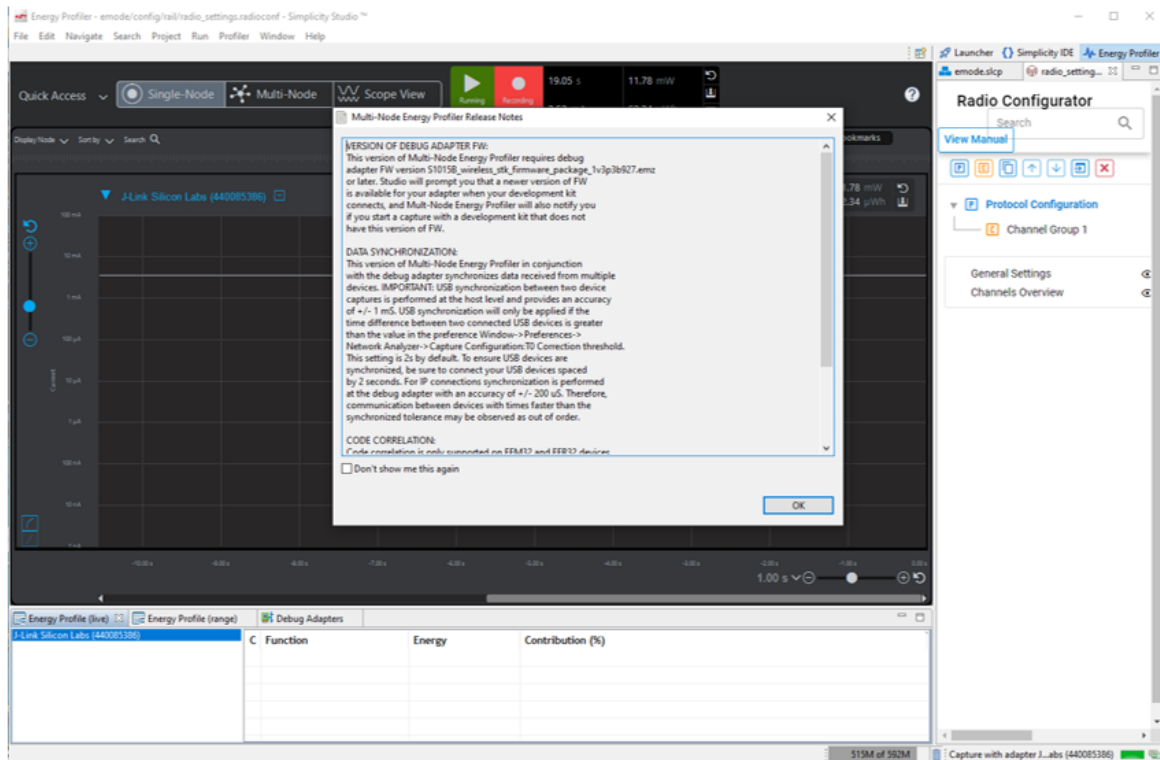
SSv5 then:

1. Rebuilds the entire project.
2. Flashes the application to compatible hardware.
3. Starts energy capture for that device.
4. Switches to the Energy Profiler perspective.
5. Displays the device data on Single-Node View, Multi-Node View, and Scope View.

In step 2 above, if more than one connected device is compatible with the application being profiled, SSv5 prompts you to select a device. Select the target of interest and click **OK**.

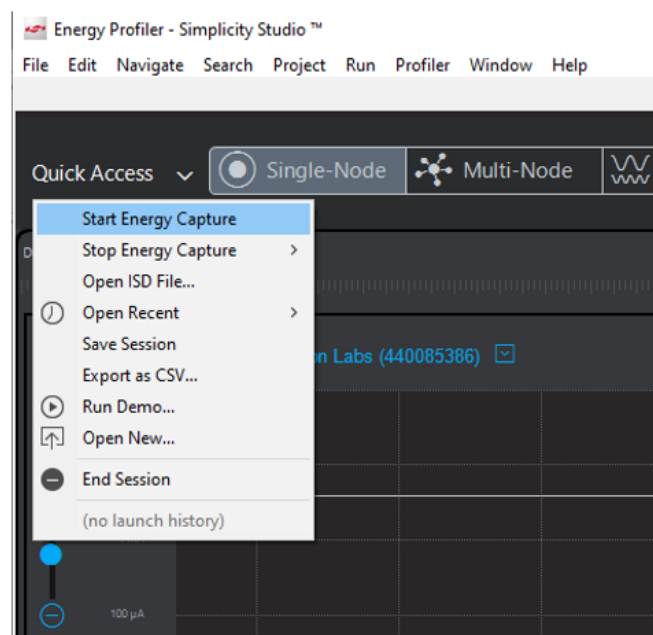


After the application is built and the firmware flashed, the Energy Profiler perspective is displayed, with a release notes dialog. Click **OK**.

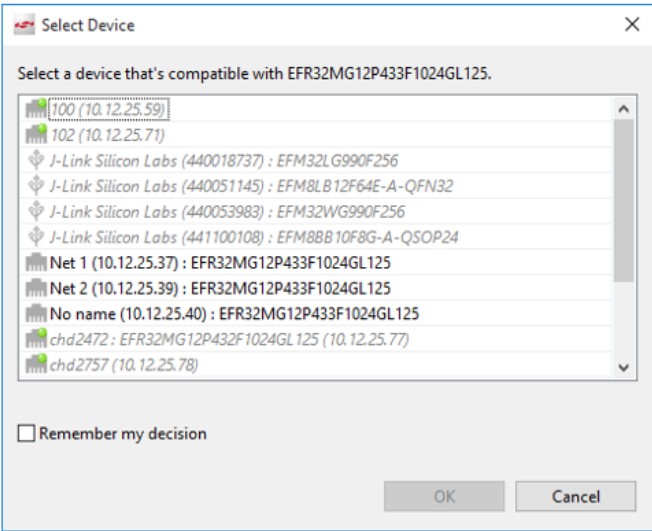


From the Energy Profiler

If application firmware is already running on a device, you can connect to it from the Energy Profiler tool. Open the Energy Profiler perspective. Click **Quick Access** to display its menu and select **Start Energy Capture**.



If more than one connected device is compatible with the application being profiled, SSv5 prompts you to select a device. Select the target of interest and click **OK**.



Energy Profiler then:

- Starts energy capture for that device.
- Depending upon which view is currently active, displays the device’s energy data on Single-Node view, Multi-Node view, or Scope view.

Customer Hardware and Software Design Information

This section discusses design requirements in order for a device to be able to use Energy Profiler features. Among these features is Code Correlation, which connects power consumption and executed code. Using code correlation is discussed in more detail in [Profiling with Code Correlation](#)

Hardware Design

EFM8 Hardware Interface

To use the Energy Profiler functionality on a board design, the board needs to include a debug interface that can be connected to a Silicon Labs starter kit (STK) or wireless starter kit (WSTK). For the basic Energy Profiler current measurements, the board must be powered from the VAEM supply of a Silicon Labs STK or WSTK. Both the current measurement and EFM8 C2 Debug interface can be obtained by using the Silicon Labs Mini Simplicity 10 pin connector. This connector is detailed in [AN958: Debugging and Programming Interfaces for Custom Designs](#). The EFM8 C2 interface signals are on SWDIO (Pin 7 C2D) and SWCLK (Pin 8 C2CK) pins shown in the following figure.

VAEM	1	2	GND
RST	3	4	VCOM_RX
VCOM_TX	5	6	SWO
SWDIO	7	8	SWCLK
PTI_FRAME	9	10	PTI_DATA

Code correlation is not possible with the EFM8 parts as they do not include the SWO pin that is used to transmit the program counter information. As mentioned in [AN958: Debugging and Programming Interfaces for Custom Designs](#), using the Silicon Labs debug adapter board (BRD8010A) is the easiest way to get the Mini Simplicity pinout from a Silicon Labs STK or WSTK development kit.

EFM32 and EFR32 Hardware Interface

To use the Energy Profiler functionality on a board design, the board needs to include a debug interface that can be connected to a Silicon Labs STK or WSTK. For the basic Energy Profiler current measurements, the board must be powered from the VAEM supply of a Silicon Labs STK or WSTK. To also include code correlation, the debug interface must include the SWD interface. Both the current measurement and the code correlation (SWD) can be obtained by using the Silicon Labs Mini Simplicity 10 pin connector. This connector is detailed in [AN958: Debugging and Programming Interfaces for Custom Designs](#). The Mini Simplicity 10 pin connector can be used with all EFM32 and EFR32 parts. The pinout is shown in the following figure.

VAEM	1	2	GND
RST	3	4	VCOM_RX
VCOM_TX	5	6	SWO
SWDIO	7	8	SWCLK
PTI_FRAME	9	10	PTI_DATA

As mentioned in [AN958: Debugging and Programming Interfaces for Custom Designs](#), using the Silicon Labs debug adapter board (BRD8010A) is the easiest way to get the Mini Simplicity pinout from a Silicon Labs STK or WSTK development kit. The debug adapter board is not compatible with the older EFM32 Development Kits (DKs) and some of the older EFM32 starter kits (STK) that have a different debug connector on them (Gecko, Giant Gecko (EFM32GG-STK3700), Leopard Gecko, Tiny Gecko, Wonder Gecko, Zero Gecko).

Software Design

To use the current monitoring functionality provided by the AEM interface, no software changes or setup are required. To use the code correlation functionality, the SWD interface must be configured to output periodic program counter information. Currently, code correlation is not possible with the EFM8 family. The Multi-Node Energy Profiler can still be used to monitor the overall energy use of the parts over time / usage scenarios.

Software can be configured in two ways:

- [Project configurator method](#) (using software components; preferred for SSv5 projects)
- [Legacy method](#) (by manually adding the necessary source code)

Project Configurator Method

This method of enabling code correlation is preferred in SSv5, as it leverages the software components and thereby reduces the chance of error.

1. In the Project Configurator, SOFTWARE COMPONENTS tab, find and install the **SWO Debug** component.
2. Click Configure to open the Component editor.
3. Open its configuration file and turn on **Enable interrupt event trace** and **Enable program counter samples**.
4. If the device allows SWO functionality on multiple GPIO pins, in the SL_Debug card's **SWV** field, select the pin to be used as the SWO output.

SWO Debug
View Source
X

SWO Configuration

SWO Frequency
875000

Enable interrupt event trace

Enable Program Counter samples

SL_DEBUG

Selected Module
DBG

SWCLKTCK
None

SWDIOTMS
None

SWV
PF2

TDI
None

TDO
None

DBG

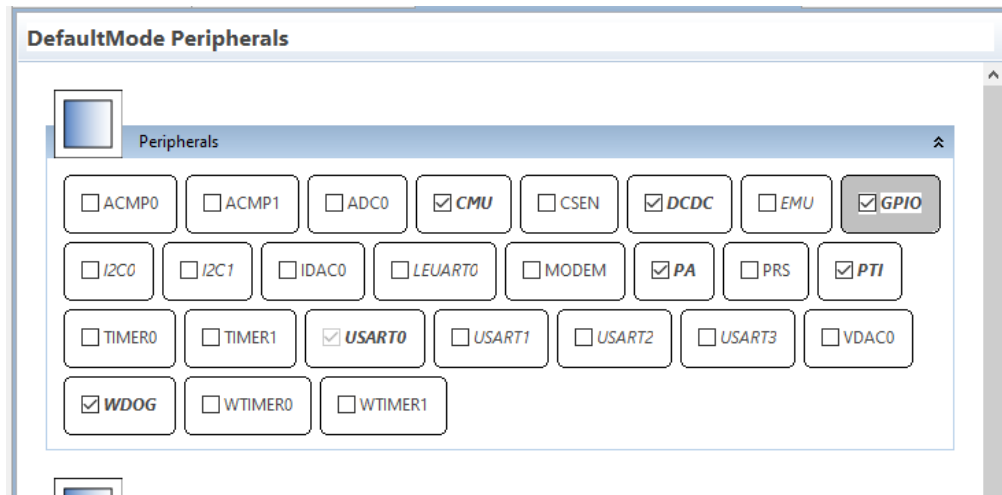
Custom Peripheral Name

Further initialization of the software component in code is not required provided that the **System Init** component is installed in the project.

Legacy Method

This method should be used for Appbuilder project and projects not created in the Project Configurator.

- The following paths must be included in your project, as they provide access to relevant header files used to enable code correlation. These header files are readily available for Silicon Labs parts. For custom design boards use bsp_trace.h and traceconfig.h as a reference instead.
 - <SSv5 install>/developer/sdks/gecko_sdk_suite/<version>/hardware/kit/common/bsp
 - Grants access to bsp_trace.h
 - (not required for AppBuilder projects) <SSv5 install>/developer/sdks/gecko_sdk_suite/<version>/hardware/kit/kitname/config
 - Grants access to traceconfig.h
 - For AppBuilder projects, instead see the next step.
- (Only for Appbuilder projects) In the Hardware Configurator file (.hwconf) in the "DefaultMode" peripheral tab, enable the GPIO module. This adds the **BSP_TRACE_SWO_** macros to the hal-config.h file.



3. Add `bsp_trace.c` to the project (from `<SSv5install>/developer/sdks/gecko_sdk_suite/<version>/hardware/kit/common/bsp`)
4. The code must enable SWO output from the MCU. To enable this output, add `#include bsp_trace.h` to the appropriate module and call `BSP_TraceSwoSetup()` during initialization as indicated in the following sections, based on the SDK being used.

Stackless project MCU SDK: Place `BSP_TraceSwoSetup()` after the `EMU_DCDCInit()` call in `main()`.

```

1  #include "bsp_trace.h"
2  .
3  .
4  .
5  /* Initialize DCDC. Always start in low-noise mode. */
6  dcdcInit.dcdcMode = emuDcdcMode_LowNoise;
7  EMU_DCDCInit(&dcdcInit);
8  // Setup SWD for code correlation
9  BSP_TraceSwoSetup();

```

Bluetooth LE SDK: Place `BSP_TraceProfilerSetup()` in `main.c` after the `initApp()` call.

```

1  #include "bsp_trace.h"
2  .
3  .
4  .
5  // Initialize application
6  initApp();
7
8  // Setup SWD for code correlation
9  BSP_TraceProfilerSetup();
10
11 // Initialize LEDs
12 BSP_LedsInit();

```

Flex SDK: Place `BSP_TraceProfilerSetup()` in `main.c` after the `BSP_Init()` call.

```

1  #include "hal_common.h"
2  #include "bsp_trace.h"
3  .
4  .
5  .
6  // Initialize the BSP
7  BSP_Init(BSP_INIT_BCC);
8
9  // Setup SWD for code correlation
10 BSP_TraceProfilerSetup();

```

EmberZNet SDK: Place `BSP_TraceProfilerSetup()` in `af-main-soc.c` after the `emberInit()` call.

```

1  #include "afv2-bookkeeping.h"
2
3  #if defined(CORTEXM3_EFR32_MICRO) || defined (CORTEXM3_EMBER_MICRO)
4      #define EXTENDED_RESET_INFO
5      #include "hal/micro/cortexm3/ diagnostic.h"
6  #endif
7  #include "bsp_trace.h"
8  .
9  .
10 .
11 int emberAfMain (MAIN_FUNCTION_PARAMETERS)
12 {
13     EmberStatus status;
14
15     int returnCode;
16     if (emberAfMainStartCallback(& returnCode, APP_FRAMEWORK_MAIN_ARGUMENTS)) {
17         return returnCode;
18     }
19 }
20
21 // Initialize the Ember Stack.
22 status = emberInit();
23
24 if (status != EMBER_SUCCESS) {
25     emberAfCorePrintln("%pemberInit 0x%x", "ERROR: ", status);
26
27     // The app can choose what to do here. If the app is running
28     // another device then it could stay running and report the
29     // error visually for example. This app asserts.
30     assert(false);
31 } else {
32     emberAfDebugPrintln("init pass");
33 }
34 // Setup SWD for code correlation
35 BSP_TraceProfilerSetup();

```

The program must be built with debug information enabled so that source code lookup is possible. If you create your project in Simplicity Studio, this is enabled by default. If you import a project into Simplicity Studio, check compiler options in project context menu **Properties...** -> **C/C++ Build** -> **Settings**. If you build the program outside of Simplicity Studio, check compiler options of the build tools.

EFM32 Software Configuration

1. Add bsp_trace.c to the project. (from <SSv5 install>\developer\sdk\gecko_sdk_suite<version>\hardware\kit\common\bsp)
2. The macros BSP_TRACE_SWO_PIN, BSP_TRACE_SWO_PORT and BSP_TRACE_SWO_LOC must be defined. For EFM32 parts this is done by default for Silicon Labs development kits in <SSv5 install>\developer\sdk\gecko_sdk_suite\<version>\hardware\kit\<board>\hal-config-board.h. For a custom board design the Silicon Labs hal-config-board.h can be used as an example for defining the values. The following is an example for the Pearl Gecko Starter Kit (SLSTK3401A):

```

1 // $[GPIO]
2 #define PORTIO_GPIO_SWV_PIN (2)
3 #define PORTIO_GPIO_SWV_PORT (gpioPortF)
4 #define PORTIO_GPIO_SWV_LOC (0)
5
6 #define BSP_TRACE_SWO_PIN (2)
7 #define BSP_TRACE_SWO_PORT (gpioPortF)
8 #define BSP_TRACE_SWO_LOC (0)
9 // [GPIO]$

```

3. The code must enable SWO output from the MCU. To enable this output, add `#include bsp_trace.h` to main.c and call `BSP_TraceProfilerSetup()` during initialization after the `EMU_DCDCInit()` call in `main()`.

```

1 #include
2 #include "bsp_trace.h"
3 .
4 .
5 .
6 /* Initialize DCDC. Always start in low-noise mode. */
7 dcdcInit.dcdcMode = emuDcdcMode_LowNoise;
8 EMU_DCDCInit(&dcdcInit);
9
10 // Setup SWD for code correlation
11 BSP_TraceProfilerSetup();

```

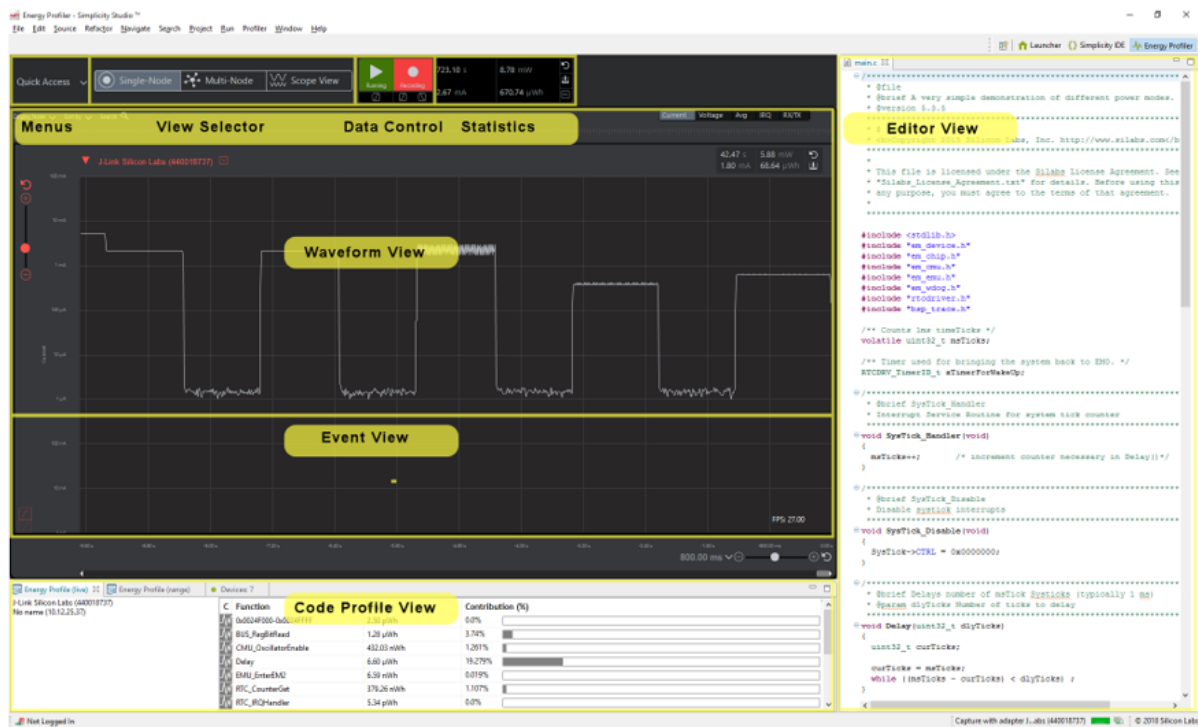
4. The program must be built with debug information enabled so that source code lookup is possible. If you create your project in SSv5, this is enabled by default. If you import a project into SSv5, check compiler options in project context menu **Properties... > C/C++ Build > Settings**. If you build your program outside of SSv5, check compiler options of the build tools.

User Interface

Energy Profiler User Interface

The Energy Profiler perspective is divided into six primary sections. The following figure shows Single-Node view.

- Quick Access Menus - The most frequently used menus for Multi-Node Energy Profiler are available on the user interface itself and also from the Profiler menu at the top menu bar.
- View Selector - Three views for Multi-Node Energy Profiler can be selected by clicking the View Selector bar.
- Data Control - Controls in this area are used to enable and disable data flow to the user interface and to disk.
- Statistics - Energy data for the waveform is shown in the statistics area.
- Code Correlation - Function execution related to power consumption is shown in the Code Correlation view.
- Editor - Source code for the program is shown here and works in conjunction with the Code Correlation view.



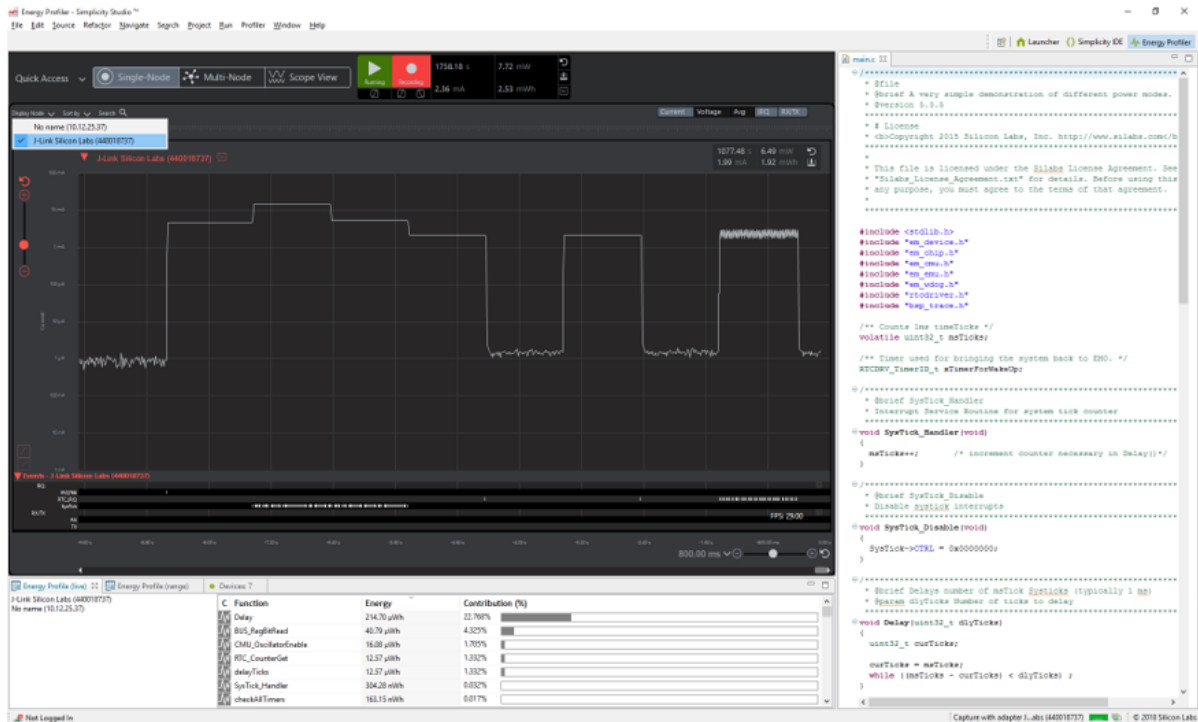
Three views are available for evaluating power performance:

- Single-Node View
- Multi-Node View
- Scope View

Single-Node View

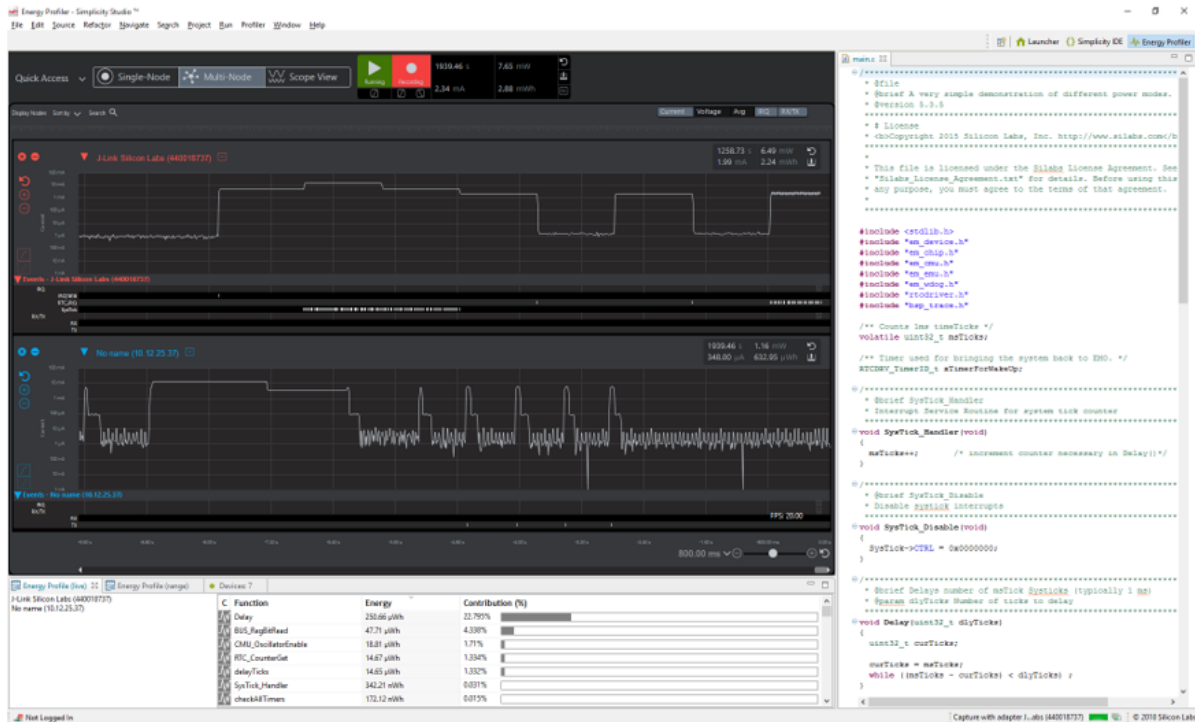
Single-Node view is used to display a single device's waveform and events. It displays a high-detail waveform and ensures that all events rows are visible, without the need to scroll the UI. The Energy Profiler perspective combines this Single-Node view, the Code

Correlation view, and the source code Editor view, allowing you to perform in-depth analysis of a single device from many viewpoints. Any active device may be selected through the **Display Nodes** menu.



Multi-Node View

Multi-Node view is used to display multiple device waveform and events. It allows you to investigate system behavior and interactions between devices. Two devices are visible in the main portion of the UI, while others are viewed by scrolling. The Multi-Node view groups each individual device's waveform and events together. The Energy Profiler perspective combines this Multi-Node view, the Code Correlation view, and the source code Editor view, allowing you to perform in-depth analysis of multiple devices from many viewpoints.

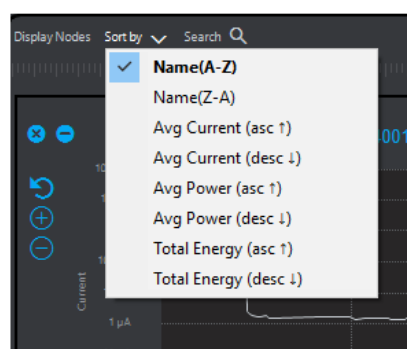


Multi-Node view offers the following capabilities:

- Sorting
- Node display control

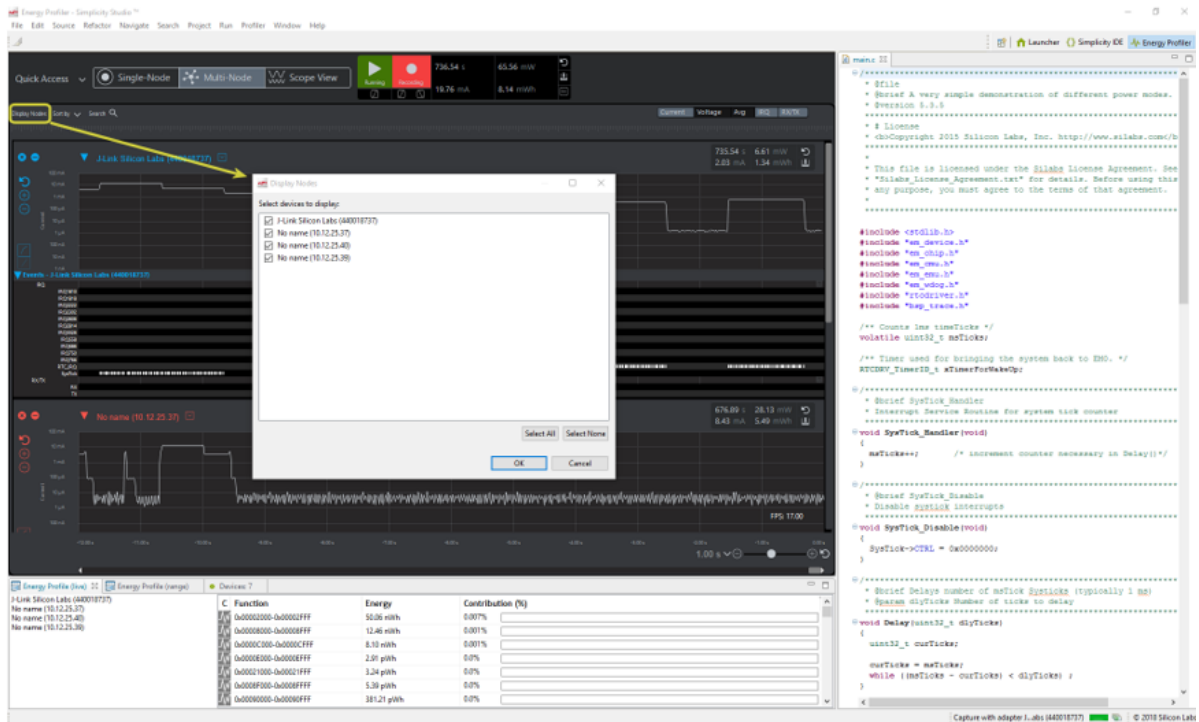
Sorting

Sorting in Multi-Node view allows you to order waveforms based upon several criteria. For example, it may be useful to sort descending by average power, such that the highest power consumers are easily identified at the top. As shown in the following figure, devices may be sorted ascending and descending by name, average current, average power, or total energy.



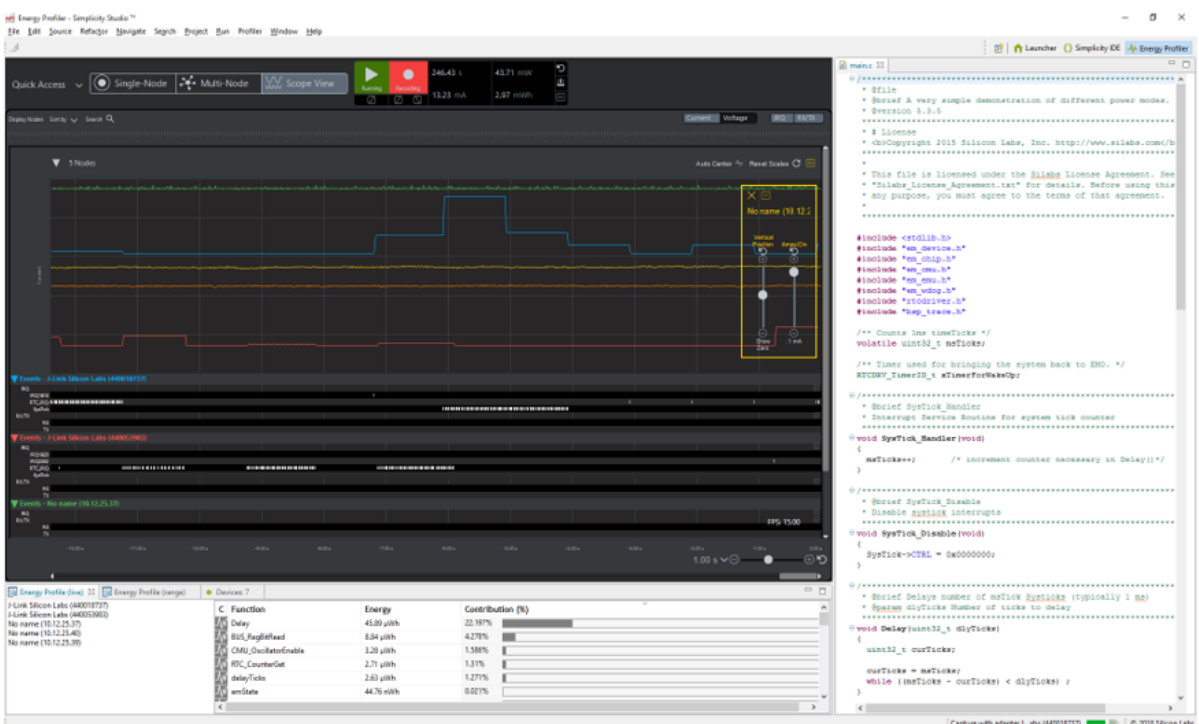
Displaying Nodes

Enabling capture on any device automatically adds it to the Multi-Node view. However, as the number of devices displayed increases, UI performance may be impacted. Click **Display Nodes** to select the devices that will be displayed. This selection only affects the waveform display. If recording is enabled, data for all actively capturing devices is streamed to disk regardless of whether or not they are displayed.



Scope View

Scope view is used to display multiple device waveforms and events, allowing you to investigate system behavior and interactions between devices. In Scope view, all waveforms are displayed in one waveform area, so that you can see all waveforms without needing to scroll the UI. It also enables the user overlay and align traces like an oscilloscope. All event traces are grouped below the waveform view. The Energy Profiler perspective combines this Scope view, the Code Correlation view, and the source code Editor view allowing you to perform in-depth analysis of a single device from many viewpoints.

