Arm Keil Studio Cloud

1.6

User Guide

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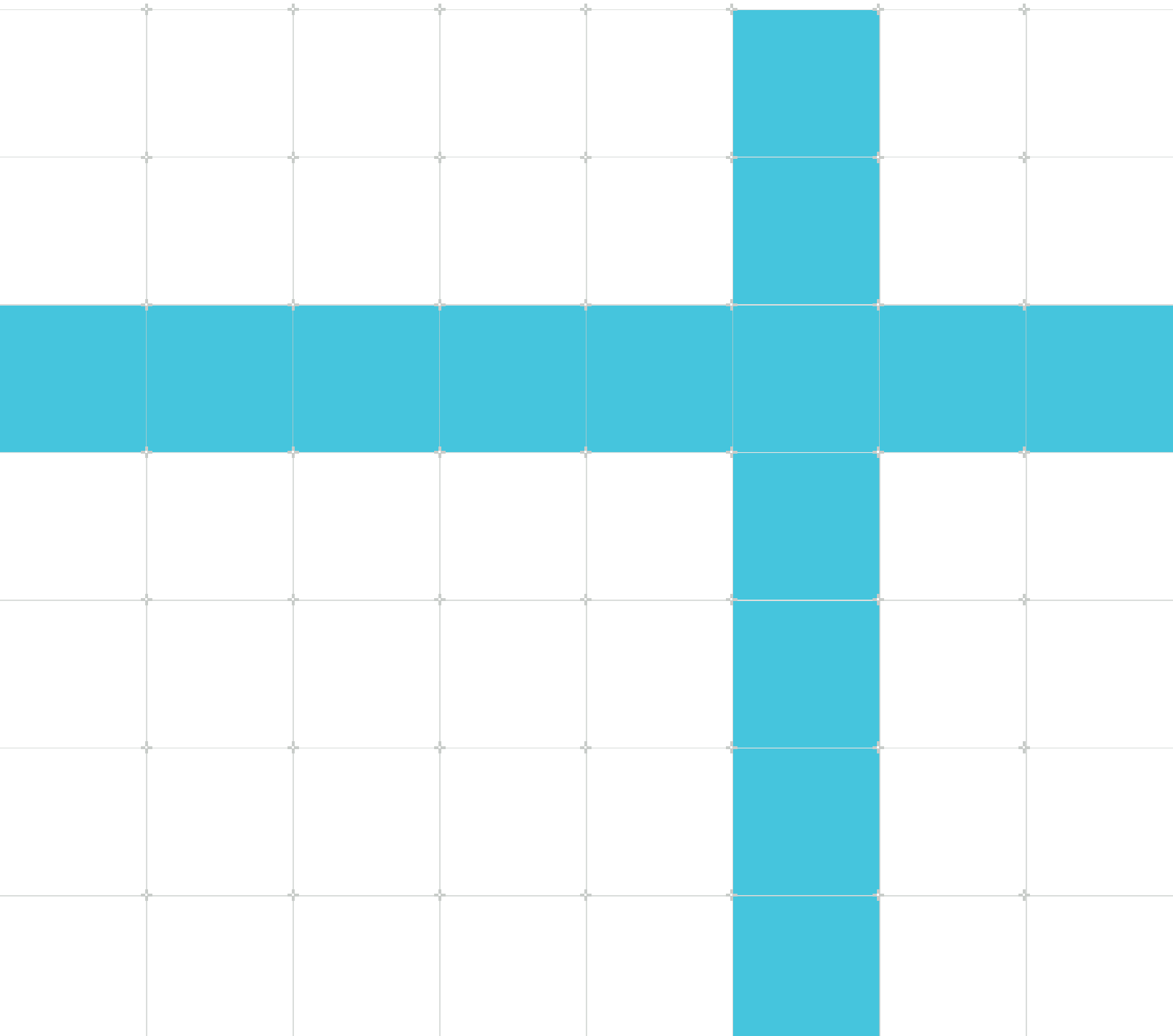

Arm Keil Studio Cloud

User Guide

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Product Status

The information in this document is Final, that is for a developed product.

Feedback

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To provide feedback on the document, fill the following survey: https://developer.arm.com/documentation-feedback-survey.

Inclusive language commitment

Arm values inclusive communities. Arm recognizes that we and our industry have used language that can be offensive. Arm strives to lead the industry and create change.

This document includes language that can be offensive. We will replace this language in a future issue of this document.

To report offensive language in this document, email terms@arm.com.

Contents

1. Introduction

1.1 Conventions

The following subsections describe conventions used in Arm documents.

Glossary

The Arm Glossary is a list of terms used in Arm documentation, together with definitions for those terms. The Arm Glossary does not contain terms that are industry standard unless the Arm meaning differs from the generally accepted meaning.

See the Arm® Glossary for more information: developer.arm.com/glossary.

Typographic conventions

Arm documentation uses typographical conventions to convey specific meaning.

Convention	Use
italic	Citations.
bold	Interface elements, such as menu names. Terms in descriptive lists, where appropriate.
`monospace`	Text that you can enter at the keyboard, such as commands, file and program names, and source code.
`monospace underline`	A permitted abbreviation for a command or option. You can enter the underlined text instead of the full command or option name.
`<and>`	Encloses replaceable terms for assembler syntax where they appear in code or code fragments. For example: `MRC p15, 0, <Rd>, <CRn>, <CRm>, <Opcode_2>`
SMALL CAPITALS	Terms that have specific technical meanings as defined in the *Arm® Glossary*. For example, **IMPLEMENTATION DEFINED**, **IMPLEMENTATION SPECIFIC**, **UNKNOWN**, and **UNPREDICTABLE**.
	Recommendations. Not following these recommendations might lead to system failure or damage.
	Requirements for the system. Not following these requirements might result in system failure or damage.
	Requirements for the system. Not following these requirements will result in system failure or damage.
	An important piece of information that needs your attention.

Convention	Use
	A useful tip that might make it easier, better or faster to perform a task.
	A reminder of something important that relates to the information you are reading.

1.2 Other information

See the Arm website for other relevant information.

- Arm® Developer.
- Arm® Documentation.
- Technical Support.
- Arm® Glossary.

2. Arm Keil Studio Cloud

Arm Keil Studio Cloud is a free to use, browser-based IDE for the evaluation and development of embedded, IoT, and Machine Learning software for Cortex-M devices. With a cloud-hosted workspace for your code, comprehensive source control integration, and a powerful C/C++ editor, you can edit your projects from any computer, share them with colleagues and export them for desktop usage in Keil µVision. You can compile projects using Arm Compiler 6, run the projects directly on supported development boards, and debug from supported browsers without the need to install any software.

Our goal is to make it quicker and easier for you to evaluate reference designs, reducing the time it takes to get your embedded projects to market, while also providing a point of integration for Arm ecosystem partners who provide professional software, tools, and services.

Keil Studio demonstrates next generation IDE technology and new concepts for CMSIS project formats. We support a range of software examples, showcasing Keil RTX, FreeRTOS, and IoT connectors for Amazon AWS IoT, Microsoft Azure IoT Hub, and Google Cloud. Keil Studio is the successor to the Mbed Online Compiler, and allows you to develop Mbed OS 5 and 6 projects on supported Mbed-enabled boards. Keil Studio also provides limited support for Mbed 2. To get started, you can import Mbed projects from your Online Compiler workspace or mbed.com.

You can access Keil Studio today using an Arm or Mbed account and get started by opening a reference design to evaluate.

To find out which development boards and debug probes are supported, check the Supported development boards and Supported debug probes pages.

Keil Studio is a new software tool under constant development, and we regularly publish bug fixes and feature updates. To use run and debug capabilities, you must use Google Chrome or Microsoft Edge (chromium).

3. Prerequisites

This chapter presents the system and account requirements you need to access Keil Studio.

3.1 System requirements

To work with development boards over USB, you must use Keil Studio in a desktop browser that supports the WebUSB standard: Google Chrome or Microsoft Edge (Chromium). All other features are supported in the latest versions of the following desktop browsers: Google Chrome, Microsoft Edge, Opera, Safari, and Mozilla Firefox.

Keil Studio supports Mbed OS 5.12 and newer, and Mbed OS 6 and newer. Keil Studio also provides limited support for Mbed 2. See Manage an Mbed project and its libraries or standalone libraries for more details.

If you are moving a project from Mbed OS 5 to Mbed OS 6, note the deprecated APIs.

Installation of udev rules on Linux

On Linux, you must install udev rules to be able to build a project and run it on your device or debug a project with Keil Studio.

The installation of udev rules requires sudo privileges. See udev rules for Linux for more information.

3.2 Access Keil Studio

You need an Arm account to work with Keil Studio. If you already have an Mbed account, you can use it to access Keil Studio.

You can create an Arm account from the Keil Studio page at: studio.keil.arm.com.

You can learn how to manage the accounts you use with Keil Studio, see Manage accounts.

4. Manage accounts

This chapter describes how to manage the accounts you use with Keil Studio from the **User Profile** view.

By default, when you log into Keil Studio, your Keil Studio account gets listed in the **User Profile** view.

If you have a personal user, organization, or enterprise GitHub account, you can link that account with Keil Studio. Linking your GitHub account with Keil Studio allows you to access and create GitHub repositories from Keil Studio. To learn how to add your GitHub account in Keil Studio, see Set credentials for GitHub.

4.1 User Profile view

The **User Profile** view lists the accounts which you have associated with Keil Studio.

The accounts that you can view in the **User Profile** view are:

- Keil Studio account: Allows you to log out of Keil Studio (by default, when you initially log into Keil Studio, your Keil Studio account is listed in the **User Profile** view).
- GitHub account: Connect or disconnect your GitHub account from Keil Studio.

Access the User Profile view

To access the **User Profile** view, click the **Accounts** icon  in the Keil Studio activity bar and select **Show User Profile**.

Features

Feature	Description
Keil Studio **Log out** button	Logs you out of Keil Studio.
GitHub **Connect to GitHub** and **Disconnect GitHub account** buttons	Connect or disconnect your GitHub account with Keil Studio. For more information, see Set credentials for GitHub.
UX research program switch	Opt-in (consent to being contacted by Arm) or opt out (do not consent to being contacted by Arm) of the Keil Studio UX research program.


Note

Disconnecting your GitHub account using the **Disconnect GitHub account** button does not remove the Keil Studio application from your list of authenticated GitHub applications. You can manage your authenticated GitHub applications from your account settings in GitHub.

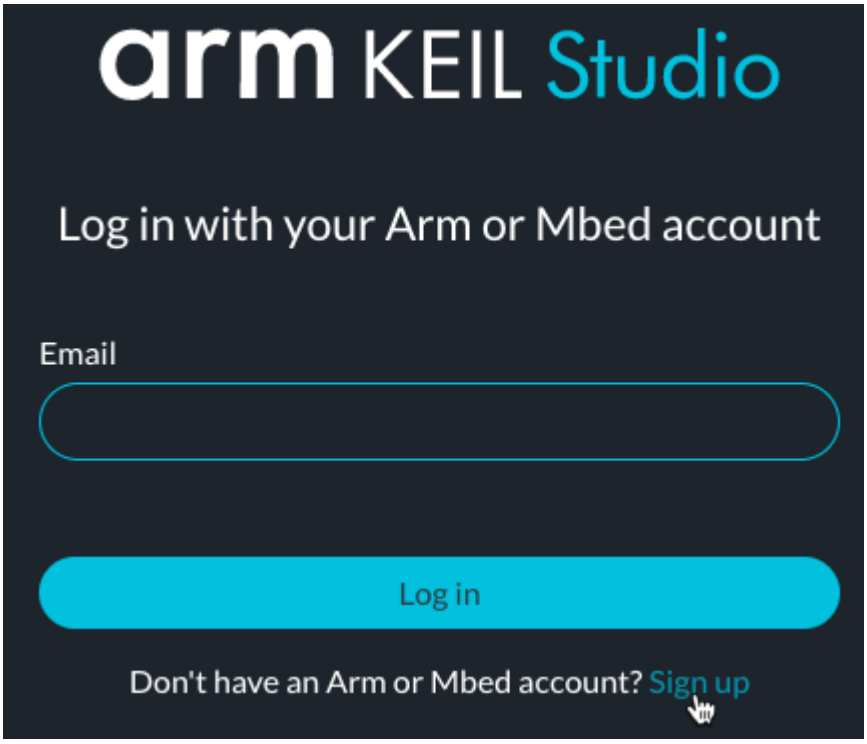
5. Farewell Mbed Online Compiler, hello Keil Studio!

Read this chapter to get up to speed with Mbed development in Keil Studio.

5.1 Meet Keil Studio, Arm's next generation online IDE

Like the Online Compiler, Keil Studio is a browser-based IDE. All you need to get access to Keil Studio and a dedicated workspace is an Mbed account or an Arm account. If you do not already have an account, you can create an Arm account directly from the Keil Studio **Log in** page.

Figure 5-1: Create an account



Keil Studio uses the WebUSB technology to allow direct device interaction from the browser. It requires compatibility with CMSIS-DAPv2 or ST-LINK/V2, so you may have to update the firmware of your development board. To update your firmware, check the Out-of-date firmware Troubleshooting page.

Keil Studio provides:

- The same underlying tooling as the Online Compiler to build Mbed projects.
- Advanced IntelliSense features.

- Integrated source control with Git.
- A debugger and a Memory Inspector to monitor the memory usage of your board.
- Serial output for your board.

To familiarize yourself with Keil Studio, check the pages in the User interface chapter, and in particular the UI layout page.

5.2 Key differences

As you are moving to Keil Studio, there are a few important points to keep in mind.

- Target selection is no longer based on adding boards as it was the case in the Online Compiler. In Keil Studio, you must manually select an appropriate build target from a list of compatible targets the first time you work with an Mbed project.
- Keil Studio Cloud uses the concept of "active project" (right-click a project > **Set Active Project** option). You must set a project as active to build, run, and debug your project, or carry out other actions such as managing the libraries included in the project.
- Libraries can be added either directly from os.mbed.com or Git providers such as GitHub. Libraries are exposed as source code in the editor, allowing you to view their inline comments or documentation directly. See Library Management for more details.
- Source control in the Online Compiler was based on Mercurial. Keil Studio Cloud primarily supports Git and natively integrates with GitHub. See Source control with Git and GitHub for more details.

5.3 Mbed development in Keil Studio

Ready? Let's get started!

Get started

Although the Online Compiler is no longer accessible, you can still import all your projects to Keil Studio in one go. See the Import Mbed projects or standalone libraries from your Mbed Online Compiler workspace page.

There are many other ways to get started with Mbed projects in Keil Studio. Check all the options on the Create, import or clone an Mbed project or a standalone library page. If you want to start from an example project shipped with Keil Studio, you can check the Get started with an Mbed OS Blinky example tutorial.

Mbed versions supported

Keil Studio fully supports Mbed OS 5.12 and newer, and Mbed OS 6 and newer. It also provides build and run support for Mbed 2 and earlier versions of Mbed OS 5 (debugging is not supported with these versions).

Because Mbed 2 is deprecated, Arm recommends that you upgrade to Mbed OS 5 or 6. This page explains the main steps using a simple Blinky project.

You might also consider moving to Mbed OS 6 bare-metal. As explained on this page, "The Mbed OS bare-metal profile offers the same functionality as Mbed OS 2 and allows targets to access features that we have added to more recent versions of Mbed OS. At the same time, it removes the RTOS and provides fewer features than Mbed OS 6, so it's smaller and therefore suitable for ultraconstrained devices."

If you still must work with Mbed 2 but want to change the version of Mbed 2 for a given project, then there is a specific procedure to follow. Check Change the Mbed version for your project page.

Library management

When you create a new project, or import or clone an existing project, you also import the libraries on which it is dependent, including Mbed OS. A project can also be a standalone library or a set of standalone libraries. Libraries are managed from the **Mbed Libraries** view. From this view, you can add or remove libraries, update libraries, check out specific versions and fix problems. Check Manage an Mbed project and its libraries or standalone libraries.

Full Mbed projects contain `.lib` files. These `.lib` files describe the libraries in your project. To share library changes with other developers, you must publish `.lib` file changes to the source control repository of your project. See the Source-control library updates page for more details.

Source control with Git and GitHub

As mentioned, Keil Studio Cloud primarily supports Git and integrates with GitHub. Note that you can also import projects from GitLab and Bitbucket, but only from public repositories.

Although Mercurial is also supported, you are encouraged to convert your Mercurial projects to Git. To make your life easier, Keil Studio gives you the possibility to convert a Mercurial project to Git and publish the converted project to your GitHub account. Check Convert a Mercurial project to Git for more details.

The integration with GitHub requires you to have a GitHub account and to link this account to your Mbed or Arm account. Check the Set credentials for GitHub page.

To understand the basics and how publishing changes to a remote repository works, check the Work with Git source control tutorial. We used a CMSIS example in the tutorial, but the principles are the same for Mbed projects.

The full details on Git are available in the Work with Git chapter of the documentation. Read the Configure a project for source control and collaboration page to see all the possibilities.

5.4 Get help

If you need help, go to the Mbed forum and use the **Keil Studio** category to contact us. You can also use the Keil forum.

6. Tutorials

This chapter contains tutorials to help you learn how to use Keil Studio.

6.1 Get started with a CMSIS Blinky example

This tutorial explains how to start a project in Keil Studio using the CMSIS Blinky example available for the NXP FRDM-K32L3A6 board. Blinky is a simple application that blinks the LED on your development board. Learn how to clone a project, and then build and run Blinky on your board.

Procedure

1. Go to keil.arm.com.
2. Click the **Hardware** menu and select **Boards** to see the list of supported boards.
   You can search for a board by name or vendor, or filter the list by vendor or core. You can also display boards with example projects with the **Only include boards with example projects** checkbox.
3. Search for and select the **FRDM-K32L3A6** board in the list.
   You can either download or clone example projects from the **Projects** tab and get access to board details from the **Features** and **Documentation** tabs.
4. Find the **Blinky** example in the **Projects** tab and click the **Open in Keil Studio** button for the example project.
5. Log into Keil Studio with your Arm or Mbed account if you are not already logged in.
   Keil Studio opens.
6. Confirm the project name in the **Clone** dialog box. Keil Studio sets the newly cloned project as the active project by default.
7. Click **Add project**.
   The project loads to your workspace and is the active project. The `README.md` file of the project displays. Review the file to learn more about project settings and board requirements.
8. The **Build target** is automatically set to the build target of the project:
   A build target tells Keil Studio how to build the project so that it matches your hardware. To build the project, click the **Build project** button,  . **Build project** builds Blinky and stops.
9. Connect your board to your computer.
10. If it is the first time you are connecting your board, follow these steps:
    a. Click the **Connected device** area under the **Build target** drop-down list to open the **Device Manager**.
    b. Click the **Add Device** button and select the device firmware for your board in the dialog box that displays at the top of the window, then click **Connect**.

       Your board displays in the **Device Manager** list of devices and appears as connected with a green dot in the **Connected device** area in the **Explorer**. After the first successful connection, Keil Studio automatically detects the board.

The target is connected. Now, the **Run project**  button is enabled. Click the **Run project** button to build Blinky and run it on your board.

6.2 Get started with an Mbed OS Blinky example

This tutorial explains how to start a project in Keil Studio using an Mbed OS Blinky example. Blinky is a simple application that blinks the LED on your development board. Learn how to create a project, and then build and run Blinky on your board.

Before you begin

Go to studio.keil.arm.com and log into Keil Studio using your Arm or Mbed account.

Procedure

1. Create a project, select **File** > **New...** > **Mbed Project**.
   The **New Project** dialog box opens.
2. Click the **Example project** drop-down list and select `mbed-os-example-blinky` under **Mbed OS 6**.
   Note that you can also use the `mbed-os-example-blinky-baremetal` example, if you are working with an ultraconstrained device. For more information, see the Mbed OS bare-metal profile page.
3. Confirm the project name.
4. Check the default options:
   - Keil Studio sets the newly created project as the active project. Build and run commands only apply to the active project. Clear the checkbox if you do not want to make the new project active.
   - Keil Studio initializes the project as a Git repository. Clear the checkbox if you do not want to turn your project into a Git repository. See Configure a project for source control and collaboration for more details.
5. Click **Add project**.
   The project loads to your workspace and is the active project. The `README.md` file of the project displays. Review the file to learn more about project settings and board requirements.
6. Connect your board to your computer. If it is the first time you are connecting your board, follow these steps:
   a. Click the **Connected device** area under the **Build target** drop-down list to open the **Device Manager**.
   b. Click the **Add Device** button and select the device firmware for your board in the dialog box that displays at the top of the window, then click **Connect**.

      Your device displays in the **Device Manager** list of devices and appears as connected with a green dot in the **Connected device** area in the **Explorer**. After the first successful connection, Keil Studio automatically detects the board.

7. Select a build target in the **Build target** drop-down list. Your build target name most likely matches the board name. A build target tells Keil Studio how to build Mbed OS so that it matches your hardware.
8. To build the project, click the **Build project** button,  . **Build project** builds Blinky and stops.
9. Click **Run project**  . **Run project** builds Blinky and runs it on your board.
   You might have to restart your board for Blinky to run.

6.3 Export and import a CMSIS project between Keil Studio and Keil MDK

While Keil Studio cannot read the Keil MDK `.uvprojx` format, you can switch from Keil Studio to Keil MDK using the CMSIS `.cprj` project file format.

This tutorial explains how to export a CMSIS project in `.cprj` format from Keil Studio and then import the project in Keil MDK. It also explains how to export a project from Keil MDK and import it in Keil Studio.

Before you begin

- In Keil Studio, create a CMSIS project from the examples provided and set it as the active project (right-click the project and select **Set Active Project**).
- If you do not have Keil MDK already installed, you can download and install the MDK-Community edition for free from keil.arm.com. You need an Arm account (or Mbed account) to access the page and get a license key.