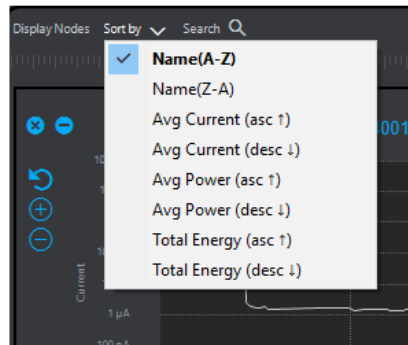


Scope view offers the following capabilities:

- Sorting
- Node display control
- Waveform display control

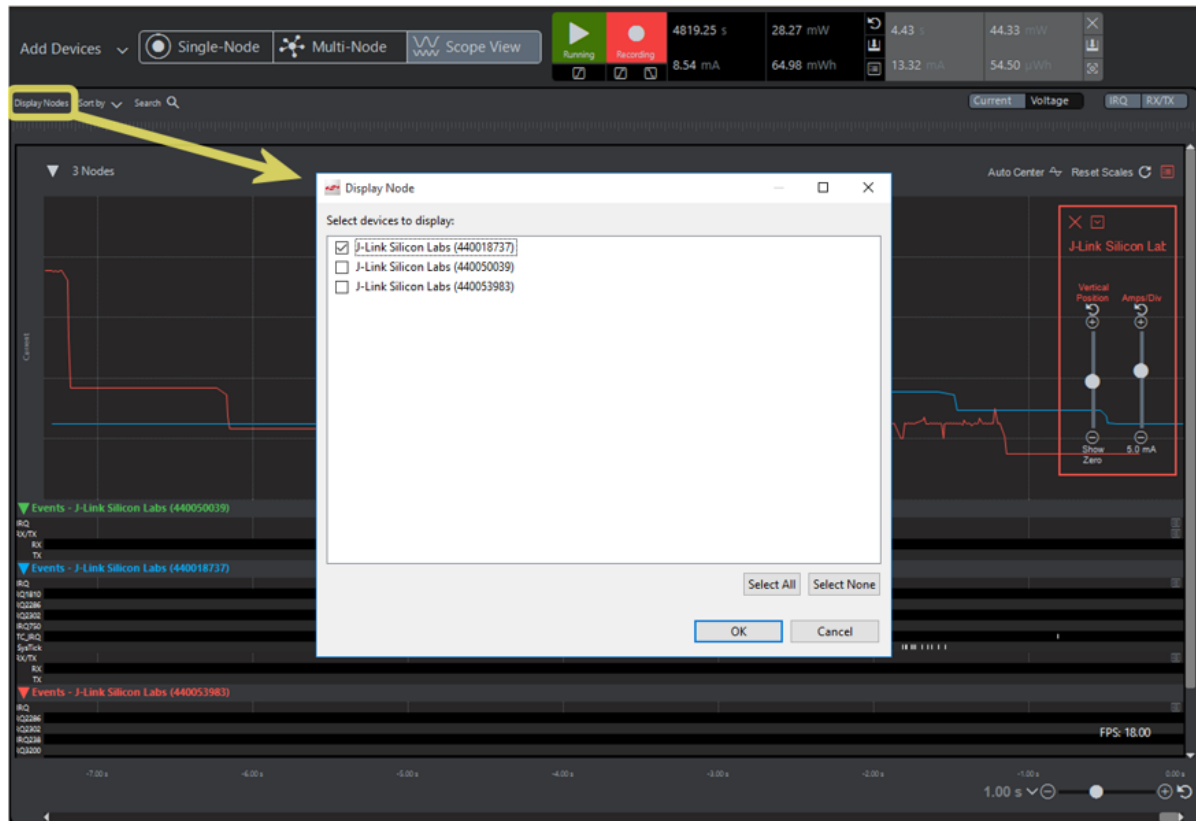
Sorting

Sorting in Scope view allows you to order events based upon several criteria. For example, it may be useful to sort events descending by average power, such that the events for the highest power consumers are easily identified at the top.



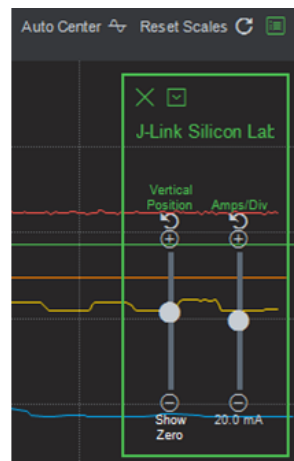
Displaying Nodes

Enabling capture on any device automatically adds it to scope view. However, as the number of devices displayed increases, UI performance may be impacted. Click **Display Nodes** to select which devices will be displayed. This selection only enables or disables display of waveform and event data in the UI. If recording is enabled, data for all actively capturing devices is streamed to disk regardless of whether they are displayed.

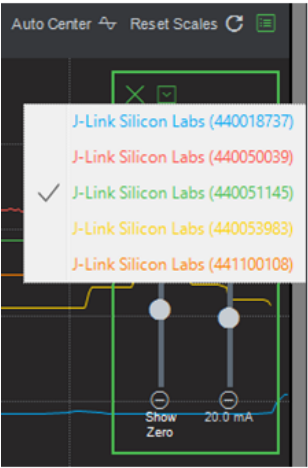


Displaying Waveforms

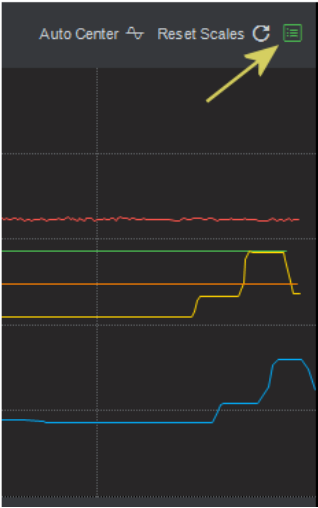
One of the Scope view's key benefits is the ability to view waveforms in a single view at difference scales, enabling you to compare waveform characteristics that would not be possible for two waveforms on the same scale. The waveform scale/offset controls are available by default at the upper right corner of the Scope waveform view. The color of the waveform scale/offset control indicates which waveform will be adjusted when the sliders are moved.



The drop-down menu at the top of the control allows you to select the device to be adjusted by the waveform scale and offset control. The debug adapter name colors match the colors in the waveform portion of Scope view.



Toggle wave scale/offset control display using the show/hide button above it.



Selecting Ranges

Energy Profiler provides the ability to select a range of data by clicking and dragging across the waveforms or events. This is useful for determining power statistics for regions of interest. Once a range is selected, a light gray section summarizing the energy statistics for the selected region is displayed. That section also allows you to re-center the selection in the waveform view if it has scrolled out of view and includes a button to close/deselect the region.



Energy Statistics

Energy Statistics

Energy Profiler calculates the following device and system statistics:

- Average current
- Average power
- Total energy

Statistics are provided for each individual device in the waveform's top bar on both Single-Node and Multi-Node views. The sum for all devices is provided in the top bar of Multi-Node Energy Profiler for all three views. Single-Node and Multi-Node views provide individual device statistics, while Scope view does not.



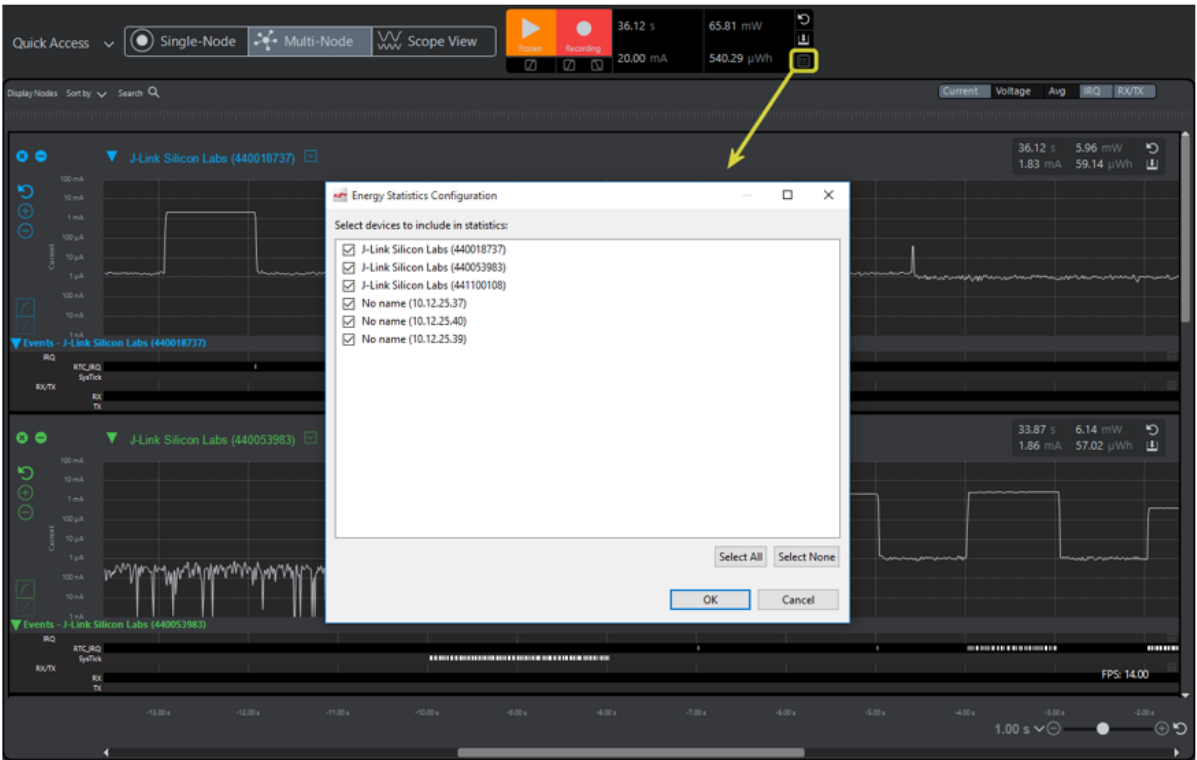
This page reviews how to:

- [Configure energy statistics](#)
- [Save a snapshot for future reference](#)
- [Review saved statistics](#)

Energy Statistics Configuration

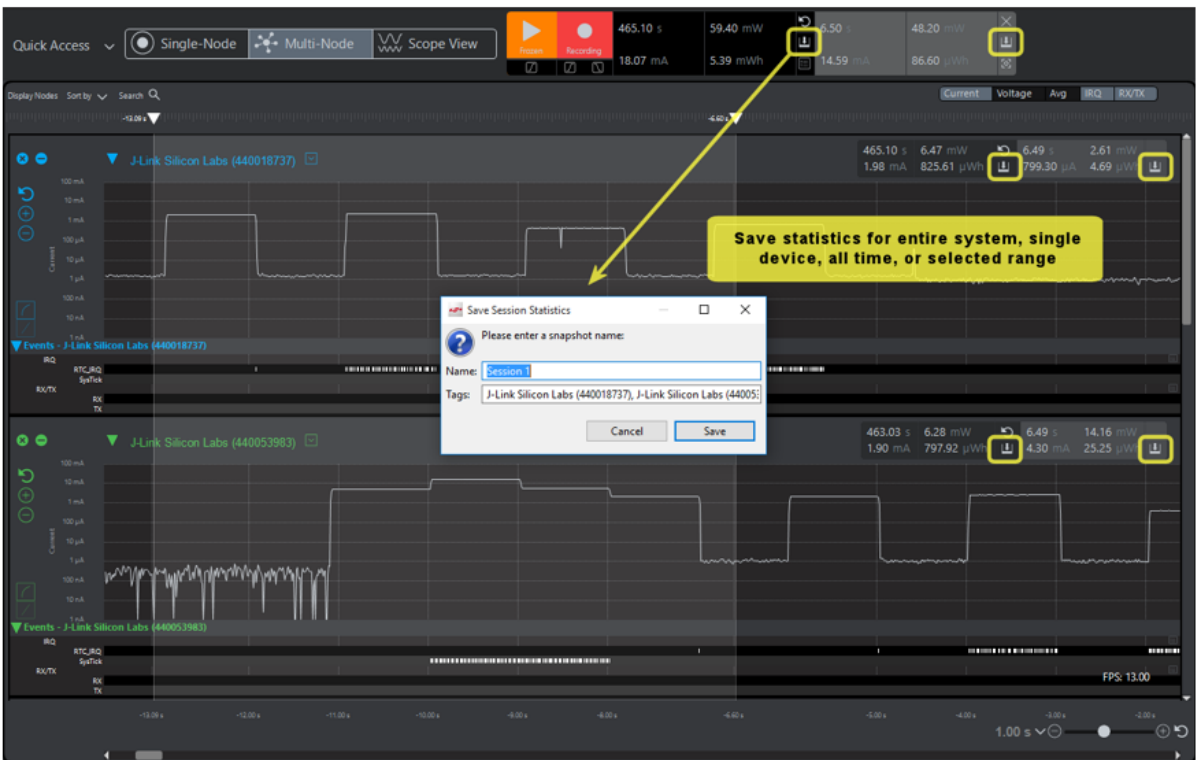
Energy Profiler allows you to select which of the actively capturing devices are included in the total system energy statistics calculation displayed in the top bar. Click the **Energy Statistics Configuration** icon and select the devices to be included in the

calculation. It is important to note that the devices available for selection are those that are actively capturing data, which may be different from the devices that are selected for display in the UI.



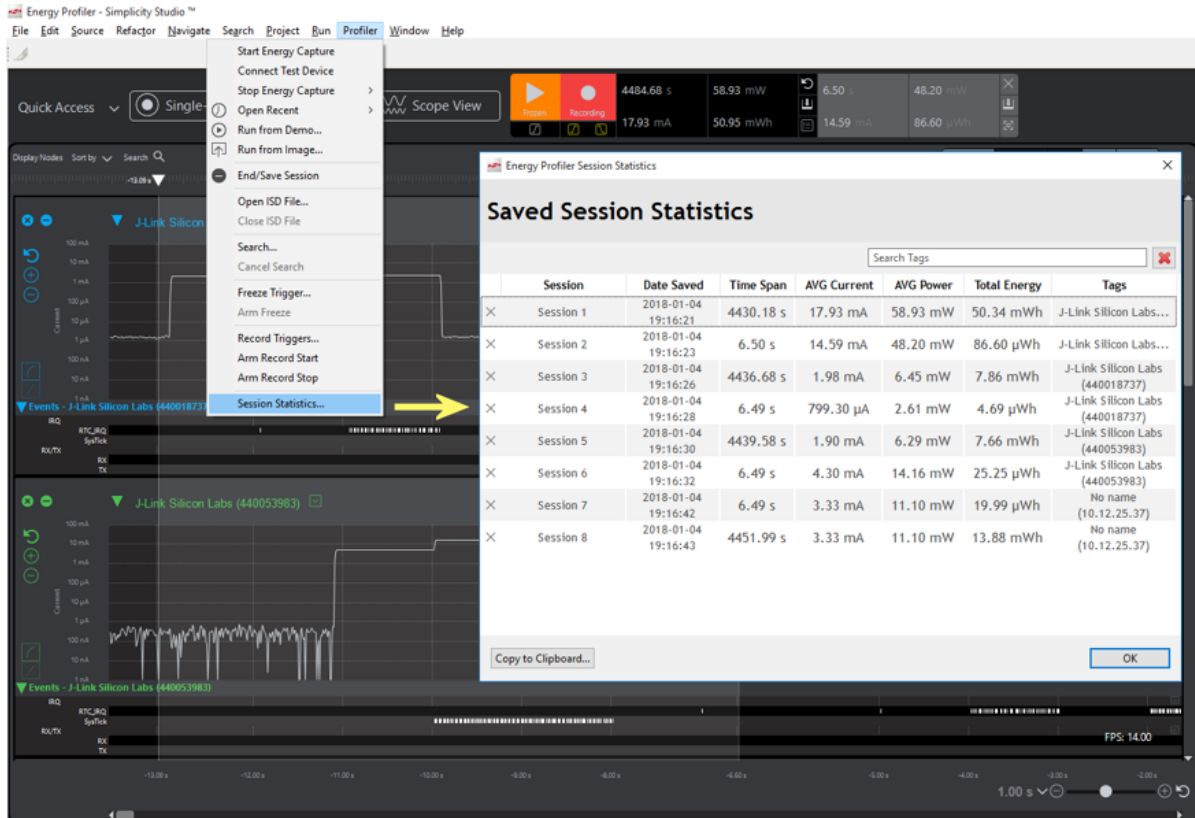
Energy Statistics Snapshot

Energy Profiler allows you to save statistics for future reference and comparison. Click the **Save Snapshot** icon on any of the energy statistics panels and be presented with a dialog to provide a name and tag for future reference.



Review Saved Statistics

Once you have saved multiple snapshots, you may want to review them, or to copy them to the clipboard for use in other applications. This is possible through the **Profiler->Session Statistics...** menu.



The screenshot shows the Energy Profiler - Simplicity Studio interface. The **Profiler** menu is open, and the **Session Statistics...** option is highlighted. A yellow arrow points from this menu item to the **Energy Profiler Session Statistics** dialog box.

The **Energy Profiler Session Statistics** dialog box displays a table of saved session statistics. The table has the following columns: Session, Date Saved, Time Span, AVG Current, AVG Power, Total Energy, and Tags.

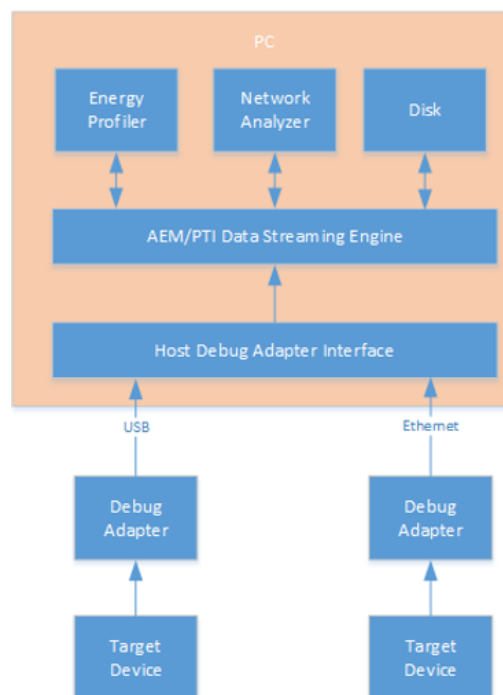
Session	Date Saved	Time Span	AVG Current	AVG Power	Total Energy	Tags
Session 1	2018-01-04 19:16:21	4430.18 s	17.93 mA	58.93 mW	50.34 mWh	J-Link Silicon Labs...
Session 2	2018-01-04 19:16:23	6.50 s	14.59 mA	48.20 mW	86.60 μWh	J-Link Silicon Labs...
Session 3	2018-01-04 19:16:26	4436.68 s	1.98 mA	6.45 mW	7.86 mWh	J-Link Silicon Labs (440018737)
Session 4	2018-01-04 19:16:28	6.49 s	799.30 μA	2.61 mW	4.69 μWh	J-Link Silicon Labs (440018737)
Session 5	2018-01-04 19:16:30	4439.58 s	1.90 mA	6.29 mW	7.66 mWh	J-Link Silicon Labs (440053983)
Session 6	2018-01-04 19:16:32	6.49 s	4.30 mA	14.16 mW	25.25 μWh	J-Link Silicon Labs (440053983)
Session 7	2018-01-04 19:16:42	6.49 s	3.33 mA	11.10 mW	19.99 μWh	No name (10.12.25.37)
Session 8	2018-01-04 19:16:43	4451.99 s	3.33 mA	11.10 mW	13.88 mWh	No name (10.12.25.37)

At the bottom of the dialog box, there is a **Copy to Clipboard...** button and an **OK** button.

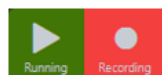
Play and Record Data Control

Play and Record Data Control

The following diagram provides a general description of data flow from target devices into SSV5 profiling applications. Data is sourced from target devices from the debug adapter either through USB or Ethernet connectivity to the host PC. The host debug adapter software layer provides data to the AEM/PTI data streaming engine, which in turn provides data to analysis applications such as Multi-Node Energy Profiler or Network Analyzer. The AEM/PTI data streaming engine saves data to disk in temporary files during a capture session. When the user ends the session, Energy Profiler prompts the user with the option to save the data to file.



[Play](#) and [record](#) controls in the top bar of the Energy Profiler perspective provide control over data being captured from connected devices.



Play Control

The Play control determines whether data being captured is displayed in the Multi-Node Energy Profiler UI. The Play control has three states:

- Running (green)
- Paused (black)
- Frozen (orange)



- **Running:** The "Running" state is entered when a capture is first started. When the Play control is green and displays "Running", it means energy capture data is actively arriving and being displayed on the UI. The visible portion of the waveform and events is the most recently captured data as it is arriving to Multi-Node Energy Profiler. The time position scroll bar is all the way to the right.
- **Paused:** The "Paused" state is entered by clicking **Play** while it is in the green "Running" state. The Play control turns black and displays "Paused", indicating energy capture data is actively arriving but it is not being displayed on the UI. The visible portion of the waveform and events may be anywhere on the timeline of previously captured data. Pausing the display has no effect on whether data is saved to disk. Save to disk is determined by the state of the Record control.
- **Frozen:** The "Frozen" state means energy capture data is actively arriving for display, but the visible portion of the waveform and events in the UI is previously captured data. The time position scroll bar may be anywhere on the timeline of previously captured data. The "Frozen" state is entered when the UI is in the play state and the time position scroll bar is scrolled or moved to the left. The "Frozen" state may also be entered as the result of a "Freeze trigger" condition. The "Frozen" Play control state has no effect on whether data is saved to disk. Save to disk is determined by the state of the Record control.

Record Control

The Record control manages data streaming to disk. There are two states to the Record control:

- Recording (red)
- Not recording (black)



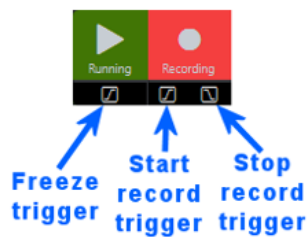
- **Recording:** When the Record control is red and displays "Recording", it means energy capture data is actively arriving and is being saved to temporary files to disk. When an energy capture is started, the "Recording" state is entered automatically. The state of the Record control has no effect on the Play control or the data being displayed in the UI. Clicking the Record control while in the "Recording" state transitions to the "Not Rec" state (that is, not recording). The "Recording" state may also be entered by use of Record triggers.
- **Not Recording:** When the Record control is black and displays "Not Rec", it means energy capture data is actively arriving but it is not being saved to disk. The "Not Rec" state is entered by clicking the Record control when it is in the "Recording" state. The state of the Record control has no effect on the Play control or the data being displayed in the UI. Clicking the Record control while in the "Not Rec" state will transition to the "Recording" state. The "Not Rec" state may also be entered by use of record triggers.

Freeze and Record Triggers

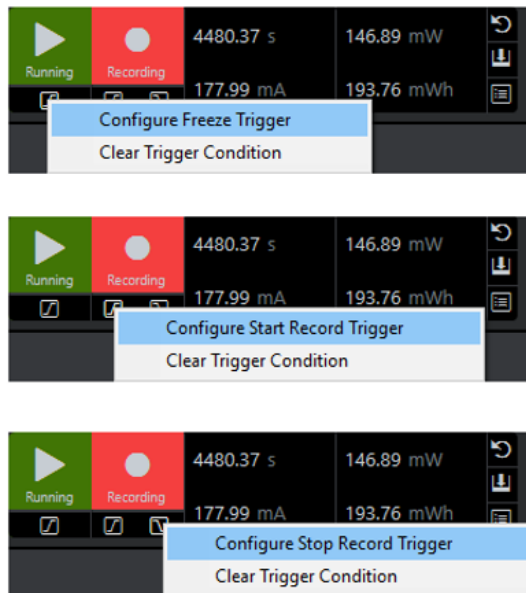
Freeze and Record Triggers

Triggers provide a method to automate freezing the display or recording to disk. Trigger icons are found below the Play and Record controls. Three triggers are available:

- [Freeze trigger](#)
- [Record start trigger](#)
- [Record stop trigger](#)



Triggers are driven by criteria set by the user. To set the criteria, use the context menu available from each trigger icon. The context menu also provides the ability to clear all conditions, which also disables the trigger.



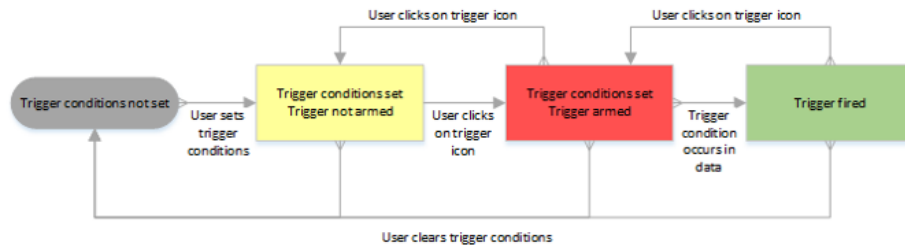
Trigger States

The four trigger states are each designated by a color:

- Grey - Trigger conditions are not set
- Yellow - Trigger conditions are set, trigger is not armed
- Red - Trigger conditions are set, trigger is armed

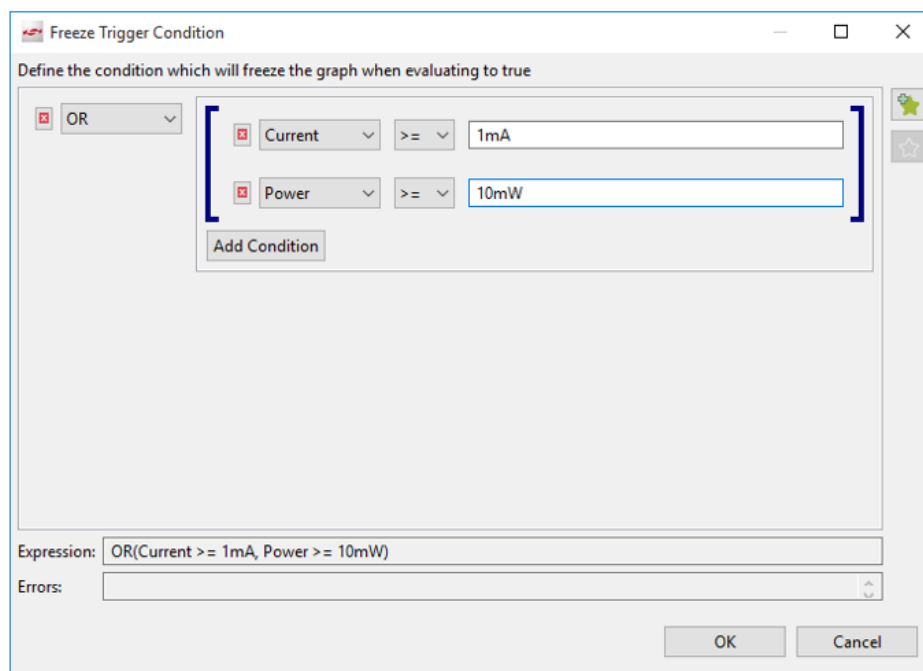
- Green - Trigger has fired

When Energy Profiler first starts up in a new workspace, all trigger icons are grey, indicating trigger conditions have not yet been set. Clicking a grey trigger icon opens the trigger configuration dialog, allowing you to specify trigger conditions. Once trigger conditions have been set, the trigger icon turns yellow, indicating the trigger conditions are set but the trigger is not armed. Clicking a yellow trigger icon arms the trigger as indicated by the trigger icon turning red. Incoming data is now evaluated against the trigger condition. Once the trigger condition is satisfied, the trigger icon turns green, indicating the armed trigger has fired. The relevant action (freeze, record start, or record stop) will have been executed. The following diagram shows the trigger state behavior.



Freeze Trigger

The freeze trigger transitions the user interface from play to freeze mode automatically based upon search criteria. The freeze criteria are set through the Freeze Trigger Conditions dialog. This is invoked either through the **Profiler > Freeze Trigger...** menu selection or by right-clicking the **Freeze Trigger** icon and selecting ****Configure Freeze Trigger**".

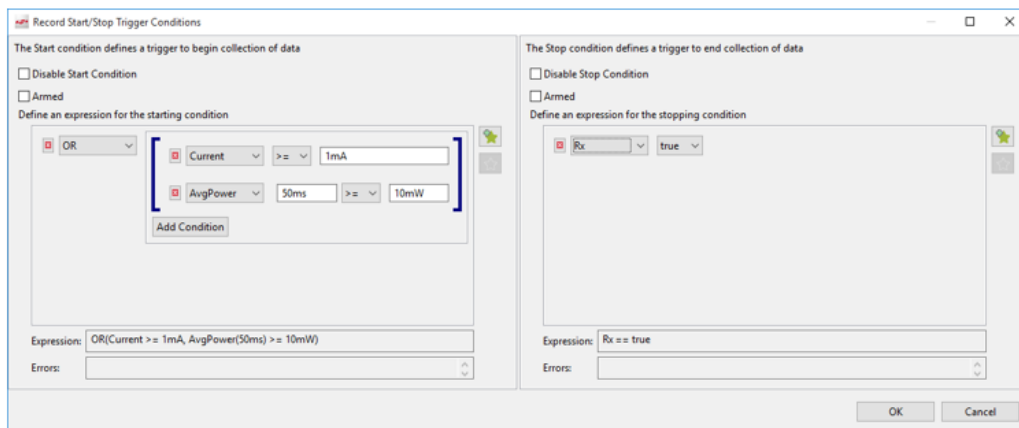


In the following diagram, the play freeze trigger condition has occurred in the incoming data. Freeze mode is automatically entered for the waveform display and data continues to arrive as indicated by the scroll bar automatically moving to the left as new data arrives. Notice that the freeze trigger icon is green, indicating the trigger condition has occurred in arriving data.



Record Start/Stop Triggers

The record start/stop triggers automatically start and stop data record to disk based upon search criteria. This may be beneficial for capturing rare conditions rather than recording large amounts of data followed by search. The record start criteria are set through the Record Start/Stop Trigger Conditions dialog, which is invoked through the **Profiler > Record Triggers...** selection" menu or by right-clicking the **Record Start** or **Record Stop** icon and selecting the **Configure** option. The record start/stop trigger conditions are set together in a single dialog as shown in the following figure.



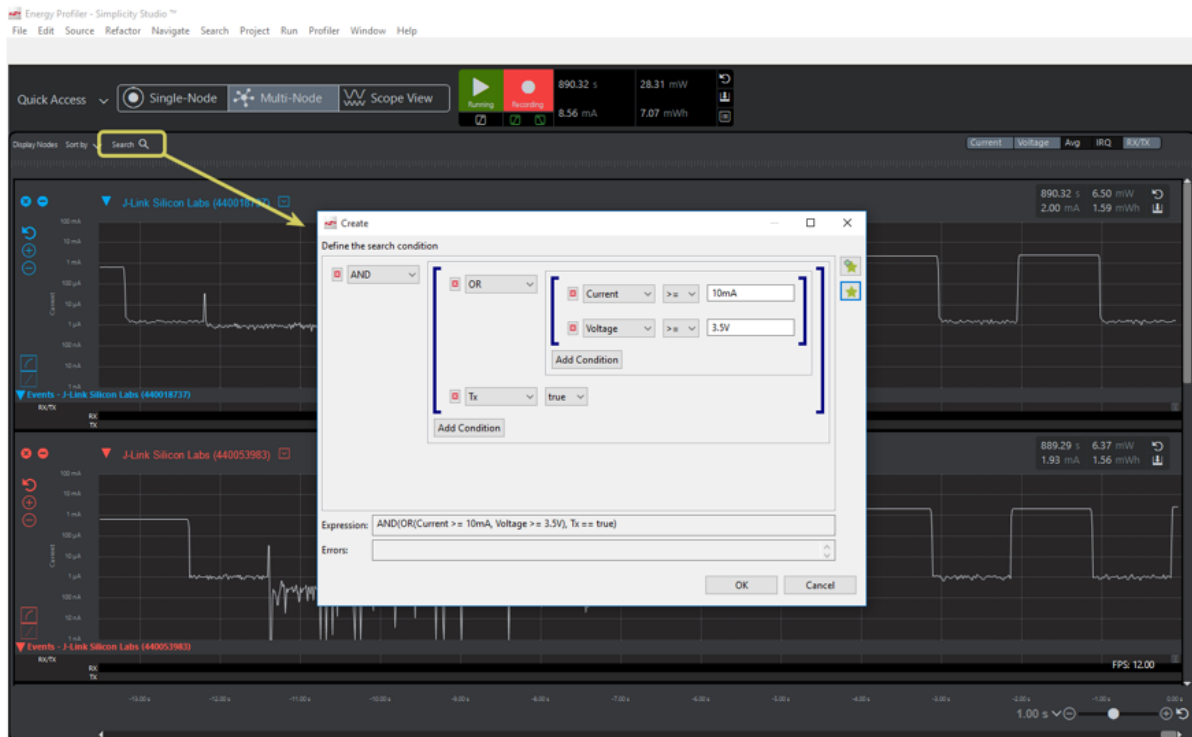
In the following figure, the record start trigger condition has occurred in the incoming data as indicated by the green record start trigger icon. The record stop trigger condition has not yet occurred and data will be written to disk until it does.



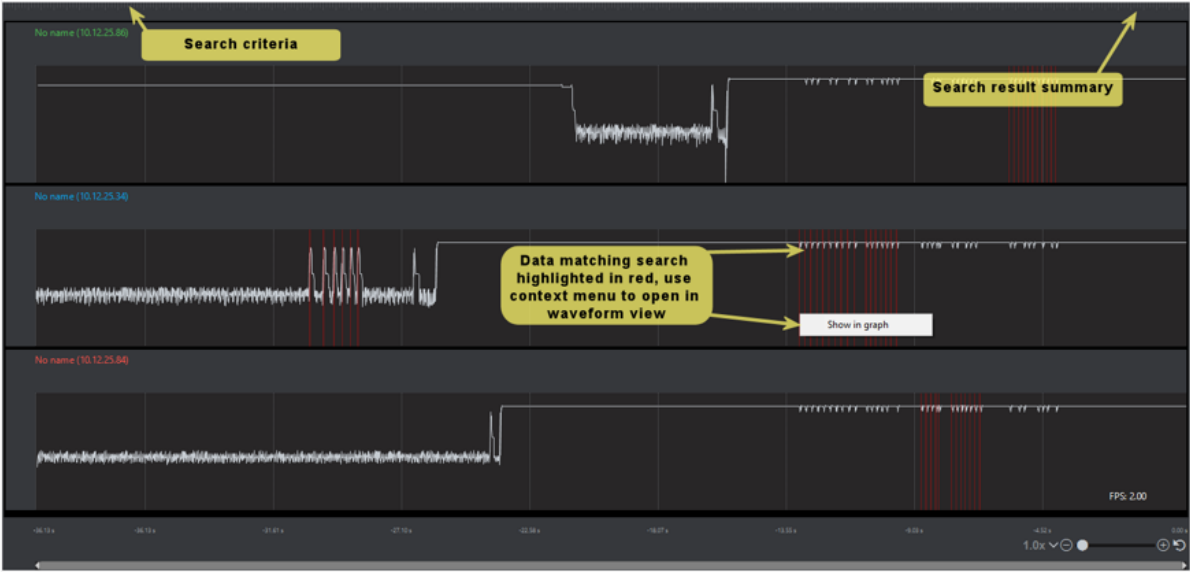
Search Capability

Search Capability

One of Energy Profiler's most powerful aspects is the ability to search data. Search is available both during a live capture and with an offline ISD file. Click **Search** to open the Search Conditions dialog.



When you click **OK**, a search is performed on all data currently available, whether from the currently active capture or in offline mode from an open file. The search results window is displayed on completion. Sections where the data matched the criteria are shown in red. A summary of the count and % coverage of the matching regions is shown at the upper right. Use the context menu to jump to the matching in the waveform view from the search results window.



Profiling with Code Correlation

Profiling with Code Correlation

Code correlation is one of the most powerful features in Energy Profiler. Energy Profiler captures program execution in conjunction with the energy data. This allows Energy Profiler to calculate the power consumed by each function executed in the application. This data may then be sorted to highlight the portions of an application that consume the most power. This enables the application developer to know where they should concentrate their software development efforts to reduce power consumption. Additionally, Energy Profiler can color-code sections of the current waveform to represent which functions were executing when a given section of the current waveform occurred.