Keil MDK is supported on Windows 64-bit variants only.

6.3.1 Export a CMSIS project from Keil Studio and import it in Keil MDK

Keil Studio uses the `.cprj` project file format natively. You can use the download options available in Keil Studio to download your project as a `.tar` file and then import the project in Keil MDK.

Procedure

1. In Keil Studio: Go to the **File** menu and select the **Download Current Selection** or the **Download Active Project** option.
   Your project is exported as `<Project_Name>.tar` and contains a `<Project_Name>.cprj` project file.

   Note: The **Download Current Selection** option is also available from the **Explorer** view in the right-click menu.

2. Open the `<Project_Name>.tar` file with an appropriate application on your PC.
3. Double-click the `<Project_Name>.cprj` project file to import the project in Keil MDK.
   The Keil µVision IDE opens.

   Note: If Keil µVision is already open, you can go to **Project** > **Import** > **Import Project from CPRJ Format** to import the project.
4. In Keil µVision: If there are missing packs, you are prompted to install them. Click **Yes** to install the packs with the **Pack Installer**.
   Keil MDK creates native MDK files (`<Project_Name>.uvprojx` and `<Project_Name>.uvoptx`) in the project folder and automatically copies specific files from software components in the **RTE** folder. It also creates folders for the output (**Objects**) and debug configuration files (**DebugConfig**). Check the Getting started with MDK to start working with the project imported.

6.3.2 Export a CMSIS project from Keil MDK and import it in Keil Studio

You can use the export option available in Keil MDK to export a project as a `.cprj` file and then import the project in Keil Studio.

Procedure

1. In Keil µVision: Open a project and go to **Project** > **Export** > **Save Project to CPRJ Format** to export the project.
   A `<Project_Name>.<Target_Name>.cprj` file is automatically saved in the root folder of the project.
2. In Keil Studio: Drag and drop the project folder from your file system to the **Explorer** view in Keil Studio.
3. Once the project is imported, right-click the project and select **Set Active Project**.
4. Build the project by clicking the **Build project** button  .

6.4 Work with Git source control

This tutorial explains the basics of Git source control in Keil Studio using the CMSIS Blinky example available for the NXP FRDM-K32L3A6 board. Note that the details provided are relevant for Mbed projects too.

Start by configuring your project for source control to be able to publish and share your changes. Then, learn how to:

- Create a working branch.
- Review code changes in the **Source Control** view.
- Stage, commit, and push your changes.
- Merge your changes into the main branch.

See the sections below for more details.

6.4.1 Configure your project for source control

There are various ways of working with source control in Keil Studio.

Before you begin

In this tutorial, you will learn how to publish your changes to a new GitHub repository.

- You need a GitHub account for this tutorial. Create an account on github.com or, if you already have an account, sign in. Once you are signed in, check that your Arm and your GitHub accounts are connected as described in Set credentials for GitHub.
- Check that you have created a `Blinky_FRDM-K32L3A6_RTX` project from the examples provided and set it as the active project (right-click the project and select **Set Active Project**).

Procedure

1. Go to the **Source Control** view.
   - If you did not previously initialize the project as a Git repository when creating the project, an "Active project is not under version control" message displays. Click the **Publish Project** button or click the **...** at the top of the **Source Control** view and select **Publish Project**.
   - If the project is already initialized for Git, click the **...** at the top of the **Source Control** view and select **Publish Project**.

   The **Publish** dialog box opens.
2. Select the **Publish to a new GitHub repository** option and enter a repository name and description.
3. By default Keil Studio creates a private repository. If you want to create a public repository, clear the **Private repository** checkbox.
4. Click **Publish**.
   The **Source Control** view shows untracked changes (with a **U** status) in the **Changes** list. Untracked changes are changes that have not been staged yet. When first setting a repository, you are on the master branch by default.
5. Go to your GitHub account and check that the repository has been created as expected. The repository does not contain any commits yet.

6.4.2 Use source control and publish your changes

You are all set. You can now update your project and publish the changes.

Before you begin

When working with other people on the same project, it is good practice to create a working branch for the feature you are currently working on, make changes on that working branch, then merge your work into the main branch (master).

Procedure

1. In the **Source Control** view, create an initial commit on the master branch:
   a. Select all the unstaged files, hover over one of the files and click **+** to stage all the files.

The files are listed under **Staged changes**.

b. In the **Message** box, enter a commit message and click **Commit** to create the initial commit.

The committed changes are visible at the bottom of the **Source Control** view and in the **History** view, and your local master branch is updated.

2. Create a working branch:
   a. Click the master branch in the status bar.

   An input field pops up at the top of the window.

   b. Click **Create new branch...** and type the name of your branch in the field. For example `my-branch`.
   c. Press **Enter**.

   The branch switches automatically to `my-branch`.
3. Go to the **Explorer** view, open the `Blinky_FRDM-K32L3A6_RTX` project folder, and look for the `Blinky.c` file.
4. Open that file and in the `thrLED: blink LED` block of code, change the `osDelay` values in the second `if` statement.
5. Now go to the **Source Control** view and click the `Blinky.c` file to check your changes. Note that you can also make changes from the side-by-side comparison window.
6. Hover over the `Blinky.c` file and click **+** to stage your changes.
   The file is listed under **Staged changes**.
7. In the **Message** box, enter a commit message and click **Commit** to commit the changes.
   The committed changes are visible at the bottom of the **Source Control** view and in the **History** view, and `my-branch` is updated.
8. To push your local commit to the remote repository, click **...** > **Push** from the **Source Control** view.
9. Finally, to merge your changes into the main branch (master):
   a. Switch to the master branch by clicking `my-branch` in the status bar and selecting master in the popup drop-down list.
   b. Click **...** > **Merge...** and select `my-branch` in the popup drop-down list to merge the changes done on `my-branch` into master.
10. Click **...** > **Push** to update the remote repository.

6.5 Debug a Blinky example

This tutorial explains how to debug a project using the CMSIS Blinky example available for the NXP FRDM-K32L3A6 board. Note that the details provided are relevant for Mbed projects too.

Learn how to start a debug session, set breakpoints, step through your code, inspect variables, and examine threads and call stacks.

Before you begin

- Clone the Blinky example for the FRDM-K32L3A6 board from keil.arm.com (**Projects** tab > **Open in Keil Studio** button) and set it as the active project (right-click the project and select **Set Active Project**).
- Connect your board to your computer. If it is the first time you are connecting your board, follow these steps:
  1. Click the **Connected device** area under the **Build target** drop-down list to open the **Device Manager**.
  2. Click the **Add Device** button and select the device firmware for your board in the dialog box that displays at the top of the window, then click **Connect**.

     Your board displays in the **Device Manager** list of devices and appears as connected with a green dot in the **Connected device** area in the **Explorer**. After the first successful connection, Keil Studio automatically detects the board.
- Check that an appropriate build target displays in the **Build target** drop-down list. If not, select one.

Procedure

1. Click the **Debug project** button to start a debug session.
   Keil Studio automatically builds and runs the project on your board. The debug session starts: Keil Studio switches to the **Debug** view and the status bar turns orange. The **Debug Console** view displays and shows debugging output. The execution stops at `main()`.
2. While the debug session is still running: go to the **Explorer** view, open the `Blinky_FRDM-K32L3A6_RTX` project folder, and look for the `Blinky.c` file.
3. Open that file and in the `thrLED: blink LED` block of code, set a breakpoint on the `if (active_flag == 1U) {` statement by clicking the left margin.
   A red dot displays where you set the breakpoint.
4. Return to the **Debug** view. You can see that your breakpoint has been added to the **Breakpoints** list on the left of the **Debug** view.
5. Click the **Continue** button to start debugging.
   The debugger runs to the breakpoint you set and stops. A yellow arrow displays next to the statement on which the debugger paused. The statement highlights in yellow.
6. Go to the **Variables** list and check the local variables which are grouped under **Local**.
   The `active_flag` variable for `thrLED` is set at `0`.
7. Locate, but do not press, the SW2 button on your board. See the FRDM-K32L3A6 guide to find the SW2 button. Prepare to press the SW2 button then:
   a. Click the **Continue** button.
   b. Press the SW2 button on your board before the debugger hits the breakpoint set earlier.
8. Check the `active_flag` variable again.
   The `active_flag` variable is now set at `1`.

9. Click the **Step over** button  three times to go straight to `osDelay(100U);`.
10. Click the **Step into** button  to check this function.
    It opens the `rtx_delay.c` file where the function is called.
11. You can now examine what happens in the **Threads** and **Call Stack** lists.
    In the current version of Keil Studio, there is only one thread (**Main**). The call stack shows the execution flow of your code. In this example, you can see that `osDelay;` is called by `thrLED` in the `Blinky.c` file and `osStatus_t` in the `rtx_delay.c` file.
12. Click the **Step into** button  again several times to check the execution flow.
13. Click the **Stop** button  to stop the debugger and return to the editor.

6.6 Connect to AWS IoT and send MQTT messages

This tutorial explains how to connect your device to AWS IoT using the CMSIS AWS MQTT demo available for the STMicroelectronics B-L475E-IOT01A board. Learn how to manage your AWS IoT things, generate certificates, and configure connection settings in your project. Once everything is set up, you will be able to send MQTT messages to AWS IoT.

6.6.1 Manage your AWS IoT things and certificates

In this section, you will learn how to create a thing and a certificate (and associated RSA key pair). You will also create a policy and attach it to the certificate. Finally, you will activate the certificate and attach it to the thing.

Before you begin

- Install the AWS Toolkit extension and connect to AWS with your credentials. Follow the steps in Install the AWS Toolkit extension and Connect to AWS from Keil Studio. Once connected to AWS, you can have access to the AWS Explorer from Keil Studio.
- You need a board that can connect to the internet. For this tutorial, we assume you are using the B-L475E-IOT01A board.
- Clone the AWS MQTT Demo example for the B-L475E-IOT01A board from keil.arm.com (**Projects** tab > **Open in Keil Studio** button) and set it as the active project (right-click the project and select **Set Active Project**).

6.6.1.1 Create a thing

Things are used to connect devices to AWS IoT. A thing is a representation of a specific device.

Procedure

1. Click the **AWS** icon  in the activity bar to open the AWS Toolkit.
2. Choose a region and open the **IoT** folder, then right-click the **Things** folder and select **Create Thing...**.

A popup appears and asks you for a new thing name.

3. Type a name and press **Enter**.
   A thing icon followed by the name you provided is added in the **Things** folder.

6.6.1.2 Add a certificate and RSA key pair

A certificate is needed to establish a secure connection between AWS IoT and your device. An X.509 certificate is a digital certificate that uses the international X.509 public key infrastructure (PKI) standard to verify that a public key belongs to the hostname/domain, organization, or individual contained within the certificate.

Procedure

1. Right-click the **Certificates** folder and select **Create Certificate...**.
   A dialog box opens.
2. Select the **AWS MQTT Demo** project folder and save the certificate there.
   Keil Studio saves an X.509 certificate and RSA key pair in the project folder.

6.6.1.3 Create a policy and attach it to the certificate

Policies define how AWS IoT and your device can interact with each other.

Before you begin

The following policy allows any resource to access AWS IoT. In production, you must use a more secure policy. See the AWS documentation on Policies and permissions in IAM for more details.

Procedure

1. Select **File** > **New File**.
2. Type a name for the file, for example, `myPolicy.txt` and click **OK**.
3. Open the file and copy and paste the following block in the file:

```
{
    "Version": "2012-10-17",
    "Statement": [
      {
        "Effect": "Allow",
        "Action": [
          "iot:Connect",
          "iot:Publish",
          "iot:Receive",
          "iot:Subscribe"
        ],
        "Resource": [
          "*"
        ]
      }
    ]
}
```

4. Go back to the AWS Explorer and attach the policy to the certificate created earlier.
   The certificate is inactive for now and no policies are found.
5. Right-click the certificate and select **Attach Policy...**.
6. Select the policy in the popup that appears.

The policy is added under the certificate.

6.6.1.4 Activate the certificate and attach it to the thing

The final step is to activate the certificate and attach it to your thing.

Procedure

1. Right-click the certificate and select **Activate...**.
2. Right-click the thing and select **Attach Certificate...**.
3. Select the certificate in the popup that appears.
   The certificate is added under the thing.

6.6.2 Configure connection settings in your project

There are different elements to configure in the `iot_config.h` and `socket_startup.c` files contained in your project. These elements control how the example application connects and authenticates with AWS IoT. Follow the steps to configure the endpoint, the thing, the certificate and private key, and the root certificate. You also must set up your Wi-Fi connection.

6.6.2.1 Configure the iot_config.h file and modify the certificate and private key files

The sections you must update in the `iot_config.h` file are presented below.

About this task

Sections to update:

- `IOT_DEMO_SERVER`: Endpoint (or remote host) you are going to connect to.
- `IOT_DEMO_IDENTIFIER`: Name of the thing you created earlier.
- `IOT_DEMO_CLIENT_CERT`: Certificate (or client certificate), that is the `<ID>-certificate.pem.crt` file in your project. You must modify the certificate as explained and copy and paste the certificate in the `iot_config.h` file.
- `IOT_DEMO_PRIVATE_KEY`: It is the client private key, that is to say the `<ID>-private.pem.key` file in your project. You must follow the same steps as for the client certificate.
- `IOT_DEMO_ROOT_CA`: It is the AWS trusted server root certificate. See the certificate provided in the following procedure. You must add the root certificate to the `iot_config.h` file.

Procedure

1. Go to **RTE** > **IoT_Client** in the project folder and open the `iot_config.h` file.
2. Start by configuring the endpoint. Go to the AWS Explorer, right-click the **IoT** folder, and select **Copy Endpoint...**.
3. Go back to the `iot_config.h` file and paste the endpoint between the quotation marks in the `IOT_DEMO_SERVER` section. An endpoint looks like this: `a3xyzzyx.iot.us-east-1.amazonaws.com`.

4. Type the name of the thing you created between the quotation marks in the `IOT_DEMO_IDENTIFIER` section.
5. Open the `<ID>-certificate.pem.crt` file stored in the project folder.
   a. Change `-----BEGIN CERTIFICATE-----` to `"-----BEGIN CERTIFICATE-----\n\`.
   b. Add a backslash `\` at the end of every line.
   c. Add `n\` to the second to last line.
   d. Change `-----END CERTIFICATE-----` to `-----END CERTIFICATE-----\n"`.
6. Copy the content of the `<ID>-certificate.pem.crt` file and paste it in the `iot_config.h` file next to `IOT_DEMO_CLIENT_CERT`. Replace the quotation marks already present by a backslash, press **Enter**, and paste the certificate.
7. Do the same for the `<ID>-private.pem.key` file.
   a. Change `-----BEGIN RSA PRIVATE KEY-----` to `"-----BEGIN RSA PRIVATE KEY-----\n\`.
   b. Add a backslash `\` at the end of every line.
   c. Add `n\` to the second to last line.
   d. Change `-----END RSA PRIVATE KEY-----` to `-----END RSA PRIVATE KEY-----\n"`.
8. Copy the content of the `<ID>-private.pem.key` file and paste it in the `iot_config.h` file in the `IOT_DEMO_PRIVATE_KEY` section. Replace the quotation marks already present by a backslash, press **Enter**, and paste the private key.
9. For the root certificate, replace the quotation marks by a backslash, press **Enter**, and then copy and paste the following in the `IOT_DEMO_ROOT_CA` section:

```
"-----BEGIN CERTIFICATE-----\n\
MIIDQTCCAimgAwIBAgITBmyfz5m/jAo54vB4ikPmljZbyjANBgkqhkiG9w0BAQsF\
ADA5MQswCQYDVQQGEwJVUzEPMA0GA1UEChMGQW1hem9uMRkwFwYDVQQDExBBbWF6\
b24gUm9vdCBDQSAxMB4XDTE1MDUyNjAwMDAwMFoXDTM4MDExNzAwMDAwMFowOTEL\
MAkGA1UEBhMCVVMxDzANBgNVBAoTBkFtYXpvbjEZMBcGA1UEAxMQQW1hem9uIFJv\
b3QgQ0EgMTCCASIwDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBALJ4gHHKeNXj\
ca9HgFB0fW7Y14h29Jlo91ghYPl0hAEvrAIthtOgQ3pOsqTQNroBvo3bSMgHFzZM\
9O6II8c+6zf1tRn4SWiw3te5djgdYZ6k/oI2peVKVuRF4fn9tBb6dNqcmzU5L/qw\
IFAGbHrQgLKm+a/sRxmPUDgH3KKHOVj4utWp+UhnMJbulHheb4mjUcAwhmahRWa6\
VOujw5H5SNz/0egwLX0tdHA114gk957EWW67c4cX8jJGKLhD+rcdqsq08p8kDi1L\
93FcXmn/6pUCyziKrlA4b9v7LWIbxcceVOF34GfID5yHI9Y/QCB/IIDEgEw+OyQm\
jgSubJrIqg0CAwEAAaNCMEAwDwYDVR0TAQH/BAUwAwEB/zAOBgNVHQ8BAf8EBAMC\
AYYwHQYDVR0OBBYEFIQYzIU07LwMlJQuCFmcx7IQTgoIMA0GCSqGSIb3DQEBCwUA\
A4IBAQCY8jdaQZChGsV2USggNiMOruYou6r4lK5IpDB/G/wkjUu0yKGX9rbxenDI\
U5PMCCjjmCXPI6T53iHTfIUJrU6adTrCC2qJeHZERxhlbI1Bjjt/msv0tadQ1wUs\
N+gDS63pYaACbvXy8MWy7Vu33PqUXHeeE6V/Uq2V8viTO96LXFvKWlJbYK8U90vv\
o/ufQJVtMVT8QtPHRh8jrdkPSHCa2XV4cdFyQzR1bldZwgJcJmApzyMZFo6IQ6XU\
5MsI+yMRQ+hDKXJioaldXgjUkK642M4UwtBV8ob2xJNDd2ZhwLnoQdeXeGADbkpy\
rqXRfboQnoZsG4q5WTP468SQvvG5\n\
-----END CERTIFICATE-----\n"
```

6.6.2.2 Set up the Wi-Fi connection in the socket_startup.c file

Configure your Wi-Fi connection.

Procedure

1. Open the `socket_startup.c` file.
2. Enter the SSID and password of your Wi-Fi network in the `SSID` and `PASSWORD` sections.

You are all set. You can now send MQTT messages to AWS IoT.

6.6.3 Send MQTT messages

Debug your project to start sending messages.

Before you begin

Before sending MQTT messages, set up an external terminal to be able to see the messages sent from the board. You can also open the AWS MQTT test client from the AWS Management Console to see the messages received. When you are ready, debug your project to start sending messages.

Procedure

1. Connect your board to your computer.
2. If it is the first time you are connecting your board, follow these steps:
   a. Click the **Connected device** area under the **Build target** drop-down list to open the **Device Manager**.
   b. Click the **Add Device** button and select the device firmware for your board in the dialog box that displays at the top of the window, then click **Connect**.

      Your board displays in the **Device Manager** list of devices and appears as connected with a green dot in the **Connected device** area in the **Explorer**. After the first successful connection, Keil Studio automatically detects the board.
3. Check that an appropriate build target displays in the **Build target** drop-down list. If not, select one.
4. Click the debug button,  .
   Keil Studio automatically builds and runs the project on the board. The **Debug** view displays and the debug session starts.


Note

If you are experiencing problems running the project on the board, set the **Connect Mode** preference to **underReset** to be able to run the project and do debugging. See Advanced debugger settings for more details on the different connect modes.

5. Check the output of the board in the terminal. When the connection is successful, the following message displays and MQTT messages start being sent:

```
AWS IoT Demo
Connecting to WiFi ...
WiFi network connection succeeded!
```

6. If the debugger is stopped, click the **Continue** button  to go through the code.
7. Check what happens from the AWS Management Console too. In **IoT Core**, go to **Test** > **MQTT test client**.
8. In the **Subscribe to a topic** tab, enter `#` in the **Topic filter** field and click **Subscribe**.

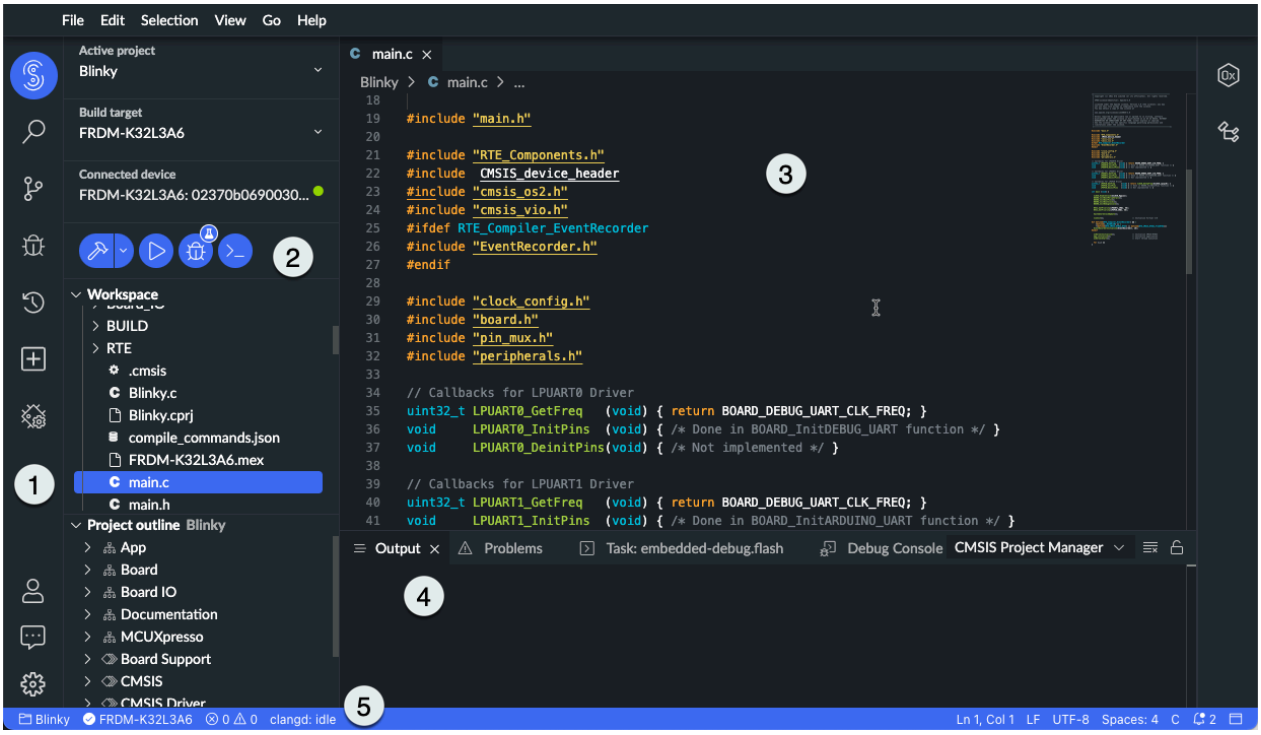
7. User interface

This chapter presents the user interface of Keil Studio and the Command palette. It also gives you tips and tricks to help you use Keil Studio in an optimal way and customize the UI to your needs.

7.1 UI layout

The Keil Studio UI has an intuitive and customizable layout made of views.

Figure 7-1: UI layout



The UI is divided into different areas:

1. Activity bar: On the left-hand side, the activity bar allows you to switch between different views and displays context-specific indicators (for example, the number of Git outgoing changes). The activity bar also gives you access to the **User Profile** view, feedback and help options, and customizable settings.
2. Side bar: The side bar contains the **Explorer** view. The **Explorer** shows all the projects contained in your workspace organized by folders. Projects with a red dot next to them contain files with errors. If there are errors in a file, the number of errors displays next to the file name. The letters next to file names are the Git or Mercurial statuses. If you are working with Mbed projects, you can see a Symbolic Link icon next to the **mbed-os** library folder of a given project. The area just above the **Workspace** tree view shows the active project and build target currently selected for the project, as well as the connected device. The main buttons to build,

run, debug the active project, and display the output of the board (**Serial Monitor** view) are also available from here. For standalone CMSIS projects only, another area below the **Workspace** tree view shows the **Project outline**. The **Project outline** displays the software components and files contained in the active project organized in a logical way.

3. Editor: The editor on the right shows the content of the files you have opened from the **Workspace** tree view. It is the main area to edit your files. You can open as many editors as you like side by side, vertically or horizontally.
4. Panels: You can display different panels below the editor area for output or debug information, or errors and warnings.
5. Status bar: The status bar gives details about the active project and the files you are editing. If you are using source control, the branch you are working on displays there too.

Most views are accessible from the **View** menu or from the activity bar. You can also search in **View** > **Open View...**.

You can hide views easily. For example, try toggling the bottom panels with **Ctrl+J** (Windows) or **Cmd+J** (macOS) or the **Explorer** view with **Shift+Ctrl+E** (Windows) or **Shift+Cmd+E** (macOS).

You can also reorganize views the way you want by dragging and dropping them.

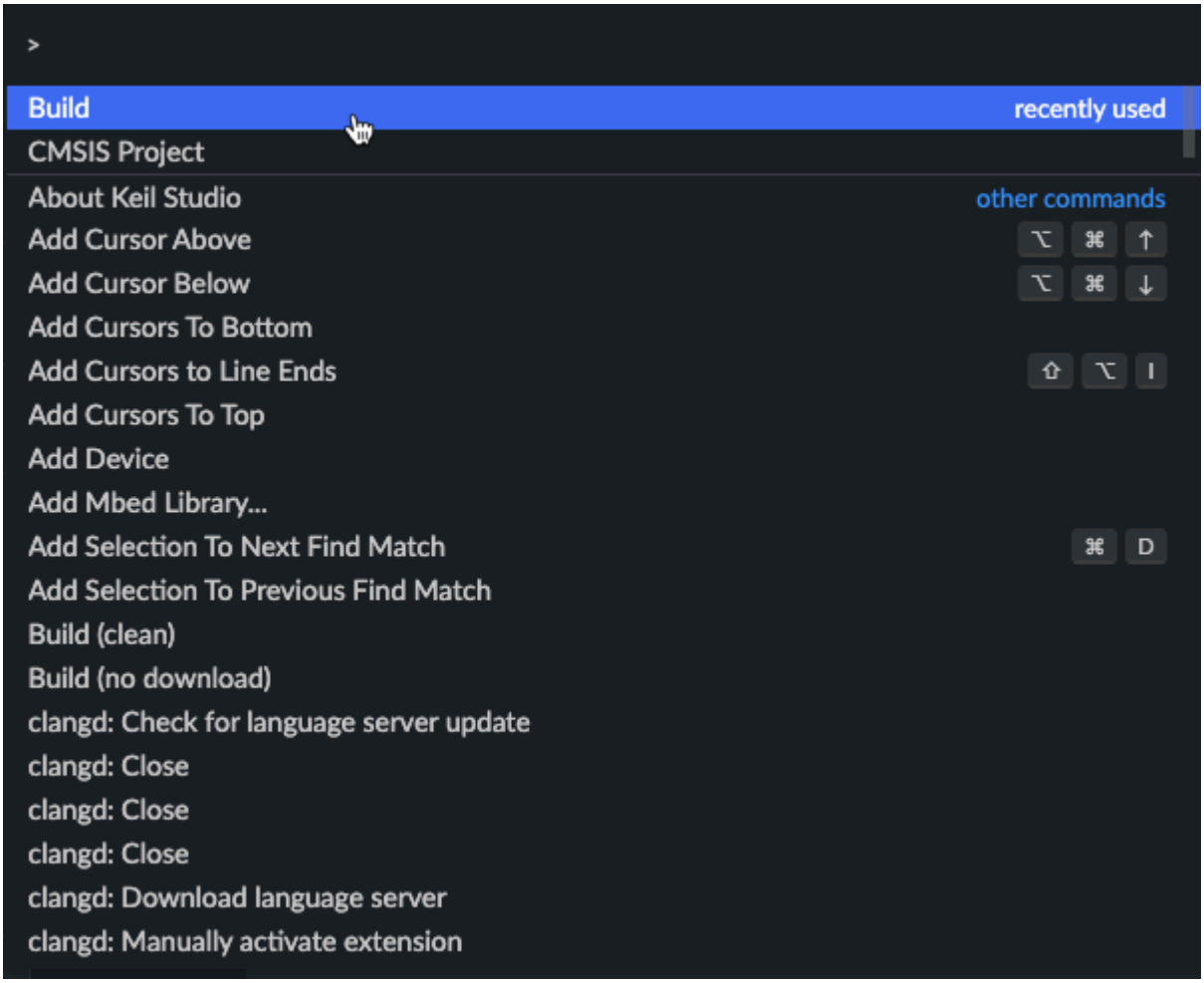
To restore the default layout, go to **View** > **Command Palette...** and look for the **View: Reset Workbench Layout** command. This command reloads Keil Studio with the default layout.

7.2 Command palette

Keil Studio is also accessible from the keyboard. The Command palette gives you access to all the functionality of Keil Studio, including keyboard shortcuts for the most common operations.

To bring up the Command palette, select **Command Palette...** from the **View** menu or press **Ctrl+Shift+P** (Windows) or **Cmd+Shift+P** (macOS). Recently used commands appear at the top. To find what you are looking for, start typing the name of a command in the search field.

Figure 7-2: Recently used commands appear at the top

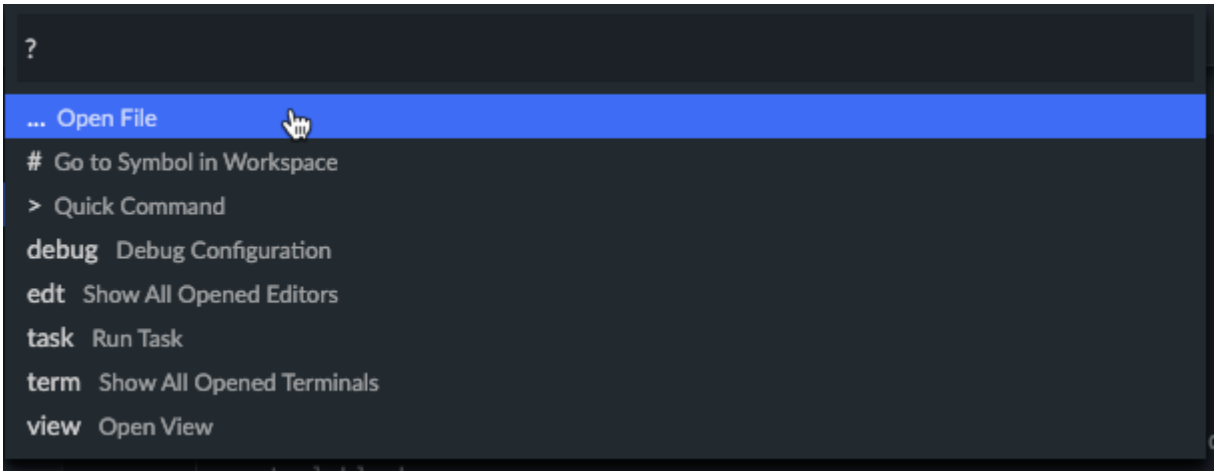


You can also open files or search for symbols from the Command palette.

- To open files: Press **Ctrl+P** (Windows) or **Cmd+P** (macOS). Recently opened files appear automatically, then file results are based on the string you enter in the search field.
- To search for symbols: Press **Ctrl+P** (Windows) or **Cmd+P** (macOS), then type `#` in the search field followed by the name of the symbol you are looking for.

If you type `?`, a list of available commands you can execute from here displays:

Figure 7-3: Available commands



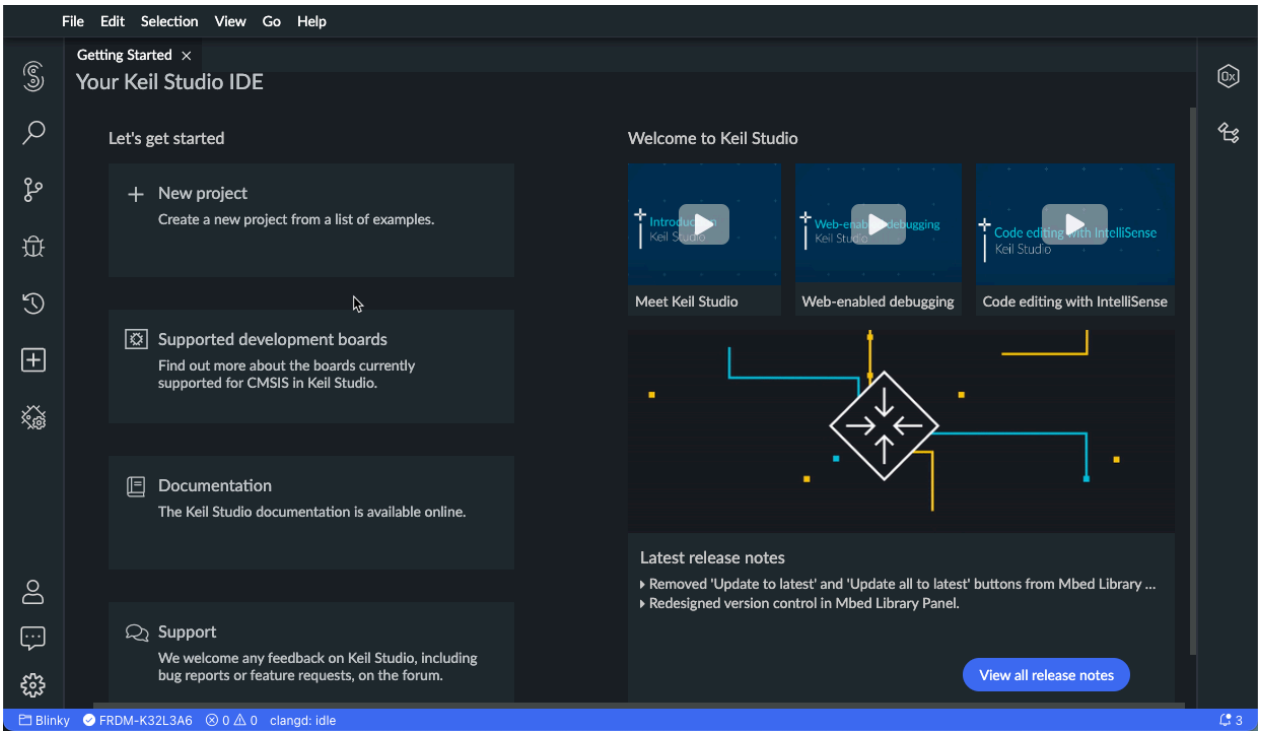
7.3 Tips and tricks

Here are some tips and tricks to help you work more efficiently with Keil Studio.

7.3.1 Getting Started page

If you are new to Keil Studio, start by checking the **Getting Started** page. It displays by default the first time you open Keil Studio. It is also accessible when you go to **Help** > **Getting Started**.

Figure 7-4: Getting Started page



This page gives you useful shortcuts, links to videos presenting Keil Studio's most popular features and a link to the release notes.

Do not forget to check the tutorials available in this guide as well, they provide step-by-step instructions to help you get started with Keil Studio.

7.3.2 Editor

An essential part of Keil Studio is the editor where you edit your code. This section presents the editor and some useful editing tips.

7.3.2.1 Use side-by-side editing

You can open as many editors as you like side by side, horizontally or vertically, with the **Split Editor Horizontal** and **Split Editor Vertical** options available in **View** > **Editor Layout**.

Whenever you open a new file, the editor that is active displays the content of that file. You can resize editors and reorder them easily. Drag and drop the title area of the editor you want to reposition or resize.

If there are many editors opened, use your mouse wheel to scroll through the tabs.

Experiment with the **Split Editor Right**, **Split Editor Left**, **Split Editor Up**, and **Split Editor Down** options.

You can maximize the size of the editor region with the **View** > **Appearance** options: **Toggle Bottom Panel**, **Toggle Status Bar Visibility** and **Collapse All Side Panels**.

7.3.2.2 Minimap

A minimap is available on the right side of the editor. You can click or drag the shaded area to jump to different sections of a file.

If the minimap does not display, select **View** > **Toggle Minimap**.

7.3.2.3 Editing tips

Here are some common features to make code editing faster.

Multi cursor selection

You can add cursors at different positions using your mouse and **Alt+Click** (Windows) or **Option +Click** (macOS)

To set cursors above or below the current position, use **Alt+Ctrl+Up arrow** (or Down arrow) (Windows) or **Option+Cmd+Up arrow** (or Down arrow) (macOS).

Column selection

You can select blocks of code by holding **Shift+Alt** (Windows) or **Shift+Option** (macOS) and dragging your mouse over what you want to select.

Copy line up or down

To copy a line up or down, use **Shift+Alt+Up arrow** (or Down arrow) (Windows) or **Shift+Option +Up arrow** (or Down arrow) (macOS).

Move line up or down

To move a line up or down, use **Alt+Up arrow** (or Down arrow) (Windows) or **Option+Up arrow** (or Down arrow) (macOS).

Navigate to beginning or end of file

To navigate to the beginning or the end of a file, use **Ctrl+Up arrow** (or Down arrow) (Windows) or **Cmd+Up arrow** (or Down arrow) (macOS).

7.4 Customize the UI

This section describes the preferences and shortcuts that you can update to tailor Keil Studio to your preferred setup.

7.4.1 Preferences

You can customize how Keil Studio operates to suit the way that you are used to working.

7.4.1.1 Change preferences

This section describes how to change preferences in Keil Studio.

Procedure

1. Go to **File** > **Preferences** > **Open Settings (UI)**.
   There are two tabs: a **User** tab and a **Workspace** tab.

   In the **User** tab, you can define preferences that apply to all workspaces. In the **Workspace** tab, you can define preferences for the workspace currently open only. Preferences set in the **Workspace** tab take precedence over preferences set in the **User** tab.

   Note: In the current version of Keil Studio, there is only one workspace available per account, so you can use the **User** tab or the **Workspace** tab interchangeably.

   The **Open Settings (JSON)** icon  opens a JSON file storing all the preferences you changed from their default values.
2. Select the **User** or the **Workspace** tab.
3. Click the preference that you want to change and modify the predefined values as needed.
   Note: For some preferences, you can add a manual value in the JSON file.
4. For preferences that require a manual value, when you click the **Edit in settings.json** link, a preference ID is added in the JSON file. You must add the correct value for that preference ID. For example, if you click **Edit in settings.json** for the **Files: Associations** preference, the JSON file opens in a separate tab and shows the `files.associations` ID without a value. You can now associate new file extensions to a language:

   ```
   {
       "files.associations": {"*.myextension": "cpp"}
   }
   ```

   In this example, your files with a `*.myextension` extension are recognized as C++ files.

Results

Once you have changed a preference, a blue line and a cogwheel icon appear to the left of the preference. You can click the cogwheel icon and select **Reset Setting** to reset the preference. You

can also copy the preference ID and the value set for the preference in JSON format (**Copy Setting as JSON** option), or copy the preference ID only (**Copy Setting ID** option).

To look for a specific preference, type the preference name or ID in the **Search Settings** field.

You can change the most common preferences without going to the **Preferences** list. For example, to switch from the default dark theme to a light theme, select **File** > **Preferences** > **Color Theme**. To indent with tabs, click the **Spaces** option on the information bar when the editor is open.

7.4.1.2 Set word wrap preferences

You can control word wrap in the editor through the **Word Wrap** preference. By default, this preference is off but if you set it on, text wraps at the width of the editor window.

Two other options are available for **Word Wrap** and work in combination with the value set for the **Word Wrap Column** preference. **Word Wrap Column** is the maximum number of characters that can be displayed on a single line.

- **wordWrapColumn**: When this option is selected, text wraps at the value set for **Word Wrap Column**.
- **bounded**: When this option is selected, text wraps at the width of the editor window or at the value set for **Word Wrap Column**, whichever is the smaller value of the two widths.

Once you have set these preferences, select **View** > **Toggle Word Wrap** to toggle between the different options for the **Word Wrap** preference.

7.4.2 Keyboard shortcuts

Keil Studio lets you perform most tasks from the keyboard with keyboard shortcuts (also called keybindings). You can modify existing keyboard shortcuts or add new ones to commands that do not yet have shortcuts associated with them.

7.4.2.1 Change keyboard shortcuts

This section describes how to change keyboard shortcuts in Keil Studio.

Procedure

1. Select **File** > **Preferences** > **Open Keyboard Shortcuts**.
2. In the **Type to search in keybindings** field, type the name of a command or keybinding. You can also do a search on the context and `"when"` clauses. Note that, if needed, you can click the **Clear Keybindings Search Input** icon  to clear the field.

3. Hover over the shortcut you want to modify and click the **Edit Keybinding** pen icon to the left of the command. You can also double-click the shortcut to edit it.
   The **Edit Keybinding for <command>** dialog box opens.
4. Update the shortcut and click **OK**. To find out what keys you can use, see the **Supported Keys** section in Using the JSON file.

   To make further changes, you can click the **Open Keyboard Shortcuts (JSON)** icon . The **Open Keyboard Shortcuts (JSON)** icon opens the `keymaps.json` file which stores all the shortcuts that have been changed from their default values. Change the lines corresponding to the shortcut or shortcuts you want to modify. For more information, see Use the JSON file.

7.4.2.2 Reset keyboard shortcuts

This section describes how to reset keyboard shortcuts in Keil Studio.

Procedure

1. Search for the keyboard shortcut you want to reset.
2. Hover over the shortcut and click the **Reset Keybinding** icon to the left of the command.
   The **Reset keybinding for <command>** dialog box opens.
3. Click **OK**.
   Alternatively, you can reset a shortcut from the **Edit Keybinding for <command>** dialog box with the **Reset** button. You can also delete the lines corresponding to the shortcut you want to reset in the `keymaps.json` file. For more information, see the next section.

7.4.2.3 Use the JSON file

All the changes that you make to keyboard shortcuts are stored in a `keymaps.json` file. You can update or delete your changes directly from the JSON file.

Keyboard rules

When you open the `keymaps.json` file, you can see that two blocks are present for each shortcut that is modified. The current value of a shortcut is presented first, followed by the previous values for that shortcut. The blocks contain what are called *keyboard rules*.

Each rule consists of:

- A `"command"` containing the identifier of the command to execute.
- A `"keybinding"` that describes the pressed keys.
- An optional `"when"` clause that contains a Boolean expression which evaluates depending on the current context. If there is no `"when"` clause, the keyboard shortcut is globally always available.

For example, if we modify the keyboard shortcut for the **Copy Line Down** command to use `shift+down` instead of `shift+alt+down` to trigger the command when using the editor, you get:

```
{
    "command": "editor.action.copyLinesDownAction",
```

```
    "keybinding": "shift+down",
    "when": "editorTextFocus && !editorReadonly"
},
{
    "command": "-editor.action.copyLinesDownAction",
    "keybinding": "shift+alt+down",
    "when": "editorTextFocus && !editorReadonly"
}
```

To reset the keyboard shortcut, you can modify the `"keybinding"` element in the first block or delete both blocks.


Note

It is not currently possible to change the `"command"` identifiers or `"when"` clauses.

Supported keys

The following keys are supported:

To use `ctrl` on Windows or Linux and `cmd` on macOS, use `ctrlcmd`.