This page reviews:

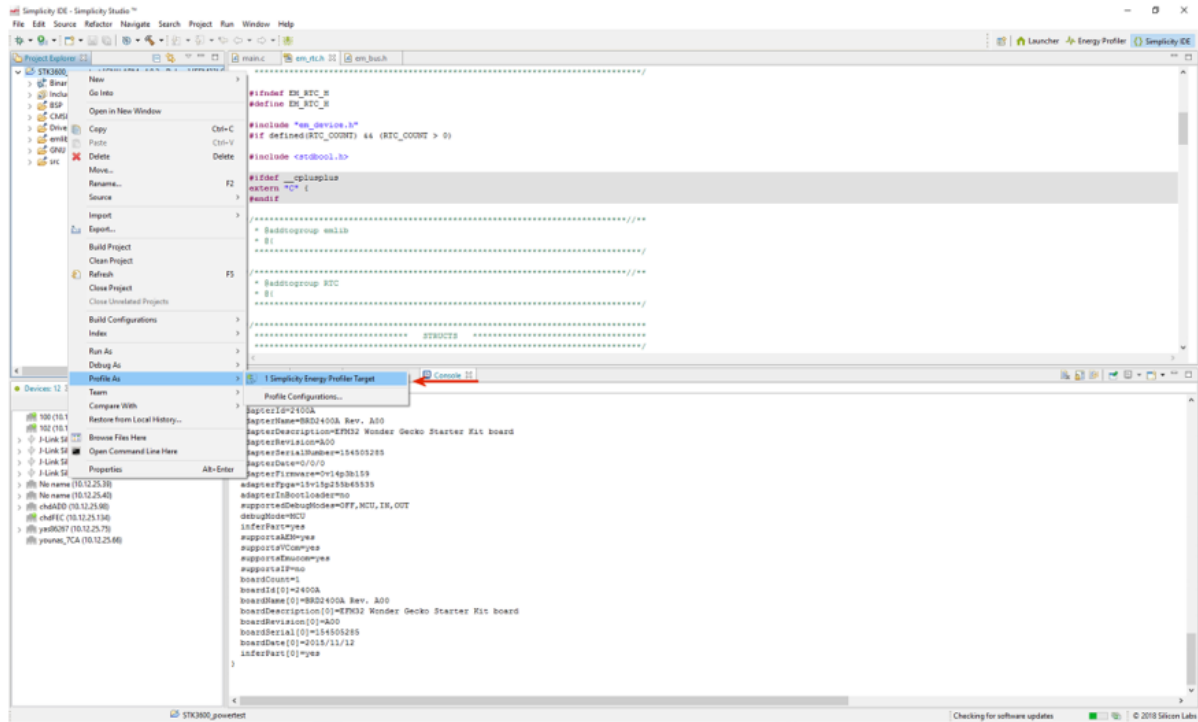
- [Enabling code correlation](#)
- [The Code Correlation view](#)
- [Color coding](#)

Enabling Code Correlation

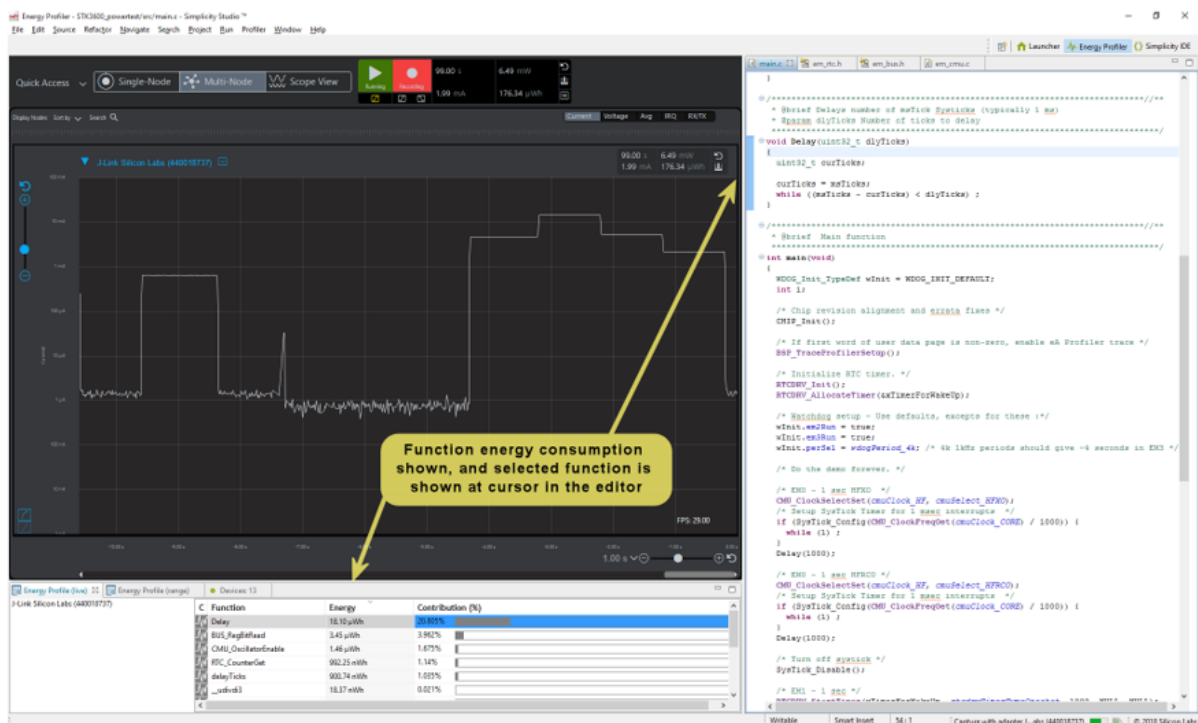
This section assumes an embedded application is already configured to produce AEM data through a debug adapter (see [Customer Hardware and Software Design Information](#) for details). For code correlation to operate, Energy Profiler needs access to debug information associated with the embedded application that is currently running. This information is available in the AXF file output from the build. Code correlation can be enabled when an application is started from the Simplicity IDE perspective through context menu commands for a given project, or it can be associated with an application already running on an embedded device that is being profiled in Energy Profiler.

From the Simplicity IDE Perspective

One simple way to enable the code correlation view is to start the energy profiling session by using the context menu on the project from the Simplicity IDE perspective, as shown below. The associated debug file will be provided to Energy Profiler when the session is started.

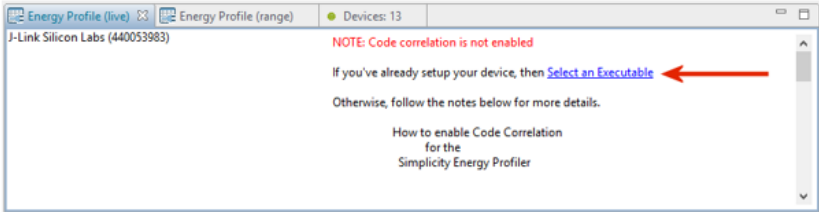


Once Energy Profiler starts, the following view is displayed. Notice in the Code Correlation view, energy consumed by each function is updated in real time. Clicking any of the functions opens the associated source code file and jumps to that function in the file.

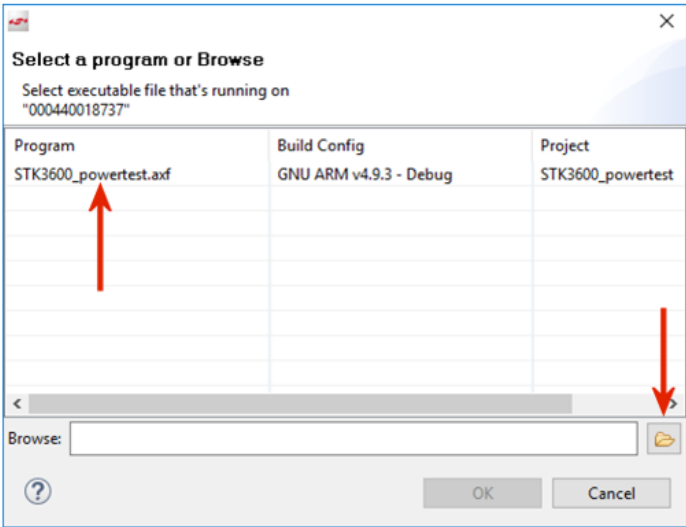


From Energy Profiler

If you start energy capture with a running embedded application, Energy Profiler does not have the debug information it needs to associate program execution with source code. In these cases, the Code Correlation view is as shown in the following figure.

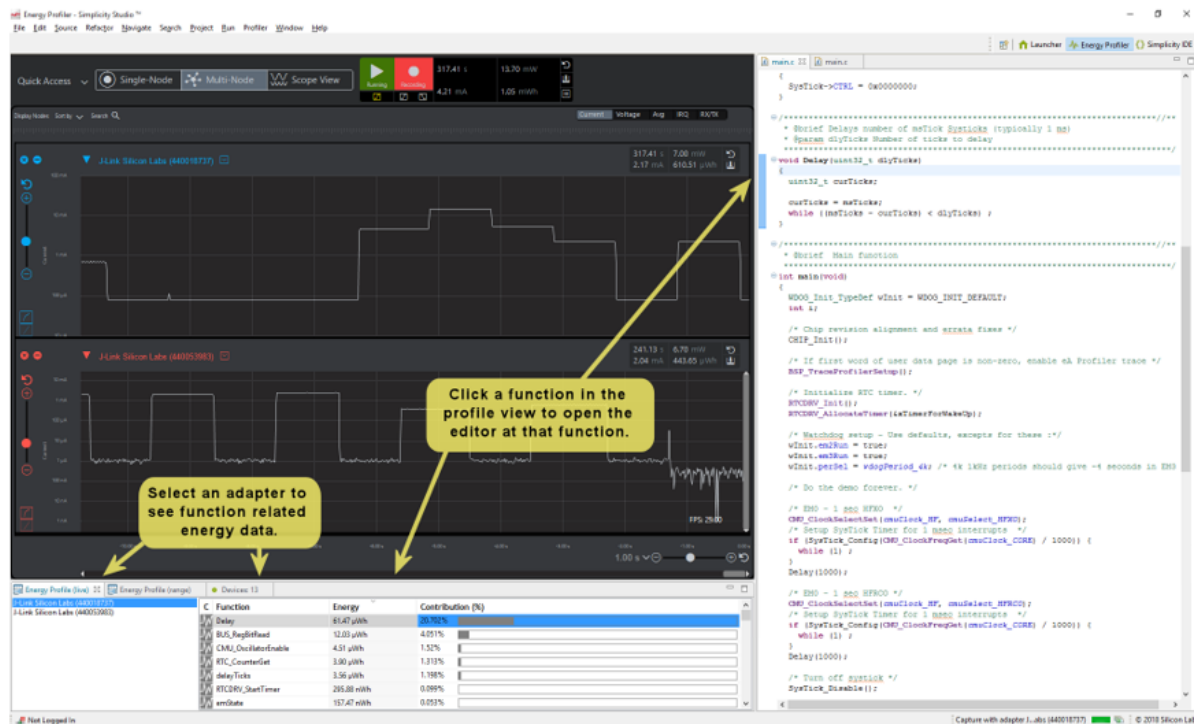


Click the **elect an Executable** link and the program selection dialog is displayed. Debug files from open projects are provided in the list. Alternatively, you may browse to select the debug file.



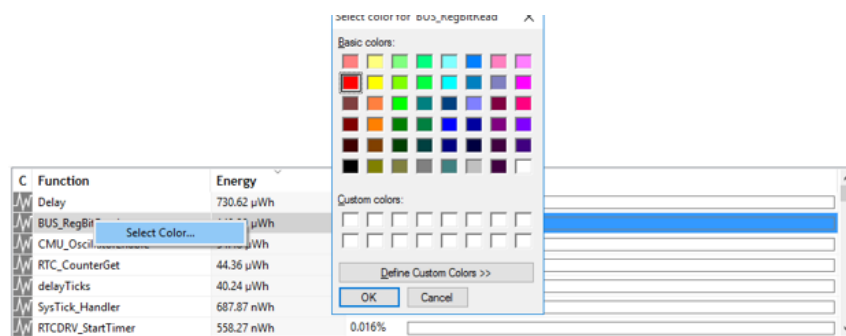
Code Correlation View

The Code Correlation view is shown below the waveform portion of the Multi-Node Energy Profiler Perspective, and works in conjunction with the Editor view. When multiple devices are displayed in the Multi-Node view, you can click on each adapter to view the function profile data associated with that device. The function data may be sorted as desired. Clicking on any function opens the associated source file in the Editor view with the start of scope for that function selected.

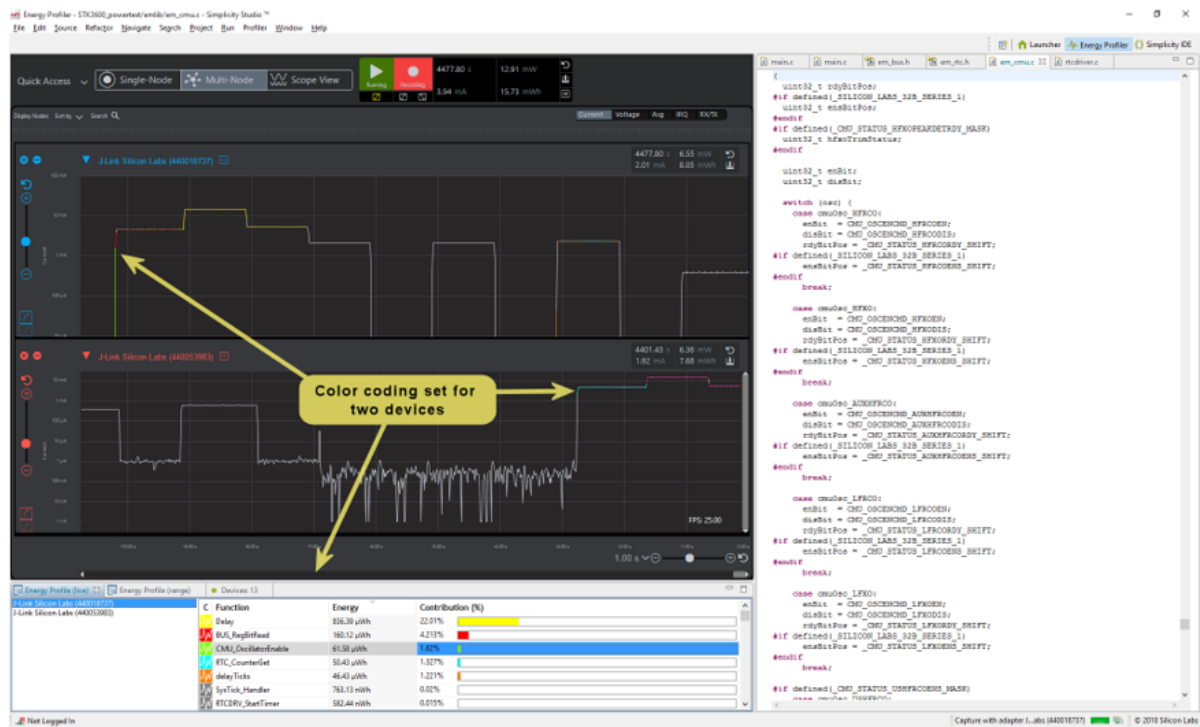


Color Coding and Code Correlation

Energy Profiler provides the ability to color-code the current waveform based on program execution. You can set the color for each function using the context menus in the Code Correlation view.



The following figure shows the current waveform view with several functions set to different colors.



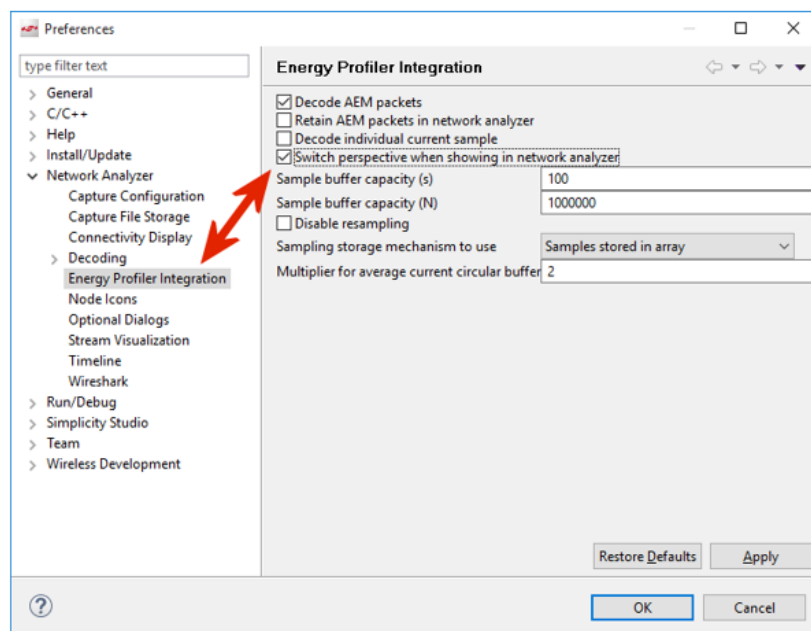
Energy Profiler and Network Analyzer

Energy Profiler and Network Analyzer Integration

Note: This functionality is only available in offline mode with a previously saved ISD file.

Energy Profiler and Network Analyzer now provide a basic level of integration when trace data from a debug adapter includes both AEM and PTI data. This integration allows you to easily move between the two applications by selecting an event in either one and selecting **Show in Network Analyzer** or **Show in Energy Profiler**.

An SSv5 preference determines whether moving between applications leaves the Energy Profiler perspective and opens the Network Analyzer perspective, or stays in the Energy Profiler perspective.

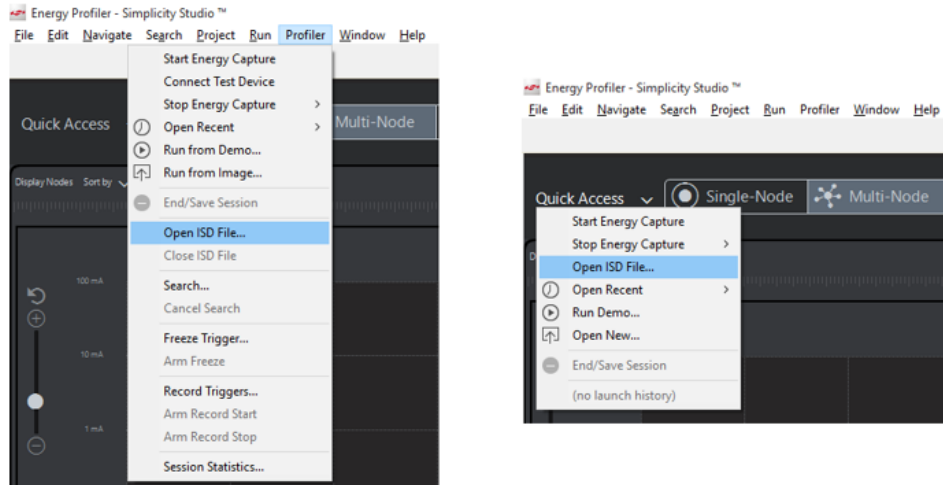


This page reviews:

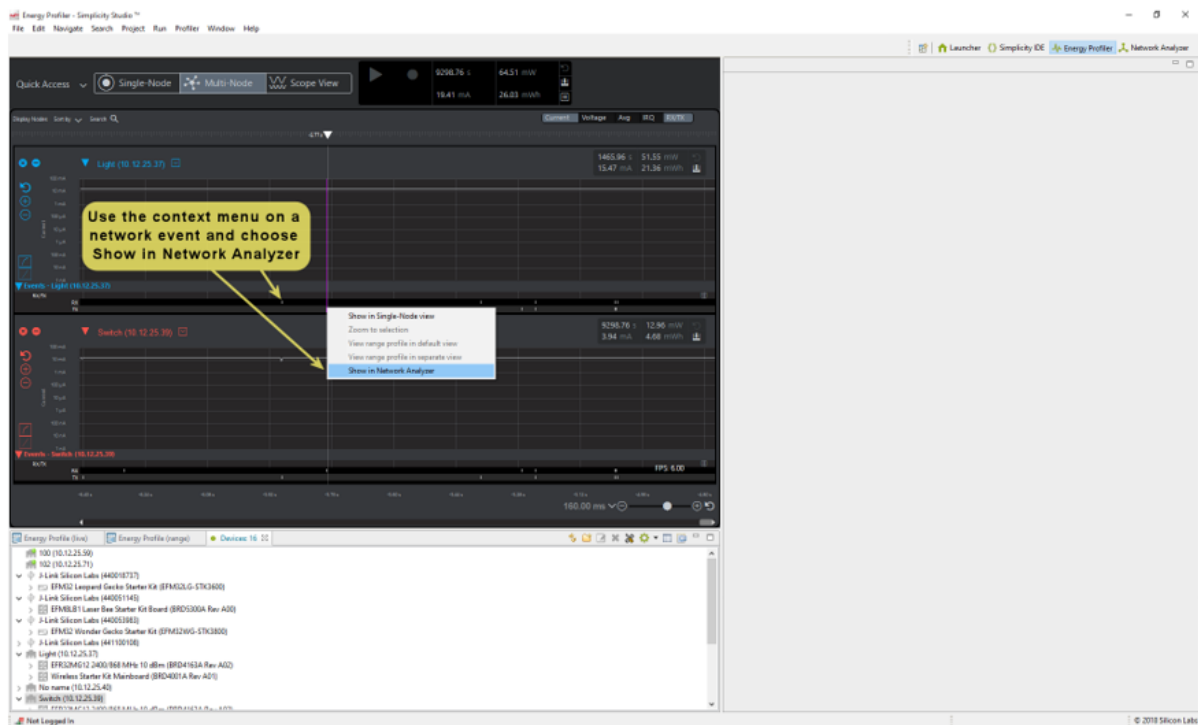
- [How to use the integrated tools](#)
- [Use Cases for Multi-Node Energy Profiler and Network Analyzer](#)
- [Post analysis using an ISD file](#)

Using the Integrated Tools

To open a previously saved ISD file, either use the top menu **Profiler > Open ISD File...** menu or the **Quick Access > Open ISD File...** menu, as shown in the following figure.



Once the file is open, you can examine previously recorded details. In the following figure, notice two devices transmitting and receiving packets. Select a TX or RX event and display the context menu. One of the options is **Show in Network Analyzer**.



Select that option and the Network Analyzer view opens either in the Energy Profiler perspective or the Network Analyzer perspective, based upon the preference setting.

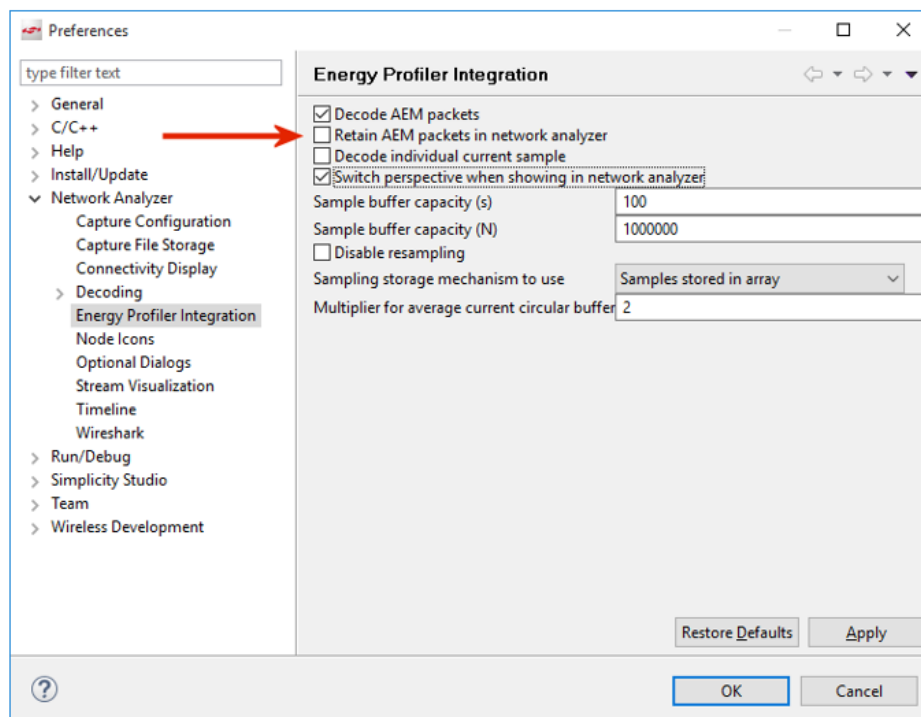
When you are interested in energy consumption of a single or multiple devices, Energy Profiler is where you will focus your time. From a network communication perspective, it provides only the start time of a TX or RX packet, and does not provide any decoding of the packets themselves. Still, this information can be revealing in your application's consumption of power relative to network activity. For example, by using the search tool, you can set search criteria that identify all points in the data where a packet was transmitted and the power exceeded a given value. If you have an expected power performance based upon your design, you can quickly identify when your system is operating outside its specification.

If you are interested in packet contents, node activity, and network interaction in a wireless network, Network Analyzer is where you will focus your time. Network Analyzer's multiple editor panes provide tiered displays of network activity, letting you drill down from a high-level map of node interactions to the details of each packet. Customizable filters enable you to specify exactly which network activities to display, allowing you to sift out information unrelated to a given task. These features allow you to determine when your network is behaving as expected, but are not available in Energy Profiler.

You will find yourself benefitting from the integration of these applications where these two information spaces intersect. For example, the Energy Profiler use case mentioned above ended at finding a transmit packet that exceeded expected power consumption. To investigate further, you could select **Show in Network Analyzer** to investigate that specific node's network activity and packet contents, in hopes of determining why the power was higher for that particular network transaction. In contrast, you may suspect that packets with specific content are the root cause of high power consumption. In Network Analyzer you could search for that data, and use **Show in Energy Profiler** to determine if indeed those packet contents are the root cause of high power consumption.

Post Analysis Using an ISD File

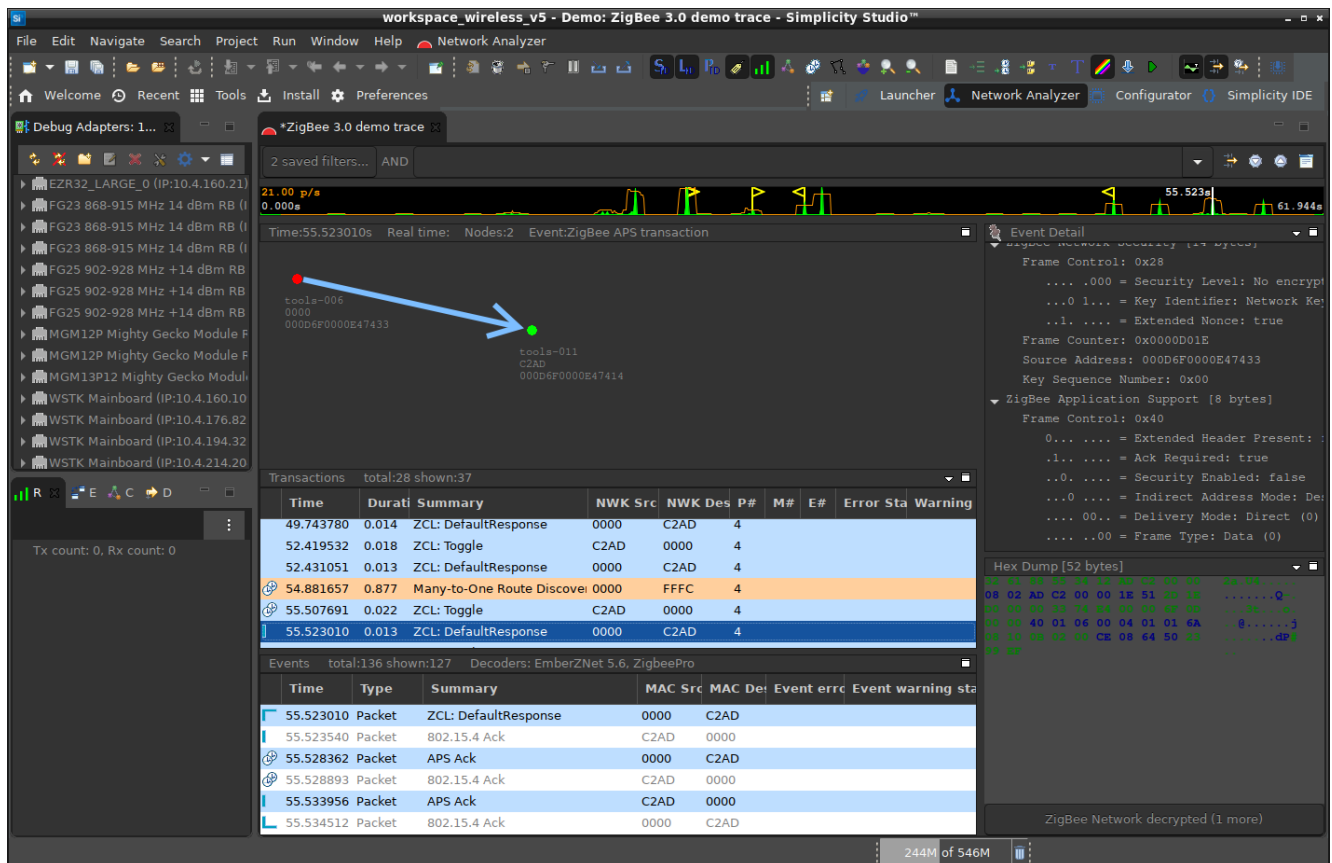
Both Network Analyzer and Energy Profiler capture data in the same format, which are saved in the ISD file format. Both applications can open an ISD file that has been save by either application. For example, if you have completed an Energy Profiler session and saved the ISD file, only to realize later that you are interested in the packet trace information, you would open that file from Network Analyzer to further investigate it. It is important to note, however, that captures started in Energy Profiler include packet trace data by default, but captures started in Network Analyzer only contain energy data if the preference to include it has been selected, as shown in the following figure.



Network Analyzer

Network Analyzer

Simplicity Studio® 5 (SSv5)'s Network Analyzer enables debugging of complex wireless systems. This tool captures a trace of wireless network activity that can be examined in detail live or at a later time.



More than simply a packet sniffer, the Network Analyzer works with the data sniffer interface on the Silicon Labs wireless chips to provide direct feedback from the baseband radio of each device, allowing any supported radio to report detailed packet transmission and reception data, such as timestamps, link quality (or LQI), receive sensitivity (or RSSI), and CRC pass/fail results, all without any software overhead.

With SSv5, any PTI-enabled Silicon Labs platform can record the radio activity regardless of the application firmware that is being used, so there's no need to have a dedicated sniffer device installed to catch the traffic. The Network Analyzer also enables capture from multiple sources simultaneously into the same log file without falsely duplicating packets. This enables the developer to compare how well different radios in the network heard the same transmission.

In cases when detail is not desired, Network Analyzer makes it easier to understand the workings of a complex wireless protocol. Related packet events are automatically grouped into a Transactions pane within the capture view, allowing for quicker parsing of what's happening during that portion of the traffic log. Quickly access statistics like total duration, number of related packets, number of point-to-point and end-to-end retries, and unexpected conditions like requests with missing responses or deliveries where expected acknowledgments are missing.

In addition to capturing packet events, Network Analyzer also captures asserts, debug prints, and many other events.

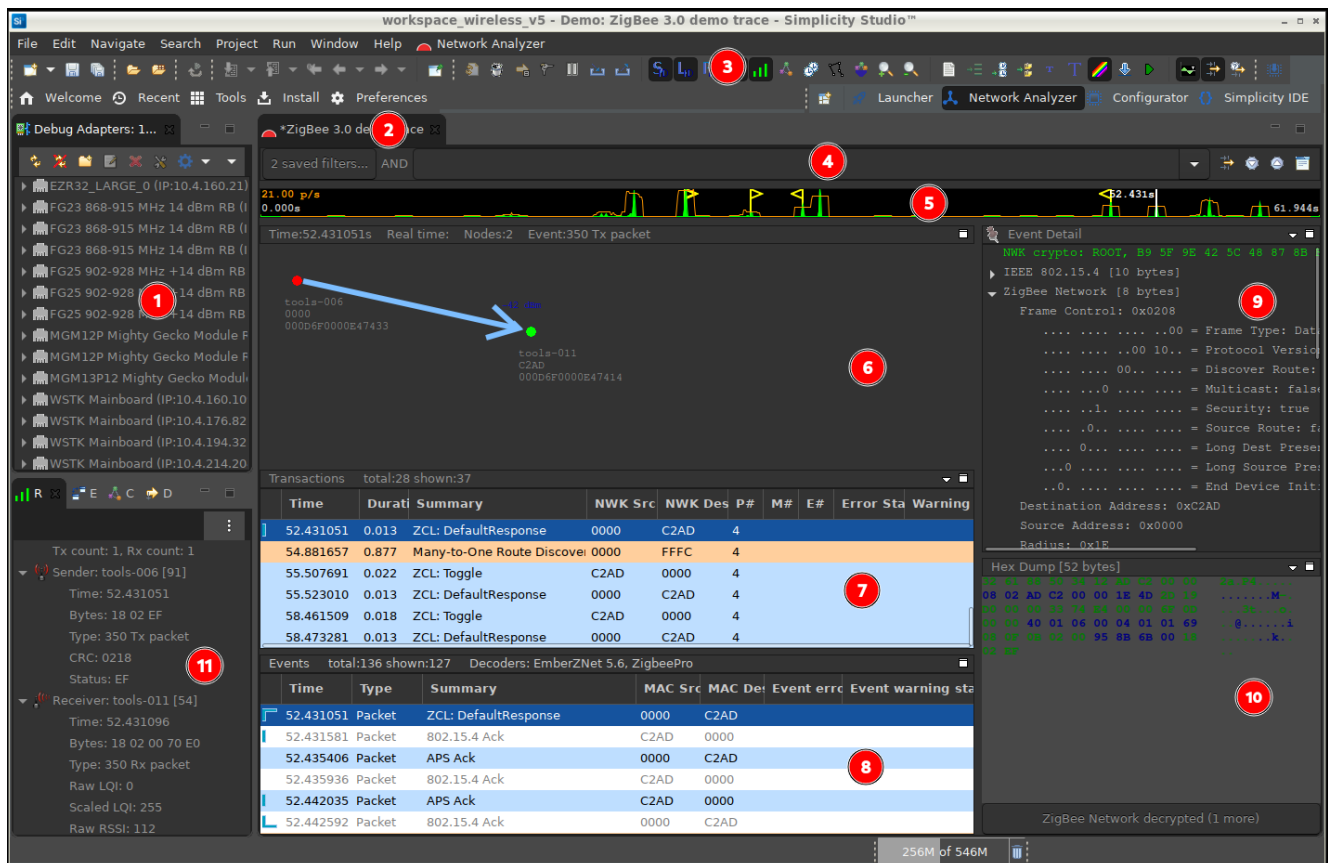
This guide contains the following sections:

- [Network Analyzer Interface](#): Provides a guided tour of all elements of the Network Analyzer Perspective.
- [Capturing Data and Managing Sessions](#): Describes how to perform live captures, and save and manage the resulting data.
- [Viewing Data in Editors](#): Goes into detail about working with the data presented in both the Stream Editor and the Large File Editor.
- [Filtering Captured Data](#): Explains how to focus on exactly what you need from a Network Analyzer session.
- [Multinetwork Considerations](#): Discusses how to manage nodes that belong to more than one network.
- [Custom Decoders](#): Explains the basics of how to create custom decoders.
- [Network Analyzer Preferences](#): Provides a reference for the many ways you can customize Network Analyzer to meet your needs.

Network Analyzer Interface

Network Analyzer Interface

The Network Analyzer Interface is presented as a Network Analyzer perspective.



The Network Analyzer perspective contains the following work areas:

- **Debug Adapters view (1)** - Lists all debug adapters and their connected hardware that are accessible to Network Analyzer. See [Simplicity IDE User Interface Review](#)
- **Capture sessions (2)** - Contain data captured from a node or set of nodes, with each session shown as a tab, and a live session shown in a ***Live** tab.
- **Editor Panes** - Display the data of a selected capture session in the editor area with up to five different panes. Network Analyzer supports two types of capture sessions:
 - **Live sessions** - Display data as it is captured; the display is continuously refreshed as new data arrives.
 - **Saved sessions** - Contain captured data that has been saved to permanent storage in a named .isd file. You can load a saved session and play it back at any time.
- **Toolbar and Menu (3) and Supporting Views (11)** - Provide options to control data capture and display.

A filter Bar (4) allows you to enter data filters, as described in [Filtering Captured Data](#).

A Timeline Bar (5) displays the statistics of the traffic over time, as discussed in [Viewing Data in editors](#)

The **Views area** (11) displays additional views in a tabbed interface.

Editor Panes

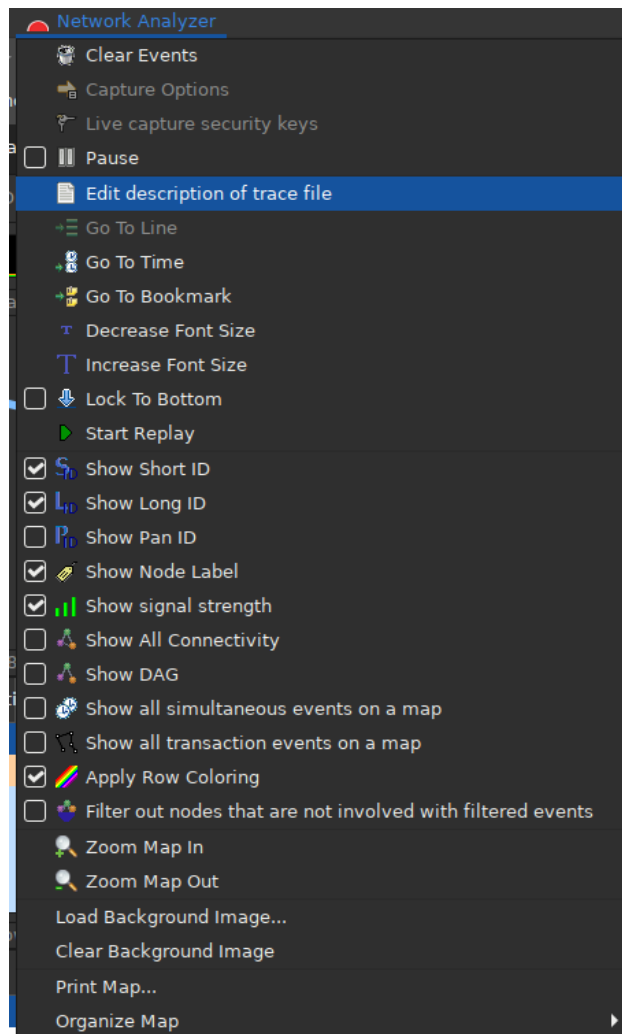
Editor panes provide different aspects of capture session data. Up to five editor panes can be open at any one time:

- **Map** (6) provides a graphical view of the network, where nodes are displayed with their network identifiers. The map also displays network activity.
- **Transactions** (7) displays high-level node interactions that might comprise multiple events.
- **Events** (8) displays information about all events transmitted and received during a capture session.
- **Event Detail** (9) displays the decoded contents of the event that is currently selected in the Events pane.
- **Hex Dump** (10) displays the data of the selected event in raw bytes. Network Analyzer highlights bytes that map to the data currently selected in the Event Detail pane. It shows multiple "layers", so if the packet is decrypted, the "raw" layer shows encrypted data, but the higher-level layers show this data progressively decrypted.

Using the editor is discussed in more detail in [Viewing Data in Editors](#)

Toolbar and Menu

The Network Analyzer Toolbar and Menu provides shortcuts to frequently-used features. Selections and controls are either enabled or disabled depending on what the user is doing.



On the toolbar, hover over any control to see a short description.

The following describes the controls in order from left to right. Where the function is also available on the Network Analyzer menu, it is so noted.



Network Analyzer toolbar controls are added to the controls already present in the Simplicity IDE. See [About the Simplicity IDE](#) for more information. This section provides Network Analyzer-specific information, if any, about those controls.

Open File - Opens a file dialog from which the user may select one of the applicable extensions, such as .isd, or .log. Equivalent to File > Open File (Network Analyzer Trace, Energy Profiler, etc.).

Open Capture Directory - Opens the folder to which an output file has previously been saved. Equivalent to File > Other Network Analyzer Actions > Open Network Analyzer Capture Directory.

Restart a Process - Simplicity IDE function.

New - Creates a new project or other file. Equivalent to File > Other Network Analyzer Functions > New Live Capture Session.

Save (Ctrl+S) - Saves any changes to the currently opened file to disk. If the file has never been saved before, the user can say where they want it saved and what extension they want to give it. If the file was previously saved, Network Analyzer saves over the old file.

Save All (Ctrl+Shift+S) - Saves all files that have been edited, including any files open elsewhere in Simplicity Studio. As with Save, the user has the option to indicate where and how to save any files that have never been saved.

Next Annotation and **Previous Annotation** - Simplicity IDE function.

Last Edit Location - Simplicity IDE function.

Back and **Forward** - Simplicity IDE function.

Pin Editor - Simplicity IDE function.

Reopen Editor - Closes and reopens the editor. When you have changed or added new decryption keys to the preferences, it is useful to be able to reopen the file and run it through the decryptors and decoders again.

Clear Events - Clears the editor of all events. This is useful when you are capturing on a network and are waiting for some set of events to occur but do not want to keep everything else around.

Live Capture Options - Opens the [Capture Options](#) dialog, used to tailor the condition under which events will be captured.

View and Modify Security Keys (Toolbar and Menu) - Opens the **Active live capture keys** dialog, where you can add security keys to be used during the current capture in progress. Any keys that are added will also be added to the list of security keys in the Network Analyzer preferences.

Pause Stream (Toolbar and Menu) - Pauses a capture without stopping it. This is useful to stop capturing for period of time, and then later continue as if nothing happened. Live events occurring during a pause are not retrievable.

Import - Select files to import and the type of import. Additional fields allow you to specify characteristics of the import. Equivalent to File > Network Analyzer Import.

Export - Select the exporter to use, and the output file name and location. Other options depend on the exporter. Equivalent to File > Network Analyzer Export.



Show Short Id (Toolbar and Menu) - Displays a node's shortId on the map, if one is known for the currently selected time.

Show Long Id (Toolbar and Menu) - Displays a node's long Id (64 bit identifier) on the map, if one is known.

Show Pan Id (Toolbar and Menu) - Displays the pan Id on the map, if one is known for the currently selected time.

Show Node Label (Toolbar and Menu) - Displays the node's label. If the node is connected to Network Analyzer over the backchannel, this value will be the host name of the adapter connected to the node.

Show Signal Strength (Toolbar and Menu)

Show All Connectivity (Toolbar and Menu) - Shows the quality of connections between nodes on the map.

Show all Simultaneous Events on Map (Toolbar and Menu) - During periods of heavy traffic, several simultaneous transactions may overlap. When enabled, the map shows all traffic. When it is disabled (default), the map shows only the traffic related to the currently selected transaction.

Show All Transactions on Map (Toolbar and Menu) - When enabled, all transactions that overlap with the currently selected one are shown on the map.

Filter Nodes (Toolbar and Menu) - Filters out nodes that are not involved with the filtered event.

Map Zoom In and **Map Zoom Out** (Toolbar and Menu) - Increases and decreases the size of the map in the map page. Zooming in can be useful if you are looking at a very large network where a large number of nodes are positioned very close together.

Edit Trace File Description (Toolbar and Menu) - Each saved Network Analyzer trace file contains a description. The description can be used to store information that is important to the trace but may not be included by default. Generally the description is used to provide context for the trace and any other information that may be of help to the viewer. A checkbox on the dialog determines if the description is shown when the file is loaded.

Go To Line (Toolbar and Menu) - Moves the event cursor directly to the event number entered. This is only enabled if the Stream preference "Show event numbers" is selected. To turn this feature on go to: Window > Preferences > Network Analyzer > Capture Configuration > Show event numbers.

Go to Time (Toolbar and Menu) - Moves the cursor to the transaction and event that match or immediately follow the specified time.

Go To Bookmark (Toolbar and Menu) - Moves the event or transaction cursor to the bookmark selected in the bookmark dialog. Assign bookmarks to events or transactions by right-clicking the event or transaction and selecting **Add Bookmark**.

Decrease Font Size and **Increase Font Size** (Toolbar and Menu) - Decreases and increases the size of the font used in the Event, Transaction and Detail panes.

Apply Row Coloring (Toolbar and Menu) - Turns coloring on and off in the Transaction and Event panes. Row colors are applied based on the pre-defined filters included in the [Filter Manager](#).

Lock To Bottom (Toolbar and Menu) - Locks the event cursor to the bottom of the Event pane. During a live capture, this causes the Map and Details panes to always show the latest event. To remove the lock, select any event or transaction during a live session, which causes a view to scroll as the events are captured.

Start Replay (Toolbar and Menu) - Begins scrolling forward through events from the current event selected. If no event is selected, the scrolling will begin from the start of the current trace file. Once replay has started, converts to a **Stop Replay** function.

Timeline Bar - Toggles the [timeline](#) shown at the top of the currently opened Stream Editor.

Toggle Filter Bar - Toggles the [Filter Bar](#) at the top of the currently opened Stream Editor.

Show Filter Manager View - Toggles the [Filter Manager View](#).

The following are selections on the Network Analyzer menu that are not on the toolbar:

Show DAG - Shows the connectivity DAG from the captured neighbor DAG events. Applies only in cases when the networking stack is instrumented with the correct abilities.

Load Background Image and **Clear Background Image** - Loads and clears a background image on the map pane. Also available on the Map pane context menu.

Print map - Prints the nodes as currently displayed in the map pane.

Organize map - Organizes the nodes on the map into a Default, Random, Square, or Hexagonal placement. Also available on the Map pane context menu.

Other Views

Network Analyzer provides access to a wide range of functionality through the use of views. The views are all accessible in the menu **Window > Show View**. For a complete listing of all available Views, select **Window > Show View > Other...**

The following lists some of the most helpful views. The first four are open in the Views area by default.

Radio Info - The Radio Info View shows data captured for each event, as discussed in [Radio Info View](#).

Event Difference - Event Difference view is a helper view that displays the specific differences between two packets, as discussed in [Event Difference View](#).

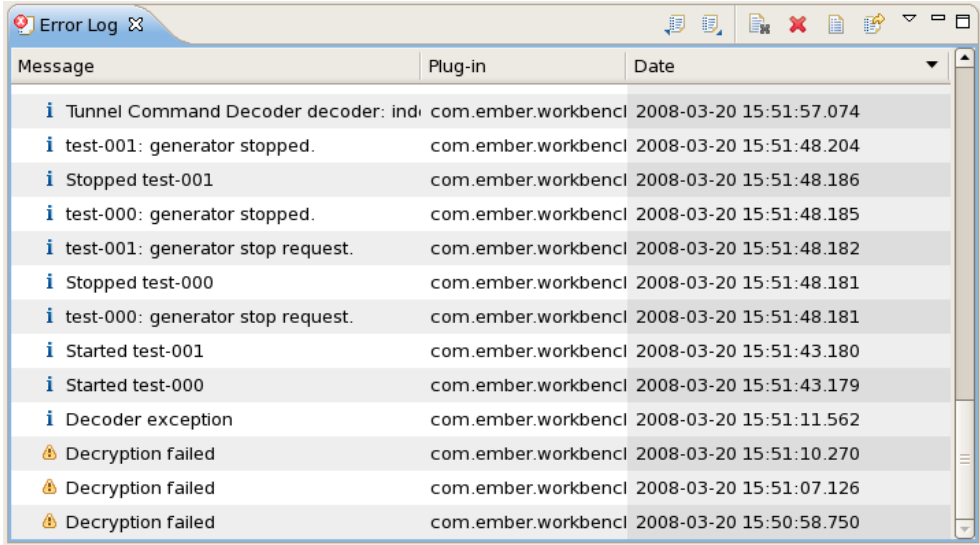
Connectivity view - (15.4 captures only) Displays a graph of network connectivity, using the neighbor information from the nodes.

Data capture view

Adapters - (deprecated)

Application Controller view - (deprecated)

Error Log - Decoder, decryption, and other types of errors are displayed in a tabular format in the Error Log View. Each error is shown in a single row with its summary message, the plugin or component that reported the error, and the date and time the error was encountered. To view detailed information about the error, double-click it. The error will be displayed in an Event Details dialog that includes the date, severity, message, and, if available, stack trace. The navigation at the top of the view allows you to perform basic functions on the Error log itself, including Export, Import, Clear, Delete, Open, and Restore.



Message	Plug-in	Date
<i>i</i> Tunnel Command Decoder decoder: indi	com.ember.workbenc	2008-03-20 15:51:57.074
<i>i</i> test-001: generator stopped.	com.ember.workbenc	2008-03-20 15:51:48.204
<i>i</i> Stopped test-001	com.ember.workbenc	2008-03-20 15:51:48.186
<i>i</i> test-000: generator stopped.	com.ember.workbenc	2008-03-20 15:51:48.185
<i>i</i> test-001: generator stop request.	com.ember.workbenc	2008-03-20 15:51:48.182
<i>i</i> Stopped test-000	com.ember.workbenc	2008-03-20 15:51:48.181
<i>i</i> test-000: generator stop request.	com.ember.workbenc	2008-03-20 15:51:48.181
<i>i</i> Started test-001	com.ember.workbenc	2008-03-20 15:51:43.180
<i>i</i> Started test-000	com.ember.workbenc	2008-03-20 15:51:43.179
<i>i</i> Decoder exception	com.ember.workbenc	2008-03-20 15:51:11.562
<i>w</i> Decryption failed	com.ember.workbenc	2008-03-20 15:51:10.270
<i>w</i> Decryption failed	com.ember.workbenc	2008-03-20 15:51:07.126
<i>w</i> Decryption failed	com.ember.workbenc	2008-03-20 15:50:58.750

Expression Manager - Also known as the [Filter Manager](#), this tool is used to compose and edit custom filtering expressions.

Progress - The Progress View shows the progress of user actions. Actions that take a long time to execute may be managed within the Progress View. For example, the application upload action can take several seconds. The Progress View provides a user interface for managing this action. If you wish to stop an action, you may do so in the Progress View.

Sample Application Wizard - (deprecated)

Other views of interest are:

Event Detail - Event details are normally shown in the EventDetail Pane within the Stream Editor. If you want to see the event details in a separate window, you can open the Event Detail View. This view shows the details for the currently selected Event in the same

format as the Event Detail Pane, but in a view that you can pull outside of Network Analyzer and resize to your liking.

Hex Dump - Similar to event details, the hex dump information is shown the Hex Dump Pane within the Stream Editor. If you want to see the hex dump in a separate window, you can open the Hex Dump View. This view shows the hex dump of the currently selected Event in the same format as the Hex Dump Pane, but in a view that you can pull outside of Network Analyzer and resize to your liking.

Search - Search data is displayed in the Search Pane within the Large File Editor. However, as with the Event Details and Hex Dump Panes, you may wish to see this data in a separate view. The Search View allows you to view search results in a window that you can pull outside of Network Analyzer and resize to your liking.

Shell - The Shell View provides command line access to the scripting capabilities of Network Analyzer. For a list of all commands available within the shell, simply enter `help` at the command line.

Capturing Data and Managing Sessions

Capturing Data and Managing Sessions

Network Analyzer can display one or more network capture sessions. Each capture session displays the transaction and event data captured from one or more nodes. The captured data is shown in editor panes. In general, Network Analyzer captures all incoming and outgoing packet data via the selected adapters, regardless of whether the host nodes have sniffer applications. The captured data includes failed transmissions, as well as debug messages from node applications that are compiled in debug mode.

This kind of capture is called a perfect trace session. The capture nodes of a perfect trace session are not sniffers but nodes that might be running your own application that you are trying to debug. The perfect trace session compiles all incoming and outgoing data from each node in chronological real time, providing a richly-layered display of all activity within a network. A perfect trace session can be especially useful for debugging a network in development as it allows you to see every packet on the network.

Network Analyzer supports two types of capture sessions:

- Live sessions display data as it is captured. The display is continuously refreshed as new data arrives. When a live session starts, it is unnamed and its data is maintained in temporary storage until you save it to a named file. Network Analyzer can capture live session data from multiple sets of adapters into the same session. You cannot, however, capture from one adapter into different sessions at the same time. You can run more than one live session at the same time.
- Saved sessions contain captured data that has been saved to permanent storage in a named .isd file. You can load a saved session and analyze it at any time.

When you start Network Analyzer, it opens a new live session. Network Analyzer displays each session in an editor with its own tab. The tab of each saved session is labeled with the session's file name; the first live session is labeled **Live**, the second **Live1**, the third **Live2**, and so on.

You can capture data from the node of any connected Debug Adapter, from one node at a time or multiple nodes simultaneously. You can also capture all network traffic over the current channel by capturing data from a connected sniffer node.

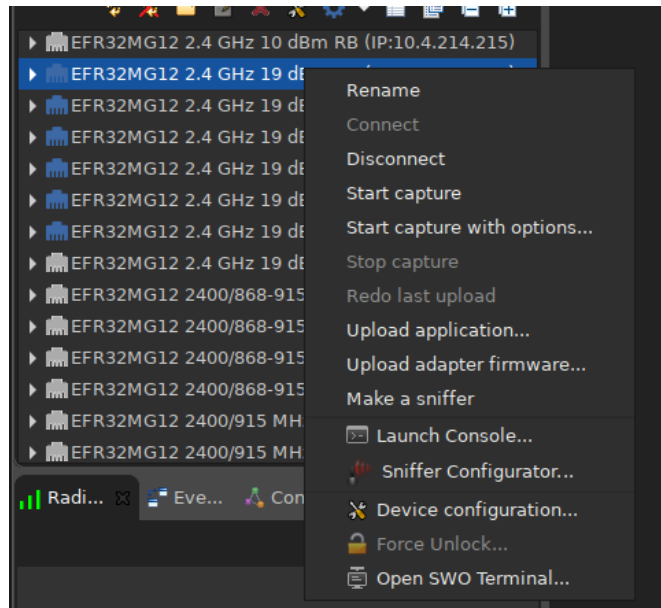
Note: The types of data captured from a node depend primarily on the software protocol running on the node, and also the capabilities of the node's radio chip and Debug Adapter.

Starting a Capture

Before starting a capture, open **Preferences > Network Analyzer > Decoding > Stack Versions** and make sure that the protocol running on the adapters is selected. If you are working in a multiprotocol environment, select 'Auto-detecting decoder stack'. A change here will not affect any active capture sessions but will apply to the next capture you start.

To start a capture:

1. Select one or more connected adapters. Multiple adapters are usually on the same network.
2. Right-click the selected adapters.
3. On the context menu, select **Start Capture**.



Alternatively, select **File > Other Network Analyzer Actions > New Live Capture Session**. This creates a new live capture session and puts it on top of the editor list.

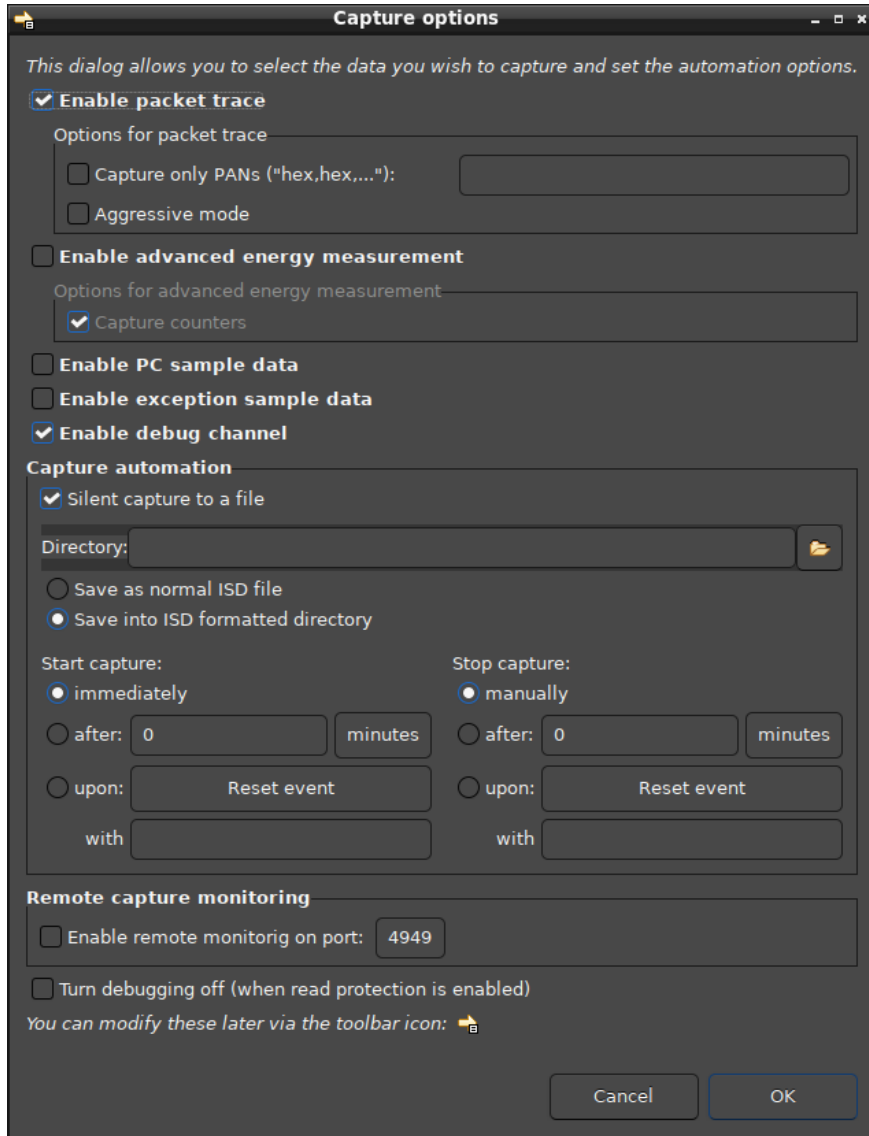
When you start a capture on an adapter, or on multiple adapters at the same time, the live session used for the capture is assigned in one of the following ways:

- If no live sessions are currently active, a new live session is created and used.
- If live sessions are active, but they are not on top of the editor stack (for example, another file is opened and currently on top), a new live session is created and used.
- If a live session is active and it is also on top of the editor stack, then this session will be used for capture.

Capturing with Options

You can filter packets out of the stream during a capture. For example, you can choose to see only packets from a certain PAN ID and drop all other packets.

1. Select one or more connected adapters.
2. Right-click the selected adapters.
3. On the menu, select **Start capture with options**.
4. Configure options in the resulting dialog, and click **OK**.



Capture options

This dialog allows you to select the data you wish to capture and set the automation options.

☒ **Enable packet trace**

Options for packet trace

☐ Capture only PANs ("hex,hex,..."):

☐ Aggressive mode

☐ **Enable advanced energy measurement**

Options for advanced energy measurement

☒ Capture counters

☐ **Enable PC sample data**

☐ **Enable exception sample data**

☒ **Enable debug channel**

Capture automation

☒ Silent capture to a file

Directory:

☐ Save as normal ISD file

☒ Save into ISD formatted directory

Start capture:

☒ immediately

☐ after: 0 minutes

☐ upon: Reset event with

Stop capture:

☒ manually

☐ after: 0 minutes

☐ upon: Reset event with

Remote capture monitoring

☐ Enable remote monitoring on port: 4949

☐ Turn debugging off (when read protection is enabled)

You can modify these later via the toolbar icon:

Cancel OK

In the capture options dialog, you can set the following:

- Capture only PANs: (15.4 protocols only) This filter, based on PAN ID, allows a comma-separated list of hexadecimal values.
- Aggressive mode: Filters out all events that may not be or definitely are not packets.
- Enable advanced energy measurement: This enables AEM packet filtering. AEM packets are used with Energy Profiler. If you turn this option on and later look at the data in Energy Profiler, you will not see any packets.
- Enable PC sample data: If selected, captures diagnostic events.
- Enable exception sample data: If selected, captures Java framework exceptions, which are used for deep diagnostics of possible Network Analyzer bugs.
- Enable debug channel: If selected, enables capturing all other non-packet events.
- Silent capture to file: If selected, performs a lengthy capture as a background task. Traffic will not show in the GUI until the capture is stopped and the file is opened. The silent capture enables you to run a capture over several days, as it does not consume memory resources, only disk space.
- The start capture options specify the trigger for delayed start of capture.
 - immediately: No automation, capture starts right away.
 - after: Capture starts after a certain time or after a certain number of events.
 - upon: Capture starts upon Node reset, or upon an event containing a specified ASCII or byte pattern.

The triggers for starting and stopping capture on node reset work only if you have DEBUG level NORMAL turned on for the node that you are capturing from. With the debug level set to Normal, the chip will send debug information, including node resets, over the back channel to Network Analyzer. Network Analyzer uses these reset and other commands to trigger the start-and-stop capture process. If

an image does not have debug turned on, it will not send reset information to Network Analyzer, and Network Analyzer has no basis for triggering start or stop capture.

You can also modify some, but not all, capture options through the Live Capture Options toolbar control.

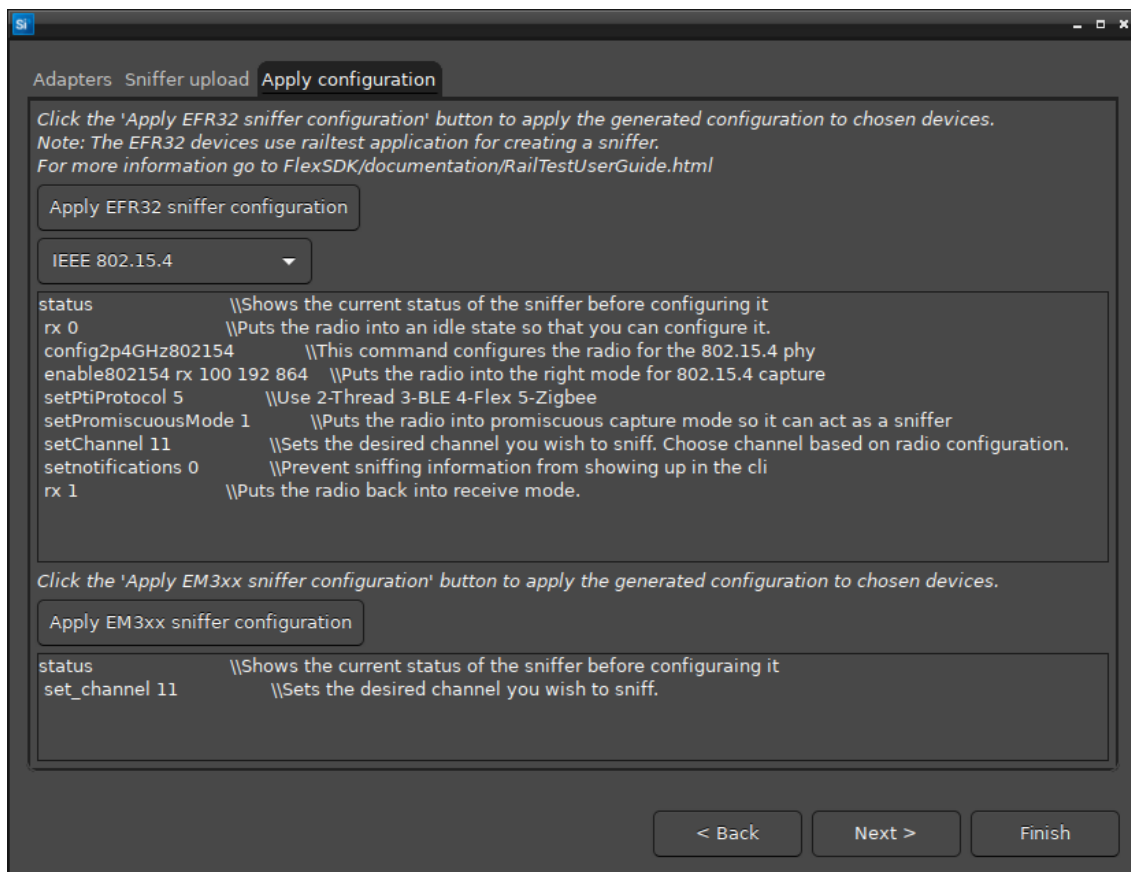
Capturing from a Sniffer Node

Any adapter's node that connects to Network Analyzer can be designated as a sniffer. A sniffer node is capable of capturing all data that is transmitted among nodes over the designated channel.

A sniffer node must have a sniffer application loaded. The sniffer application enables the node to capture over-the-air transmissions between nodes over the designated channel. When you start capturing from a sniffer node, the sniffer node captures all packets that are exchanged by the nodes on the designated channel.

If no sniffer application is currently loaded, load one in either of the following ways:

- In the Debug Adapters view, right-click the adapter and select **Sniffer Configurator**.
 - On the Adapters tab, select the adapter.
 - On the Upload tab, select the target adapter.
 - On the Apply Configuration tab, apply the appropriate configuration.



- In the Debug Adapters view, right-click the adapter and select **Make Sniffer**. Network Analyzer will first check whether the node has a Sniffer image on it before attempting to upload the new Sniffer image.

Stopping a Capture

1. Select one or more connected adapters.
2. Right-click the selected adapter(s).
3. On the context menu, select **Stop Capture**.

To resume capture, select **Start Capture**.

Pausing a Capture

Pause a capture at any time by selecting **Pause** on the Network Analyzer menu or the toolbar. This is a convenient way to stop capturing from a device or devices without having to start a new capture at a later time. Events that occur during the pause are lost, and cannot be retrieved.

Clearing Session Events

Click **Clear Events** on the Network Analyzer menu or toolbar to purge all events and their associated transactions from the current session. **Caution!** You cannot retrieve cleared events.

This is mostly used if you are working on a scenario on an embedded node, where you control some activity through command-line actions. You then simply "Clear" events between each retry, instead of having to do a complete "Start Capture / Stop Capture".

Note: Network Analyzer is designed to stay connected and continue capturing, even when the firmware on the target node is uploaded and the node resets. That does not stop the capture session.

Saving a Session

When you start a capture, it is initially written to an unnamed live session. At any point during a live session, you can save the data thus far captured to a file by selecting File > Save or clicking the toolbar Save control. After you save a session file, Network Analyzer continues to append capture data to it; however, you must save again in order to retain this data in the session file.

Network Analyzer saves session data to an .isd file, which is a compressed file that stores session data and the network state. Network state includes display settings such as map modifications, which Network Analyzer restores when you reload the session file.

Network Analyzer closes a saved session from further captures after you explicitly stop the capture, or when you start another live session. After a saved session is closed, it cannot be reopened to capture more data.

If you modify a saved session file - for example, set bookmarks or reposition icons in the Map pane - Network Analyzer asks whether to save or discard those changes before you close the session.

Note: For security reasons, Security Keys that you may use to decrypt captured data are not included in saved .isd files by default. If you wish to share security keys with your files, you should turn on the option "Save decryption keys in Network Analyzer files" on the Security Keys preference page, which you can access by selecting Window > Preferences > Network Analyzer > Decoding > Security Keys

Saving Multiple Sessions

If multiple open capture sessions have unsaved data, you can save all of them at once by selecting **File > Save All**, or using the toolbar **Save All** control.

Exporting to Other File Formats

To export a capture session to another file format:

1. Select **File > Network Analyzer Export** or click the toolbar **Network Analyzer Export** control.
2. Select the export format

3. Name the output file.
4. Click **Save**.

Extracting Individual Events

You can extract specific events from the Transactions pane, Events pane, or Hex Dump pane, and save them into a separate text log file.

To extract specific events to a text file:

1. Right-click the event in the Transactions, Events, or Hex Dump panes that you want to extract.
2. On the menu, select **Extract to**.
3. Name the output file with a text extension.
4. Click **Save**.

Once you specify a file, you can append additional events to it by right-clicking the event that you want to append and selecting **Append to <file>**.

Open and Close Options

To open a capture file, select **File > Open Recent File (Network Analyzer trace ...)** or click the toolbar control.

To close a single capture session, close the session tab.

To close all capture sessions, right-click any session tab and select **Close All**, or select **File > Close All**.

To close all but the current capture session, right-click its session tab and select **Close Others**.

Replaying a Session

(Rarely used) Replay events of the current session, whether live or saved, by selecting **Start Replay** on the Network Analyzer menu or the toolbar. Network Analyzer replays the session from the selected event at a constant speed. Replaying events in a live session has no effect on the capture in progress.

Once replay has started, both the toolbar control and the menu selection convert to a **Stop Replay** function.

Viewing Data in Editors

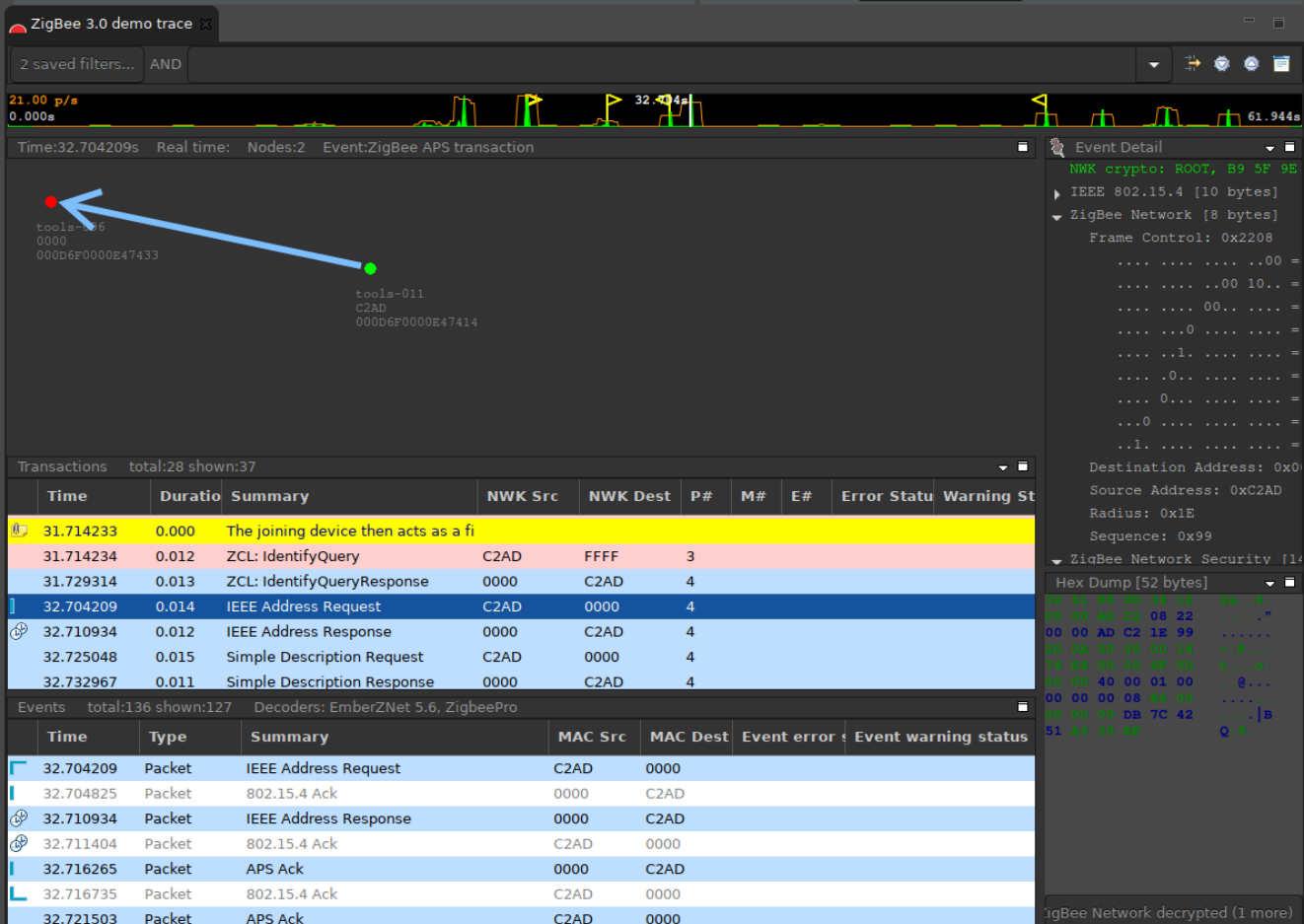
Viewing Data in Editors

On the File menu, select **Open File (Network Analyzer trace ..)** or **Open Recent File (Network Analyzer trace ...)** to open data in an editor. If the file is smaller than the size set in Preferences > Network Analyzer > Capture File Storage for a file to be considered large, Network Analyzer opens it in the Stream Editor. Otherwise, Network Analyzer opens it in the Large File editor.