You can use `shift`, `ctrl`, `alt`, `meta`, `option (alt)`, `command (meta)`, `cmd (meta)` as modifiers.


Note

If you define a custom shortcut with `cmd`, `command`, or `meta` in your `keymaps.json` file, the same `keymaps.json` file does not work on a Windows or Linux machine because these machines do not have equivalent keys.

You can also use the following strings for special keys: `backspace`, `tab`, `enter`, `return`, `capslock`, `esc`, `escape`, `space`, `pageup`, `pagedown`, `end`, `home`, `left`, `up`, `right`, `down`, `ins`, `del`, and `plus`.

Chords (two separate keypress actions) are supported and must be separated with a space.

8. Work with standalone CMSIS projects and CMSIS solutions

This chapter describes the differences between standalone CMSIS projects and CMSIS solutions and how to work with them in Keil Studio.

8.1 Standalone CMSIS projects

You can work with standalone CMSIS projects that contain a single `.cprj` project file. CPRJ is a generic CMSIS-aware project file format that allows IDEs and command-line build tools to share projects.

See this page for more details on the CPRJ project file format.

8.2 CMSIS solutions

You can also work with solutions that can contain one or more projects. A solution is a container used to organize related projects that are part of a larger application and that can be built separately.

See Project setup for related projects for a solution example.

Solutions are defined in YAML format using `*.csolution.yaml` files. A `*.csolution.yaml` file defines the complete scope of an application and the build order of the projects the application contains. Individual projects are defined using `*.cproject.yaml` files. A `*.cproject.yaml` file defines the content of an independent build - it is the solution-based equivalent of a `.cprj` file.

The `*.csolution.yaml` and `*.cproject.yaml` files of a solution can be manually edited. Keil Studio integrates the Red Hat YAML Language Support extension and uses YAML schemas to make the editing of these files easier. See the vscode-yaml repository for more information on the extension.

The solution and project files are then translated to the CPRJ project file format.

See the Overview of the **csolution - CMSIS Project Manager** project and the project examples presented to understand how solutions and projects are structured. The **csolution - CMSIS Project Manager** project is under development and part of the Open-CMSIS-Pack open-source project.

8.3 Create or clone a standalone CMSIS project

This section describes how to start working with standalone CMSIS projects in Keil Studio.

You can:

- Create a project from an example shipped with Keil Studio.

- Clone an example project from keil.arm.com.
- Clone an existing project from a Git hosting service (such as GitHub).

Arm recommends that you use the example projects provided. The examples use predefined `.cprj` templates. See this page for more details on the CPRJ project file format.

8.3.1 Create a project from a CMSIS example project

You can create a CMSIS project from an example.

Procedure

1. Select **File** > **New...** > **CMSIS Project**.
   The **New Project** dialog box opens.
2. Click the **Example project** drop-down list and select an example from the list.
   Each example has a readme.md file that explains the details of that example.
3. In the **Project name** field, edit the name of the new project or keep the name provided by default.
4. Check the default options:
   - Keil Studio sets the newly created project as the active project. Build and run commands only apply to the active project. Clear the checkbox if you do not want to make the new project active.
   - Keil Studio initializes the project as a Git repository. Clear the checkbox if you do not want to turn your project into a Git repository. See Configure a project for source control and collaboration for more details.
5. Click **Add project**. Keil Studio creates the project in your workspace.

8.3.2 Clone a CMSIS example project from the Keil Studio website

You can clone a CMSIS project from keil.arm.com.

Procedure

1. Go to keil.arm.com.
2. Click the **Hardware** menu and select **Boards** to see the list of supported boards.
   You can search for a board by name or vendor, or filter the list by vendor or core. You can also display boards with example projects with the **Only include boards with example projects** checkbox.
3. Once you have found an example project, click the **Open in Keil Studio** button for the project you want to use.
4. Log into Keil Studio if you are not already logged in.
   Keil Studio opens.
5. Confirm the project name in the **Clone** dialog box.
   Keil Studio sets the newly cloned project as the active project by default.
6. Click **Add project**. The project loads to your workspace and is the active project.

8.3.3 Clone a CMSIS project

You can clone existing CMSIS projects from a Git hosting service (such as GitHub).

Before you begin

For projects on a Git hosting service, you can clone public repositories without setting up your Git credentials. If you want to clone a private repository, set up Git credentials.

For more information about what cloning a repository means, see the git-clone chapter on git-scm.com.

Procedure

1. Open the **File** menu and select **Clone...**.
   The **Clone** dialog box displays.
2. Paste the full HTTPS or SSH URL of the relevant web page on a Git hosting service and (optionally) edit the project name.
   Keil Studio sets the newly cloned project as the active project by default. Build and run commands only apply to the active project.
3. Clear the checkbox if you do not want to make the new project active.
4. Click **Add project**.
   You can push changes back to the remote repository from Keil Studio. For more information, see Source control.

8.3.4 Further resources about CMSIS

You are now ready to work on your project.

You can learn more about CMSIS.

When you are ready, build and run your project.

8.4 Manage a standalone CMSIS project

This section describes how to use the **Project outline**.

8.4.1 Project outline

The **Project outline** is accessible from the **Explorer** view and gives you an overview of what is included in your project (software components and files). You can easily manage your project files from the **Project outline** and organize them by groups to simplify the project maintenance.

8.4.2 Manage your project files from the Project outline

The **Project outline** allows you to see what is in your project (software components and files). You can change how your project is structured using groups. Groups are useful to structure code files into logical blocks.

You can, for example, sort files according to:

- Their function (for example, you can separate CPU-related files from system calls and other source files).
- Separate groups for different teams.
- Memory they execute in.
- Compiler and linker settings (for example, optimization level).

File groups have no influence on the build process for your project (unless you specify command-line options for the groups in the `.cprj` file of the project).

When managing groups, you can:

- Create a group.
- Add a file from the **Workspace** to a group.
- Delete a group. This action deletes the group and removes the files contained in the group from the **Project outline** (the files are still available from the **Workspace**).
- Move a group inside another group.
- Rename a group.

With files, you can:

- Add a file from the **Workspace** to the **Project outline**.
- Move a file to a different group.
- Remove a file from a group (the file is still available from the **Workspace**).

Changes you make to the **Project outline** are reflected in the `.cprj` file.

Procedure

1. Hover over the **Project outline** and click the **...** button, then select **New Group**.
2. Enter the name of the group in the popup and press **Enter**.
3. Right-click the group and select **Add File to Group...**.

   A dialog box opens.
4. Select the file you want to add to the group and click **Add**.

5. Select a file category in the popup.

   For some file types, the file category is automatically set (for example, `*.c` files are in the `sourcec` category by default, so there is no file category selection). The file categories available are described in the Build section of the CMSIS documentation.

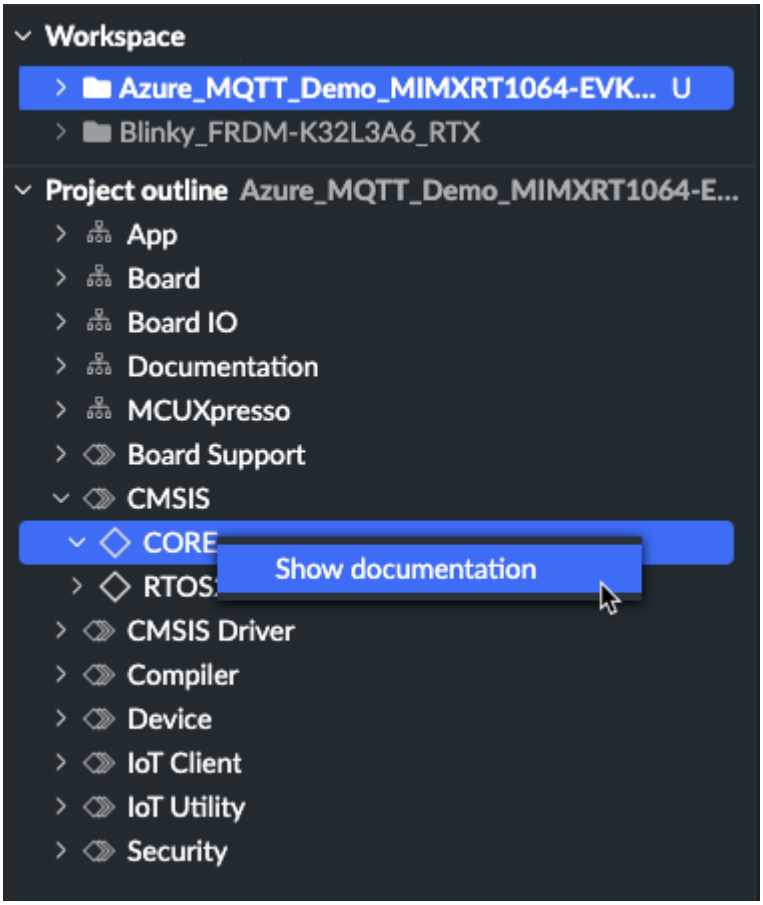
   Note that you can also add a file to a group from the **Workspace**. Right-click a file in the **Workspace** and select **Add to Project Outline**, then select a destination group and a file category.
6. If you need to move a group inside another group, right-click the group and select **Move to Group...**.
7. Select a destination group in the popup.
8. Similarly, to move a file to a different group, right-click the file and select **Move to Group...**.
9. Select a destination group in the popup.

Results

You can easily create groups, add files to groups, and reorganize groups and files the way you want to.

Note that you can open the documentation available for component groups and subgroups from the **Project outline**. Open a class, then right-click a group (for example: **CORE** for the **CMSIS** component class) and select **Show documentation**.

Figure 8-1: The 'Project outline'



8.5 Manage a CMSIS solution and its software components

This section describes how to manage CMSIS solutions and their software components.

8.5.1 Software Components view

The **Software Components** view shows all the software components selected in the active project of a CMSIS solution.

From this view, you can see all the component details (called attributes in the Open-CMSIS-Pack documentation.

You can also:

- Modify the software components to include in the project and manage the dependencies between components for each target type (build target) you have defined in your solution.

- Build the solution using different combinations of pack and component versions, and different versions of a toolchain.

8.5.2 Open the Software Components view

This topic describes how to open the **Software Components** view.

Procedure

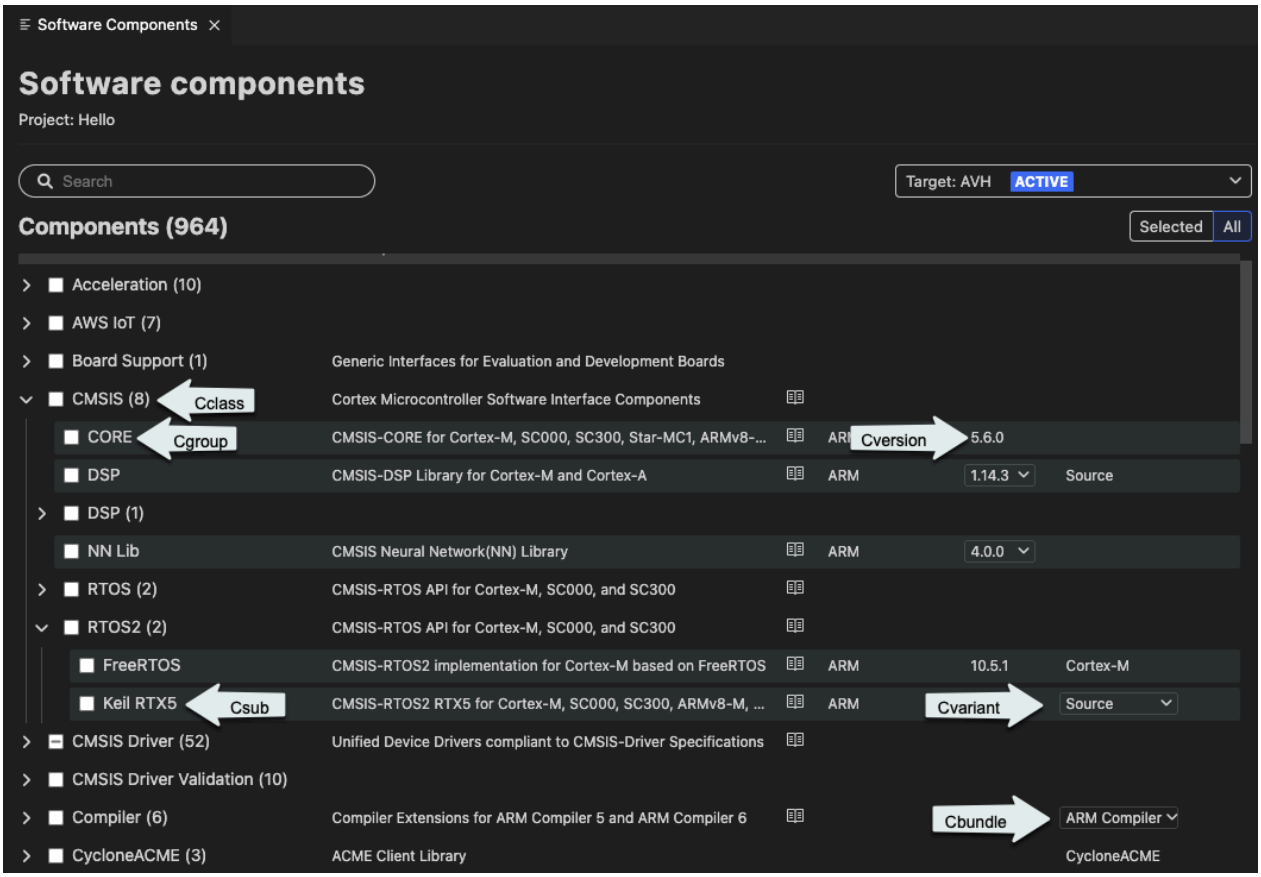
1. Set the solution you want to work on as the active project.
2. Click the **Open Software Components view** button  from the **Explorer**.

Results

The **Software Components** view opens.

By default, the view displays the components included in the active project only (**Selected** toggle button). If you click the **All** toggle button, all the components available for use display.

Figure 8-2: The 'Software Components' view showing all the components that are available for use



With the **Target** drop-down list, you can select components for the different target types (build targets) you have in your solution.

The CMSIS-Pack specification states that each software component has the following attributes:

- Component class (Cclass): A top-level component name. For example: **CMSIS**.
- Component group (Cgroup): A component group name. For example: **CORE** for the **CMSIS** component class.
- Component version (Cversion): The version number of the software component.

Optionally, a software component might have these additional attributes:

- Component sub-group (Csub): A component sub-group that is used when multiple compatible implementations of a component are available. For example: **Keil RTX5** under **CMSIS > RTOS2**.
- Component variant (Cvariant): A variant of the software component is typically used when the same implementation has multiple top-level configurations, like **Source** for **Keil RTX5**.
- Component vendor (Cvendor): The supplier of the software component. For example: **ARM**.
- Bundle (Cbundle): Allows you to combine multiple software components into a software bundle. Bundles have a different set of components available. All the components in a bundle are compatible with each other but not with the components of another bundle. For example: **ARM Compiler** for the **Compiler** component class.

Documentation links are available for some components at the class, group, or sub-group level.

Click the book icon  of a component to open the related documentation.

Use the **Search** field to search the list of components.

8.5.3 Modify the software components in your project

This topic describes how to select software components.

Before you begin

You can add components from all the packs available (it is not limited to the packs that are already selected for a given project).

Procedure

1. Click the **All** toggle button to display all the components available.
2. Select a target type (build target) in the **Target** drop-down list. You can select components for the different target types defined in the solution.
3. Use the checkboxes to select or clear components as required. For some components, you can also select a vendor, variant, or version.

   The `cproject.yaml` file is automatically updated.
4. Manage the dependencies between components and solve validation issues from the **Validation** panel.

Issues are highlighted in red and have an exclamation mark icon  next to them. You can remove conflicting components from your selection or add missing component dependencies from a suggested list.

5. If there are validation issues, hover over the issues in the **Validation** panel to get more details. You can click the proposed fixes to find the components in the list. Sometimes, you must choose between different fix sets. Select a fix set in the drop-down list, make the required component choices, and then click **Apply**.

   If a pack is missing in the solution, a message "Component's pack is not included in your solution" displays in the **Validation** panel. An error also displays in the **Problems** view. To install the missing pack, right-click the error in the **Problems** view and select the **Install missing pack** option. If there are several packs missing, use **Install all missing packs**. You can also install missing packs with the **CMSIS: Install required packs for active solution** command from the Command Palette.

   There can be other validation issues such as:

   - A component you selected is incompatible with the selected device and toolchain.
   - A component you selected has dependencies which are incompatible with the selected device and toolchain.
   - A component you selected has unresolvable dependencies. In such cases, you must remove the component. Click **Apply** from the **Validation** panel.

Note: In the current version, you can undo changes from the **Source Control** view or by directly editing the `cproject.yaml` file.

9. Work with Mbed projects

Keil Studio supports Mbed OS 5.12 and newer, and Mbed OS 6 and newer.

Keil Studio also provides limited support for Mbed 2: you can build and run Mbed 2 projects, but you cannot do debugging. Arm recommends that you upgrade to Mbed OS 5 or 6 to benefit from all the features. See Upgrade from Mbed 2 to Mbed OS 5 or 6 for more details.

9.1 Create, import or clone an Mbed project or a standalone library

This section describes how to work with Mbed projects and standalone libraries in Keil Studio.

You can:

- Create a project from an example shipped with Keil Studio (examples are available for Mbed OS 5, Mbed OS 6, and Mbed 2). You can also create a project as an empty Mbed project (with Mbed OS 5 and Mbed OS 6).
- Create a blank Mbed project (start from an empty folder with a manually selected version of Mbed OS). You can create a standalone library in a similar way.

You can also:

- Import a project or a library from your local file system.
- Import projects or libraries from your Mbed Online Compiler workspace.
- Clone an existing project or library from os.mbed.com/code (as a URL) or a Git hosting service (such as GitHub).

9.1.1 Create a project from an Mbed example project or an empty Mbed project

You can create an Mbed project from an example or an empty project.

Procedure

1. Create a project, either:
   - In the **Explorer** view, click the **Active project** drop-down list then click the **New project** button  .
   - Select **File** > **New...** > **Mbed Project**.

   The **New Project** dialog box displays.
2. Click the **Example project** drop-down list and select an example from the list.
   Each example has a readme.md file that explains the details of that example.

To create an Mbed project with no content (other than Mbed OS), select **empty Mbed OS project** under **Mbed OS 6** or **Mbed OS 5**.

3. In the **Project name** field, edit the name of the new project or keep the name provided by default.
4. Check the default options:
   - Keil Studio sets the newly created project as the active project. Build and run commands only apply to the active project. Clear the checkbox if you do not want to make the new project active.
   - Keil Studio initializes the project as a Git repository. Clear the checkbox if you do not want to turn your project into a Git repository. See Configure a project for source control and collaboration for more details.
5. Click **Add project**. Keil Studio creates the project in your workspace.

9.1.2 Create a blank Mbed project or a standalone library

You can create a blank project that has no Mbed OS and no standard files, such as `main.cpp`. You must manually add a version of Mbed OS to a blank project. You can create a standalone library the same way.

Procedure

1. To create an empty folder that is not associated with an existing project, right-click an empty area in the **Explorer** and select **New Folder**.
   The **New Folder** dialog box opens.
2. Type a name for the folder and click **OK**.
   An empty folder is created.
3. Right-click the folder and select **Set Active Project**.
4. Right-click the folder again and select **Add Mbed Library...**.
   The **Add Mbed Library** dialog box opens.
5. If you want to create a blank Mbed project, add a copy of Mbed OS to convert your folder to an Mbed project as follows:
   a. In the **URL** field, enter `https://github.com/ARMmbed/mbed-os` and click **Next** (the format `git@github.com:ARMmbed/mbed-os.git` also works).
   b. From the drop-down list, select the branch or tag of Mbed OS you want to use. You can use any supported version, including patch versions.

      Release tags are listed on the Mbed OS releases page.
6. If you want to create a standalone library, add a copy of the library as follows:
   a. In the **URL** field, enter the URL for a library from os.mbed.com or from a Git hosting service and click **Next**.
   b. From the drop-down list, select the branch or tag you want to use.
7. Click **Finish**. The selected branch or tag is added to the folder.

9.1.3 Import an Mbed OS project or a standalone library from your file system

You might already have Mbed projects or libraries on your file system. For example, you might have downloaded an Mbed project or a library from os.mbed.com/code or another online location.

Procedure

- To import a project or library from your file system, drag and drop your project folder to the **Explorer** view.