- **Stream Editor:** The Stream Editor decrypts, decodes, and displays details of individual events.
- **Large File Editor:** The Large File Editor does not offer any detailed decoding and presentation of events. Instead, it provides a high-level overview of a file and allows users to open their points of interest in the Stream Editor.

The Stream Editor provides details about individual events. However, in the case of really large captures, this may tax system resources. The Large File Editor shows an overall timeline and node statistics. It allows you to scan very large captures for areas of interest, which you can then open in Stream Editor.

Stream Editor



The screenshot displays the Stream Editor interface for a ZigBee 3.0 demo trace. The top section shows a timeline with a signal graph and a packet list table. The packet list table contains the following data:

Time	Duration	Summary	NWK Src	NWK Dest	P#	M#	E#	Error Status	Warning Status
31.714233	0.000	The joining device then acts as a fi							
31.714234	0.012	ZCL: IdentifyQuery	C2AD	FFFF	3				
31.729314	0.013	ZCL: IdentifyQueryResponse	0000	C2AD	4				
32.704209	0.014	IEEE Address Request	C2AD	0000	4				
32.710934	0.012	IEEE Address Response	0000	C2AD	4				
32.725048	0.015	Simple Description Request	C2AD	0000	4				
32.732967	0.011	Simple Description Response	0000	C2AD	4				

The right pane shows the Event Detail for the selected packet (32.704209), displaying the IEEE 802.15.4 frame structure and the ZigBee Network Security details. The bottom pane shows the Events list, including the selected packet (32.704209) and its details.

The Stream Editor contains five editor panes, each of which provides a different view of the captured session data:

- [Map pane](#): Provides a map of the network, with nodes displayed with their network identifiers. The map also displays network activity.
- [Transactions pane](#): Displays high-level node interactions that might comprise multiple events.
- [Events pane](#): Displays information about all packets transmitted and received during a capture session.
- [Event Detail pane](#): Displays the decoded contents of the packet that is currently selected in the Events pane.
- [Hex Dump pane](#): Displays the data of the selected event in raw bytes. Network Analyzer highlights bytes that map to the data currently selected in the Event Detail pane.

All five editor panes may be open at once. Live captured data is continuously updated and displayed in the editor panes.

A [Timeline Bar](#) displays the statistics of the traffic over time.

Views are presented in a tabbed interface in the lower left of the default Network Analyzer perspective.

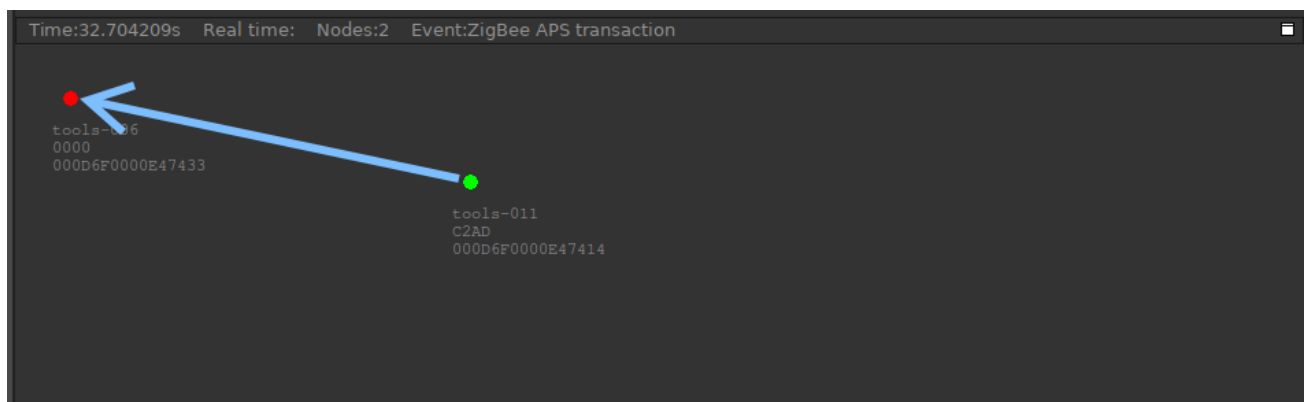
- [Radio Info View](#): Shows the information from the radio of all the receivers in the network that have heard the currently selected event.
- [Event Difference View](#): Displays the differences between two packets.
- [Connectivity View](#): (15.4 captures only) Displays a graph of network connectivity, using the neighbor information from the nodes.

For more information about using the Stream Editor panes, see the [Editor navigation tools](#).

Map Pane

The following information is applicable to 15.4 networks only.







The Map pane shows all interaction between nodes at a high level. As events occur or are replayed, the Map pane refreshes to show the pattern of network communication. Debug messages issued from a node also display next to the node.



Each node in the map pane is given a different color depending on its capabilities within the network as they are understood by Network Analyzer based on captured data.

- RED: The node is a network coordinator.
- BLACK: The node is a router.
- GREEN: Default color for network nodes.

The following figure shows the graphical elements that appear in the Map pane to depict network activity. Thick lines depict transactions, while thin lines depict single packets.

Unicast transmissions	
	Unicast transaction: completed after a single try.
	Unicast transaction: completed after multiple retries.
	Failed transaction: no end-to-end ACK
	Transmission of a unicast packet.
Multicast transmissions	
	Multicast transaction transmitted from initiating node.
	Transmission of multicast packet.

Note: The colors shown vary according to the transaction or event type, and can be configured through the [Filter Manager](#).

The data that is shown for each node is managed through menu/toolbar options:

- **Show Short ID** toggles display of the node's 16-bit address that is unique within the personal area network (PAN).
- **Show EUI64** toggles display of the node's unique 64-bit IEEE address.
- **Show PAN ID** toggles display of the PAN identifier of the node's network. This label can be useful when the map displays multiple networks.
- **Show Node Label** displays the custom label that you create for map display only.
- **Show LQI** toggles display of link quality data that pertains to the quality of connection between nodes. This is available with perfect trace captures, but not with sniffer captures.
- **Show Connectivity** shows the neighbor relationships between nodes in the network.
- **Simultaneous Events** displays on the Map pane all events that occurred at the same time as the transaction or event that is currently selected. The currently selected event is in color and any other events display in gray.
- **Zoom Map In** and **Zoom Map Out** enlarge and shrink the space that the map uses to display nodes. Zoom options have no effect on the size of node icons.

You can move node icons within the Map pane display. This has no effect on network functionality. However, it can help to highlight certain node interactions and relationships. When you move node icons in a session, Network Analyzer asks whether to save those changes before you close the session.

Right-click anywhere in the map pane to bring up a context menu.

- **Organize Map** establishes the layout of all nodes on a map. You can also modify individual node positions as needed. The following layouts are available:
 - Default Placement aligns nodes in a linear pattern.
 - Random Placement scatters the nodes across the map randomly.
 - Square Grid aligns the nodes in a grid.
 - Hexagonal Grid aligns the nodes in a hexagonal, offset pattern.
- **Load Background Image** and **Clear Background Image** manage the display of a background image in the Map pane.

Right-click on a node to bring up a context menu.





- **Assign EUI64** lets you assign a EUI64 to a node (not available if Network Analyzer obtains the EUI64). Network Analyzer obtains a node's EUI64 only when that node associates with a network. If the node already belongs to a network when a session begins, its EUI64 is unknown. This option lets you display a known EUI64 for a node; the node's actual EUI64 is unaffected by this label. The

Multinetwork checkbox can be used to indicate that the node is operating on multiple networks. See [Multinetwork Considerations](#) for more information.

- **Multinetwork** toggles the multinetwork property. See [Multinetwork Considerations](#) for more information.
- **Label** lets you customize the node's adapter (device) label with any string up to 25 characters long. This string appears in brackets after the node's device name. (By default, the Map pane labels each node that is undergoing capture with its device name.) You can also make the labels time-dependent by entering a start time. This lets you supply multiple names for the same node. This can be useful while debugging applications, by indicating the node's current state.
- **Icon** and **More Icons** allow you to display the node as an icon.

Transactions Pane

The Transactions Pane displays higher-layer protocol events that consist of multiple packet transmissions. For example, a Zigbee broadcast is retransmitted by every node in the network. By analyzing packet headers, Network Analyzer determines which packets belong to the same transaction and groups them accordingly.

Transactions total:28 shown:37										
	Time	Duration	Summary	NWK Src	NWK Dest	P#	M#	E#	Error Status	Warning Status
	31.714233	0.000	The joining device then acts as a fi							
	31.714234	0.012	ZCL: IdentifyQuery	C2AD	FFFF	3				
	31.729314	0.013	ZCL: IdentifyQueryResponse	0000	C2AD	4				
	32.704209	0.014	IEEE Address Request	C2AD	0000	4				
	32.710934	0.012	IEEE Address Response	0000	C2AD	4				
	32.725048	0.015	Simple Description Request	C2AD	0000	4				
	32.732967	0.011	Simple Description Response	0000	C2AD	4				
	49.732008	0.000	After the bindings are made, the sw							
	49.732009	0.018	ZCL: Toggle	C2AD	0000	4				
	49.743780	0.014	ZCL: DefaultResponse	0000	C2AD	4				
	52.419532	0.018	ZCL: Toggle	C2AD	0000	4				
	52.431051	0.013	ZCL: DefaultResponse	0000	C2AD	4				

Typical 15.4 transactions include:

- **802.15.4 association:** Involves a request-response protocol that consists of at least 6 packet transmissions.
- **APS unicast:** Can contain the following events:
 - A MAC layer unicast packet and its MAC retries
 - Acknowledgements for each hop along the route
 - An end-to-end APS acknowledgement message, which itself consists of multiple MAC unicast packets
 - Multiple end-to-end APS retries
- **Zigbee route discovery:** Involves a broadcast route request followed by unicast route-reply packets across multiple hops.

In the case of Bluetooth Low Energy (and Bluetooth mesh), a “transaction” refers to an actual Bluetooth Low Energy transaction as defined in the core specification. This corresponds most of the time to a Bluetooth Low Energy procedure. Equally, the event pane displays the actual Bluetooth Low Energy events corresponding to the transaction or procedure. For more details, refer to the Bluetooth Core specification document.

Network Analyzer understands the protocol semantics for many transaction types. Therefore it can group multiple packets in real time to facilitate high-level analysis.

All transactions are listed in chronological order, using transaction start times. Each selection maps to one or more events in the Events Pane, which are marked accordingly. Clock icons indicate concurrent transactions with the current selection.







All transactions and their events are uniquely numbered. However, the transaction numbers may not be in sequence, and various factors will result in number gaps. For example, only top-level transactions and the lowest-level packets are shown. Intermediate transactions are not shown. Also, number gaps are likely to occur if filters are turned on.

When you click on a transaction, the information shown in the Event Detail Pane and the Hex Dump Pane corresponds to the first packet in the transaction. However, if filters are turned on, the first transaction might not be shown in the Event Pane. In that case, the event detail information in the transaction display will not be consistent with the first packet shown in the Event Pane. In fact,





with a filter expression such as `show(transaction.summary != null, SELF)` only transactions are displayed and the Event Pane will be blank. In that case, click the transaction to see the first events in the transaction in the Event Detail and Hex Dump Panes.

Events Pane

The Events pane displays information about packets received by the current session. All events are displayed in chronological order.

Events total:136 shown:127 Decoders: EmberZNet 5.6, ZigbeePro							
	Time	Type	Summary	MAC Src	MAC Dest	Event error s	Event warning status
	32.704209	Packet	IEEE Address Request	C2AD	0000		
	32.704825	Packet	802.15.4 Ack	0000	C2AD		
	32.710934	Packet	IEEE Address Response	0000	C2AD		
	32.711404	Packet	802.15.4 Ack	C2AD	0000		
	32.716265	Packet	APS Ack	0000	C2AD		
	32.716735	Packet	802.15.4 Ack	C2AD	0000		
	32.721503	Packet	APS Ack	C2AD	0000		
	32.722118	Packet	802.15.4 Ack	0000	C2AD		
	32.725048	Packet	Simple Description Request	C2AD	0000		
	32.725664	Packet	802.15.4 Ack	0000	C2AD		
	32.732967	Packet	Simple Description Response	0000	C2AD		
	32.733438	Packet	802.15.4 Ack	C2AD	0000		
	32.738065	Packet	APS Ack	0000	C2AD		

Events that belong to the currently selected transaction in the [Transactions pane](#) are marked by one of the following icons:

Transaction icon	Meaning
	Start of transaction
	Intermediate event
	End of transaction
	Single-event transaction

Clock icons mark unrelated events that are concurrent with the selected transaction in the Transactions pane.

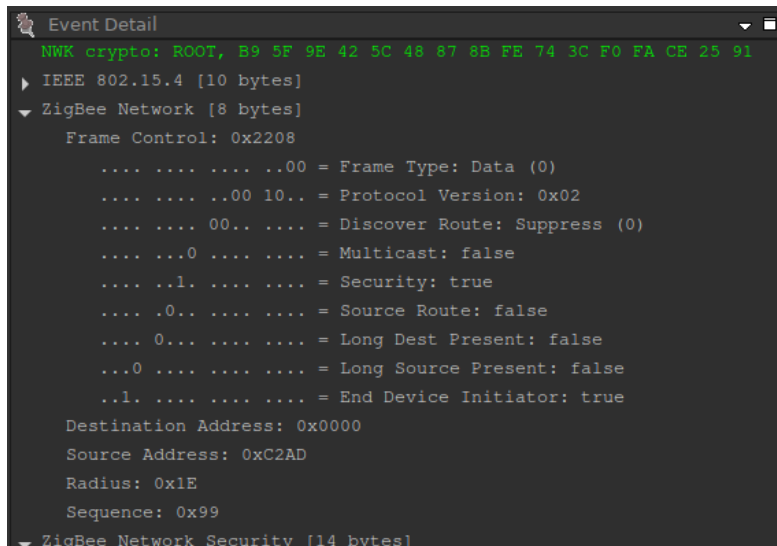
Event Detail Pane

The Event Detail pane displays the decoded contents of the event that is currently selected in the [Events pane](#). The content of this pane varies according to the event type. If a transaction is selected on the [Transactions pane](#), the Event Detail pane shows the details of the first event in the transaction.

Pane options include:

- **Expand Bitfield:** Shows the bitfields in an expanded mode, like Wireshark.
- **Use Fixed Fonts:** Can improve readability as information is presented aligned.

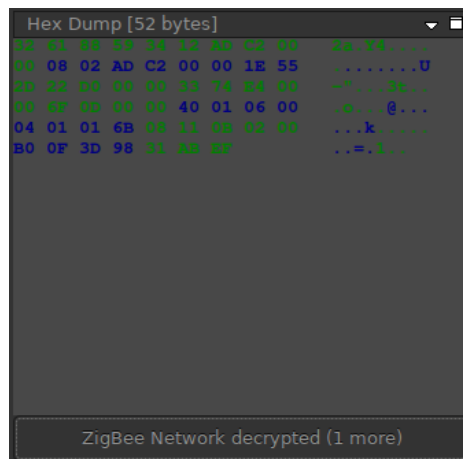
When capturing from multiple devices, Network Analyzer may capture the same packet as heard by several different sources. In order to reduce confusion, Network Analyzer automatically performs duplicate detection on all packets captured. If the transmission is captured over the backchannel, only the transmitted packet is kept. Otherwise the first receive packet is kept. All duplicate packets are dropped after extracting their RadioInfo data. Only the radio info frame for each duplicate packet is kept. The radio info for each individual instance of a packet captured by Network Analyzer is visible in the [Radio Info View](#)



Pinning a field: The Event Detail pane has the ability to "pin" a field into view. When you double-click on a specific field, the Pin icon in the top left of the pane turns bright red, indicating that it is active. Now, as you move through events, this field is always visible when it is present in the currently selected packet. This is useful if you are interested in a specific field across multiple events in a trace file. In the above figure, the Zigbee Application Support Delivery Mode is "pinned" into view. The pin can be deactivated at any time by either double-clicking on the pinned field, or by clicking the Pin icon itself.

Hex Dump Pane

The Hex Dump pane displays data in raw bytes of a selected event in the [Events pane](#). Clicking on bytes in the Hex Dump pane selects the corresponding field in the [Event Detail pane](#). Alternatively, selecting a field or a frame in the Event Detail pane highlights the corresponding bytes in the Hex Dump pane. The pane shows multiple "layers", so if the packet is decrypted, the "raw" layer shows encrypted data, but the higher-level layers show this data progressively decrypted.



Timeline Bar

The Timeline bar displays the statistics of the traffic over time. The Timeline bar function on the Network Analyzer toolbar toggles the Timeline Bar on and off.



Available actions are:

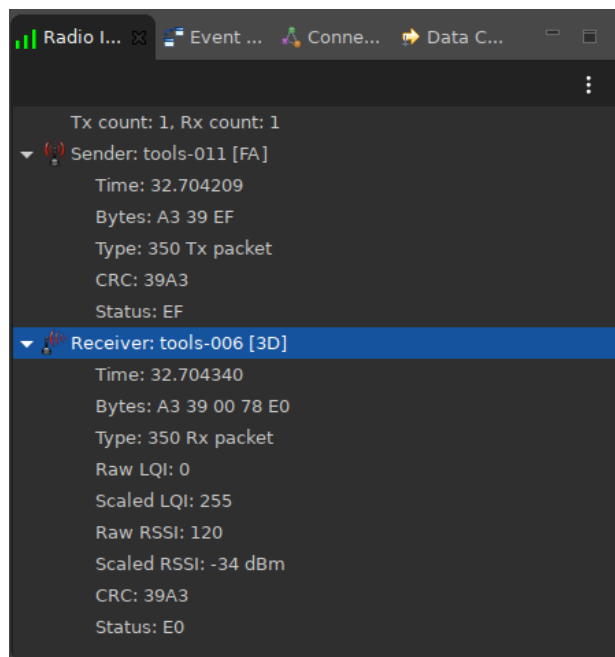
- Click on the Timeline bar to move the cursor to the event closest to the time selected.
- Click and drag on the Timeline bar to filter the display to only the time within the selected area.
- Right-click to display a timeline menu.

The Timeline bar shows bookmarks as yellow flags. You can click a bookmark to jump to it in the Transaction and Event panes. It shows red flags for errors, such as out-of-sequence problems.

Radio Info View

The Radio Info view is a helper view that shows the information from the radio of all the receivers in the network that have heard the currently selected event. It is available through the tabbed Views interface in the lower left of the default Network Analyzer perspective. If not, add it through **Window > Show View**.

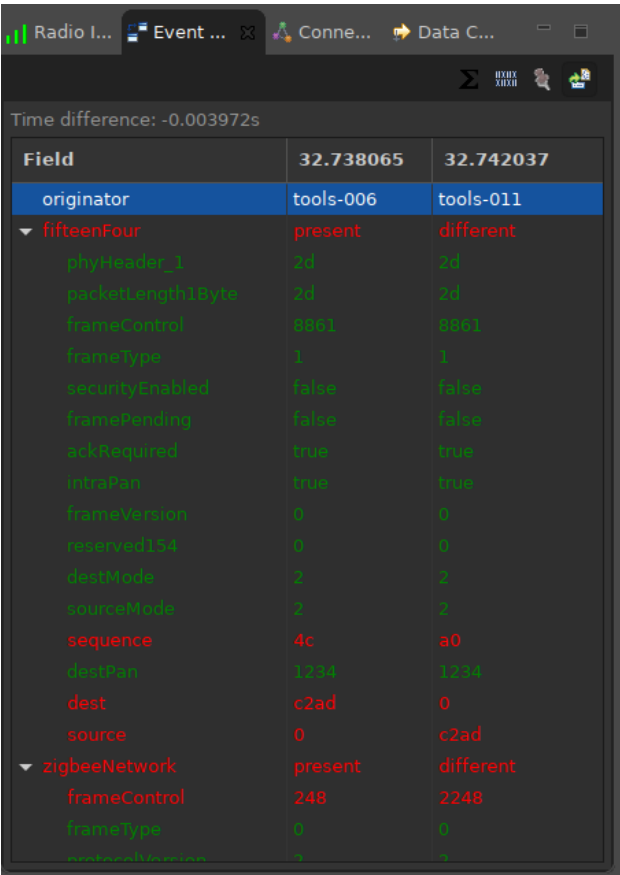
The view displays in a tree all the information that has been gathered from the receiver nodes. Displayed information includes LQI value, CRC value, and the status bits that show several states of the radio.



The event that supplied radio information in the figure above was captured from both the sending and receiving nodes. This is possible because the trace that contains this event was created by capturing from both the sending and receiving nodes simultaneously using Network Analyzer's Perfect Trace capability. While the original events were merged into a single event by Network Analyzer's duplicate detection mechanism, the radio information was retained for each event and is shown in the Radio Info view with the time that the event was captured by Network Analyzer.

Event Difference View

Event Difference view is a helper view that displays the specific differences between two packets. It is available through the tabbed Views interface in the lower left of the default Network Analyzer perspective. If not, add it through **Window > Show View**.

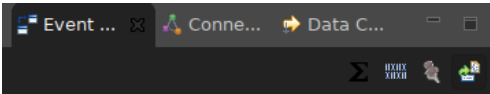


Field	32.738065	32.742037
originator	tools-006	tools-011
▼ fifteenFour	present	different
phyHeader_1	2d	2d
packetLength1Byte	2d	2d
frameControl	8861	8861
frameType	1	1
securityEnabled	false	false
framePending	false	false
ackRequired	true	true
intraPan	true	true
frameVersion	0	0
reserved154	0	0
destMode	2	2
sourceMode	2	2
sequence	4c	a0
destPan	1234	1234
dest	c2ad	0
source	0	c2ad
▼ zigbeeNetwork	present	different
frameControl	248	2248
frameType	0	0

Once the view is shown, it tracks the selected events. The view will by default show the difference between the last two events selected. If you select event 1, and then click on event 2, the view shows the difference between those two events. If later you select event 3, the view shows the differences between event 2 and 3.

Packet frames that do not have any differences are shown in green. Frames that contain differences are shown in red. Expand the frame to see which portions of the frames are different.

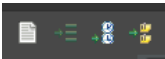
The menu at the top of the view supports additional functions.



- **Show traffic counts:** Opens a window showing the statistics for the events between, but not including, the two selected event.
- **Show byte differences:** Enables viewing of individual bytes in the view.
- **Pin last selected event:** Changes the way events are tracked. If this is enabled, then the first event for diffing stays the same, and only the second event changes. You can use this if you wish to always differentiate events against a certain static event, rather than always viewing last two selected events.
- **Include fields that are same:** Enables filtering out fields that are same in both events.

Editor Navigation Tools

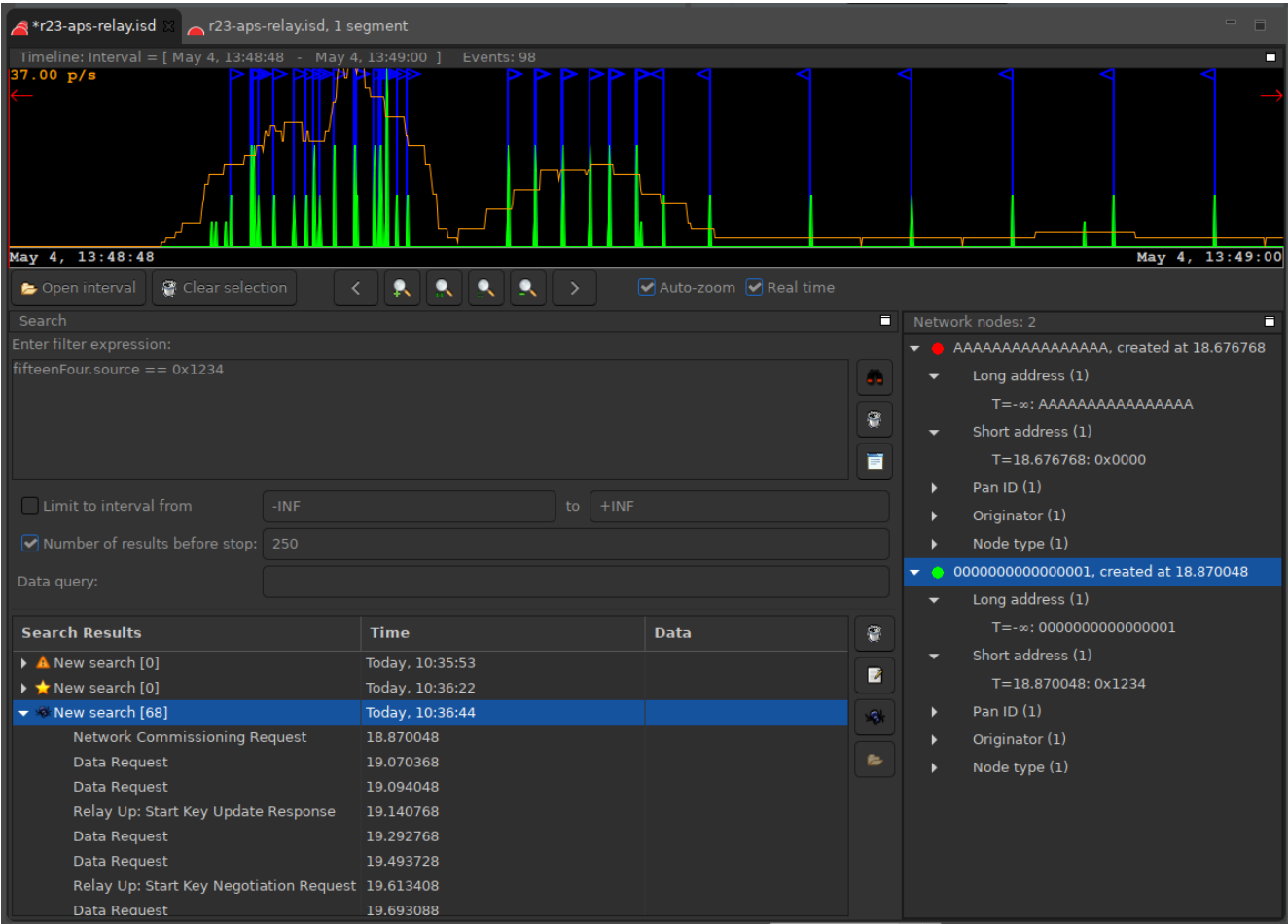
Some of the Network Analyzer Toolbar functions are specific to working in the Stream Editor.



- **Edit description of trace file:** Opens a simple dialog which allows you to view and edit overall description of the captured data. This is helpful if you need to pass on some information others for analyzing the contents of the trace file.
- **Go to Line:** Moves the cursor to the event or transaction having the specified event number. This is only enabled if the Stream preference "Show event numbers" is selected. To turn this feature on go to: Window > Preferences > Network Analyzer > Capture Configuration > Show event numbers.
- **Go to Time:** Moves the cursor to the transaction and event that match or immediately follow the specified time.
- **Go to Bookmark:** Moves the cursor to the selected bookmark. Assign bookmarks to events or transactions by right-clicking the event or transaction and selecting **Add Bookmark**.
- **Lock to Bottom:** Locks the cursor on the latest event during a live session. To remove the lock, select any event or transaction during a live session, which causes a view to scroll as the events are captured.

Large File Editor

If the file is larger than the size set in Preferences > Network Analyzer > Capture File Storage, Network Analyzer opens it in the Large File editor. The Large File Editor allows you to find and select a region of interest, which you can then open and analyze with the Stream Editor.



The Large File Editor consists of three component panes:

- [Large File Timeline](#): Shows a high-level view of a large file's traffic over time.
- [Large File Search pane](#): Provides a mechanism for searching across very large files.
- [Large File Network Nodes pane](#): Shows all of the network devices included in a large file.

Large File Timeline

The Large File Timeline shows a high-level view of a large file's traffic over time. It works similarly to the [Stream Editor's](#) timeline. In fact, the Large File and the Stream Editor timelines use the same widget.

Large File Timeline Segments: The entire set of events shown in the Large File Timeline is broken into segments. By default, each segment includes up to 5,000 events. Segments boundaries are shown in the Large File Timeline by horizontal grey lines.

Large File Timeline Time Markers: The Large File Timeline shows the actual time during which a file was captured. The capture start-time appears in the bottom left corner of the Timeline. The capture end-time appears in the bottom right corner.

Moving the cursor to any point on the timeline displays the time for that point.

Large File Intervals: A Large File Interval is a subset of an entire trace. You can create an interval by clicking and dragging. Click on the Large File Timeline at the desired start-point, and then drag the cursor along the timeline to the desired end-point.

The click and drag operation creates the interval you defined, and zooms the timeline view into that interval. To clear the interval, click the Clear Selection button in the toolbar under the timeline, or right-click on the timeline and select **Clear interval**.

Once you have created an interval, you can open that interval in the Stream Editor by clicking the Open Interval button, or right-clicking in the timeline and selecting **Open Interval**.

Timeline Flags: Search results and errors are displayed in the Large File Timeline by flags. Search results are displayed as a yellow flag. Errors are displayed as a red flag. When you move the mouse over the flag, the Timeline displays the Summary of the Event or Transaction that is associated with the flag.

Large File Search

Use the Large File Search mechanism to search for events across very large files. The entire filter language is supported in the Large File Search. For more information, see [Filter Language](#).

To run a search in the Large File Editor, enter the filter expression into the Filter Expression text box and click the Start Search control. The search progress is shown in the Large File Timeline. Options allow you to limit the search within a time interval or to limit the number of search results. It is useful to limit the number of search results, as the system can become slow if the search expression matches an extremely large number of events.

Filter results are shown in the Search Results table. Search results are grouped into results trees and labeled with the time and date that the search was performed.

To view search result details, double-click an individual search result. This opens three segments in a Stream Editor: one before the selected event, one that contains the event, and one after the event.

Note: The expressions and search results are saved into the Network Analyzer file. Thus they will be seen by other users who open the same Network Analyzer file.

Controls to the right of the search results allow you to delete, tag, open, and assign decorative icons to the searches and search results.

Large File Network Nodes

The Large File Network Node pane shows all of the network devices included in a large file. The information provided about each node in a trace includes:

- EUI64 address
- Short address
- PAN ID
- Node type

Since each of these values is subject to change over time, the summary also includes the time at which each value was discovered.

Filtering Captured Data

Filtering Captured Data

By default, the Events pane displays all session events. You can build and apply filters that constrain Network Analyzer to show only events that are of interest. By filtering events, you can analyze results more efficiently.

Each capture session has its own filter settings. A filter can be used either to search for the next matching event or to display only the events that match the filter. In the latter mode, when you change a session's filters, Network Analyzer immediately refreshes the display. When you exit Network Analyzer, all session filters are cleared and must be reapplied when you restart. Network Analyzer provides two ways to edit filters:

- **Filter Manager:** Maintains a set of saved filters that you can review and edit. You can also add new filters. You specify any of the saved filters for display on the Filters menu, accessed through the **n saved filters** button on the filter bar, so that they are available for use in one or more sessions.
- **Filter Bar:** An editor that attaches to a given session, where you can enter one or more filter expressions on the fly. Network Analyzer discards filter bar expressions for all sessions when it exits.

Quick filters are available when you right-click on events and transactions. They provide an easy way to create common expressions for the filter bar.

Filter Language is a powerful syntax used to create filters.

Filter Manager

The Filter Manager lets you:

- Use filter expressions to customize display of entries in the Events pane.
- Specify which filters appear in the Filters menu.

The Filter Manager is available through menu and toolbar selections as well as through Window > Show View (as Expression Manager).

Expression Manager

Use the table to manage your filters. The 'Color?' column is used to specify the filter as a coloring rule, and highest priority coloring rules are applied first.

Name	Expression	Menu	Color?	Priority	Map	Fg	Bg	Stack types
Transaction	show(isType(Transaction), SELF)	<input type="checkbox"/>	<input type="checkbox"/>	15				Use with all stack types
Show only Bluetooth Mesh Pa	(bleAdv.adv_type_0 == 0x2a bleAdv.adv_type_0 == 0x2b)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	15				Use with: BLUETOOTH
Hide Radio Errors	!event.isRadioError	<input checked="" type="checkbox"/>	<input type="checkbox"/>	15				Use with all stack types
Hide Link Status	!event.linkStatus	<input checked="" type="checkbox"/>	<input type="checkbox"/>	15				Use with: ZIGBEE
Hide Empty BLE Packets	!(event.summary != "Empty")	<input checked="" type="checkbox"/>	<input type="checkbox"/>	15				Use with: BLUETOOTH
Hide Diagnostic Events	event.type != Diagnostic	<input checked="" type="checkbox"/>	<input type="checkbox"/>	15				Use with all stack types
Radio Errors	event.isRadioError	<input type="checkbox"/>	<input checked="" type="checkbox"/>	10	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
MAC Ack	show(fifteenFour.frameType == 2, SELF)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	10	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Bookmark	isType(Bookmark)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	10	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
ZigBee unicast transaction	transaction.type == Unicast	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
ZigBee transport datagram	transaction.type == Datagram	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
ZigBee broadcast transaction	transaction.type == Broadcast	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
ZigBee association transactio	transaction.type == Associate	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
ZigBee Unicast Command	transaction.type == CmdUnicast	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
ZigBee APS transaction	transaction.type == APS	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
ZigBee APS Alarm	transaction.type == Alarm	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
SKKE Protocol Negotiation	transaction.type == SKKE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Route discovery transaction	transaction.type == Route	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
RF4CE Pairing	transaction.type == Pairing	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
RF4CE Discovery	transaction.type == Discovery	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
PANA session	transaction.type == Pana	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Network Rejoin transaction	transaction.type == Rejoin	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Message out of Sequence	event.type == OutOfSeq	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Link Status	event.linkStatus	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Leave Transaction	transaction.type == Leave	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Fragment	show(event.fragment, SELF)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Entity Authentication	transaction.type == EA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
BLE Attributes Protocol	transaction.type == BleAttr	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
BLE Advertisement	transaction.type == BleAdv	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Packet	event.type == Packet	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types
Non-packet	event.type != Packet	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Use with all stack types

New...
Delete
Reset
Export
Import
Reapply

An older feature, the Expression Builder, is deprecated.

Maintaining Filters

To add a filter to the Filters menu, check the Menu checkbox. This makes the filter available to the current sessions.

To restore filters to installation settings, click **Reset**.

To rename a filter, click on the name field and edit.

You can also create new, delete, export and import filters.

Setting Filter Color Schemes

You can associate a color scheme with each filter. If an event evaluates as true for a given filter expression, Network Analyzer applies the filter's color scheme to that event. An event can be configured with a color scheme for two display levels:

- For the Map pane, the color used by the graphic representing the event type.
- For the Events pane, the foreground and background colors used by event type instances.

Note: Setting a color scheme on a filter expression does not specify whether to display events; it only determines how to display certain event types.

Note: If a filter's foreground color is the same as its background color you will not be able to read the text in the event and it will effectively disappear from view.

To set a filter color scheme, in the Filter Manager:

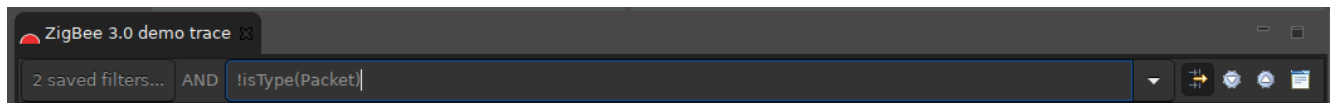
- Next to the filter of interest, check the Color checkbox to enable the controls for Map (Map color), and Fg (Foreground color) and Bg (background color) for event instances.
- Click the control you want to set to enable the color selector control.

3. Click the color selector control, set the filter's color, and click **OK**. If you have changed Foreground or Background colors you will see the change on the Name field.
4. For each filter, set the color scheme's Priority level by assigning a positive or negative integer value. If an event evaluates as true for multiple filters, Network Analyzer uses the color scheme with the highest precedence. In the case where there is no clear precedence, Network Analyzer randomly chooses one of the matching color schemes.
5. To refresh the Map pane and Events pane with the new color scheme, click **Reapply**.