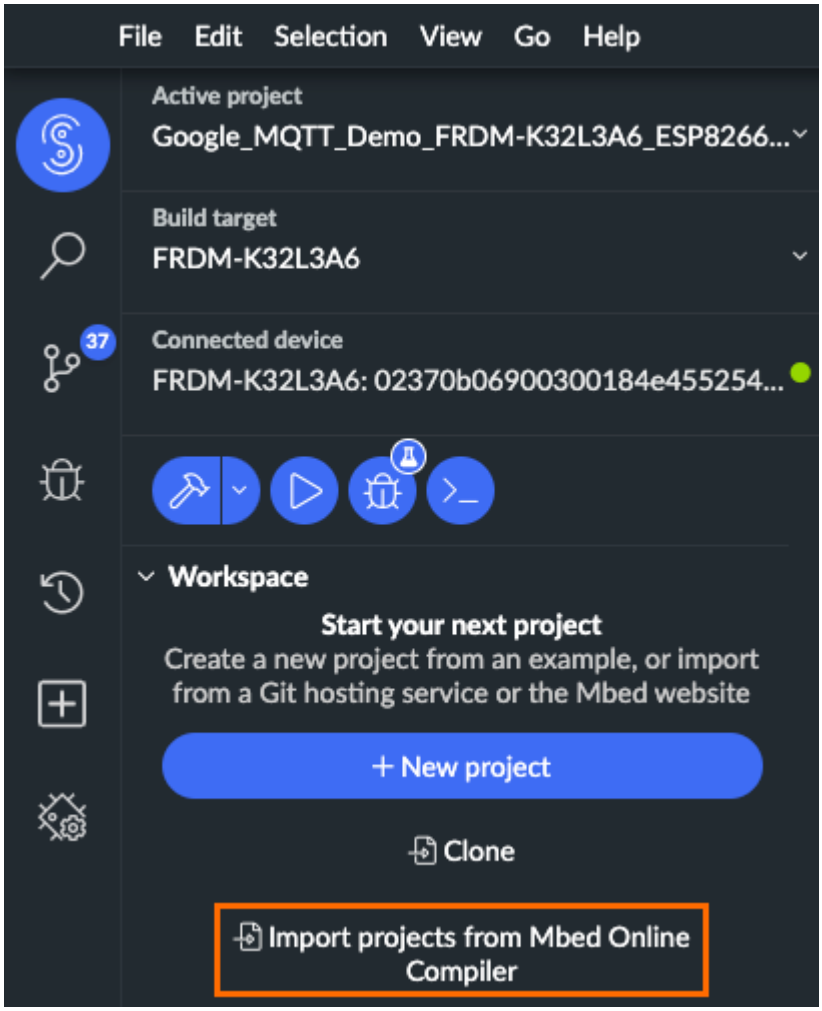
9.1.4 Import Mbed projects or standalone libraries from your Mbed Online Compiler workspace

The Mbed Online Compiler is deprecated but you can still import Mbed projects or libraries stored in your Online Compiler workspace to Keil Studio. You can either import all your projects and libraries at once, or import them one by one. The import process creates copies.

Procedure

1. Open the **Copy Programs from Mbed Online Compiler** dialog box:
    - If you have already used Keil Studio and have projects in your workspace, go to **File** > **Import from Mbed Online Compiler...**.
    - Alternatively, if it is the first time you log into Keil Studio, your workspace is empty and the **Explorer** view displays by default. Click the **Import projects from Mbed Online Compiler** button from the **Explorer** view.

Figure 9-1: Explorer view and Import projects from Mbed Online Compiler button



The **Copy Programs from Mbed Online Compiler** dialog box displays.

2. Select the first checkbox to import copies of all your projects and libraries, or select them one by one.
3. Click the **Copy programs** button.
   A progress bar indicates the progress of the import. A message and status icon display for each project or library. If a copy fails, hover over the  icon to get more details on the import.
4. Click the **Finish** button and check your imported projects or libraries in the **Explorer** view.

Next steps

If you have imported Mbed 2 programs, Arm recommends that you upgrade to Mbed OS 5, or 6 to benefit from all the features. See Upgrade from Mbed 2 to Mbed OS 5 or 6 for more details.

Warning

Keil Studio lets you import non-valid Mbed projects. You must check and, if necessary, fix the structure of your Mbed projects in Keil Studio once the import is finished to be able to build the projects or run them on your device.

For a project to be valid, its **mbed** or **mbed-os** Mbed library folder must be directly under the top-level project folder (not inside a subfolder). For example:

Figure 9-2: Valid Mbed 2 project

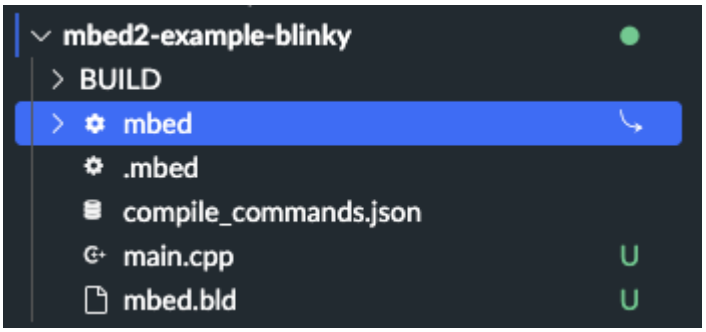
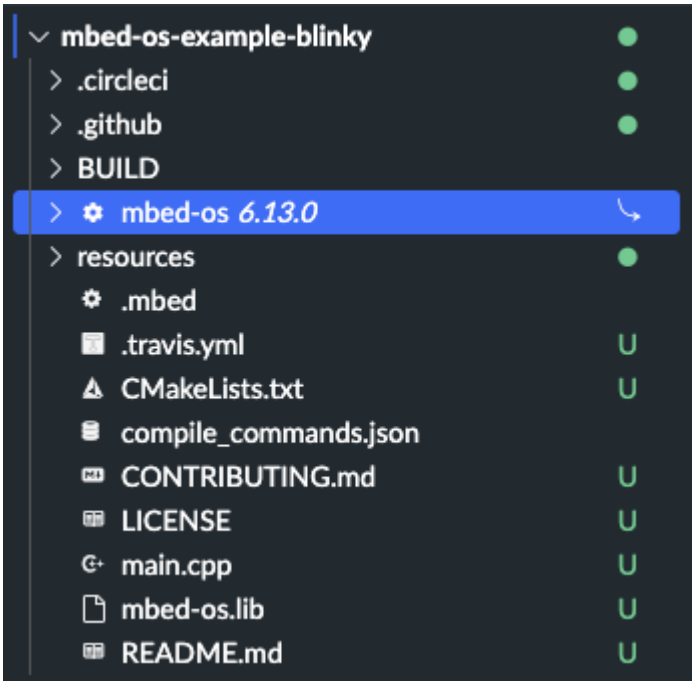


Figure 9-3: Valid Mbed OS 6 project



9.1.5 Clone an Mbed project or a standalone library

You can clone existing Mbed projects or libraries from os.mbed.com/code (as a URL) or a Git hosting service (such as GitHub).

Before you begin

For projects and libraries on a Git hosting service, you can clone public repositories without setting up your Git credentials. If you want to clone a private repository, set up Git credentials. For Mbed projects and libraries on Mercurial, Mercurial uses your Arm account or Mbed account credentials, so you have access to the same Mercurial repositories as on os.mbed.com.

For more information about what cloning a repository means, see the git-clone chapter on git-scm.com.

Procedure

1. Open the **File** menu and select **Clone...**.
   The **Clone** dialog box displays.
2. Paste the full HTTPS or SSH URL of the relevant web page and optionally edit the project name.
   This can be a page listed on os.mbed.com/code or a page on a Git hosting service.

   Keil Studio sets the newly cloned project or library as the active project by default.
3. Clear the checkbox if you do not want to make the new project active.
4. Click **Add project**.
   For Mbed projects, Keil Studio clones the project with the version of Mbed OS it was originally created with.

   You can push changes back to the remote repository from Keil Studio. For more information, see Source control. For libraries with .lib files, see Source-control library updates.

9.1.6 Next steps

After importing or cloning an Mbed project, you must check whether the project has all the required libraries and default configuration files. If you import or clone an Mbed project that has an unsupported version of Mbed OS, you must add a supported version of the `mbed-os` library to be able to use the project in Keil Studio.

See Manage an Mbed project and its libraries or standalone libraries for more information.

Imported or cloned Mbed projects have an `.mbed` file storing their settings, such as a default build target and toolchain. The build target you select in the UI overrides the build target set in the `.mbed` file.

9.1.7 Further resources about Mbed OS

You are now ready to work on your project.

You can find out more about Mbed OS APIs and programming on the Mbed OS documentation site.

When you are ready, build and run your project.

9.2 Manage an Mbed project and its libraries or standalone libraries

This section describes how to manage Mbed projects and their libraries, or standalone libraries.

When you create an Mbed project, or import or clone an existing project, you also import the libraries on which it is dependent, including Mbed OS which is delivered as `mbed-os`.

- When you create an example Mbed project, including an empty example, Keil Studio adds the version of Mbed OS that you selected when creating the project.
- When you import or clone an existing Mbed project, Keil Studio adds the version of Mbed OS stated in the `mbed-os.lib` file of the imported project.

Your project might require extra libraries, for example libraries that support hardware you have added to your development board. If you must add extra libraries, see Add a library.

The Mbed OS bare-metal profile is not a separate library; the Mbed OS bare-metal profile is the full Mbed OS library, which is stripped down at build time. For more information, see the Mbed OS bare-metal profile page.

Keil Studio provides limited support for Mbed 2. You cannot modify the Mbed 2 library of a project (`mbed.bld` file) from the **Mbed Libraries** view. You can manually change the version of Mbed in the `mbed.bld` file. See Change the Mbed version for your project. However, Arm recommends that you upgrade to Mbed OS 5 or 6 to benefit from all the features. See Upgrade from Mbed 2 to Mbed OS 5 or 6 for more details.

9.2.1 Mbed OS 5 or 6 project

This section describes how to manage the libraries in an Mbed OS 5 or 6 project.

9.2.1.1 Open the Mbed Libraries view

Libraries are stored inside folders and identified by a cogwheel icon in the **Explorer**. The **Mbed Libraries** view lists all the libraries in an active project. From the **Mbed Libraries** view, you can see library details, such as the library version and where it was imported from. You can also add or remove libraries, and change the versions you have.

Procedure

1. Right-click the project name in the **Explorer** view and select **Set Active Project**.
2. Select **Mbed Libraries** from the **View** menu.
   The **Mbed Libraries** view opens in the bottom panel. When a library has dependencies with another library, it is indented under the main library.

9.2.1.2 Add a library

This section describes how to add libraries to an existing project.

About this task

You can add libraries to an existing project from os.mbed.com or from a Git hosting service. Each library that you add to a project is identified by a `.lib` file.

The Keil Studio **Explorer** view hides `.lib` files by default. Go to **File** > **Preferences** > **Open Settings (UI)** and search for the **Exclude** preference. Open the `settings.json` file and set `"files.exclude"` to `false` for `"**/*.lib"` files.

Procedure

1. Set the project you want to work on as the active project.
2. To add a library, you can:
   - Select **View** > **Mbed Libraries** to open the **Mbed Libraries** view and click the **Add new library** button +.
   - Right-click the project from the **Explorer** view and select **Add Mbed Library...**.

   The **Add Mbed Library** dialog box opens.
3. Enter the URL for a library from os.mbed.com or from a Git hosting service.
4. Modify the library name as required and click **Next**.
5. Select the release, branch, or tag that you want to import in the drop-down list.
   Notes:
   - For Mbed OS libraries, you must be connected to GitHub to see the list of Mbed OS releases available. See Set credentials for GitHub.
   - When a branch is checked out, the library checks out to the tip of the selected branch.
   - When a tag is checked out, the library is put in a detached head state.
6. Click **Finish**.

You can monitor the progress of the import with the progress indicator in the bottom right-hand corner of the screen. When the import is complete, the library displays in the **Mbed Libraries** view and in the **Explorer** view.

9.2.1.3 Remove a library

This section describes how to remove a library from a project.

Procedure

1. Set the project you want to work on as the active project.
2. Select **View** > **Mbed libraries** to open the **Mbed Libraries** view.
3. Hover over the library that you want to remove and click the **Remove library** button − that displays in the right-hand corner.
   The **Remove library** dialog box opens.
4. Click **Remove**.

9.2.1.4 Change the version of a library

This section describes how to change the version of a library.

About this task

When you import a library to Keil Studio, either manually or as a dependency for an imported project, you clone the library to your workspace.

Libraries are associated with specific projects in your workspace. If you have multiple projects that use a particular library, you have multiple copies of the same library; one per project. Each copy of the library can be at a different commit. If you update a library for one project, it does not update other copies of that library.

If you update a top-level library with dependencies, then all the libraries referenced by the main library are updated at the same time.

Procedure

1. Set the project you want to work on as the active project.
2. To change the version of a library:
   - Select **View** > **Mbed libraries** to open the **Mbed Libraries** view and click the blue tag with the library version (**Change library version**) for the library that you want to update.

     Figure 9-4: Tag example

   - In the **Explorer** view, right-click the library that you want to update, and select **Change Library Version**.

     The **Update <selected-library> to Version** dialog box opens.

3. Click the drop-down menu and select the version of the library you want to use.
   Notes:
   - For Mbed OS libraries, you must be connected to GitHub to see the list of Mbed OS releases available. See Set credentials for GitHub.
   - When a branch is checked out, the library checks out to the tip of the selected branch.
   - When a tag is checked out, the library is put in a detached head state.
4. Click **Update library**.
   The selected version of the library starts to check out. You can monitor the progress of the checkout with the progress indicator in the bottom-right corner of the screen.

   When the checkout is complete, the `.lib` file is updated.

9.2.1.5 Fix library problems

This section describes how to fix library problems.

About this task

When there are problems with any of the libraries in an active project, the **Fix all problems** button in the top right-hand corner of the **Mbed Libraries** view indicates the number of fixes required. For example, if you do not have the source of a library downloaded, or if you check out a new commit of a project that refers to a library commit that is not checked out.

To view details about the required fixes, click the **Fix all problems** button.

You can fix all the libraries in the active project in one click, or you can fix each library individually.

Procedure

1. In the top right-hand corner of the **Mbed Libraries** view, click the **Fix all problems** button  . The **Fix all libraries** dialog box opens with details about all the required fixes.
2. Click **Fix all**. Alternatively, to fix a specific library, click the **Fix problems** button for the library you want to fix.

9.2.1.6 Source-control library updates

`.lib` files describe the libraries in your project. To share library changes with collaborators, commit `.lib` file changes to the source control repository of your project. Do not add the library directory and its contents to your project repository.


Note

The `.lib` file only identifies the commit that you are using; the file does not include branch information. In Keil Studio, you can check out a library to the tip of a specific branch, but this information is not included if you open your project repository in another application, or if you push changes to a remote repository.

9.2.2 Mbed 2 project

This section describes how to manually change the version of Mbed for your Mbed 2 project. This section also describes how to upgrade to Mbed OS 5 or 6, which is the recommended approach.

9.2.2.1 Change the Mbed version for your project

Any Mbed 2 project is shipped with an `mbed.bld` file which contains a link to the Mbed 2 library version used for the project. You cannot modify the Mbed 2 library version from the **Mbed Libraries** view. Instead, you must manually update the version of Mbed in the `mbed.bld` file.

Procedure

1. Set the project as the active project.
2. Open the `mbed.bld` file from the **Explorer** view. The file contains a link to the Mbed 2 library.
3. Delete the link.
4. Go to os.mbed.com and find the Mbed 2 version you need.
5. Copy the URL and paste it in the `mbed.bld` file.
6. Select **Command Palette...** from the **View** menu or press **Ctrl+Shift+P** (Windows) or **Cmd +Shift+P** (macOS).
7. Look for the **Refresh Mbed 2 SDK** command and select it.
   Keil Studio synchronizes the `mbed.bld` file and the Mbed 2 source files contained in the `mbed` folder in your project.

9.2.2.2 Upgrade from Mbed 2 to Mbed OS 5 or 6

Arm recommends that you upgrade your Mbed 2 projects to Mbed OS 5 or 6 to benefit from all the features.

About this task

The main steps are as follows:

1. Mbed 2 projects contain an `mbed.bld` file or an `mbed-rtos.lib` file or both. Mbed OS 5 projects or later have an `mbed-os.lib` file. Once you have created or imported an Mbed 2 project, delete the `mbed.bld` and `mbed-rtos.lib` files from your project and add the correct `mbed-os.lib` file.
2. Check for compilation errors and try to correct your code to fix errors.

See the following upgrade example. In this example, we use the Mbed 2 Blinky example project that is available in Keil Studio.


Note

Optionally, you can enable the bare-metal profile for your project to use Mbed without an RTOS. See Using the bare-metal profile for more information.

Procedure

1. Select **File** > **New...** > **Mbed Project**.
   The **New Project** dialog box opens.
2. Click the **Example project** drop-down list, then look for the Mbed 2 `mbed2-example-blinky` example and select it.
3. Click **Add project**. Keil Studio creates the project in your workspace.
4. Open the project from the **Explorer** view.
5. Right-click the `mbed.bld` file and select **Delete**.
   Note: If you cannot see the `mbed.bld` file, check that files with this extension are not hidden by default. Go to **File** > **Preferences** > **Open Settings (UI)** and search for the **Exclude** preference. Open the `settings.json` file and check the visibility for `"**/*.bld"` files. The `"files.exclude"` value must be set to `false`.
6. Right-click the name of your project and select **Add Mbed Library** to add the `mbed-os.lib` file.
   The **Add Mbed Library** dialog box opens.
7. In the **URL** field, paste the following URL: https://github.com/ARMmbed/mbed-os (it is the GitHub URL where you can find the Mbed OS source code).
8. Keep `mbed-os` in the **Library Name** field and click **Next**.
9. Select the latest Mbed OS version and click **Finish**.
   Keil Studio imports the `mbed-os.lib` library.
10. Check that an appropriate build target displays in the **Build target** drop-down list. If not, select one.
11. Click the **Build project** (hammer)  button to build the project.
    Two errors display in the **Output** view: `use of undeclared identifier 'wait'`.
12. In the code, replace `wait` by `wait_ns` and `(0.2)` by `(1000)`. `wait` has been deprecated in later versions of Mbed OS.
13. Build the project again. The project now builds successfully.

10. Build and run a project

This chapter describes how to build a project or run a project on a device with Keil Studio.

10.1 Connect your hardware

This section describes how to connect your hardware for the first time.

Procedure

1. Connect your hardware to your computer.
2. Click the **Connected device** area under the **Build target** drop-down list to open the **Device Manager**.
3. Click the **Add Device** button and select the device firmware for your hardware in the dialog box that displays at the top of the window, then click **Connect**.

   Your hardware displays in the **Device Manager** list of devices and appears as connected with a green dot in the **Connected device** area in the **Explorer**. After the first successful connection, Keil Studio automatically detects the hardware.

10.2 Build and run a project on a device

This section describes how to build and run a project.

Procedure

1. Ensure the project you want to build and run is set to active.
   To make the project active, right-click the project name in the **Explorer** view and select **Set Active Project**.
2. Check that an appropriate build target displays in the **Build target** drop-down list. If not, select one.
   The build target tells Keil Studio how to build the RTOS so that it matches your hardware. For Mbed projects, you must manually select an appropriate build target for a given project the first time you work with that project. For standalone CMSIS projects, the build target is automatically selected. For CMSIS solutions, you must manually select a build target.
3. Select one of these options:
   - **Build project**: Build the project, without running it on your device.
     - **Build project** (hammer)  : Checks the `BUILD` subdirectory (where the previous build is stored) and optimizes build time by using as much as it can from the last build. For example, if two consecutive builds are for the same build target, the build rebuilds only the files that actively changed between the two builds, or from the point at which you stopped the previous build attempt.

    - **Clean build** (click the drop-down next to the hammer): Ignore all previous builds. A clean build is slower than reusing a previous build, but guarantees that your build has no old artifacts.

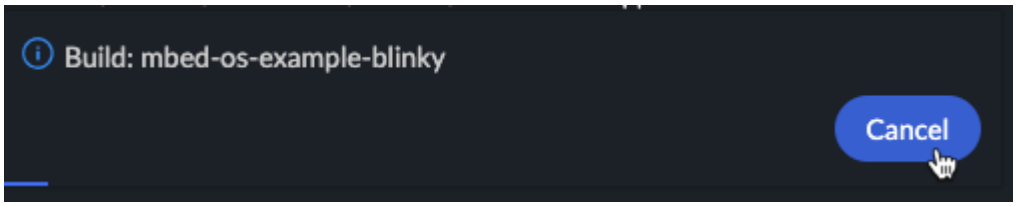
- **Run project**  : If a binary is available, Keil Studio runs the project on the device. If there is no binary, Keil Studio builds the project and then runs it on the device.

For boards with multiple cores: You must select the appropriate processor for your project in the **Select a processor** drop-down list that displays at the top of the window when you click the **Run project** button. Note that the **Select a processor** drop-down list does not display when the **daplink** option is selected for the **Flash Mode** setting (**Run** category) (in **File** > **Preferences** > **Open Settings (UI)**).

Note that there is only one default build profile.

You can stop a build at any time with the **Cancel** button in the notification that displays in the bottom right-hand corner of the screen.

Figure 10-1: Cancel a build



10.3 Output view

The output of a build displays in the **Output** view. This topic describes how you can copy, search the contents of the **Output** view, look for errors and warnings, and clear the **Output** view.

To open the **Output** view, select **View** > **Output**.

To turn auto scrolling off, click this icon  . When the auto scrolling is off, you can read the output or copy content from the output while the build is running and new output content is logged. To turn auto scrolling on again, click the icon one more time.

To copy the output, right-click in the **Output** view and select **Copy** or **Copy All**:

- **Copy**: Copies the line where your cursor is.
- **Copy All**: Copies the whole output.

To search the content of the output, right-click in the **Output** view and select **Find**. When the **Output** view is in focus, you can also go to the **Edit** menu and select **Find**.

Errors display in red and warnings display in yellow. If a link is available, use **Cmd + mouse click** to follow the error or warning to the relevant part of the code.

To clear the build output, click the **Clear Output** icon  or right-click and select **Clear Output**.

10.4 Configuring compile-time customizations

This section describes how to configure compile-time customizations in Keil studio.

For Mbed projects only: The Arm Mbed OS configuration system, a part of the Arm Mbed OS build tools that underpin Keil Studio, customizes compile-time configuration parameters. Each library might define various configuration parameters in its `mbed_lib.json`. The project-level `mbed_app.json` might override the values of these configuration parameters. At compile time, the configuration system gathers and interprets the configurations defined in all `mbed_lib.json` files and the `mbed_app.json` file, and creates a single header file, `mbed_config.h`. In `mbed_config.h`, the defined configuration parameters are converted into C preprocessor macros.

Some examples of configuration parameters:

- The sampling period for a data acquisition application.
- The default stack size for a newly created OS thread.
- The receive buffer size of a serial communication library.
- The flash and RAM memory size of an Mbed target.
- Bare-metal profile and small C-library use.

To use the configuration system, see the Mbed OS documentation about the configuration system.

11. IntelliSense

In this chapter, learn how to quickly navigate your code, how to use the IntelliSense code editing features to update and improve your code, and how to enable and use linting.

11.1 Code editing

Keil Studio provides C and C++ language support using the clangd language server and the Language Server Protocol (LSP). Keil Studio includes various navigation features and IntelliSense code editing features to help you code faster and more efficiently.

The IntelliSense code editing features are available for standalone files or for multiple files, for all your projects.


Note

A build target must display in the **Build target** drop-down list to get all IntelliSense features.

11.1.1 Navigate your code

This section describes how to quickly navigate your code, and how to use the highlighting, in-tool pop up information, and focused-searching functionality in Keil Studio.

Quick file navigation

This section describes how to quickly navigate your files using keyboard shortcuts in Keil Studio.

To follow a link included in your code or find a file where a code element has been defined, hold **Cmd** (macOS) or **Ctrl** (Windows and Linux) and click the link or the code element. The file opens in a new tab and is directly accessible from the **Explorer** view.

Bracket and quote highlighting

By default, the editor highlights the matching brackets or quotes when your cursor is over them. When you type the left bracket or quote, the editor automatically inserts the matching right bracket or quote.

Source hover

Additional information about the code elements you are hovering over in your code displays in a popup.

Go to Declaration and Peek Declaration

To navigate to a declaration, use the **Go to Declaration** and **Peek Declaration** options.

Hover over a code element, right-click, and select one of these options:

- **Go to Declaration**: Opens the header file where the declaration is defined in a separate tab.
- **Peek** > **Peek Declaration**: Takes you to the declaration but the declaration is presented inline.

Go to Definition and Peek Definition

You can navigate to the definition of a code element with the **Go to Definition** and **Peek Definition** options.

Hover over a code element, right-click, and select one of these options:

- **Go to Definition**: Opens the file where the element is defined in a separate tab.
- **Peek** > **Peek Definition**: Takes you to the definition of an element but the definition is presented inline.

Go to Implementations and Peek Implementations

You can navigate to the implementations of an abstract class with the **Go to Implementations** and **Peek Implementations** options.

The **Go to Implementations** and **Peek Implementations** options show the implementations of an abstract class inline (or, if there is only one implementation, the **Go to Implementations** option takes you directly to it).

Go to References and Peek References

You can find the references to a code element throughout all the files of an active project with the **Go to References** and **Peek References** options.

The **Go to References** and **Peek References** options show the code element references inline (or, if there is only one reference, the **Go to References** option takes you directly to the element).

To navigate between references and make edits in the inline editor:

1. Double-click a reference to open the file or files where the code element appears.
2. Hover over the code element, right-click, and select one of the options.

Go to Symbol

This section describes how to use the **Go to Symbol...** option in Keil Studio to perform a symbol-focused search of your code.

To use the **Go to Symbol...** option:

1. Right-click anywhere in the editor and select **Go to Symbol...**. Alternatively, select **Go** > **Go to Symbol in Editor...**.

   The search bar displays the available symbols in the file you are currently working on.
2. Select a symbol to go to that symbol.


Note

You can also search for symbols in the workspace with the **Go** > **Go to Symbol in Workspace** option.

Open the Outline view

The **Outline** view gives you a tree view of the classes, variables, and functions in the current file.

To use the **Outline** view:

1. From the **View** menu, select **Outline** or click the **Outline** button  in the right-hand side of the screen.
2. To navigate through the file, click the elements in the **Outline** view.

In the **Outline** view, orange icons represent classes, white icons represent variables, and purple icons represent functions.

Show AST

You can open an abstract syntax tree with the **Show AST** option in the right-click menu.

The abstract syntax tree opens in the Side bar below the **Project outline**. It shows how the clangd language server parses the code.

11.1.2 Edit and refactor your code

This section describes the auto-completion, renaming, format-correcting, and refactoring functionality that is available in Keil Studio, to help you edit your code.

Auto-completion and signature help

When you start typing a keyword, type, function, variable name, or other project element that Keil Studio recognizes, the editor offers to complete what you are typing. A drop-down list with possible options opens where you can select what you need. The list also shows an icon that represents the code entity of each option (for example namespace, function, class or variable), and signature help for parameters of functions. Clicking the “i” icon gives you more details on each option.

You can trigger auto-complete and help for existing code by pressing **Ctrl+Space**.

Rename an element

If you want to rename an element in your code such as a class, a function, or a variable, use the **Rename symbol** option. This option renames all the occurrences of a symbol in the file you are currently working on.

To find and replace a string everywhere in the file you are currently working on, use the **Change All Occurrences** option.

Code formatting

This topic describes how to change the indentation to format you code correctly.

The **Format Document** and **Format Selection** options allow you to indent your code correctly.

If you select:

- **Format Document**: the indentation corrects in the whole file you are currently working on.
- **Format Selection**: only the line, or lines, of code you selected indent correctly.

To change the indentation:

1. Click the **Spaces** or **Tab Size** option on the right-hand side of the status bar.

   A drop-down list opens at the top of the editor.
2. Select **Indent Using Spaces** or **Indent Using Tabs** in the drop-down list, then select the number of spaces and tabs to use for the indentation.

Fix-its, Peek Problem, and Quick Fix

Fix-its offer suggestions to correct problems in your code, for example a missing bracket or semicolon.

Either:

- To display corrections, click an element underlined with a squiggly line.

  A light bulb icon appears next to the problematic line. Click the light bulb and check the correction suggested. If you are happy with the suggestion, click the popup message.
- Use the **Peek Problem** and **Quick Fix...** options to correct your code. Hover over a red squiggly line in your code to display these options. **Peek Problem** shows the errors inline. **Quick Fix...** operates the same way as fix-its, click the popup message to apply a correction.

Problems view

Keil Studio lists detected problems in your code in the **Problems** view.

To use the **Problems** view:

1. To open the view, go the **View** menu and select **Problems**, or click the **Problems** option in the status bar.
2. To collapse the list of problems in the **Problems** view, click the **Collapse All** icon  .

   You can also close the error messages one by one or click the **Clear All** icon  to clear all the messages at once.

Refactoring

Keil Studio supports refactoring operations such as extract function and extract variable.

You can either use the following steps, or alternatively, you can click the light bulb next to the code you want to refactor.

To refactor your code:

1. Select the source code you want to extract, right-click the code, and select **Refactor...**:
   - If you are extracting a function, an **Extract to function** popup message appears. Source code fragments can be extracted into a new function.
   - If you are extracting variable, an **Extract subexpression to variable** popup message appears. You can create a new local variable for the currently selected expression.
2. To refactor the code, click the popup message for your function or variable extraction.

11.2 Code linting

Linting is the automated checking of your source code for programmatic and stylistic errors. Linting intends to improve the overall quality of your code and make code reviews and tests more efficient.

Keil Studio uses clang-tidy, a clang-based C/C++ linter tool. Clang-tidy is an extensible framework for diagnosing typical programming errors, or style issues (generally anything which can be detected during static analysis of the code). Clang-tidy checks your code as you type and uses squiggly lines to highlight problems and light bulbs to suggest fixes in the editor. The clang-tidy linter checks complement existing IntelliSense capabilities that were already available with Keil Studio and brought by clangd.

11.2.1 Enable clang-tidy

Clang-tidy is not enabled by default. This topic describes how to enable clang-tidy for the active project.

About this task

To enable clang-tidy, create a `.clang-tidy` file in the root folder of the active project.

Procedure

1. From the **Explorer** view, right-click on the active project and select **New File**.
2. In the **New File** dialog box, type `.clang-tidy` and click **OK**.
   Keil Studio creates a `.clang-tidy` file in your project folder.
3. To enable all the default clang-tidy checks in the `.clang-tidy` file, type `Checks: '*'`.

11.2.2 Configure clang-tidy checks

For each of your projects, you can configure the checks that clang-tidy must carry out using a `.clang-tidy` file. You can decide which clang-tidy checks you want to enable or disable and configure advanced custom checks.

11.2.2.1 Enable or disable checks

If you must enable or disable particular checks, use the clang-tidy command-line format in your `.clang-tidy` files. The command-line format specifies a comma-separated list of positive and negative globs: positive globs add subsets of checks, and negative globs (prefixed with –) remove subsets of checks.

For example, to enable `modernize-` checks that advocate usage of modern (currently "modern" means "C++11") language constructs, use:

```
Checks: 'modernize-*'
```

See the Clang-Tidy Checks page for a complete list of available checks. A "Yes" in the **Offers fixes** column indicates that the check is supported. For more general information, see the Clang-Tidy page.

11.2.2.2 Configure advanced custom checks

Shows an example of how to configure advanced custom checks.

In the following example, we enable all checks and provide the additional option to `modernize-use-nullptr`:

```
Checks: '*'
CheckOptions:
- key:             modernize-use-nullptr.NullMacros
  value:           NULL,CUSTOM_NULL
```

For more information, see the official YAML website.

12. Manage files

This chapter describes how to search the content of files, compare, upload, download, and move files in Keil Studio.

12.1 Find a file

This section describes how to find a file in the workspace.

Procedure

1. Go to the **Go** menu and select **Go to File...**.
   A drop-down list displays and shows the recently opened files by default.
2. Type the name of the file you are looking for.
   The list of files is updated as you type.
3. Once you have found your file in the list, click the file to open it in the editor.

12.2 Search the content of files

You can search the content of multiple files for the active project or for a specific folder. You can also search the content of a single file. Keil Studio searches through both saved and unsaved changes.

12.2.1 Search the content of multiple files

This section describes how to search for a term or a regular expression across all files in an active project.

Procedure

1. Click the **Search** icon or go to the **Edit** menu and select **Find in Files**. You can also press **Ctrl +Shift+F** (Windows) or **Cmd+Shift+F** (macOS).
   The **Search** view opens. Enter text in the search box.
2. To search inside a single folder, go to the **Explorer** view, right-click the folder, and select **Find in Folder**.
   The lower part of the view displays the search results, sorted under the files in which they appear.
3. To view only the list of files in which the text you searched for appears, click the **Collapse All** icon  .
   Note: If the **Search** view is hiding the **Explorer** view, you can click the Keil Studio icon, or press **Ctrl+Shift+E** (Windows) or **Cmd+Shift+E** (macOS) to return to it.

Example 12-1: Search examples

- Include or exclude files, folders, and path segments in your search

  To specify which files to include or exclude in your search:

  1. Click the ellipsis (**Toggle Search Details**)  .
  2. In the **files to include** and **files to exclude** search boxes, enter file names, separated by commas, to include or exclude in your search.

     For example, if you enter `resources, sources` in the files to exclude search box, the search excludes all files and folders named `resources` or `sources`.

- Find and replace

  To replace the searched-for text with new text, click the **Toggle Replace** button  , and enter your new text. Note that with the **Edit** > **Replace in Files** option, you can directly open the **Search** view with the **Replace** field visible.

  To replace all instances of the text in all files, click **Replace All**  .

  To replace all instances of the text in a specific file, hover the cursor over the file name in the search results, and click the **Replace All** button that appears near the file name.

12.2.2 Search the content of a specific file

This section describes how to search for a term or a regular expression in a specific file.

Procedure

1. Go to the **Edit** menu and select **Find**. You can also press **Ctrl+F** (Windows) or **Cmd+F** (macOS). A search box opens at the top of the file tab. Enter text in the search box.
2. To do a search on one part of the file only, enter text in the search box, then select the lines you want to check and click the **Find in selection** button  .
3. To replace the searched-for text with new text, click the **Toggle Replace** button  and enter your new text.
   The replace option is also available from **Edit** > **Replace**.
4. To replace a single instance or all instances of the text in the file, click the **Replace**  or the **Replace All**  button.

12.2.3 Include or exclude search patterns

You can include or exclude search patterns in files, folders, and path segments using glob syntax (wildcards). You can also search using regular expressions.

Wildcard	Description
`*`	Matches zero or more characters. For example, `*.html` matches all HTML files.
`[`	Matches zero or more path segments. For example, `tools]{.ui}` matches `tools/python` and `tools/python/Scripts`.
`?`	Matches any single character. For example, `3.?` matches `3.4`.
`[]`	Matches one character in the bracket. For example, `3.[0-9]` matches `3.1` and `3.2`.
`{}`	Matches any of the conditions in the bracket. For example,`{*.html,*.json}` matches all HTML and JSON files.

Regular expression example: With `LED\d`, you can find all instances of the string `LED` followed by a one number character, for example `LED1` and `LED2`.

12.3 Compare files

Keil Studio supports a side-by-side view of files, both for comparing local and remote versions in source control and comparing two local files. You can compare any two files in your workspace, even if they are not in the same project.

Procedure

1. Right-click a file and select **Select for Compare**.
2. Right-click a second file and select **Compare with Selected**.
   Keil Studio displays both files in a single tab, with highlighted differences.

Related information

Compare local and remote versions in Git source control on page 74
Compare local and remote versions in Mercurial source control on page 85

12.4 Upload and download files or projects

This section describes how to upload or download a file or project in Keil Studio.

Procedure

- Either:
  - **Upload**: You can use the **File** > **Upload Files...** option to upload files to the root directory of a project. The option displays in the menu only once you have clicked a project in the **Explorer**. You can also drag and drop files to add them to your project.
  - **Download**: You can download a project or any file in a project with the **File** > **Download Current Selection** option. You can also download the active project with the **File** > **Download Active Project** option.

12.5 Change file locations

Keil Studio puts new files and folders in the root directory. If you move these files to other folders in your project structure, Keil Studio detects the location change and builds your project with the correct file paths.

Procedure

1. To create a folder, either:
   - Right-click the project and select **New Folder**.
   - Go to **File** > **New Folder**.
2. If necessary, you can drag and drop files to move around files.
   Warning: For Mbed projects only - You cannot move the `mbed-os` library; the `mbed-os` library must remain in the root folder.

12.6 Copy the path of a file or folder

You can copy the full or the relative path of a file or folder to the clipboard.

To copy the full path, right-click a file or folder in the **Explorer** view and select **Copy Path**.

To copy the relative path, right-click a file or folder and select **Copy Relative Path**.

13. Source control

This chapter describes how to use Keil Studio with the Git and Mercurial source control technologies. It also describes how to use the **History** view to view your commit history.

13.1 Work with Git

Keil Studio supports the most common Git actions for your projects, including branching, stashing and synching with the remote repository.

The flow of Keil Studio matches the Git flow with the “stage” step:

1. Set a remote repository.
2. Branch.
3. Edit files.
4. Stage changes.
5. Commit.
6. Push.

Before you begin, set your GitHub credentials.

If you are not yet familiar with Git, check Get started with Git.

13.1.1 Get started with Git

If you are new to Git, the official git-scm.com website is a good place to start. You can check the Book and videos available in particular.

You can find other useful videos and content in the Visual Studio Code documentation.

Lastly, if you have not already done so, check our Work with Git source control tutorial to get familiar with the Keil Studio interface. You can learn how to:

- Create a working branch.
- Review code changes in the **Source Control** view.
- Stage, commit, and push your changes.
- Merge your changes into the main branch.

13.1.2 Set credentials for GitHub

Working with Git-based hosting services requires authentication against those services. You can connect to your Git hosting service directly from Keil Studio and link your Arm account and your GitHub account.

Procedure

1. Go to the **User Profile** view, click the **Accounts** icon  in the activity bar and select **Show User Profile**.
2. Click **Connect to GitHub**:
   - If you are already logged into GitHub in your browser, you are directed to a GitHub Application authentication screen where you can authorize the Keil Studio application to connect with your GitHub account. Read the authentication terms, and if you accept the terms, click **Authorize <github-account-name>**.
   - If you are not logged into GitHub in your browser, you are directed to the GitHub login screen. Provide your GitHub credentials and click **Sign in**.

     Next, the GitHub Application authentication screen displays where you can authorize the Keil Studio application to be used with your GitHub account. Read the authentication terms, and if you accept the terms, click **Authorize <github-account-name>**.

   Your browser returns you to the **User Profile** view in Keil Studio. Your GitHub account is now listed in the view, under your Keil Studio account information.

Related information

Manage accounts on page 14
User Profile view on page 14

13.1.3 Interface and features reference

Source control in Keil Studio is handled in two views: The **Source Control** view, for handling the current work, and the **History** view to see previous commits. They always show the active project.

The image highlights:

1. The actions menu.

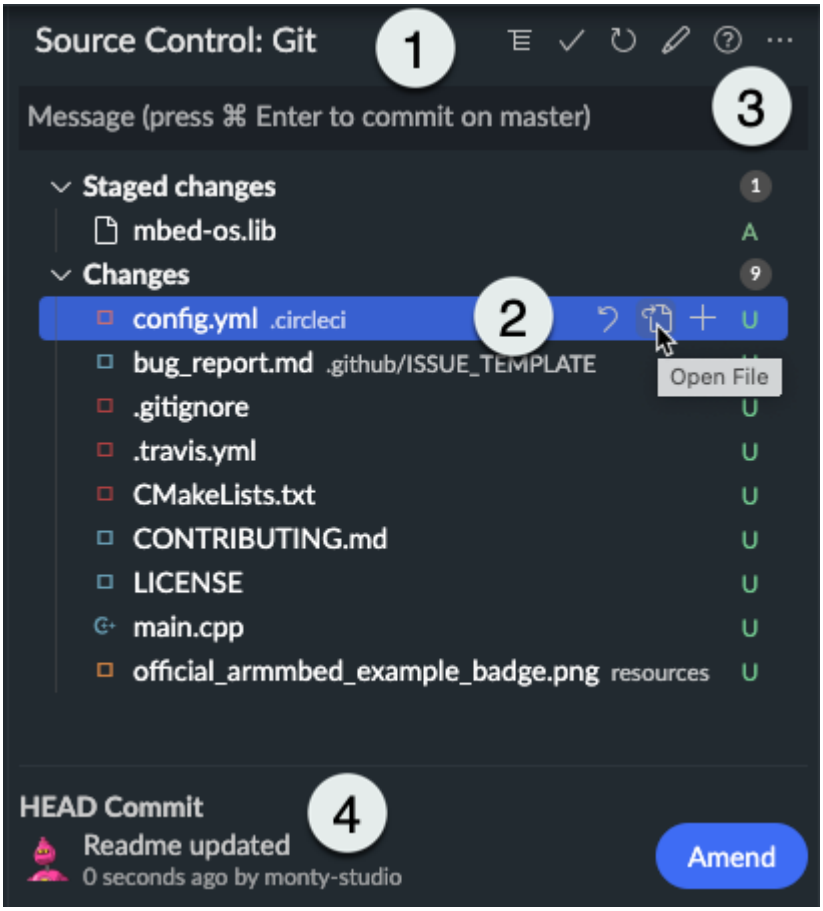
   The following buttons allow you to display your changes as a list or as a tree view:

   - **Toggle to List View** 
   - **Toggle to Tree view** 

   Note the **...** button for more actions.
2. The buttons available on each file when you hover over a file name: Discard Changes, Open File, Stage Changes (**+**), and Unstage Changes (**-**).
3. Nine changed files and one staged file.

4. The last (head) commit.

Figure 13-1: The 'Source Control' view for Git.



Group	Features	Comments
Local changes	Discard all changes	Revert all changed files to their state as of the last time they were pushed (or their starting state if they have never been pushed).
Local changes	Stage changes and Stage all changes	Use the **Stage** option for files you want to add to your next commit. Staging files manually breaks your work into logical units, each in its own commit, rather than having to commit all files together.
Local changes	Unstage changes and Unstage all	Return a staged file, or all staged files, to the **Changes** list.
Local changes	Refresh	Update the list of local changes.
Commits	Commit	Put all staged files into a single record of local changes. The commit is the record you can push to the remote repository.
Commits	Add signed-off-by	Tag your commit and add comments, a signature, the date, and your email. For some projects, it is a requirement for all contributions submitted as pull requests.
Commits	Commit (amend)	Change your last commit (head commit) by amending the message and the content of the commit, or only the content. This option combines your staged changes with the head commit.
Commits	Amend (button)	Change your last commit (head commit) by amending the message and the content of the commit, or only the content. This option combines your staged changes with the head commit.

Group	Features	Comments
Branch management	Branch	Create a new local branch or check out an existing branch. The default branch for a newly set repository is Master.
Branch management	Fetch	Fetch changes from the remote, but do not merge them into the current local branch.
Branch management	Merge	Incorporate changes from another branch into the current branch. For example, add the latest changes from the remote repository to your local copy.
Branch management	Pull	Apply the latest changes from the default remote repository to your local repository (fetch and merge). We recommend pulling only with a clean working copy; if you have any uncommitted local changes, use fetch and merge.
Branch management	Pull from...	Pull from a specific remote, rather than the current one.
Branch management	Push	Send new local commits to the remote.
Branch management	Push to...	Push to a specific remote, rather than the current one.
Stash	Stash	Set aside your changed files. It allows: a) Switching branches without committing local changes; apply the stash when you are ready to go back to the branch. b) Applying work from one branch to another; apply the stash in the new branch.
Stash	Apply latest stash	dd the latest stashed changes to the branch, without clearing the stash.
Stash	Apply stash	Add a specified stash to the branch, without clearing the stash.
Stash	Drop stash	Discard all changes in the stash.
Stash	Pop latest stash	Apply the latest stash and clear the stash.
Stash	Pop stash	Apply a specified stash and clear the stash.
Initialize	Initialize the active project	Turn an unversioned project into a Git repository.
Publish	Publish project > Set remote URL	Publish your new or initialized project to an existing Git remote repository.
Publish	Publish project > Publish to a new GitHub repository	Publish your new or initialized project to a new GitHub remote repository.
Publish	Fork on GitHub	Fork a Git project and publish it to a new GitHub repository.