A filter whose menu checkbox is selected is shown in the Filters menu. The order in which the filters are displayed in the Filters menu is determined by their order in the filter manager table.

Filter Bar

A session's Filter Bar provides the same level of functionality as the Filter Manager for building expressions. Any filter expression that appears in a session's Filter Bar is combined with the saved filter expressions that are already in effect for that session.



The Filter bar is displayed by default, but can be toggled on and off using the **Show Filter Bar** menu control.

You can compose a Filter Bar expression in the following ways:

1. Enter the expression directly in the filter edit field, and press Enter.
2. Create a Quick filter.

To apply a Filter Bar filter, enter an expression into the filter edit field and press Enter.

To find an event that matches the filter, click the Find icons on the Filter Bar.

To remove a filter, select it and press Enter.

Note: A history of filter expressions is maintained in the drop-down list.

Quick Filters

Network Analyzer provides several filters that are available from the Transactions pane, Events pane, Event Detail pane, and Hex Dump pane.

To access a quick filter, right-click an item and choose a quick filter pop-up menu option.

Hide or Show Events/Transactions

Access these filters by right-clicking an event (Events pane) or transaction (Transactions pane) and selecting a pop-up menu option to hide or show specific information. The filter options that are available depend on the selected transaction or event. You can specify to hide all events/transactions of the selected type, or to show only that type. In addition if you select an event of type APITrace, the pop-up menu displays two filter options:

- Hide type: APITrace
- Show only type: APITrace

Further, if you select an event such as a neighbor exchange that has a source and/or destination address, the pop-up menu also contains these two filter options:

- Show only destination: short-ID
- Show only source: short-ID

In all cases, Network Analyzer enters the corresponding filter expression in the session's Filter Bar. This can help you to understand the filter language. For example, if you specify to show only route discovery transactions, this expression is set in the filter bar:

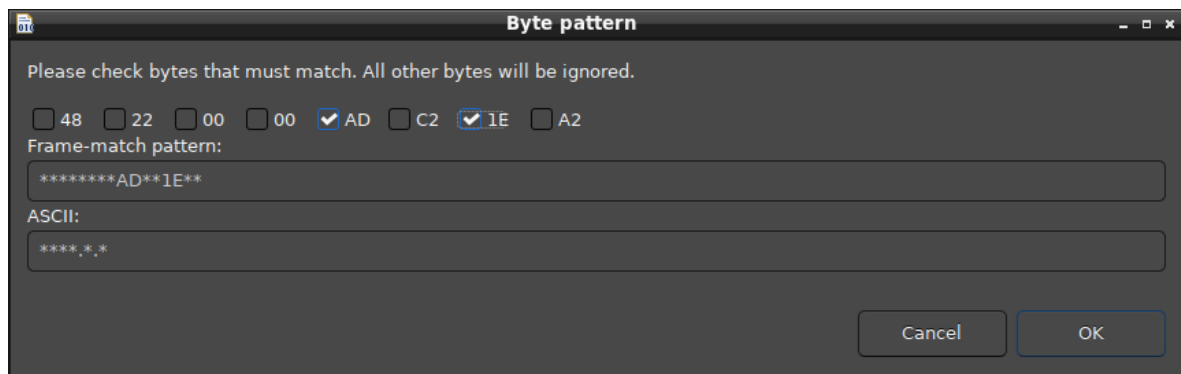
```
isType(Route)
```

Frame Byte Pattern Filtering

A frame pattern filter matches a specific byte-array pattern. For example, you could filter for packets in a payload whose frame has the third byte equal to 0x33. (Many more complex combinations are possible.)

To create a frame pattern filter:

1. Right-click a frame in the Event Detail pane or Hex Dump pane.
2. Select Filter by frame pattern from the pop-up menu.
3. In the Byte Pattern dialog, check the byte pattern match desired and click OK. The filter is added to the Filter Bar for this session.



Filter Language

Filter language enables you to construct logical expressions, based on decoded fields in events. The following are some examples:

- `fifteenFour.sequence == 0x52` : Matches events where 15.4 sequence number equals hex 0x52.
- `fifteenFour.ackRequired == true && fifteenFour.source == 0x035f` : Matches events where 15.4 ack required flag is set, and source shortId is 0x035f.
- `isPresent(zigbeeSecurity.frameCounter)` : Matches events that contain the Zigbee security frame, and the frameCounter field within it.
- `event.summary | "string"` : Matches events where a string is a substring of the summary.
- `isType(Packet)` : Matches events that are packets.
- `frameMatch(fifteenFour, "**88**EF/*****")` : Matches events where 15.4 frame contains second byte equal to 0x88 and fourth byte equal to 0xEF.

A good way to learn the filter language is by first using the **Add to filter** context menu option in the Event Detail Pane. This option will add a filter expression for the chosen field.

You can use most standard logical operators (&&, ||) and standard comparison operators (==, !=, |, <, >, <=, >=, etc.) in filter expressions.

Event and Transaction Filter Extensions

In addition to filtering on decoded packet fields, you can filter on several other Event and Transaction values.

Event Extensions:

- `event.summary`: A String value of the summary shown in the Event Pane.
 - Example: `event.summary == "APS Ack"`
- `event.linkStatus`: True if the packet is a Link Status packet.
 - Example: `event.linkStatus == true`
- `event.ack`: True if the packet is an 802.15.4 ack.

- Example: `event.ack == true`
- `event.time`: The time that the event was transmitted (tx) or received (rx).
 - Example: `event.time >= 75.78`
- `event.originator`: The adapter that saw and reported the event.
 - Example: `event.originator == "ewb-unit04"`
- `event.status`: The event status, listed in the righthand column of the event status window
 - Example: `event.status == "ZCL: ReportEventStatus"`
- `event.type`: The type of event, shown in the Type column of the Event and Transaction Panes.
 - Example: `event.type == "Packet"`
- `event.corrupt`: The event corruption string, empty if event is not corrupt
 - Example: `event.corrupt < "crypt"`

Transaction Extensions:

- `transaction.summary`: Filters on the transaction summary field shown in the Summary column of the Transaction Pane.
 - Example: `transaction.summary == "ZCL: LoadControlEvent"`
- `transaction.packetCount`: Filters on the number of packets in the transaction shown in the P# column of the Transaction Pane
 - Example: `transaction.packetCount == 4`
- `transaction.macRetries`: Filters on the number of MAC retries in the transaction shown in the M# column in the Transaction Pane.
 - Example: `transaction.macRetries == 2`
- `transaction.endToEndRetries`: Filters on the number of end to end retries shown in the E# column in the Transaction Pane.
 - Example: `transaction.endToEndRetries == 3`
- `transaction.status`: Filters on the status of the transaction shown in the Status column of the Transaction Pane.
 - Example: `transaction.status == "CRC failed"`
- `transaction.dest`: Filters on the network destination of the transaction shown in the NWK Dest column of the Transaction Pane.
 - Example: `transaction.dest == 0x05c7`
- `transaction.source`: Filters on the network source of the transaction shown in the NWK Src column of the Transaction Pane.
 - Example: `transaction.source == 0x0000`

How Network Analyzer Applies a Filter

When Network Analyzer captures an over-the-air message, it runs the message through a processing stream. The processing stream is made up primarily of Decoders and Groupers.

Decoders: Decoders are responsible for making sense of the message based on its format so that it may be displayed to the user. Each over-the-air message captured becomes a single Event of type Packet. This Event is displayed to the user in the Event view.

Groupers: The groupers are responsible for making sense of a series of packets and grouping them into a hierarchy under a single Transaction. The Transaction is displayed in the Transaction view.

Using `show(expression, SELF|PARENT|CHILD|SIBLING)`

Events exist within a hierarchical structure where Transactions represent the top of the hierarchy and Events are at the bottom. The hierarchical nature of trace data creates something of a problem for filtering. In most cases, you wish to see Transactions associated with filter-matching Events, and vice versa.

For instance, if you use a filter like: `"transaction.summary == Association"`, you probably do not want to see only the transactions in the Transaction Pane. You probably also want to see the events contained within the Association displayed in the Event Pane.

You can solve this problem by using the optional `show(expr, args)` syntax in your filters.

The show syntax allows you to explicitly indicate the conditions under which an event or transaction should match your filter. The arguments for the show syntax are as follows:

SELF - The Event or Transaction matches if it contains data that matches the expression provided.

PARENT - A Transaction should be shown if any one of its child Events matches the filter.

CHILD - An Event should be shown if the Transaction to which it belongs matches the filter.

SIBLING - An Event matches if its PARENT transaction contains another Event which itself matches the filter.

Filter display defaults: Filter expressions that do not explicitly contain the optional `show(expr, args)` syntax are implemented as though they contain one of two default syntaxes. Which default syntax is used depends on where the filter is executed, in the Stream Editor or in the Large File Editor.

- Stream Editor default: `show(expression, SELF|PARENT|CHILD)`
By default, filter expressions that do not explicitly contain the `show(expr, args)` syntax are implemented as though they were wrapped in the following syntax: `show(expression, SELF|PARENT|CHILD)`. The SELF|PARENT|CHILD arguments provide what Silicon Labs believes a user expects to see when a filter is run in the Stream Editor. The filter display includes the events and transactions that match the filter itself. If an Event matches the filter, you also see an associated Transaction (PARENT) regardless of whether that Transaction matches the filter. Likewise, if a Transaction matches the filter, you also see its associated Events (CHILD) regardless of whether those Events match the filter.
- Large File Editor default: `show(expression, SELF)`
By default, the search mechanism in the Large File Editor returns only those Events and Transactions which themselves match the filter expression provided. This behavior makes it very easy to run a filter to search for all the Transactions with a given summary without having the search results bogged down with hits for their associated Events.

Expression Validation

Lexical validation - When you enter a filter expression, the filter engine validates whether the expression is lexically correct. If an expression is not lexically correct, Network Analyzer gives you an error message with a suggestion about where there may be a problem in the expression.

Event Key validation - When you enter a lexically correct expression, Network Analyzer also runs an event key validation. It checks that any identifier provided represents a real entity within an Event or Transaction. If the filter engine is not able to find any associated data for an event key within the expression, Network Analyzer will warn you that you are using an unverified identifier.

For example, in the expression

```
fifteenFour.dest == 0xffff
```

`fifteenFour.dest` is a verifiable event key in that Network Analyzer knows that it represents real data in an event.

Here are two examples to illustrate the validation of expressions in Network Analyzer. Consider this expression:

```
foo == bar
```

The filter mechanism has no way of knowing what `foo` and `bar` represent, or that they even represent any type of data within an Event or Transaction. While this expression is lexically correct, Network Analyzer will warn the user that `foo` and `bar` could not be verified, and that the expression may provide unexpected results. In fact, this expression will not show anything, since `foo` may very well equal `bar`, but the filter engine has no way of knowing that.

Consider also this expression:

```
foo == foo
```

This expression also displays a warning. However, when run, it will return ALL events, because while Network Analyzer does not know what `foo` is, it knows it definitely equals `foo`.

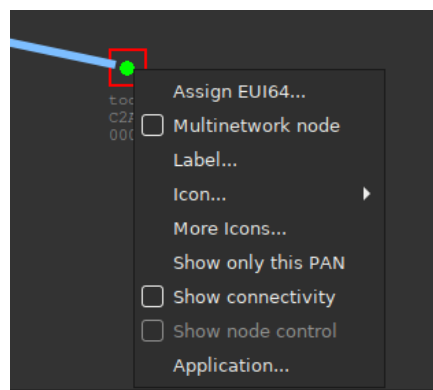
Special identifiers - Several special identifiers are not mapped to an event key.

- `payload.xxx`, which evaluates into the payload bytes for a given layer `xxx`, for example `payload.raw` or `payload.tcp_stream`. You can form expressions like `payload.raw == {001122aabbcc}` to match payloads
- `flag.xxx`, which evaluates into the value of the event flag for a given event, for example: `flag.neighbor_exchange` or `flag.fragment`.

Multinetwork Considerations

Multinetwork Considerations

If your application uses nodes operating on multiple networks, this information can be reflected when reviewing capture sessions. Currently, however, Network Analyzer cannot auto-detect multinetwork nodes. At the onset, unless all traditional, conceptual nodes constituting the multinetwork node are assigned EUI64s, each conceptual node shows up as a separate node in the Map editor pane. Each such node must be assigned the same EUI64 by right-clicking on the node in the Map editor pane and selecting **Assign EUI64...** A dialog pops up that facilitates the assignment, and the **Multinetwork EUI64** checkbox must be checked to inform Network Analyzer that the node is indeed a multinetwork node. This sequence is illustrated in the following figure.



Once all the constituent conceptual nodes have been assigned the same EUI64, Network Analyzer coalesces them into one node in the Map editor pane. Alternatively, if all the conceptual nodes know the EUI64 or all have been coalesced but Network Analyzer has not been informed that the node is multinetwork, the **Multinetwork node** menu item in the figure above can be toggled. Once a node is known to Network Analyzer to be multinetwork, it is indicated as such by being colored magenta in the Map editor pane.

Custom Decoders

Custom decoders

Network Analyzer provides functionality to create custom decoders. This section provides a quick guide for using this feature.

Custom decoders can be created in Lua language, which is embedded inside Network Analyzer.

Step 1: Create a Lua File

Create a '*.lua' file that contains the logic of your decoder. Example:


```

1  local decoder = {}
2
3  decoder.name = "Lua Test Decoder 1"
4  decoder.filterName = "luadecoder1"
5  decoder.description = "An example of a Lua decoder"
6
7  -- Init function is called whenever the decoder is created the first time.
8  -- It is NOT called for every packet. So only do global initialization here.
9  function decoder.init()
10 end
11
12 -- Accept is called for EVERY packet. if Accept returns true, then decode is called.
13 function decoder.accept()
14     log("Accept.")
15     if payloadByte(0) == 0x13 then
16         return false
17     else
18         return true
19     end
20 end
21
22 -- Decode function is called for EVERY packet that is accepted.
23 function decoder.decode()
24     log("Decode.")
25     append("firstByte", 1)
26     local byte2 = decode("secondByte", 1)
27     appendBits("bit0", 1)
28     appendBits("bit1", 1)
29     appendBits("bit23", 2)
30
31     if byte2 == 0x02 then
32         append("theWord", 2)
33     else
34         appendBytes("array0", 2)
35     end
36
37     setSummary("Lua decoded packet")
38 end
39
40 return decoder

```

Step 2: Register the Lua Decoder

The workflow inside Network Analyzer to create a Lua custom decoder is as follows:

- Go to **Window > Preferences > Network Analyzer > Decoding**.
- Click Add...
- Navigate to the *.lua file location, and select it.
- Make sure the left-most checkbox that enables the custom decoder is enabled.

At this point, the custom decoder is registered to the decoding system and will be used when appropriate.

Internals

The custom decoder is Lua code, containing a `decoder` object, that will be read by the decoding system.

Lua Decoder Object

The Lua object is essentially a table of key/value pairs. This table lists the keys and the types of the values expected for the given keys, in order for the decoder to be recognized as such.

Name of element	Type of element	Purpose
name	String	Human readable name of the decoder mostly to show in the Preference table.
filterName	String	Decoding key used in filtering and similar.
description	String	Description that provides more in-depth description of this object.
init	void function	Initialization function, called only once when the Lua file is loaded. Intended for global initializations.
accept	boolean function	Function that returns true/false, depending on whether the passed event is something this decoder is interested in.
decode	void function	Decoding function that performs decoding. This function will only be called if <code>accept()</code> function returns true.

Lua API

Inside the functions that are part of the Lua decoder, you can use some APIs that reach into the Network Analyzer java space. Following is the list of decoding functions.

Function	Return value	Arguments	Purpose
append	void	String fieldName, int length	Appends an integer field with a given fieldName and length to the list of decoded fields.
appendBits	void	String fieldName, int length	Appends length bits as bitmask inside the last decoded integer.
appendBytes	void	String fieldName, int length	Appends length bytes as a binary blob to the list of decoded fields.
decode	int	String fieldName, int length	Decodes an integer field with a given fieldName and length, and returns the value for further use.
log	void	String	Logs the message for debugging purpose.
payloadByte	int	int index	Returns a value of the byte at the specified index.
setSummary	void	String	Sets the summary of the packet for display in Network Analyzer UI.

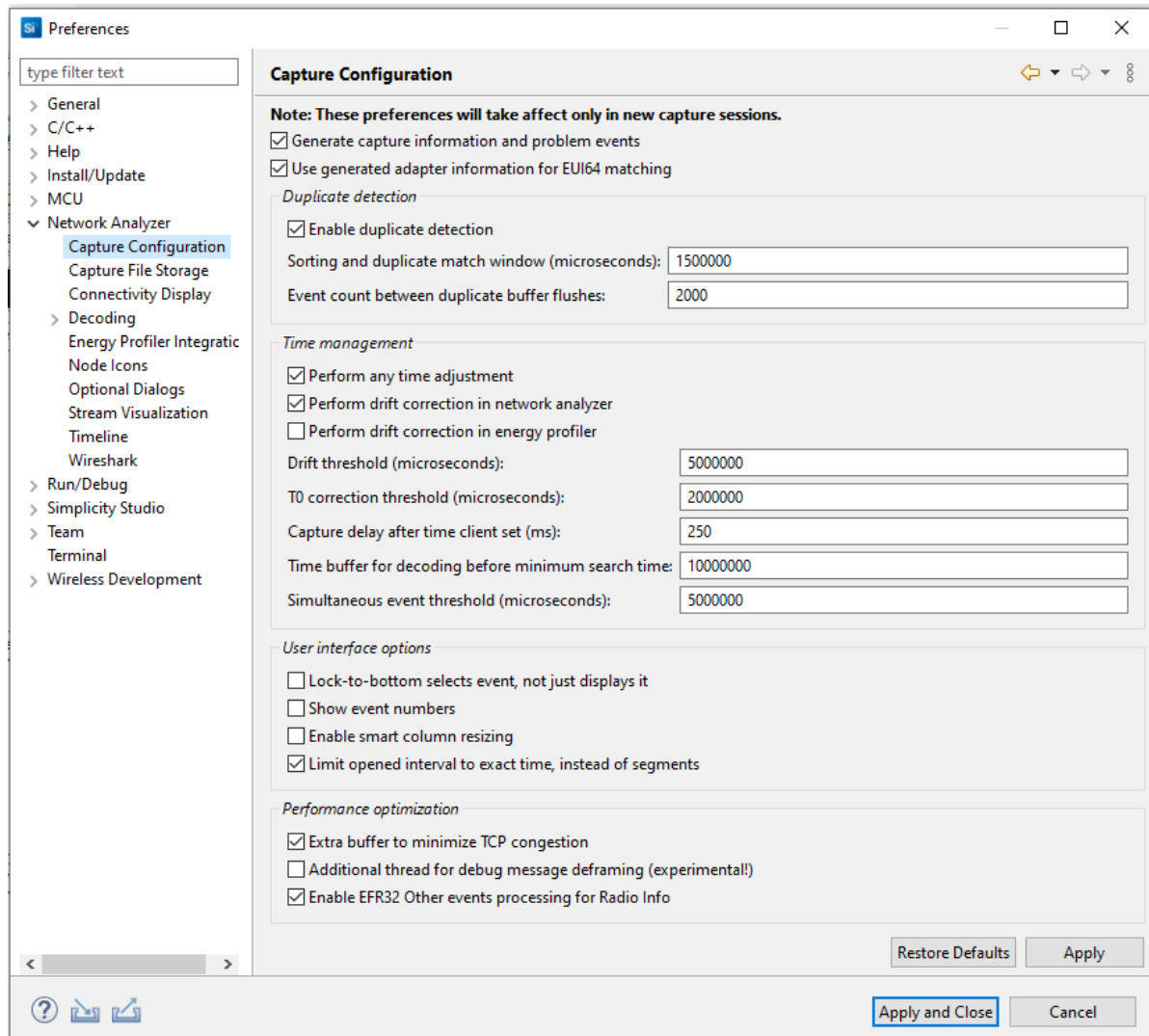
Network Analyzer Preferences

Network Analyzer Preferences

To access Network Analyzer preferences, select Window > Preferences > Network Analyzer. The preferences you set apply to all capture sessions. Network Analyzer saves your preferences and uses them each time Network Analyzer restarts. Preference categories include:

- [Capture Configuration](#)
- [Capture File Storage](#)
- [Connectivity Display](#)
- [Decoding](#)
- [Energy Profiler Integration](#)
- [Node Icons](#)
- [Optional Dialogs](#)
- Stream Visualization (deprecated function)
- [Timeline](#)
- [Wireshark](#)

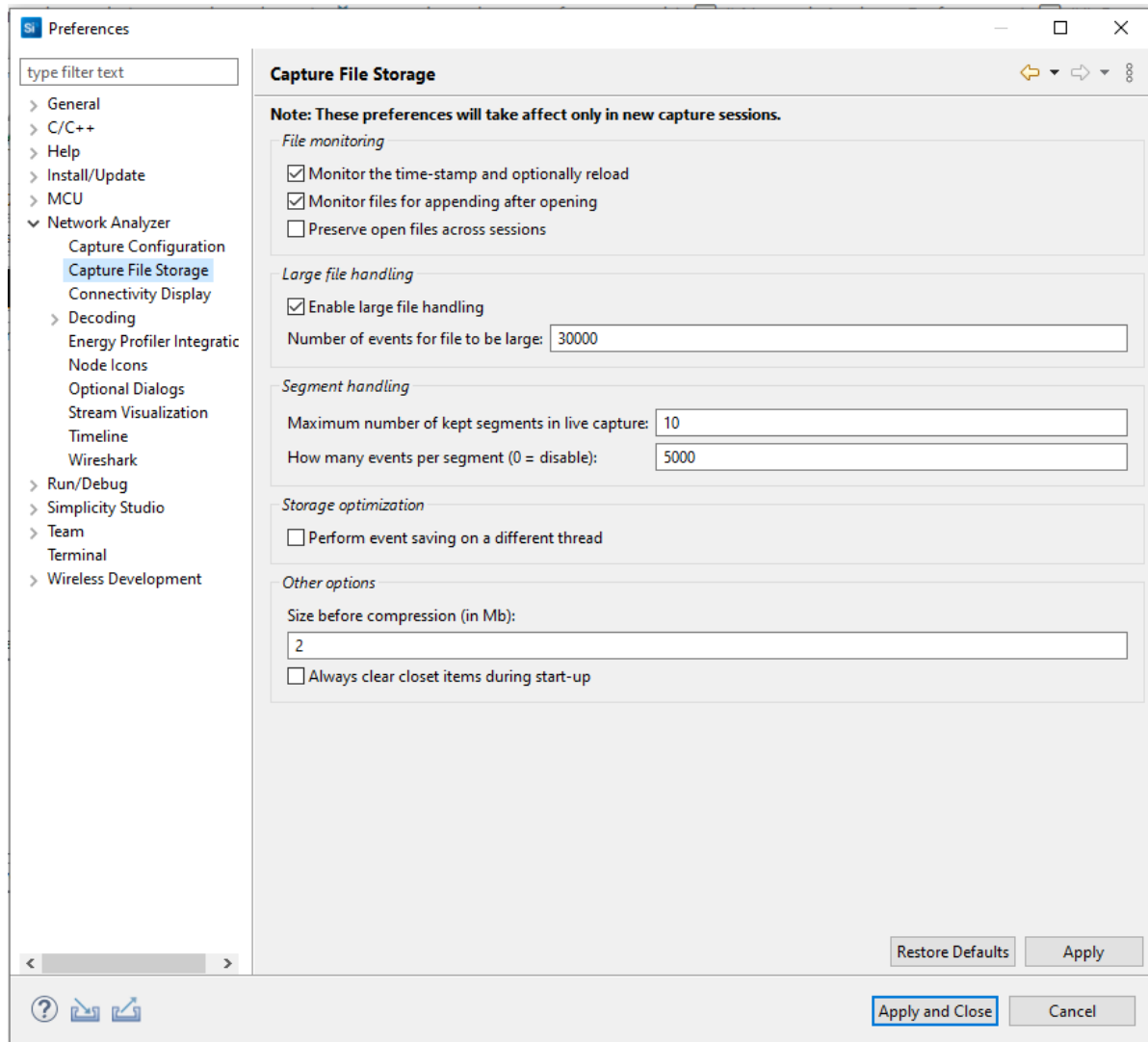
Capture Configuration Preferences



These preferences offer general, time management, and user interface configuration options. Changes take effect in the next new capture session. Some options are:

- Sorting and duplicate match window: Specifies in microseconds a time span in which duplicate packets can be detected. If identical packets arrive within the specified time span, Network Analyzer detects the duplication and allows only one to display.
- Perform drift correction in network Analyzer: Allows drift for autocorrection.
- Drift Threshold: Specifies the amount of time-drift that Network Analyzer will tolerate between the absolute PC clock and the adapter clocks before it resets its "time-correction" factor. In most situations you should not change this value. In a typical situation, adapter clocks are more precise than PC clocks, but they do not provide absolute time, just relative time against an arbitrary reference.

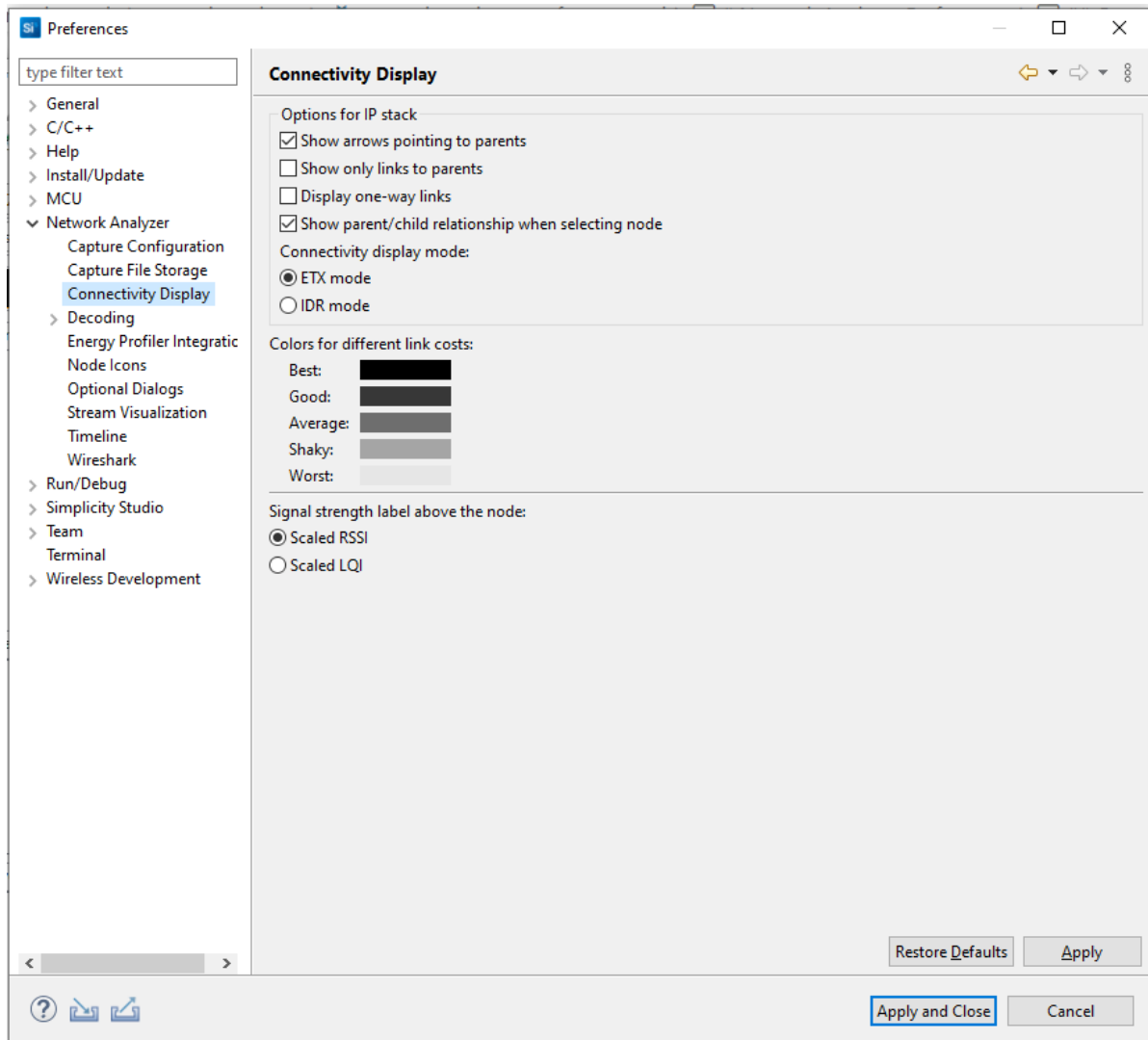
Capture File Storage Preferences



These preferences determine, among other things, what is considered a large file, which in turn determines the default editor used. Changes take effect in the next new capture session. Some of the options are:

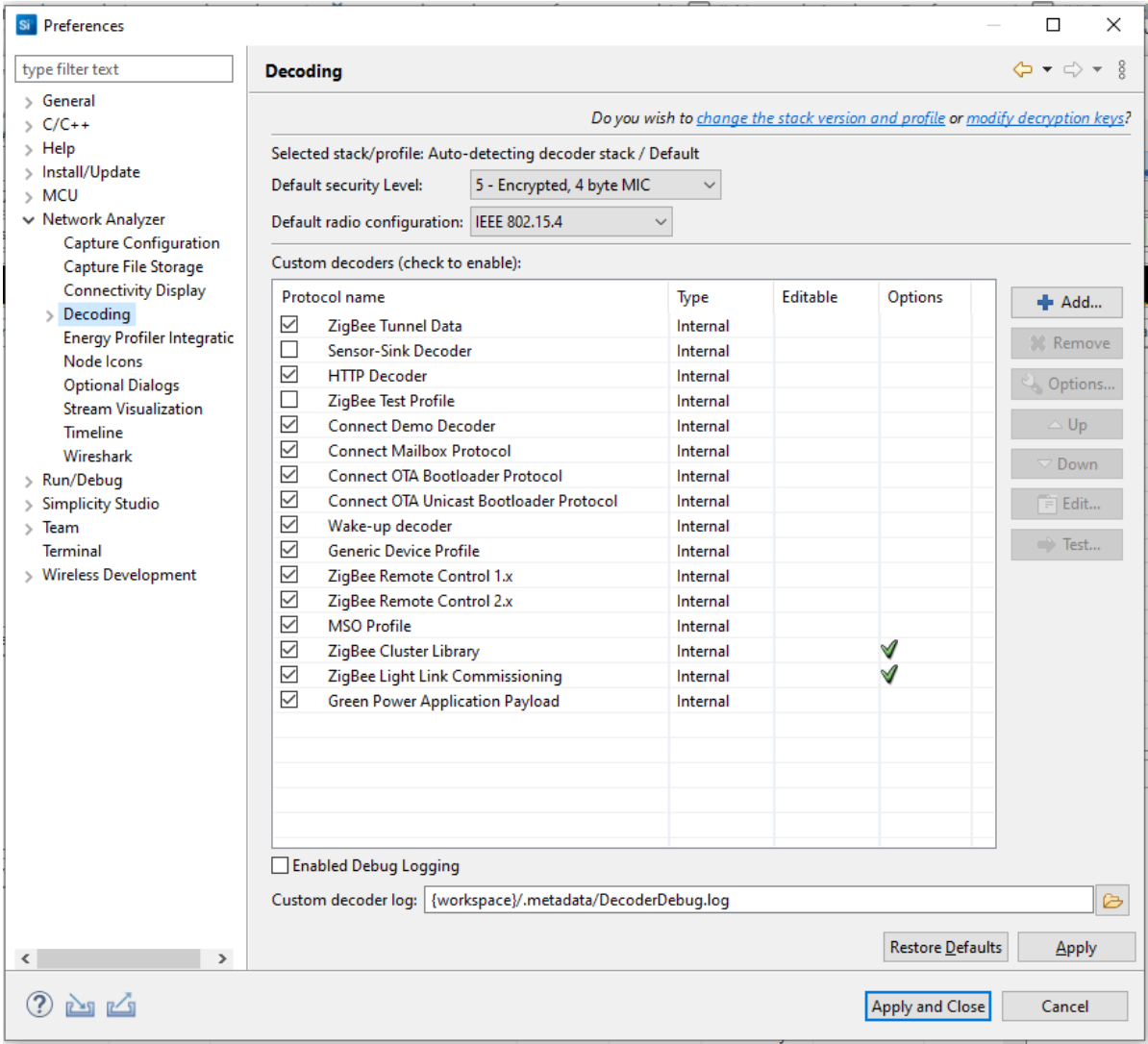
- Monitor the timestamp and optionally reload: Monitors whether the file has changed on the disk, and prompts to reload if so.
- Monitor files for appending after opening: Enables Network Analyzer to detect new packet data appended by an external program to an open session file, and read it in for display.
- Preserve open files across sessions: Instructs Network Analyzer to automatically reopen files from previous session
- Enable large file handling: Enables Network Analyzer to handle large files in the Large File Editor. Files are considered large if they contain more events than the number entered in "Number of events for a file to be large."

Connectivity Display Preferences



These preferences customize how device connectivity is displayed.

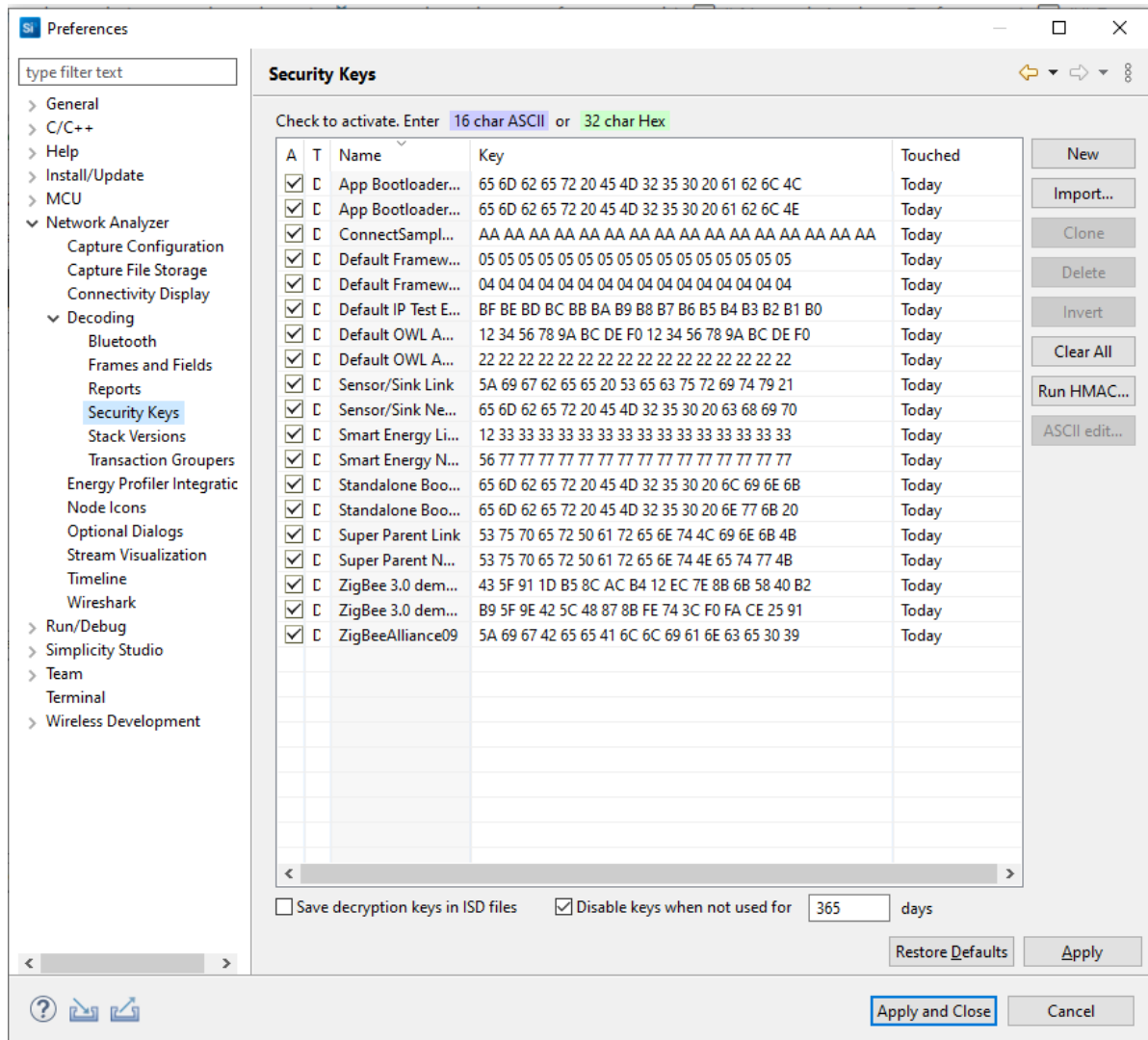
Decoding Preferences



The **Decoding** preferences group affect how decoding is handled. Changes take effect in the next new capture session. On the Decoding dialog, some options are:

- Selected stack: The stack selected for decoding newly captured data. Links allow you to make changes in other preference interfaces. This setting has no effect on a previously captured trace. The decoding stack for a trace file is stored in the file itself.
- Security level: The security level set for the MAC and network layers. Valid values include 1 through 5.