13.1.4 Configure a project for source control and collaboration

Whether you have decided to work from a new example project, or you have cloned an existing project, several options are available when working with Git in Keil Studio.

For newly created projects (which are not yet configured for source control):

- You can initialize a project for Git, in other words, turn your unversioned project into a Git repository. It means you can work locally on your project and then, when you are ready to share your work with other people, decide to publish your local project to a remote repository.
- You can publish a project right away. Two options are available. You can either:
  - Point to an existing remote repository (without any commits).
  - Publish a new repository on GitHub from Keil Studio.

For cloned projects:

A project cloned from GitHub or another Git hosting service automatically points to the remote repository you cloned the project from. Keil Studio offers you the possibility to fork a cloned project and publish it to your GitHub account in one go.

13.1.4.1 Initialize and publish a project

Learn how to initialize your project for Git and publish your project.

Before you begin

- Your active project must not yet be configured for source control.
- You must connect your GitHub account with Keil Studio. To learn how to connect your GitHub account with Keil studio, see Set credentials for GitHub.

Procedure

1. Go to the **Source Control** view.
   - If you did not previously initialize the project as a Git repository when creating the project, an "Active project is not under version control" message displays.
     a. You can decide to simply initialize the project for Git (turn your project into a Git repository) without publishing it yet. Click the **...** at the top of the **Source Control** view and select **Initialize the Active Project**.
     b. You can also publish the project (it initializes the project for Git and creates a remote repository on GitHub to publish your changes). Click the **Publish Project** button or click the **...** at the top of the **Source Control** view and select **Publish Project**.
   - If the project is already initialized for Git, click the **...** at the top of the **Source Control** view and select **Publish Project**.

     The **Publish** dialog box opens.
2. Use the **Publish** dialog box to publish your repository:
   - To use an existing remote repository (without any commits):
     a. Select the **Set remote URL** radio button and enter a URL for your remote repository. The format can be either SSH (if you have set up an SSH key) or HTTPS. The URL must not contain a branch name. For example, for GitHub:
        - SSH: `git@github.com:user-name/repo-name`
        - HTTPS: `https://github.com/user-name/repo-name`
     b. Click **Set remote repository**.
   - To publish a new repository:
     a. Select the **Publish to a new GitHub repository** radio button and enter a repository name and description.
     b. By default Keil Studio creates a private repository. If you want to create a public repository, clear the **Private repository** checkbox.
     c. Click **Publish**.

Setting a remote repository or publishing a new repository through the UI is only possible once for each new project. Setting a remote repository is not possible for a project you clone from Git. The remote repository is automatically set to the repository you cloned it from.

13.1.4.2 Fork a Git project

Learn how to fork a project cloned from GitHub or another Git hosting service and publish it to your GitHub account in one go.

Procedure

1. In the **Explorer** view, set the project you want to fork as the active project.
2. Move to the **Source Control** view.
3. Click the **...** button and select **Fork on GitHub**.
4. Depending on where the project comes from, Keil Studio forks the project directly or asks you to set up a destination repository.
   - If the project was cloned from GitHub, then Keil Studio forks the project directly. Check your GitHub account.
   - If the project was cloned from another Git hosting service, the **Set Up Destination GitHub Repository** dialog box opens:
     a. Modify the repository name if needed and add a description.
     b. By default Keil Studio creates a private repository. If you want to create a public repository, clear the **Private repository** checkbox.
     c. Click **Next**.

   Keil Studio forks the project and creates a repository in your personal workspace on GitHub.

13.1.5 Create or switch branches

This section describes how to create a branch or switch to a different branch.

About this task

Git uses branches to isolate your work from the work of other people or from code that must remain stable. Keil Studio allows creating branches, and synching the remote and local branches. You can see which branch you are working on from the status bar (when first setting a repository, you are on the master branch by default).

Procedure

1. Click the current branch in the status bar.
   The available branches are listed at the top of the window.
2. Create or switch:
   - To create a branch: Select **Create new branch...** and enter a name to create a branch.

     The name of the new branch must not contain spaces.

The branch is created locally; the branch publishes to the remote repository the first time you push from the branch.

- To switch to a different branch, search for and select an existing branch in the list.

13.1.6 Manage local files

This section describes the different options to manage your local files and explains how to update the remote.

13.1.6.1 File statuses

Statuses display to the right of each file to indicate changes.

- **U**: Untracked - a new file in the **Changes** list (not yet staged).
- **A**: Added - a new file in the **Staged changes** list.
- **M**: Modified - an existing file in either the **Changes** or **Staged changes** list.
- **D**: Deleted - a deleted file.
- **C**: Merge Conflict - you must resolve the merge conflict before you can push.

13.1.6.2 View changes

This section describes how to view the changes you have made to a file in Keil Studio.

Procedure

- To view the changes you have made to a file, double-click its name. The file opens.

  The changes open in a new tab, comparing what was available in the file before the changes and what has changed.

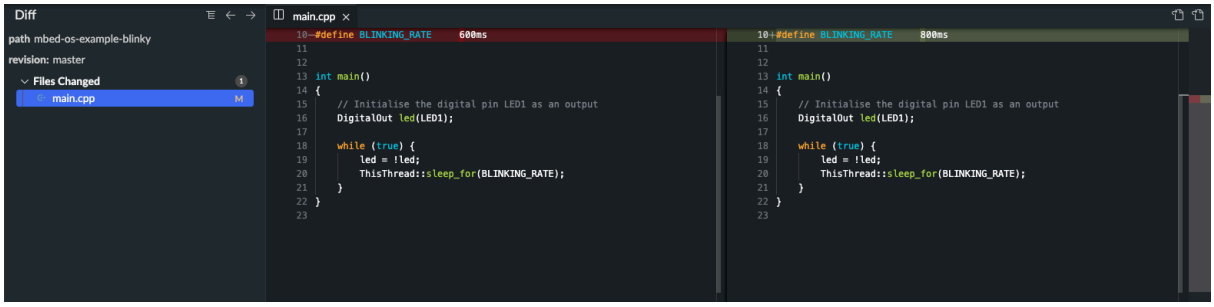
Figure 13-2: Double-click a file to view its side-by-side comparison

- To compare the same file or folder across multiple Git branches, right-click a file or folder and select **Compare With**. Keil Studio shows a list of available branches. Select a branch.

  If you compare a single file, Keil Studio opens a diff view of that file.

  If you compare an entire folder, Keil Studio opens a tab listing all the files. To open a diff view, click a file:

  Figure 13-3: List of files changed in the folder



Next steps

You can open the file for editing by clicking the **Open File** icon in the top right-hand corner of the screen.

Go back to the changes by clicking the **Open Changes** icon.

Note that you can open several files at once for editing: hold **Shift** or else **Cmd** (macOS) or **Ctrl** (Windows and Linux) and select the files, then right-click and select **Open File**.

When in the editor, if there are changes to a file, the **Open Changes** icon is also available when you open the file.

13.1.6.3 Stage, commit, and push changes

This section describes how to stage, commit, and push changes in Keil Studio.

About this task

Use **staging** to manually control which of your edited files are added into each commit. It breaks your work into logical units, each in its own commit, rather than having to commit all files together. You can always remove a file from the **Staged changes** list, and later add it to a different commit. When you are ready, commit and push your changes.

Procedure

1. In the **Source Control** view, all new and modified files are listed under **Changes**.
2. Hover your mouse over the file you want to commit and click **+** to stage your changes. The file is listed under **Staged changes**. To stage several files at once, hold **Shift** or else **Cmd** (macOS) or **Ctrl** (Windows and Linux) and click the files you want to stage, then click **+**.
3. In the **Message** box, enter a commit message for the staged changes.

4. Click **Commit** or **Commit (Signed Off)**.
   The committed changes are visible at the bottom of the **Source Control** view, and in the **History** view.
5. To push the commit to the remote branch, click **...** > **Push**.
   Note:
   - To stage or unstage one or several files, you can also select the file or files, right-click, and select **Stage Changes** or **Unstage Changes**.
   - If you try to push your changes to a repository on which you do not have permission, you will get an error message with a **Fork on GitHub** button. Click this button to fork the repository and then try to push your changes again. See also Fork a Git project.
   - If you try to push your changes to a repository on which you do not have permission and a fork already exists, you will get an error message with a **Set Fork as Default** button. Click this button to use your fork and then try to push your changes again.

13.1.6.4 Amend local commits

Before pushing to the remote to share your work with others, you can rewrite local commits.

To rewrite local commits, you can:

- Add, update, or remove files in your last commit and change the commit message.
- Change multiple commits at once.

If you have already pushed your changes to the remote and notice that something is not quite right, you can still fix your commits, and force push the changes. However, you must be absolutely certain that nobody has pushed commits to the remote before doing a force push because force pushes overwrite commits.

13.1.6.4.1 Change the last commit

This section describes how to change your last commit in Keil Studio.

About this task

With the **Commit (amend)** option, you can amend your most recent commit and change the content of the commit by adding, updating, or removing files. You can also optionally change the commit message.

Procedure

1. Stage the files that you want to include in your last commit.
   Note: To remove a file from your last commit, first delete it from the **Explorer** view (the file appears as deleted **D** in the **Changes** list), then stage the deleted file.
2. Click **...** > **Commit (amend)**.
3. Add a commit message in the message box that opens. Or, to reuse the last commit message and only update the content of the commit, press **Enter**.

13.1.6.4.2 Change multiple commits

This section describes how to change multiple commits in Keil Studio.

About this task

With the **Amend** button, you can roll back several commits to reset your head commit to a prior state. The changes done between the original head commit and the current head commit are staged. This way you can add, modify, or remove files and stage new changes.

Procedure

1. Click the **Amend** button for each commit that you want to amend.
   All the changes you had committed are staged. You can decide which changes to stage or unstage and combine commits.

   Use the **Unamend** button if you change your mind and prefer to keep a commit untouched. This resets the head commit to the commit you have just "unamended". If there are several commits to "unamend", click **Unamend all commits** (**-**).
2. Once you are happy with the changes, in the **Message** box, enter a commit message for the staged changes.
3. Click **Commit** or **Commit (Signed Off)**.

Results

The changes commit and the commit can be seen at the bottom of the **Source Control** view, and in the **History** view. In the **History** view, you can see that the amended commits are replaced by the new commit.

You can clear all the commits in the **Commits being amended** list at once with the **Clear amending commits** (**x**) button. The files staged while amending the commits remain in the **Staged changes** list.

13.1.6.5 Ignore files

To keep your file list tidy and navigable, you can exclude files from the **Source Control** view. For example, by default Keil Studio does not list any Mbed OS files.

Use `.gitignore` to list the files you want to exclude. The `.gitignore` file exists by default in all Mbed projects, and is visible and editable in Keil Studio.

For more information about how `.gitignore` files work and how to use them, see the Ignoring Files chapter on git-scm.com.

13.1.7 Synchronize

If the remote repository has changed since you last pulled, you must synchronize your local copy before you can push any of your own changes to the remote.

The **Synchronize Changes** indicators on the left-hand side of the status bar show:

- How many changes have been pushed to the remote repository since your last pull.
- How many commits you have on your local copy.

The **Synchronize Changes** indicators are also a button that displays the available synchronization options.

Synchronization options

Keil Studio offers three synchronization options. Each one combines different Git operations to automatically manage the changes.

To display the available options, click the **Synchronize Changes** button:

- **Pull and push commits from and to 'origin/<branch name>'**: Apply the latest changes from the remote repository to your local repository by doing a pull (fetch and merge), then push your changes to the remote repository. This option might generate merge conflicts.
- **Fetch, rebase, and push commits from and to 'origin/<branch name>'**: Put aside the local changes, fetch the remote changes to bring the local up to date, reapply your local changes, and push to the remote. The rebase option compresses all the changes into a single "patch" to integrate with the remote branch. This option might generate merge conflicts.
- **Force push commits to 'origin/<branch name>'**: Overwrite the remote branch with your local branch, regardless of the status of that remote branch.

Resolve merge conflicts

Synchronizing remote and local changes by pulling or rebasing can lead to merge conflicts when a single file has been edited in both locations. Merge conflicts can also happen when you apply or pop a stash, if the stash contains changes that contradict further work on the branch.

By default, when Git sees a conflict between two branches being merged, Git:

1. Adds merge conflict markers, **<<<<<<< ======= >>>>>>>**, into your code.
2. Marks the file as conflicted.
3. Lets you resolve the merge conflicts.

The top half of a conflict is the branch you are merging into, and the bottom half is from the commit that you are trying to merge in.

So, for example, if you pull (fetch and merge):

- The top half shows your local changes.
- The bottom half shows the remote changes which you were trying to merge in.

To resolve a conflict, you have to decide which part you want to keep or merge the contents yourself, and then remove all the merge conflict markers. Once you are happy with the corrections on a given file, click **+** to stage your changes.

For more information about merge conflicts, see the About merge conflicts page of the GitHub Help.

13.2 Work with Mercurial

Keil Studio supports the most common Mercurial actions for Mbed projects hosted on os.mbed.com, including branching and synching with the remote repository.

The Mercurial flow in Keil Studio:

1. Set a remote repository.
2. Branch.
3. Track files.
4. Edit files.
5. Commit.
6. Push.

Before you begin, check the Credentials section.

13.2.1 Credentials

For Mercurial, on any operating system, your credentials are taken from the Arm account with which you logged into Keil Studio. You can work with all public repositories, and any private repository to which you have access through os.mbed.com.

Keil Studio supports Mercurial repositories from os.mbed.com only.

13.2.2 Interface and features reference

Source control in Keil Studio is handled in two views: The **Source Control** view, for handling the current work, and the **History** view to see previous commits. Both views always show the active project.

The image highlights:

1. The actions menu.

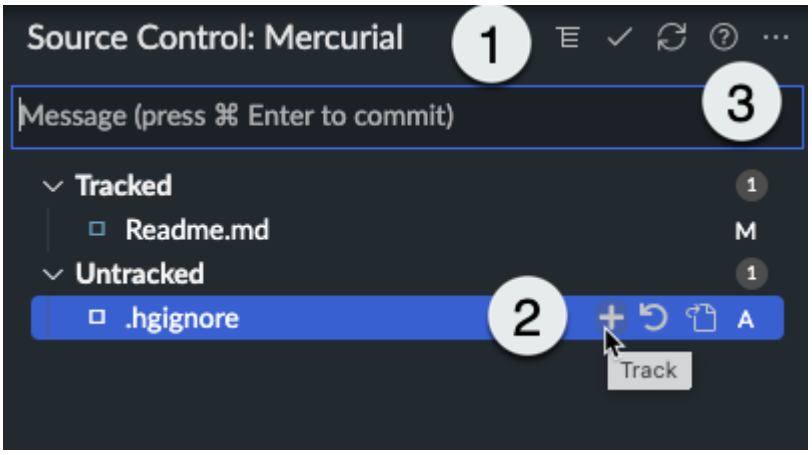
The following buttons allow you to display your changes as a list or as a tree view:

- **Toggle to List View**:
- **Toggle to Tree view**:

Note the **...** button for more actions.

2. The buttons available on each file when you hover over a file name: Track (**+**), Untrack (**-**), Discard Changes, and Open File.
3. One tracked file - a **Modified** (M) file, which had already been committed to Mercurial once and has changed since it was committed. One untracked file - an **Added** (A) file, which has not been committed yet.

Figure 13-4: The 'Source Control' view for Mercurial



Group	Features	Comments
Local changes	Track and Track all files	Use the **Track** option to monitor the files for changes. A tracked file with changes is automatically added to a commit. You can move files back to the **Untracked** list only if you have never committed them (these files are marked with "A", for "Added"). Once you commit files, they remain tracked.
Local changes	Discard all changes	Revert all changed files to their state as of the last time they were pushed (or their starting state if they have never been pushed).<
Local changes	Refresh	Update the list of local changes.
Commits	Commit	Put all tracked files into a single record of local changes. The commit is the record you can push to the remote repository.
Branch management	Branch	Create a new local branch or checkout an existing branch. The default branch for a newly set repository is "default".
Branch management	Pull	Apply the latest changes from the default remote repository to your local repository (pull and merge).
Branch management	Push	Send new local commits to the remote.
Branch management	Push to...	Push all branches to a specific remote, rather than the default remote.

Group	Features	Comments
Branch management	Merge heads	Merge two or more heads of a branch into a single head.
Publish	Set remote URL	Publish your new project to an existing Mercurial remote repository.
Publish	Convert to a Git Repository and Fork on GitHub	Convert your Mercurial project to a Git project and publish it to a new GitHub repository.

13.2.3 Configure a project for source control and collaboration

For newly created projects (which are not yet configured for source control):

You must manually set the remote repository for a given project (that is to say point to an existing remote repository without any commits). You must create remote repositories directly through os.mbed.com.

For cloned projects:

A project cloned from Mercurial automatically points to the remote repository you cloned the project from. With Keil Studio, you can convert a project cloned from Mercurial to Git and publish the converted project to your GitHub account in one go.

13.2.3.1 Set a remote repository

Learn how to set a remote repository.

Before you begin
Your active project must not yet be configured for source control.

Procedure
1. Initialize the project for source control:
   a. Go to the **Source Control** view.
   b. Click the **Set remote URL** button.

      The **Set Remote URL** dialog box opens.
   c. Enter a URL for your remote repository.

      Note: The URL must not contain a branch name.
2. Set a remote repository. Click **Set remote repository**.
   Setting a remote repository through the UI is only possible once for each new project.

13.2.3.2 Convert a Mercurial project to Git

Learn how to convert a project cloned from Mercurial to Git and publish the converted project to your GitHub account in one go.

Procedure

1. In the **Explorer** view, set the project you want to convert as the active project.
2. Move to the **Source Control** view.
3. Click the **...** button and select **Convert to a Git Repository and Fork on GitHub**.
   The **Set Up Destination GitHub Repository** dialog box opens.
4. Modify the repository name if needed and add a description.
5. By default Keil Studio creates a private repository. If you want to create a public repository, clear the **Private repository** checkbox.
6. Click **Next**.
   The **Match authors to GitHub users** dialog box opens.
7. This step is not mandatory, but Arm recommends including the GitHub username of each contributor to the project (or alternatively providing their GitHub email address). Including the GitHub username of each contributor preserves the commit history of the project you are converting.
8. Click **Migrate now**.
   Keil Studio converts the project to Git and creates a repository on GitHub.

13.2.4 Create or switch branches

This section describes how to create a branch or switch to a different branch in Keil Studio.

About this task

Mercurial uses branches to isolate your work from the work of other people or from code that must remain stable. Keil Studio allows creating branches, and synching the remote and local branches. You can see which branch you are working on from the status bar (when first setting a repository, you are on the “default” branch by default).

Procedure

1. Click the current branch in the status bar.
   The available branches are listed at the top of the window.
2. Create or switch:
   - To create a branch: Select **Create new branch...** and enter a name to create a branch.

     The name of the new branch must not contain spaces.

     The branch is created locally; the branch publishes to the remote repository the first time you push from it.
   - To switch to a different branch, search for and select an existing branch in the list.

13.2.5 Manage local files

This section describes the different options to manage your local files and explains how to update the remote.

13.2.5.1 File statuses

Statuses display to the right of each file to indicate changes.

- **A**: Added - a new file in either the **Tracked** or **Untracked** list.
- **M**: Modified - an existing file in the **Tracked** list.
- **D**: Deleted - a deleted file.
- **C**: Merge Conflict - you must resolve it before you can push.

13.2.5.2 View changes

This section describes how to view the changes previously made to a file.

Procedure

- Either:
  - Double-click its name to open the file.

    The changes open in a new tab, comparing what was available in the file before the changes (in red) and what has changed (in green).

    Figure 13-5: Double-click a file to view its side-by-side comparison

  - Open the file for editing by clicking the **Open File** icon in the top right-hand corner of the screen. Go back to the changes by clicking the **Open Changes** icon.

    When in the editor, if there are changes to a file, the **Open Changes** icon is also available when you open the file.

13.2.5.3 Track, commit, and push changes

This section describes how to track, commit, and push changes in Keil Studio.

Procedure

1. In the **Source Control** view, all new files are listed under **Untracked**.
   Files that have already been committed once are automatically shown in the **Tracked** list when you modify them.
2. Hover your mouse over the file you want to commit and click **+** to track your changes. The file is listed under **Tracked**.
3. In the **Message** box, enter a commit message for the tracked changes.
4. Click **Commit**.
   The committed changes can be seen in the **History** view.
5. To push the commit to the remote branch, click **...** > **Push**.
   Note: To track or untrack one or several files, you can also select the file or files, right-click, and select **Track** or **Untrack**.

13.2.5.4 Ignore files

You can exclude files from the **Source Control** view to keep your file list tidy and navigable. For example, by default Keil Studio does not list any Mbed OS files.

Use `.hgignore` to list the files you want to exclude. The `.hgignore` file exists by default in all Mbed projects, and is visible and editable in Keil Studio.

For more information about how `.hgignore` files work and how to use them, see the Mercurial documentation.

13.2.6 Synchronize

If the remote repository has changed since you last pulled, you must synchronize your local copy before you can push any of your own changes to the remote.

Resolve merge conflicts

Synchronizing remote and local changes can lead to merge conflicts when a single file has been edited in both locations.

By default, when Mercurial sees a conflict between two branches being merged, Mercurial:

1. Adds merge conflict markers, **<<<<<<< ======= ||||||| >>>>>>>**, into your code.
2. Marks the file as conflicted.
3. Lets you resolve the merge conflicts.

The top half of a conflict is the branch you are merging into. The bottom half is from the commit that you are trying to merge in.