Security Keys



Specifies the security decryption keys. To enable a key, select the Decryption key checkbox. To edit a key, select its name or key values. All enabled decryption keys are run against each incoming packet until one is successful. Successful keys are automatically moved to the top of the key list to improve performance. Decryption keys can also be obtained from network traffic for future use.

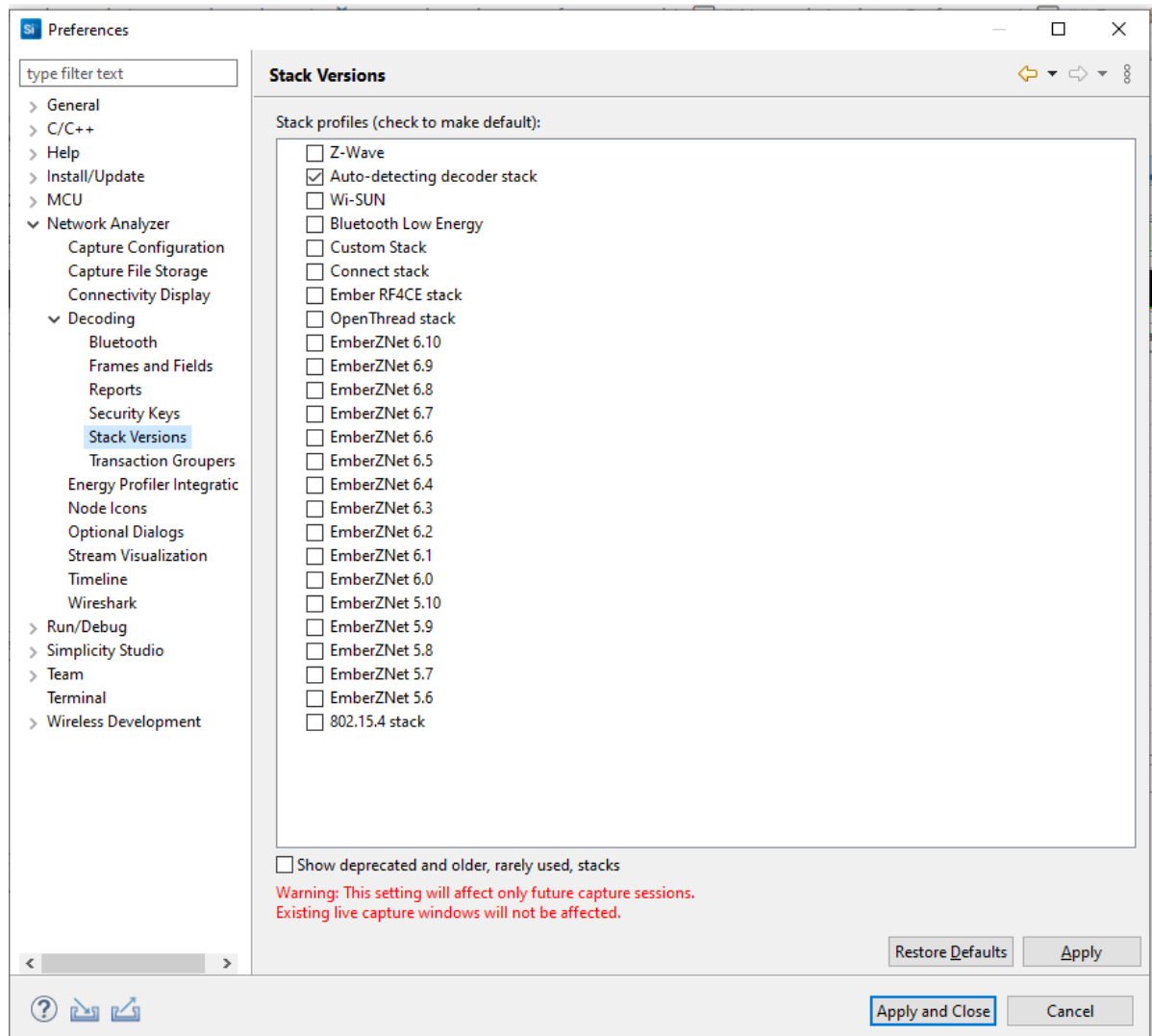
Buttons on the right of the dialog provide the following features:

- New: Creates a new key for editing.
- Import: Opens a dialog from which you can import a key file.
- Clone: Creates a copy of the currently selected key.
- Delete: Removes the currently selected key.
- Invert swaps the order of the key values.
- Clear All: Removes all security keys.
- Run HMAC: Opens a dialog that allows you to manually calculate the HMAC authenticated key from trust key and IEEE EUI64 address.
- ASCII edit...: Converts a human-readable ASCII string into a binary security key.

The checkboxes at the bottom of the keys list provide the following options:

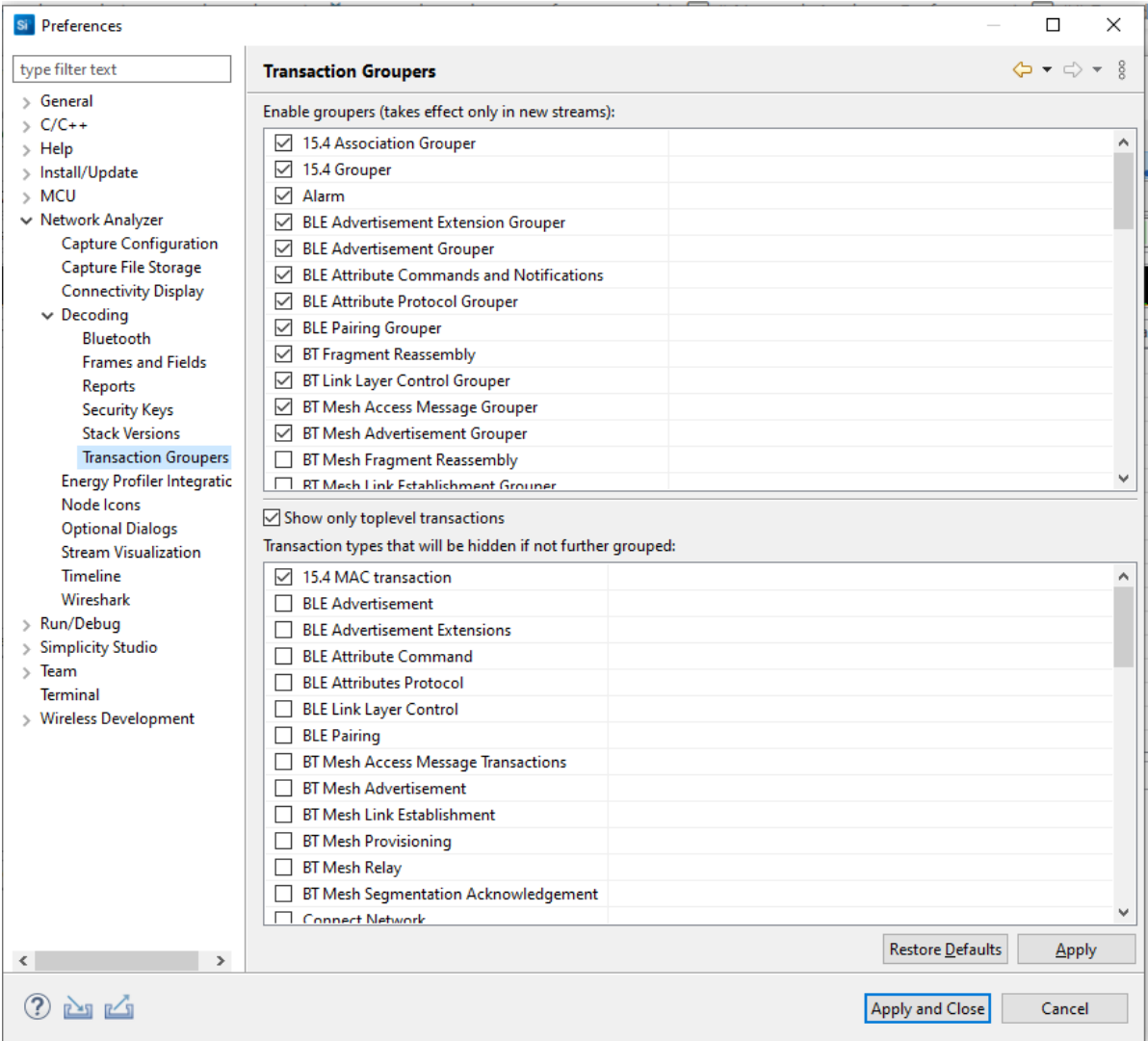
- Save decryption keys in ISD files (unchecked by default): Saves the security keys that you have specified into the capture file along with your traffic. Note: If you are sharing the Network Analyzer file with users who have a right to know your key, this may make the opening of the file easier for them, as they will not have to separately enter the key. However, by doing this, you create a security risk. Never enable this option, if your keys must remain secure and known to you only.
- Disable keys when not used for n days (checked by default): You can configure the number of days unused keys should be kept.

Stack Versions



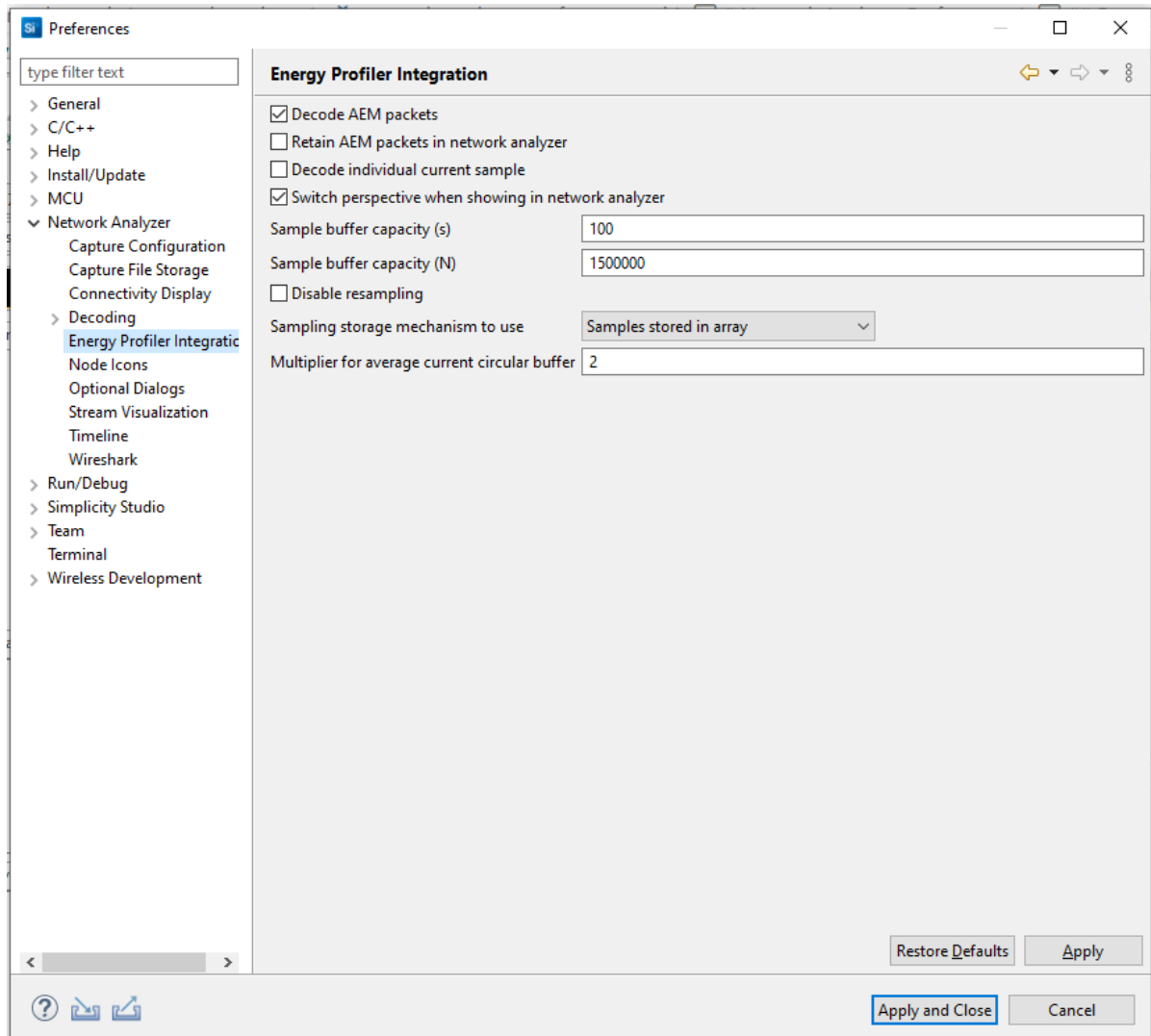
A list of profiles representing Gecko SDK Suite stack versions. Check the stack that is deployed on the network you are using. If you are working with Dynamic Multiprotocol projects, select 'Auto-detecting decoder stack'.

Transaction Groupers



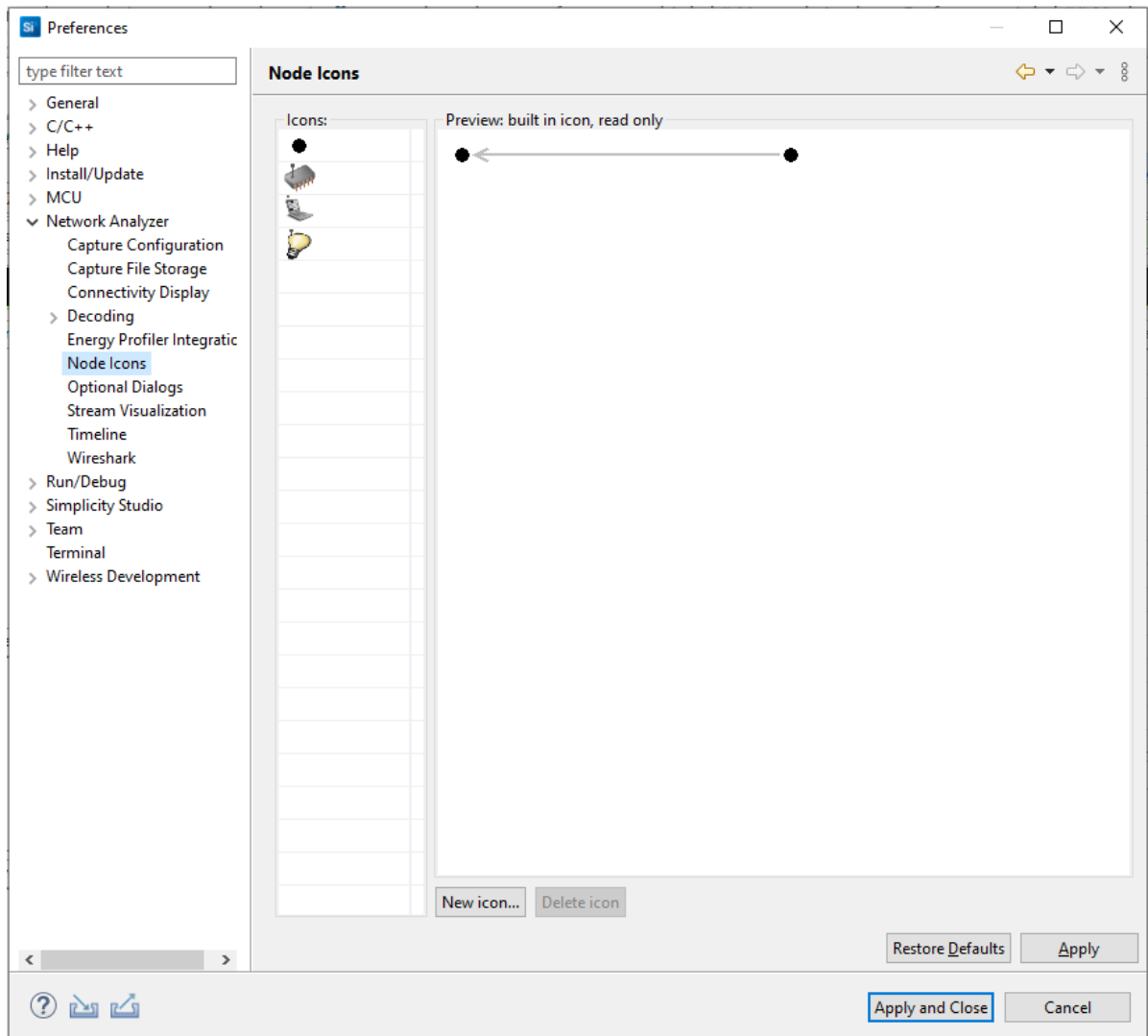
A table of all the groupers loaded into Network Analyzer. Transaction groupers are responsible for making transactional sense out of a trace of network data. Groupers watch for batches of events and record them as a transaction.

Energy Profiler Integration Preferences



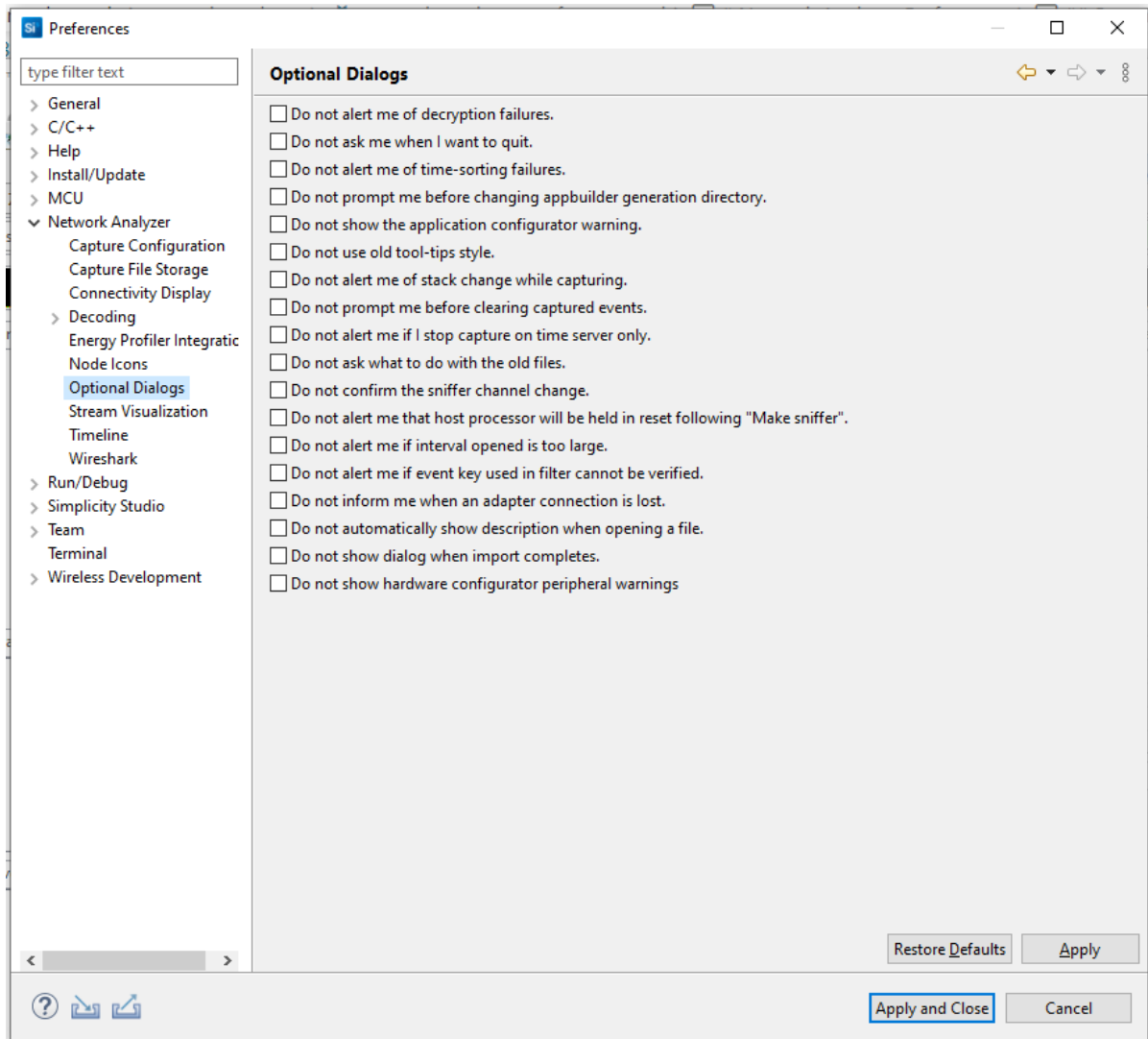
See [Energy Profiler and Network Analyzer](#) in the Energy Profiler section for more information about using the two tools together and the effect of these preferences.

Node Icon Preferences



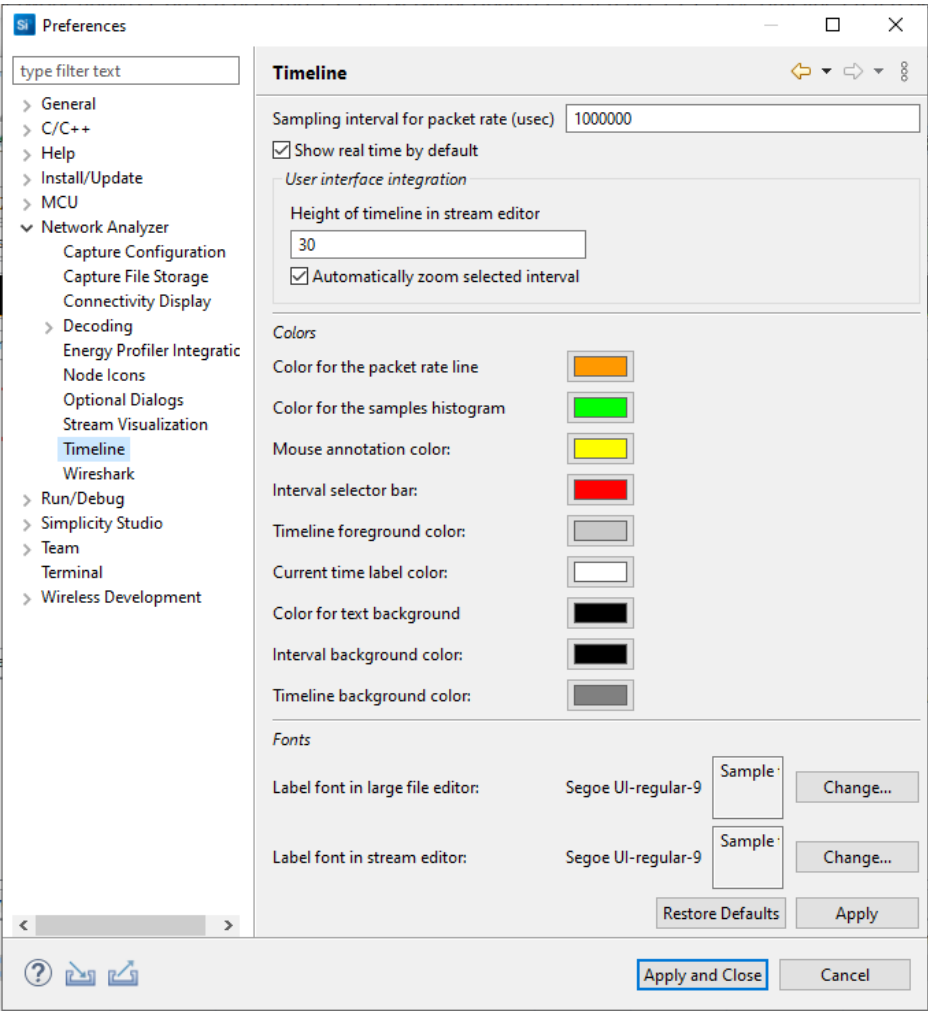
Network Analyzer provides several predefined icons. The Node Icons dialog displays all icons that are available for customizing display of nodes in the map pane. You can also add icons of your own.

Optional Dialog Preferences



Some dialogs can be turned off if you prefer not to interact with them.

Timeline Preferences



Among other options, you can choose the colors and fonts for features of the Timeline.

Wireshark Preferences

If you are using the Wireshark open source packet analyzer, these options configure the integration.

Preferences

type filter text

> General

> C/C++

> Help

> Install/Update

> MCU

> Network Analyzer

Capture Configuration

Capture File Storage

Connectivity Display

> Decoding

Energy Profiler Integratic

Node Icons

Optional Dialogs

Stream Visualization

Timeline

Wireshark

> Run/Debug

> Simplicity Studio

> Team

Terminal

> Wireless Development

Wireshark

This preference page configures the wireshark integration preferences.
Wireshark is an open source packet analyzer, which can be
freely downloaded from wireshark.org.

Wireshark executable:

C:\Program Files\Wireshark\wireshark.exe

Test wireshark...

Text2pcap executable:

C:\Program Files\Wireshark\text2pcap.exe

Test text2pcap...

Data streaming mechanism:

Use temporary file

Restore Defaults

Apply

Apply and Close

Cancel

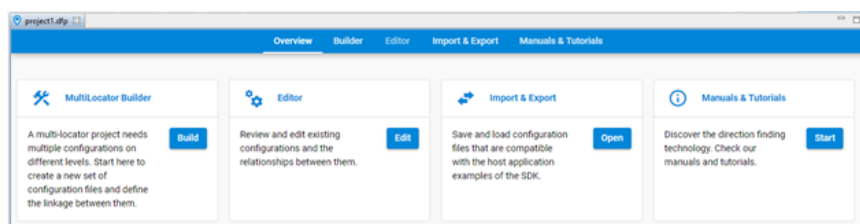
Bluetooth Direction Finding Tools

Bluetooth Direction Finding Tool Suite

A Real Time Locating System (RTLS) consists of many locators that pick up the signals of asset tags to locate them in 3D space. To calculate the positions of the asset tags, you must know each locator's position, orientation, and configuration (such as antenna array type, switching pattern, and so on). The Silicon Labs' Real Time Locating (RTL) library also needs configuration parameters, such as estimation mode, azimuth, elevation constraints, and so on, to provide the best estimation for a given environment. The Bluetooth Direction Finding Tool Suite, accessed primarily through the Direction Finding Dashboard, is meant to ease development with the Silicon Labs' RTL library. It provides multiple tools to configure the system, and also helps development with analyzer tools that calculate many output parameters from the observed IQ samples.

Note: The tools were created for demonstration purposes, and not to be used in production. For development purposes, start with the sample application described in [AN1296: Application Development with Silicon Labs RTL Library](#).

The Bluetooth Direction Finding Dashboard aggregates the tools used to create and configure Direction Finding projects (*.dfp). These projects are created through **Files > New > Project > Simplicity Studio > Direction Finding Project**.



The tools available through the Dashboard include:

- MultiLocator Builder: Used to create a multi-locator configuration setup using topologies and individual locator's configurations, and link them to produce a multi-locator configuration file.
- Editor: Used to review and edit a multi-locator configuration and its building blocks, namely the topology and single locator configurations. The Editor provides a framework that draws on other tools:
 - The AoA Positioning Tool demonstrates the location estimation of the Real Time Locating (RTL) library. Global RTL settings can also be configured in the tool, and those settings are saved into the multi-locator configuration file.
 - AoA Configurator provides an editable 3D representation of a topology and locator devices. Use the tool to add locators, drag them to the desired position, and rotate them to the best orientation.
 - AoA Analyzer (also available through the Tools menu) can create a single locator configuration file, and then apply the configuration for a single locator board and run the RTL library to estimate angles from the incoming data.
- Import & Export: Used to migrate configuration files to and from the SDK's AoA host projects.

For details about the tools and references to other direction-finding documentation, see [UG514: Using the Bluetooth® Direction Finding Tool Suite](#)

Tips and Tricks

Tips and Tricks

Many of these tips rely on changes in Preferences. This can be accessed through the **Window > Preferences** selection, or the **Preferences** button on the toolbar.

- [Useful Windows 10 paths](#)
- [Useful Mac OS paths](#)
- [Default Project Locations](#)
- [Optionally Disable Automatic Updates](#)
- [Performance Enhancements](#)
- [SDK installation or updates are not working](#)
- [Speed up debug session startup](#)
- [Speed up reading large source files](#)
- [Speed up the indexer](#)
- [Restore a perspective layout](#)
- [Find a Version](#)
- [Report a Bug](#)
- [Capture a Simplicity Studio 5 Thread Dump](#)
- [Convert an Existing Simplicity Studio 5 Project from GCC to IAR](#)
- [Using custom boards](#)

Useful Windows 10 paths

Default Simplicity Studio Install Path: C:\SiliconLabs\SimplicityStudio

Downloaded location for kit resources:

C:\SiliconLabs\SimplicityStudio\v5\offline\ae\www.silabs.com\documents\public\schematic-files

Command line or direct GUI access to Simplicity Commander:

C:\SiliconLabs\SimplicityStudio\v5\developer\adapter_packs\commander

Protocol SDK locations for all GSDK SDKs:

- GSDK 4.x: C:\Users\<NAME>\SimplicityStudio\SDKs\gecko_sdk\protocol\<protocol>
- GSDK 3.x: C:\SiliconLabs\SimplicityStudio\v5\developer\sdk\gecko_sdk_suite\<GSDK version>\<protocol>

Beginning with GSDK 4.0, content such as documentation or demos that was previously installed with the SDK is now downloaded after being accessed through Simplicity Studio: C:\SiliconLabs\SimplicityStudio\v5\offline\com.silabs.sdk.stack.super_<version>

Useful Mac OS paths

Default Simplicity Studio Install Path: /Applications/SimplicityStudio.app/Contents/Eclipse (recommend changing to one word SimplicityStudio.app)

Downloaded location for kit resources:

/Applications/SimplicityStudio.app/Contents/Eclipse/offline/ae/www.silabs.com/documents/public/schematic-files

Command line or direct GUI access to Simplicity Commander:

/Applications/SimplicityStudio.app/Contents/Eclipse/developer/adapter_packs/commander

Protocol SDK locations for all GSDK SDKs:

- GSDK 4.x: /Users/<NAME>/SimplicityStudio/SDKs/gecko_sdk/protocol/<protocol>
- GSDK 3.x: /Applications/SimplicityStudio.app/Contents/Eclipse/developer/sdks/gecko_sdk_suite/<GSDK version>/protocol

Beginning with GSDK 4.0, content such as documentation or demos that was previously installed with the SDK is now downloaded after being accessed through Simplicity Studio:

/Applications/SimplicityStudio.app/Contents/Eclipse/offline/com.silabs.sdk.stack.super_<version>

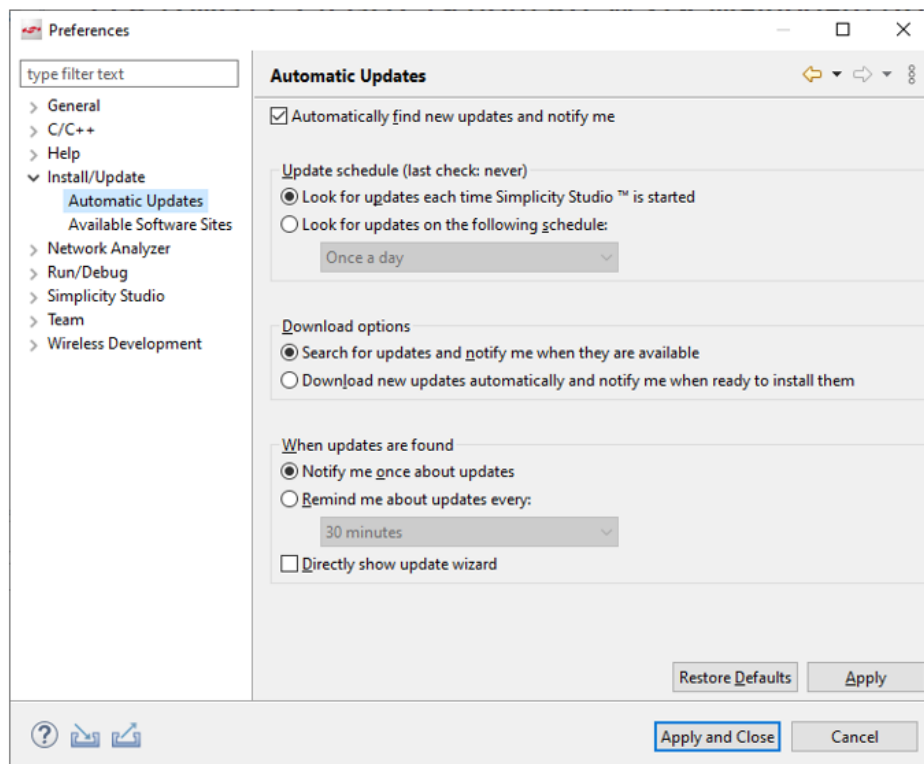
Default Project Locations

Default project locations in your Windows 10 workspace C:\Users<user>\SimplicityStudio Ex: C:\Users\daseymou\SimplicityStudio

Default project locations in your Mac workspace /Users/<user>/SimplicityStudio Ex: /Users/mahallam/SimplicityStudio

Optionally Disable Automatic Updates

By default, SSv5 checks for updates when you first open it. You can manage update frequency through **Preferences > Install/Update > Automatic Updates**.



Either uncheck **Automatically find new updates and notify me** or change the **Update Schedule** selection to use a schedule such as once a week.

If you have turned automatic updates off, you can check for updates by clicking **Install** on the toolbar, then **Manage Installed Packages**, and then **Check for Updates** on the Product Updates tab.

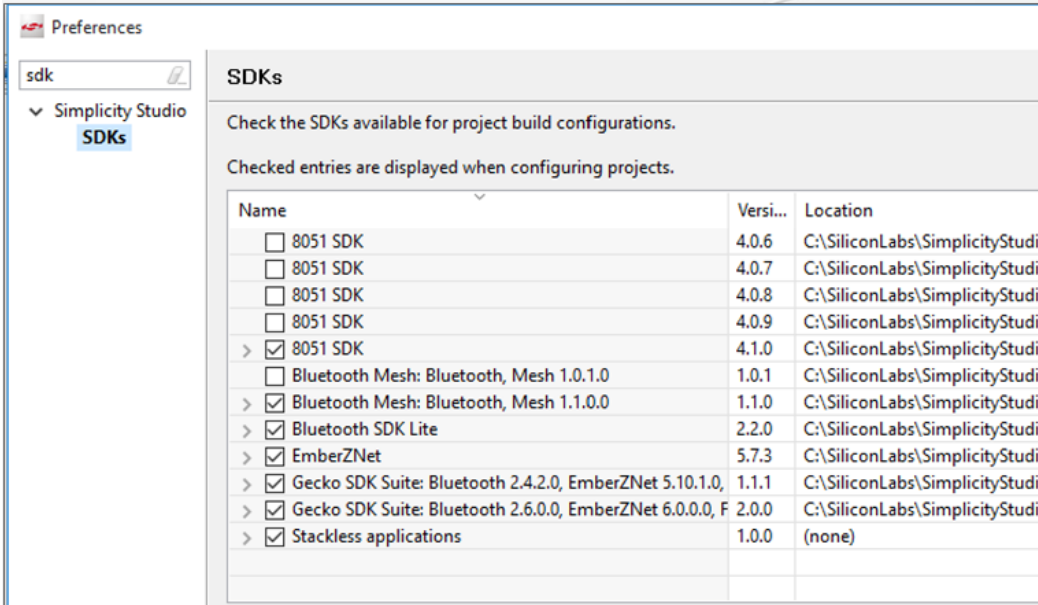
See [About Update Frequency](#) for details on the selections available.

Performance Enhancements

To improve SSv5 performance, try one or more of the following suggestions.

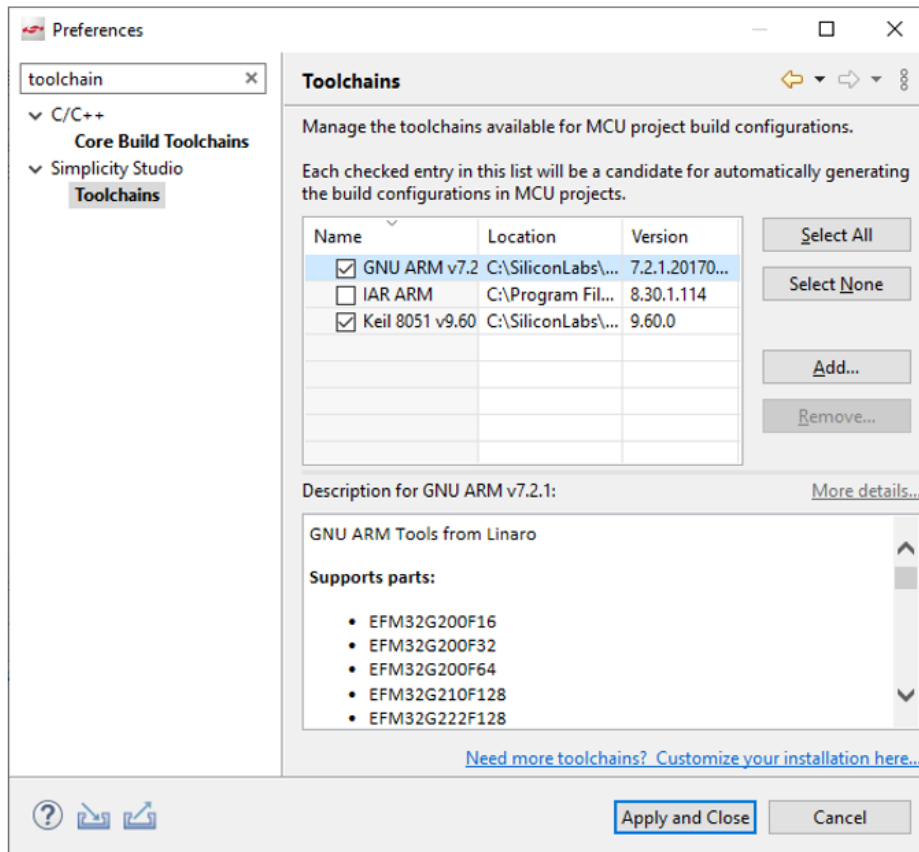
Disable SDKs not being used

If you have installed many different versions of different SDKs and GSDKs over time, go to **Preferences**, type `SDK` in the filter field, and uncheck the ones not currently being used.



Disable unused targets or toolchains

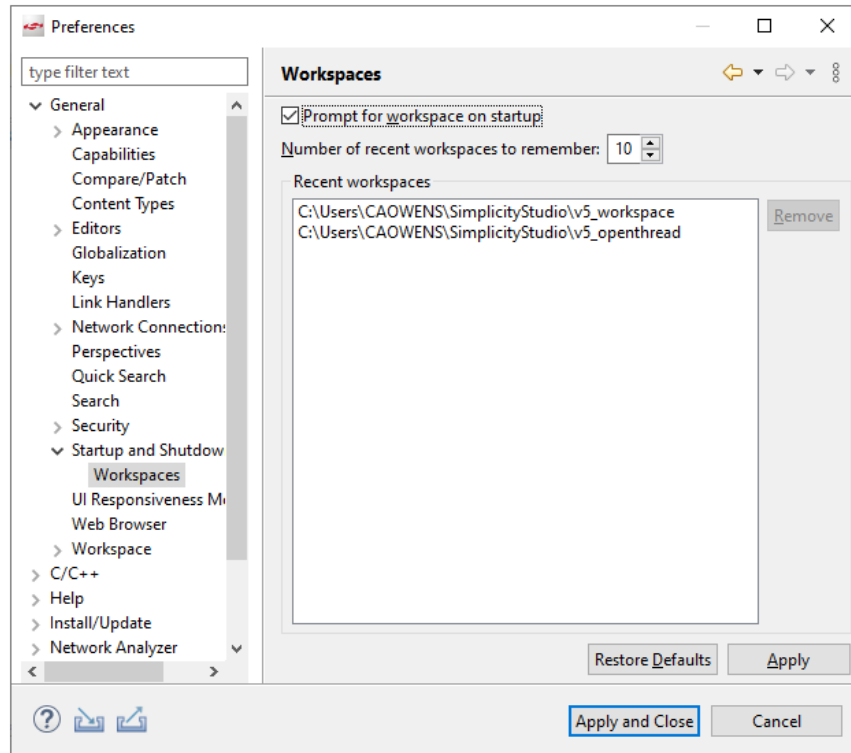
If you have installed multiple toolchains but are not using all of them, or are not using all of the targets, disable the unused ones. Go to **Preferences** and type `toolchain` or `target` in the filter field, and uncheck any unused items.



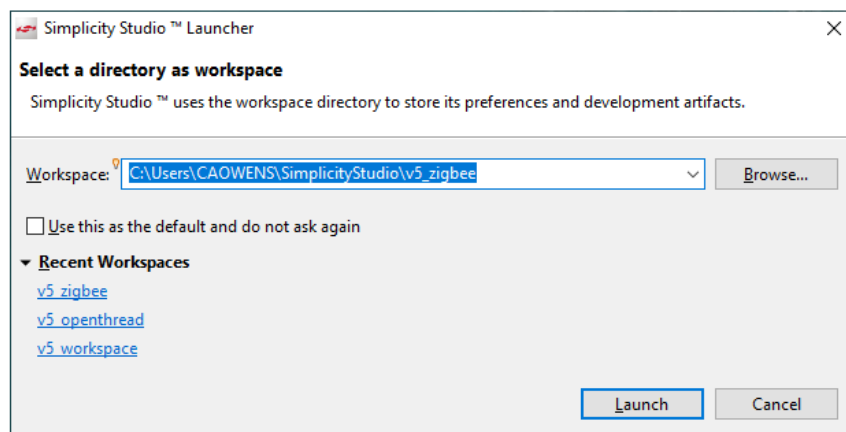
Use different workspaces for different GSDK versions or compilers

Overloading a workspace with projects and different versions of SDKs can slow down SSV5 operations. Keep separate workspaces for specific project and/or SDK versions and/or toolchains. Note that this is necessary if you are using different versions of the IAR compiler to match different versions of the GSDK.

While you can use **File > Switch Workspaces** to change workspaces as described in [Project Explorer View](#), if you will be working with different workspaces, you may wish to have SSV5 prompt you on startup about which workspace to use. Go to **Preferences > General > Startup and Shutdown > Workspaces** and check **Prompt for workspace on startup**.



Then on startup you can select a workspace or create a new workspace by clicking **Browse** and adding a directory.

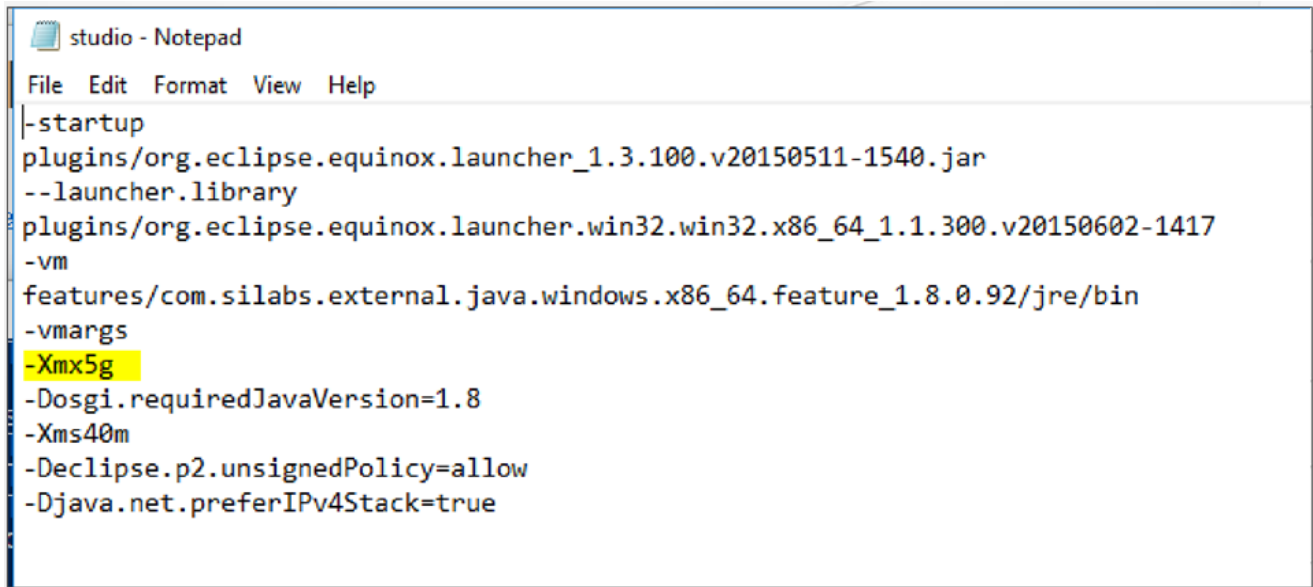


Increase heap size

Close SSv5. Use a text editor to open following file within the Simplicity Studio root path, for example:

C:\SiliconLabs\SimplicityStudio\v5\studio.ini

In the following figure, the line `Xmx5g` was added to increase the maximum Java heap SSv5 will use to 5 GBytes. Choose larger or smaller depending on your system resources. Without that line SSv5 defaults to a maximum of one quarter of the system RAM. On a system with 8 GBytes of RAM that would be 2 GBytes and SSv5 might run out of Java Heap space on memory-intensive operations.



```
studio - Notepad
File Edit Format View Help
-startup
plugins/org.eclipse.equinox.launcher_1.3.100.v20150511-1540.jar
--launcher.library
plugins/org.eclipse.equinox.launcher.win32.win32.x86_64_1.1.300.v20150602-1417
-vm
features/com.silabs.external.java.windows.x86_64.feature_1.8.0.92/jre/bin
-vmargs
-Xmx5g
-Dosgi.requiredJavaVersion=1.8
-Xms40m
-Declipse.p2.unsignedPolicy=allow
-Djava.net.preferIPv4Stack=true
```

SDK installation or updates are not working

The cause might be your IT department using proxy servers, and potentially also man-in-the-middle security monitoring. See the following knowledge base articles for more information on how to work around these situations:

[Configuring Simplicity Studio to Work with Proxy Servers](#)

[Installing SSL Security Certificates for Simplicity Studio Updates](#)

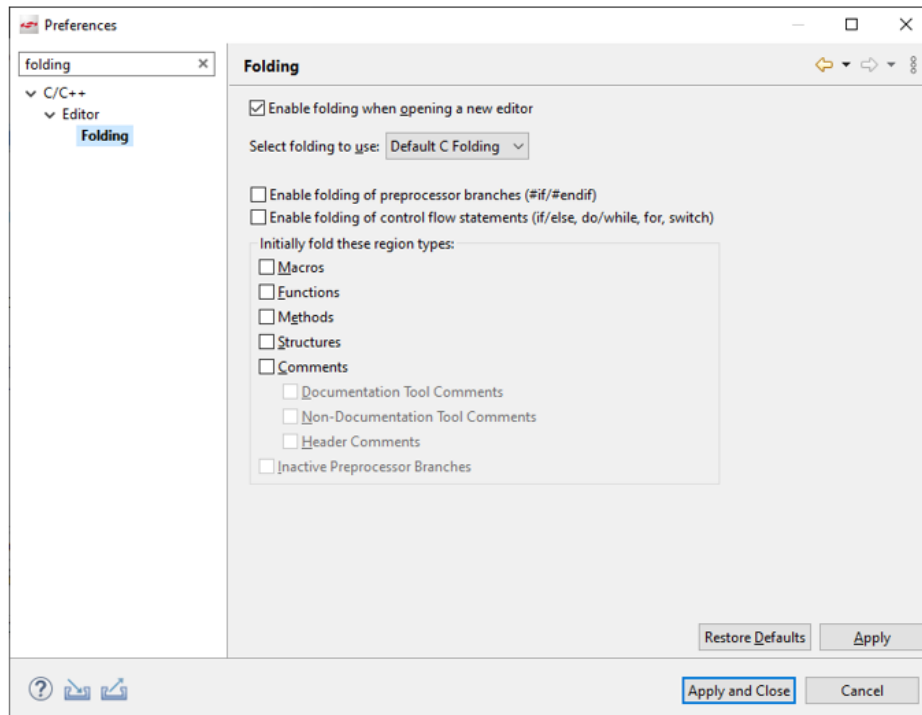
Speed up debug session startup

Go to Preferences > Run/Debug > Launching, and under General Options uncheck **Build (if required) before launching**.

This will interfere with your workflow if you are accustomed to making a change and clicking the Debug button to build the project before launching the project.

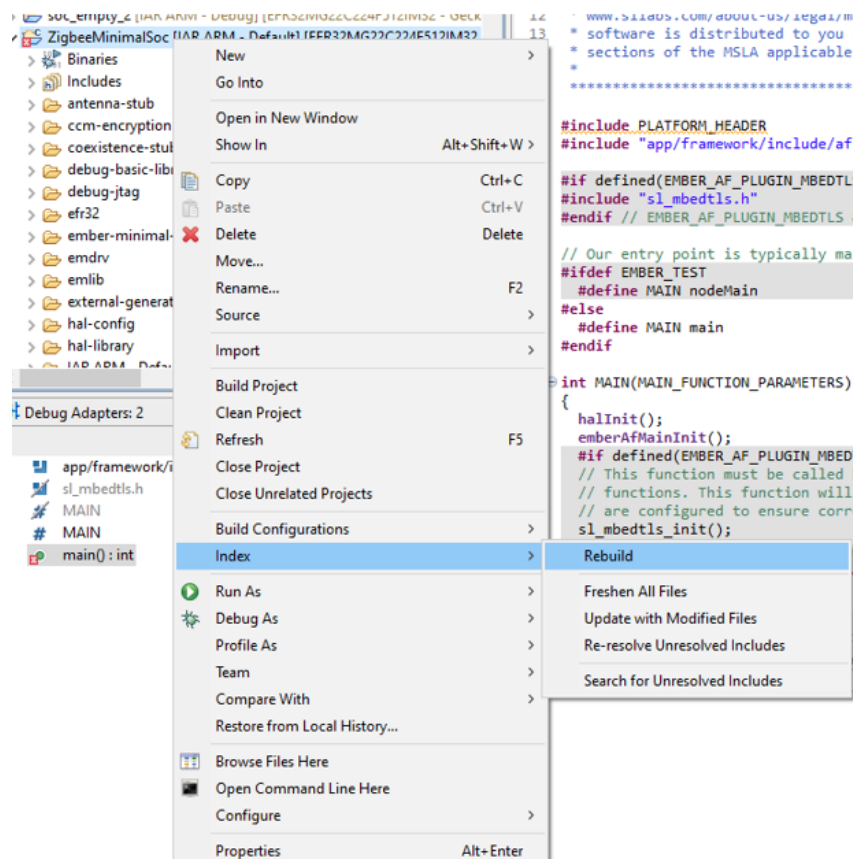
Speed up reading large source files

Enable folding of #if/#ifdef's and if/else, do/while, for, and switch statements in source code. Go to **Preferences** and type **folding** in the filter field, and check the three "Enable folding ..." options.



Speed up the indexer

If the Indexer is taking a long time to run, close other projects. If still slow, in the Project Explorer view right-click the project directory and select **Index > Rebuild**.




Restore a perspective layout

To reset a perspective to its original layout, right-click the perspective button in the toolbar and select **Reset**.

Find a Version

Go to **Help > About Simplicity Studio** for version information. The overall SSv5 version is at the top of the dialog. The Studio Version tab lists version information for all the components that make up SSv5. The Toolchains and SDKs tab lists version information for the installed SDKs and toolchains.

About Simplicity Studio



Simplicity Studio Version: **SV5.0.0.RC3**









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Filter Packages

☒ Installed Packages

Studio Version

Toolchains and SDKs

Studio Package Name	SV5.0.0.RC3	SV5.0.0.RC2
 Bundled Salesforce Support	4.8.0	4.8.0
 Bundled Wine Support	1.8.10	1.8.10
 Configurator Base Framework	4.2.3	4.2.3
 Connect SDK ESF Components	8.1.1	8.1.1
 Core WASP Components	8.1.1	8.1.1
 Debug Adapter Support for J-Link	4.2.0	4.2.0
 Debug Adapter Support for J-Link OB	4.2.6	4.2.6
 Debugger Framework	4.4.3	4.4.3

Release Note: Debug Adapter Support for J-Link

4.2.0

Refactoring of APIs in infrastructure


4.0.5

Add JlinkConfigUtils as a public utility

4.0.4

Build infrastructure change

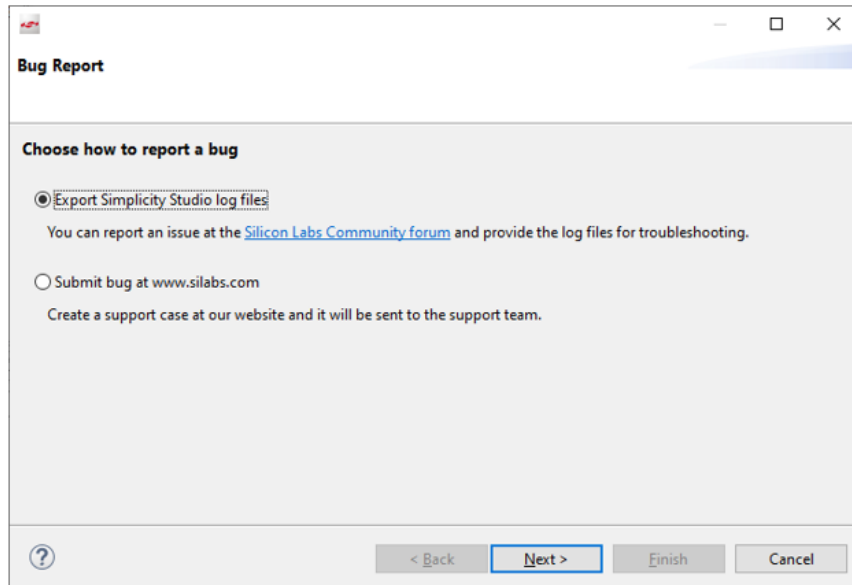
4.0.3

 Advanced...

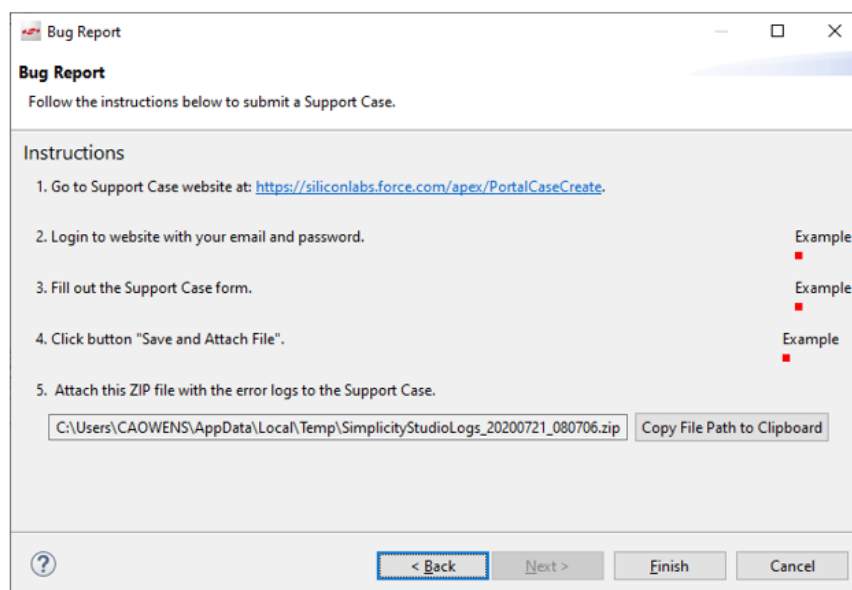
OK

Report a Bug

Go to **Help > Report bug** The default selection generates a log file to the location you specify. This is useful if you need to attach a log to a case that's already created.



Select **Submit bug at Silabs.com** if you are creating a new ticket. This generates the log file and provides instructions on creating a ticket.



Capture a Simplicity Studio 5 Thread Dump

If Simplicity Studio 5 happens to hang (become unresponsive for several minutes) during an operation, the best way to report this to Silicon Labs is to use a Java tool called jstack to capture a thread dump while the program is still in the hung state. This thread dump can be used by the Silicon Labs team to analyze the hang. If Simplicity Studio 5 is shut down and restarted, a thread dump at that point will not be useful. The jstack tool is included in the Simplicity Studio 5 installed Java Runtime Environment (JRE).

Once you have generated the thread dump file according to one of the following procedures, attach it to a Silicon Labs support case along with other details of what operation was being performed right before the hang as well as any screenshots taken of what was shown in the application. A support case can be created from the Silicon Labs Simplicity Studio Community home page or with this url: <https://siliconlabs.force.com/s/contactsupport>.

The procedure to use the jstack tool for Windows, MacOS and Linux is described in the following sections.

Windows

1. Open Windows Task Manager and go to the Details tab to find the PID for Simplicity Studio (studio.exe).
2. Open a command prompt and issue the following command, adjusting it based on the Simplicity Studio installation path:

```
[SIMPLICITY_STUDIO_INSTALLATION]\features\com.silabs.external.java.windows.x86_64.feature_11.0.5\jre\bin\jstack.exe PID > [PATH]\SSv5ThreadDump.txt
```

For example, with the default installation path:

```
C:\SiliconLabs\SimplicityStudio\v5\features\com.silabs.external.java.windows.x86_64.feature_11.0.5\jre\bin\jstack.exe -l -e 41068 > C:\temp\SSv5ThreadDump.txt
```

MacOS

1. Open a terminal window.
2. Use the following command to get the PID:

```
ps aux | grep studio
```

This is an example of the output with the pid **76698**:

```
USERNAME@mac0010128 ~ % ps aux | grep studio
USERNAME 76698  5.6  9.7 12491892 1633396  ??  S    Tue09AM  92:52.70 /Applications/SimplicityStu
```

```
1 .app/Contents/MacOS/studio
2 USERNAME 194200.00.04268300680 s000 R+3:26PM 0:00.00 grep studio
3
```

1. Use the PID with the jstack command

```
[SIMPLICITY_STUDIO_INSTALLATION]/Contents/Eclipse/jre/Contents/Home/bin/jstack -l -e PID >
[PATH]/SSv5ThreadDump.txt
```

For example

```
/Applications/Simplicity\ Studio.app/Contents/Eclipse/jre/Contents/Home/bin/jstack -l -e 76698 >
~/Documents/SSv5ThreadDump.txt
```

Linux

1. Open a terminal window.
2. Use the following command to get the PID:

```
ps aux | grep studio
```

This is an example of the output with the pid **10233**:

```
1 ThinkPad-W530:~$ ps aux | grep studio
2 USERNAME      10233 10.1 27.3 110505488 2115904 ?    Sl   12:55   10:58 /home/USERNAME/SimplicityStud
```

1. Use the PID with the jstack command:

```
[SIMPLICITY_STUDIO_INSTALLATION]/jre/bin/jstack -l -e PID > [PATH]/SSv5ThreadDump.txt
```

For example:

```
~/SimplicityStudio_v5/jre/bin/jstack -l -e 10233 > ~/Documents/SSv5ThreadDump.txt
```

Convert an Existing Simplicity Studio 5 Project from GCC to IAR

1. Create a new IAR build configuration:
 - Right-click the project folder and select Build Configurations > Manage.
 - In the resulting Manage Build Configurations dialog, click **New**.
 - Select the IAR ARM build configuration to use (IAR ARM Default recommended) and click **OK**.
2. Still in the Manage Build Configurations dialog, select the new build configuration and click **Set Active**.
3. Open the project's .slcp file and, on the OVERVIEW tab, click **Edit** on the Project Generators card.
4. Select IAR EMBEDDED WORKBENCH PROJECT and click **Save**.
For Bluetooth projects steps 5 through 7 are also necessary. For Platform and Flex projects proceed to step 8.
5. In the Project Explorer view:
 - Right-click the project folder and select Properties.
 - In the resulting Properties dialog, expand C/C++ Build and select Settings.
 - Under Tool Settings select IAR Linker for ARM > Library and select all of the libraries with GCC or gcc in the name or path and also the 'gcc', 'c', 'm' and 'nosys' libraries.
 - Click **Delete** in the dialog menu.
 - Click **Apply and Close**.
6. In the Project Explorer view:
 - Expand gecko_sdk_n.n.n > platform > Device > SiliconLabs > <target-part> > Source.
 - Right-click the GCC folder and select Resource Configurations > Exclude from Build...
 - In the resulting dialog, check the box for the IAR ARM ... build configuration.
 - Click **OK**
7. Check if the project contains gecko_sdk_n.n.n > service > udelay > src > sl_udelay_armv6m-gcc.s. If it does, exclude it from the build with the same command as in the previous step.

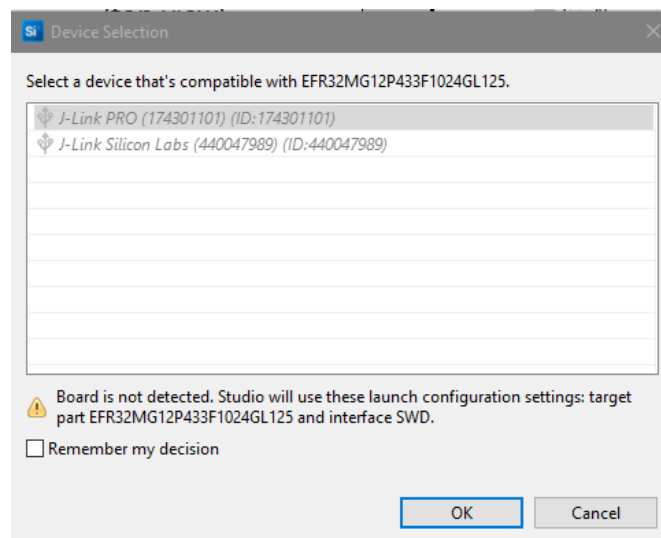
8. Build the project. It should be successful. If not, check if any other GCC-specific files exist that need to be excluded from the build configuration.

Using Custom Boards

Connect the board either using an external Segger J-Link Debug Adapter or a Silicon Labs mainboard, with Debug Mode set to OUT. (In the Debug Adapters view, right-click the device, select **Device Configuration**, and change the Debug Mode on the Adapter Configuration tab). Create the project with the chip part number set in the Target, SDK, and Toolchain Selection dialog.

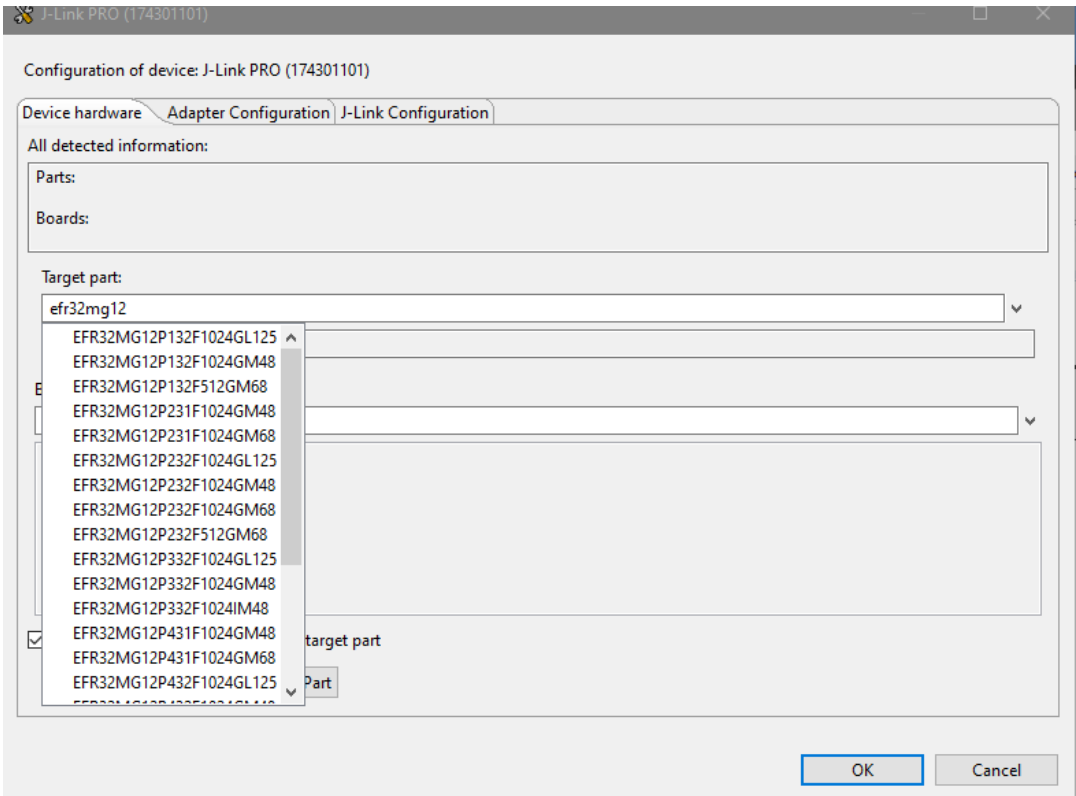
You cannot use Flash Programmer until the debug adapter's device configuration has been configured with the part. Use Simplicity Commander instead.

Projects based on custom boards can be built and flashed as part of a debug session. Simplicity Studio then displays and allows you to confirm the target settings to use for the debug session.

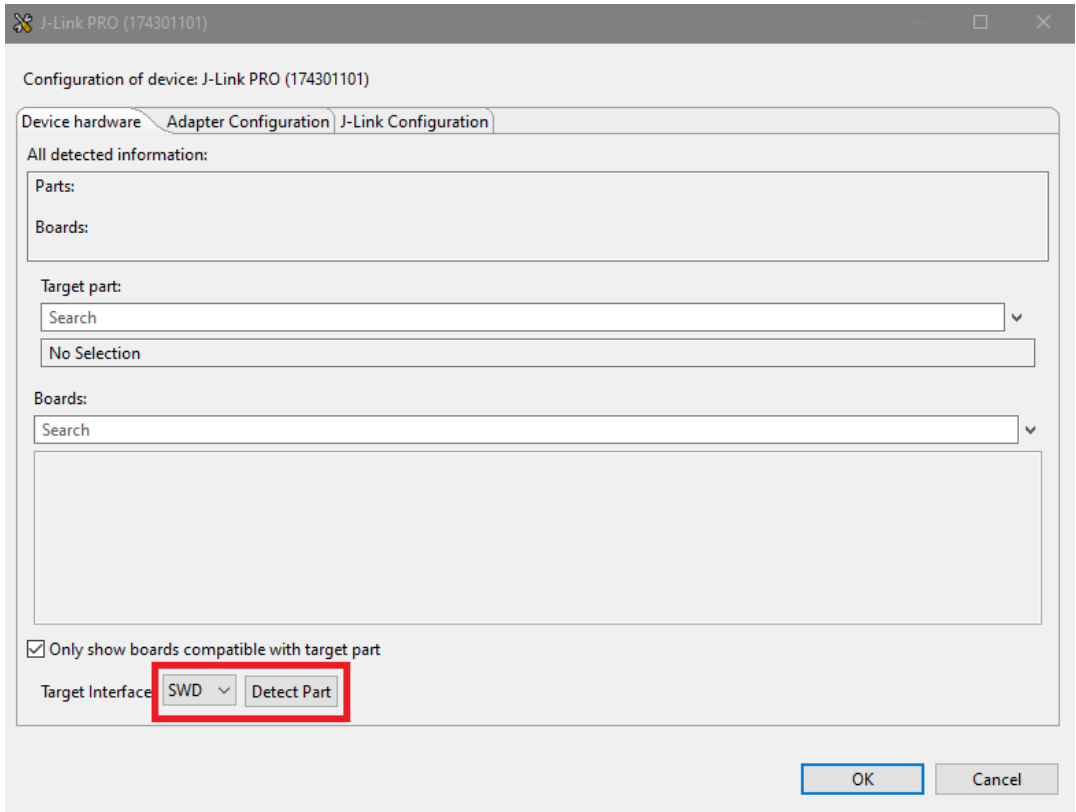


You can change the debug adapter's device configuration by right-clicking the device in the Debug Adapters view, selecting **Device Configuration**, and making either of these changes:

1. On the Device Hardware tab, enter the target part number.



1. On the Device Hardware tab, change the Target Interface to **SWD**. Click **Detect Part**.



Revision History

Revision History

Revision 5.3.2 released March 9, 2022

- Getting Started: Added more information about linking sources in a new project.
- About the Launcher: Clarified the interface overview, with new information about the perspectives menu; added instructions on adding an SDK to the list shown on the General Information card.
- NCP Commander: Added information about the scripting feature.
- Tips and Tricks: Added a tip about working with custom radio boards.

Revision 5.3.1 released January 26, 2022

- Getting Started: Updated Start a Project to reflect other project types available
- NCP Commander: Updated to include Bluetooth mesh functionality
- Using the tools: New section on the Bluetooth Direction Finding Tool Suite
- Various maintenance updates.

Revision 5.3.0 released December 15, 2021

- Installation instructions reflect installing the Gecko SDK from GitHub.
- Project migration text includes newer migration options.
- New SDK Extensions section.
- New Solutions section.
- Project Configurator now supports Zigbee, Bootloader, and Z-Wave.
- New Zigbee Cluster Configurator tool.
- NCP Commander enhanced with dynamic GATT database interactions.
- Tips and Tricks updated with new installation information.

Revision 5.2.0 released June 16, 2021

- Version changed to correlate with Simplicity Studio 5.
- Tools: Standalone NCP Commander documented.
- Getting Started: Linux installation instructions added.
- Energy Profiler: Code correlation software setup instructions updated.
- Tips and Tricks: Links added at the top of the page; tip on changing from GCC to IAR compiler added.
- Various maintenance updates.

Revision 1.1.0 released December 9, 2020

- General updates for Simplicity Studio 5.1.
- Launcher perspective (Getting Started, About the Launcher):
 - Software Examples and Demos tabs combined into a single tab, enhanced filtering options.
 - Examples from GitHub repositories.

- New security firmware update option for Series 2 devices.
- Developing for 32-Bit Devices:
 - Project Configurator now supports Bluetooth Mesh and 32-Bit MCU SDKs.
 - New Project Configurator Configuration Tools tab.
 - New Bluetooth Mesh Node Configurator tool.
 - Pin Tool, new 'Add Component' functionality.
- Testing & Debugging:
 - New Beta quality GNU Debugger.
- Tools:
 - New Bluetooth NCP Commander tool.
- Tips & Tricks:
 - Update protocol locations for Bluetooth Mesh.
 - New 'Capture a Simplicity Studio 5 Thread Dump' tip.

Revision 1.0.0 released July 29, 2020

- Initial release