So, for example, if you pull (pull and merge):

- The top half shows your local changes and your base version (after the ||||||| markers).
- The bottom half (after the ======= markers) shows the remote changes which you were trying to merge in.

To resolve a conflict, you must decide which part you want to keep or merge the contents yourself, and then remove all the merge conflict markers. Once you are happy with the corrections on a given file, click **+** on the file entry in the **Merge changes** list to resolve the conflict and move the file to the **Tracked** list.

For more information about merge conflicts with Mercurial, see the Tutorial - Merging conflicting Changes.

13.3 History view

The **History** view shows your commit history.

To view the changes that have been made for a given commit, click the eye icon  . The commit info includes the commit message, date, and a list of changed files.

To see the details of the changes on a given file, double-click the file. The changes open in a new tab.

14. Monitor and debug

This chapter describes the **Serial Monitor** view, and how to debug supported development boards in Keil Studio.

14.1 Use the Serial Monitor view

The **Serial Monitor** view displays the output of your board.

If it is the first time you are connecting your hardware, follow these steps:

1. Connect your hardware over USB.
2. Click the **Connected device** area under the **Build target** drop-down list to open the **Device Manager**.
3. Click the **Add Device** button and select the device firmware for your hardware in the dialog box that displays at the top of the window, then click **Connect**.

   Your hardware displays in the **Device Manager** list of devices and appears as connected with a green dot in the **Connected device** area in the **Explorer**. After the first successful connection, Keil Studio automatically detects the hardware.

If you are having trouble getting serial output, try disconnecting and reconnecting the board.

You can only have one **Serial Monitor** view open for each connected board. Before you open an external serial monitoring program, close the **Serial Monitor** view for your board in Keil Studio.

14.1.1 Access the Serial Monitor view after a first successful connection of your board

To open or reopen the **Serial Monitor** view, choose one of the following options.

Procedure

1. Choose one of the following options:
   - From the **Explorer** view, click the **Open serial monitor** button  .
   - From the **Device Manager**, hover over the device for which you want to open a serial monitor and click the **Open Serial** icon  .
2. Select a serial port in the dialog box that displays at the top of the window, then click **Connect**. A drop-down list displays at the top of the window where you can select a Baud rate. The Baud rate is the data rate in bits per second between your computer and your device. To view the output of a device correctly, you must select an appropriate Baud rate. The Baud rate you select must be the same as the Baud rate of your active project.
3. Select a Baud rate.

The **Serial Monitor** view opens with the Baud rate selected.

Next steps

If you need to modify the baud rate, follow the steps below:

1. Click the **Change active device Serial baud rate** icon in the status bar and select a baud rate in the drop-down list.

   Figure 14-1: Change active device Serial baud rate icon

2. Select again a serial port in the dialog box that displays at the top of the window, then click **Connect**.

14.2 Debug a project with Keil Studio

This section describes the debugger mode and debugging tools available in Keil Studio.

14.2.1 Introduction

You can step debug a project on any connected board that supports a WebUSB-enabled CMSIS-DAP interface or an ST-LINK interface. The debugger mode provides different ways of checking what your code is doing while it runs. You can step through your code, examine the execution path of your code, or look at the values stored in variables, and more.

The section explains how to debug with development boards that are automatically detected and configured. For more information about supported hardware, see Supported development boards and Supported debug probes.

Note

Debugging features are not available for Mbed 2 projects. Arm recommends that you upgrade to Mbed OS 5 or 6 to benefit from all the features. See Upgrade from Mbed 2 to Mbed OS 5 or 6 for more details.

14.2.2 Debug first steps

This section explains how to start a debug session.

Before you begin

If you are experiencing problems running an Mbed project on an ST board, set the **Connect Mode** preference to **underReset** to be able to run the project and do debugging. See Advanced debugger settings for more details on the different connect modes.

Procedure

1. Set the project you want to debug as the active project.
2. Connect your hardware over USB.
3. If it is the first time you are connecting your hardware, follow these steps:
   a. Click the **Connected device** area under the **Build target** drop-down list to open the **Device Manager**.
   b. Click the **Add Device** button and select the device firmware for your hardware in the dialog box that displays at the top of the window, then click **Connect**.

   Your hardware displays in the **Device Manager** list of devices and appears as connected with a green dot in the **Connected device** area in the **Explorer**. After the first successful connection, Keil Studio automatically detects the hardware.
4. Check that an appropriate build target displays in the **Build target** drop-down list. If not, select one.
5. Click the debug button  .
   Keil Studio automatically builds and runs your project on the connected board. The **Debug** view displays and the debug session starts. The debugger stops at the function “main” of your application.

14.2.3 Restart or stop the debugger

This section explains how to restart or stop the debugger.

Procedure

- To restart the debugger, click the **Restart** button  .
  - If you click the **Restart** button when the debugger is running, the debugger continues to run until a breakpoint is hit or until you click **Pause**.
  - If you click the **Restart** button when the debugger is paused, the debugger starts to debug the code from the start. Restarting from a paused state is faster than stopping the debugger and initiating a new debug session from the **Explorer** view.
- To stop the debugger and return to the editor, click the **Stop** button  .

14.2.4 Navigate your code using the step buttons

There are several options available to help you navigate your code quickly.

- **Step over**  : Advance the debugger to the next source line that follows in the program execution to go straight to the parts of code you are more interested in.
- **Step into**  : Advance the debugger into each function. The debugger then breaks on the first line that gets executed in the function.

- **Step out**  : Advance the debugger until the current function returns (in other words, advance all the way through the current function).

Note that **Step over** and **Step out** operations halt on breakpoints.

14.2.5 Set breakpoints

Breakpoints are useful when you know which part of your code must be examined. To look at values of variables, or to check if a block of code is getting executed, you can set one or more breakpoints to suspend your running code.

Before you begin

By default, Keil Studio stops on the first line of `main()`. To change this default behavior, select **File** > **Preferences** > **Open Settings (UI)** and search for **Run To Main** in the **Debug** category. To keep the program running until the first user breakpoint, clear the checkbox.

Procedure

1. Click the margin to the left of a line of code in the editor. A red dot displays. You can also right-click the margin and select **Add Breakpoint**.
2. To start debugging, click the **Continue** button  .
   The debugger runs to the first breakpoint it encounters and stops. A yellow arrow displays next to the statement on which the debugger paused. The statement highlights in yellow.

Next steps

- Once you have set a breakpoint, you can remove the breakpoint, or disable and enable the breakpoint again. Right-click the breakpoint and select **Remove Breakpoint** or **Disable Breakpoint** (or **Enable Breakpoint** if the breakpoint is disabled). You can also remove a breakpoint by clicking that breakpoint in the margin.
- To remove, or disable, and enable breakpoints, more options are available from the **Breakpoints** list:
  - **Activate/Deactivate Breakpoints**  : Activate or deactivate all breakpoints at once. Activating or deactivating breakpoints does not change the enable or disable state of each breakpoint.
  - **Remove All Breakpoints**  : Remove all breakpoints at once.
  - When you right-click a breakpoint from the list, the following options are available: **Remove Breakpoint**, **Remove All Breakpoints**, **Enable All Breakpoints**, **Disable All Breakpoints**.
  - To disable or enable a breakpoint, select the checkbox next to the breakpoint in the list.

14.2.6 Set function breakpoints

With function breakpoints, you can break execution when a function is called. Breaking execution is useful, for example, when you know the function name but not the functions location.

Procedure

1. Click the **Add Function Breakpoint** button  in the **Breakpoints** list.
   The **Add Function Breakpoint** dialog box opens.
2. Type the name of the function you are looking for (function names are case-sensitive) and click **OK**.

14.2.7 Examine threads and call stacks

You can examine and work with threads in the code that you are debugging. Working with threads is useful for debugging multithreaded applications. Each thread appears on a separate row in the **Threads** list and has a call stack. In the current version of Keil Studio, only one thread displays in the **Threads** list (**Main**).

Procedure

- When you select the **Main** thread, the call stack displays in the **Call Stack** list. The call stack shows the order in which methods and functions are called. The call stack list is a good way to examine and understand the execution flow of your code.
- When you right-click the **Main** thread, the following options are available:
  - When the debugger is paused, click **Continue**, **Step over**, **Step into** or **Step out** to navigate the code.
  - When the debugger is running, click **Pause** to pause the debugger.
- When you right-click a call stack from the **Call Stack** list, the **Copy Call Stack** option becomes available. The **Copy Call Stack** option allows you to copy a call stack to the clipboard to further investigate a problem.

14.2.8 Inspect variables

You can inspect variables and check if they are storing the values you expect. If you find an incorrect value, find out where it was set (you might have to restart the debugger, look at the call stack, or both).

Local variables, global variables, and function arguments are shown in the **Variables** list.

When the debugger is paused, to see a properties current value, hover over the object with your cursor. You can also view variable values in the **Variables** list.

The value **<not in scope>** means that a variable is known but is not visible at the current location of the program.

Global variables are grouped by modules (compilation units) in the **Variables** list under the **Global** entry. Modules display as `<file_name>: <{alias}/file_path>`. Where alias is either `{cmsisPacks}` or `{workspace}`. To see the global variables defined for a module, click that module.

Only modules with global variables are visible.

You can display variable values inline in the editor with the **Inline Values** setting. Go to **File** > **Preferences** > **Open Settings (UI)** and search for **Inline Values** in the **Debug** category.

When the debugger is paused, you can copy the value of a variable. From the **Variables** list, right-click a variable and select **Copy Value**.

Double-click an entry in the **Call Stack** list to see the **Local Variable** values for that entry.

14.2.9 Inspect registers

The **Registers** list displays register contents for the detected CPU.

The following tables provide register details for the Armv6, Armv7, and Armv8 architectures.

Armv6

Register category	Description
Core	Shows the CPU core registers (R0 to R15) and the processor status register (xPSR). Note that R13 (SP) means current Stack Pointer, R14 (LR) means Link Register, R15 (PC) means Program Counter.
Banked	Shows the Main Stack Pointer (MSP) and Process Stack Pointer (PSP). Depending on the currently active stack pointer of the CPU, R13 (SP) either shows the value of MSP or PSP. See the **Status** category below.
System	Shows more CPU register values (BASEPRI, PRIMASK, FAULTMASK, CONTROL).
Status	Shows CPU state details. **Mode** can be “Thread” or “Handler”. **Privilege** shows the CPU code execution and can be “Privileged” or “Unprivileged”. **Stack** shows the currently selected stack pointer (MSP or PSP).

Armv7

Register category	Description
Core	Shows the CPU core registers (R0 to R15) and the processor status register (xPSR). Note that R13 (SP) means current Stack Pointer, R14 (LR) means Link Register, R15 (PC) means Program Counter.
Banked	Shows the Main Stack Pointer (MSP) and Process Stack Pointer (PSP). Depending on the currently active stack pointer of the CPU, R13 (SP) either shows the value of MSP or PSP. See the **Status** category below.
System	Shows more CPU register values (BASEPRI, PRIMASK, FAULTMASK, CONTROL).

Register category	Description
Status	Shows CPU state details. **Mode** can be “Thread” or “Handler”. **Privilege** shows the CPU code execution and can be “Privileged” or “Unprivileged”. **Stack** shows the currently selected stack pointer (MSP or PSP).
FPU	FPU (Floating-Point Unit) is only shown if the Floating Point (FP) extension is enabled. Shows FP extension registers: thirty-two 32-bit single-precision registers (S0 to S31) and sixteen 64-bit double-precision registers (D0 to D15). Also shows selected bits of the Floating-Point Status and Control Register (FPSCR). See the ARMv7-M Architecture Reference Manual for more details on FPSCR. Values are shown in both binary and numeric format.

Armv8

Register category	Description
Core	Shows the CPU core registers (R0 to R15) and the processor status register (xPSR). Note that R13 (SP) means current Stack Pointer, R14 (LR) means Link Register, R15 (PC) means Program Counter.
Banked	Shows the Main Stack Pointer (MSP) and Process Stack Pointer (PSP). Depending on the currently active stack pointer of the CPU, R13 (SP) either shows the value of MSP or PSP. See the **Internal** category below. Shows also special-purpose registers: PRIMASK, BASEPRI, and FAULTMASK (Mask registers), and CONTROL. MSPLIM and PSPLIM (Main and Process stack pointer Limit registers) can also display depending on the CPU.
FPU	FPU (Floating-Point Unit) is shown if only the Floating Point (FP) extension is enabled. Shows FP extension registers: thirty-two 32-bit single-precision registers (S0 to S31) and sixteen 64-bit double-precision registers (D0 to D15). Also shows selected bits of the Floating-Point Status and Control Register (FPSCR). See the Armv8-M Architecture Reference Manual for more details on FPSCR. Values are shown in both binary and numeric format.
FPU-MVE	This category is only shown if the MVE (M-Profile Vector Extension) is enabled (not the FP extension). MVE uses registers of the FP extension.
MVE	This category is shown when both the FPU and MVE extensions are enabled. The MVE extension provides operations on various SIMD data types.
Secure	This category is only shown when the Security (TrustZone) extension is enabled. When the core is in Secure state, it can access both Secure and Non-secure memories. If the Security extension is enabled, the processor starts up in Secure state.
Non-Secure	This category is only shown when the Security (TrustZone) extension is enabled. When the core is in Non-secure state, it can access Non-secure memories only.
Internal	Shows CPU state details. **Mode** can be “Thread” or “Handler”. **Privilege** shows the CPU code execution and can be “Privileged” or “Unprivileged”. **Stack** shows the currently selected stack pointer (MSP or PSP).

14.2.10 Check peripherals

Silicon vendors provide System View Description (CMSIS-SVD) files, which describe the peripheral registers of devices. Silicon vendors distribute their descriptions as part of CMSIS Device Family Packs (DFP). Keil Studio uses CMSIS-SVD files in the background to display peripheral details. For more information on SVD, see the official CMSIS-SVD documentation.

The **Peripherals** list shows information about the peripheral registers of your device during a debug session.

From this list, you can:

- View peripheral register property values.
- View additional information about a given property when you hover over it.

- Copy property values with the **Copy Value** button  .
- Change property values at runtime with the **Update Value** button  .

There are also options to pin a peripheral register to the top of the list  or refresh property values  .

14.2.11 Debug with an Arm Mbed LPC1768 board

If you are using an LPC1768 board, you must update the firmware of your board to the latest version and add some configuration in your project before being able to do debugging.

Procedure

1. Connect your board to your computer.
2. If it is the first time you are connecting your board, follow these steps:
   a. Click the **Connected device** area under the **Build target** drop-down list to open the **Device Manager**.
   b. Click the **Add Device** button and select the device firmware for your board in the dialog box that displays at the top of the window, then click **Connect**.

      Your board displays in the **Device Manager** list of devices and appears as connected with a green dot in the **Connected device** area in the **Explorer**.

      After the first successful connection, Keil Studio automatically detects the board.
3. Set the project you are working on as active and ensure the correct build target is selected in the **Build target** drop-down list.
4. Download the latest firmware from the Firmware LPC1768 LPC11U24 page and follow the instructions on that page to update the firmware of your board (power-cycle the board).
5. Create an `mbed_app.json` file at the root of the project.
6. Add the following configuration in the `mbed_app.json` file:

```
{
    "target_overrides": {
        "LPC1768": { "target.device_has_remove": ["SEMIHOST",
 "LOCALFILESYSTEM"] }
    }
}
```

7. Save the file.
8. Click the debug button,  .
   Keil Studio automatically builds and runs your project on the LPC1768 board. The **Debug** view displays and the debug session starts. The debugger stops at the function “main” of your application.

14.2.12 Advanced debugger settings

The following tables describe advanced settings for the debugger. The settings are available in the **Debug** or **Run** categories in **File** > **Preferences** > **Open Settings (UI)**.

Most of the settings in the **Debug** and **Run** categories are related to how Keil Studio connects to and resets a board, and how the flash download of code works.

For flash download, you can either:

- Use DAPLink (**daplink** option for the **Flash Mode** setting in the **Run** category). In this case, the DAPLink firmware takes care of the flash download.
- Use a WebUSB-enabled CMSIS-DAP firmware or an ST-LINK firmware (**cmsis** option). In this case, flash algorithms contained in the CMSIS-Pack that is used in your project are deployed in the background to do the flash download. You can refine how the debugger behaves by selecting your preferred options.

See the CMSIS-Pack documentation for more information on flash programming algorithms.

There are also options to change how panels display in the user interface in the **Debug** category.

Connection and flash download options in the **Debug** category:

Setting	Description
Connect Mode	Controls the operations that are executed when the debugger connects to the board. The options are: • auto (default): The debugger decides which connect mode to use based on the connected device. For ST boards, when auto is selected, underReset is used. For other boards, haltOnConnect is used. • haltOnConnect: Stops the CPU of the board for a reset before the flash download or the debug session. • underReset: Asserts the hardware reset during the connection. • preReset: Triggers a hardware reset pulse before the connection. • running: Connects to the CPU without stopping the program execution during the connection.
Reset After Connect	Performs a reset operation as defined in Reset Mode after connecting to the board.
Reset Mode	Controls the reset operations performed by the debugger. The options are: • auto (default): The debugger decides which reset to use based on information from the CMSIS-Pack. • system: This mode uses the ResetSystem sequence from the CMSIS-Pack. • hardware: This mode uses the ResetHardware sequence from the CMSIS-Pack. • processor: This mode uses the ResetProcessor sequence from the CMSIS-Pack.
Run First	If selected, a flash download is triggered when you start a debug session. To save connection time, the flash download only happens if the code has changed, the active project has changed, or the board has been disconnected and reconnected.
Verify Application	Compares the content of the target memory with the program loaded in the debugger. Enable this option to ensure that the image loaded in the target system matches the image loaded in the debugger. This prevents debugging the wrong code when working with various targets or more instances of Keil Studio.

Flash download options in the **Run** category:

Setting	Description
Erase Mode	The erase modes available if you are not using DAPLink. The options are: • sectors (default): Erase only sectors to be programmed. • full: Erase full chip. • none: Skip flash erase step.
Flash Mode	The flash modes available. The options are: • auto (default): The debugger decides which flash mode to use based on the connected device. With auto, cmsis is always used unless an LPC1768 board is detected (daplink is used in that case). • cmsis: If selected, flash algorithms contained in the CMSIS-Pack that is used in your project are deployed in the background to do the flash download. • daplink: If selected, the DAPLink firmware does the flash download of programs to your board.
Program Flash	Flash program option if you are not using DAPLink. Writes code into the flash memory.
Reset Run	Reset option if you are not using DAPLink. Triggers a hardware reset after the flash download.
Verify Flash	Flash verify option if you are not using DAPLink. Verifies the content downloaded to the flash memory during the flash download.

Options to change how panels display in the user interface in the **Debug** category:

Setting	Description
Internal Console Options	Controls when the **Debug Console** view displays. The options are: • neverOpen: The **Debug Console** view never displays. • openOnSessionStart (default): The **Debug Console** view displays whenever a debug session starts. • openOnFirstSessionStart: The **Debug Console** view displays the first time a debug session is started only.
Open Debug	Controls when the **Debug** view displays. The options are: • neverOpen: The **Debug** view never displays. • openOnSessionStart (default): The **Debug** view displays whenever a debug session starts. • openOnFirstSessionStart: The **Debug** view displays the first time a debug session is started only.

14.2.13 Switch to RAM debugging

This section explains how to switch from flash debugging to RAM debugging.

Before you begin

When debugging a program, the debugger loads instructions to the flash memory and data to the RAM memory. This is known as flash debugging and it is the default behavior in Keil Studio.

Keil Studio also supports RAM debugging, which is faster and does not require flash algorithms like flash debugging. With RAM debugging, everything gets loaded to the RAM.

No specific settings are needed to do RAM debugging in Keil Studio but your program must be configured in a certain way.

Look at the following example to find out how to configure your project.

Some settings used for flash debugging might affect how your RAM debugging program runs. Check the advanced settings available for the debugger in the **Debug** or **Run** categories in **File** > **Preferences** > **Open Settings (UI)**. Select **auto** or **cmsis** for the **Flash Mode** setting, select **Deploy First**, and make sure **hardware** is not selected for **Reset Mode**.

Procedure

1. Clone the Blinky example for the FRDM-K32L3A6 board from keil.arm.com (**Projects** tab > **Open in Keil Studio** button) and set it as the active project (right-click the project and select **Set Active Project**).
2. Open the `Blinky.cprj` file included in the project.
   Note: The Keil Studio **Explorer** view hides `.cprj` files by default. Go to **File** > **Preferences** > **Open Settings (UI)** and search for the **Exclude** preference. Open the `settings.json` file and check that `.cprj` files are not listed under `"files.exclude"`.
3. In the `target` section, go to this block of code:
   ```
   ```
   <ldflags add="--callgraph --diag_suppress 6314 --entry=Reset_Handler --
   info sizes --info summarysizes --info totals --info unused --info veneers
   --load_addr_map_info --map --strict --summary_stderr --symbols --xref"
   compiler="AC6" file="./RTE/Device/K32L3A60VPJ1A_cm4/K32L3A60xxx_cm4_flash.scf"/>
   ```
   ```
4. Replace it by this block to point at the `K32L3A60xxx_cm4_ram.scf` file in the project (this file is provided by default in the **RTE** > **Device** folder):
   ```
   ```
   <ldflags add="--diag_suppress 6314 --strict --summary_stderr --info summarysizes
   --map --load_addr_map_info --xref --callgraph --symbols --info sizes --info
   totals --info unused --info veneers --entry=Reset_Handler" compiler="AC6"
   file="./RTE/Device/K32L3A60VPJ1A_cm4/K32L3A60xxx_cm4_ram.scf"/>
   ```
   ```
5. Click the **Debug project** button to start a debug session.
6. Check the debugging output in the **Debug Console**.

14.3 Use the Memory Inspector view

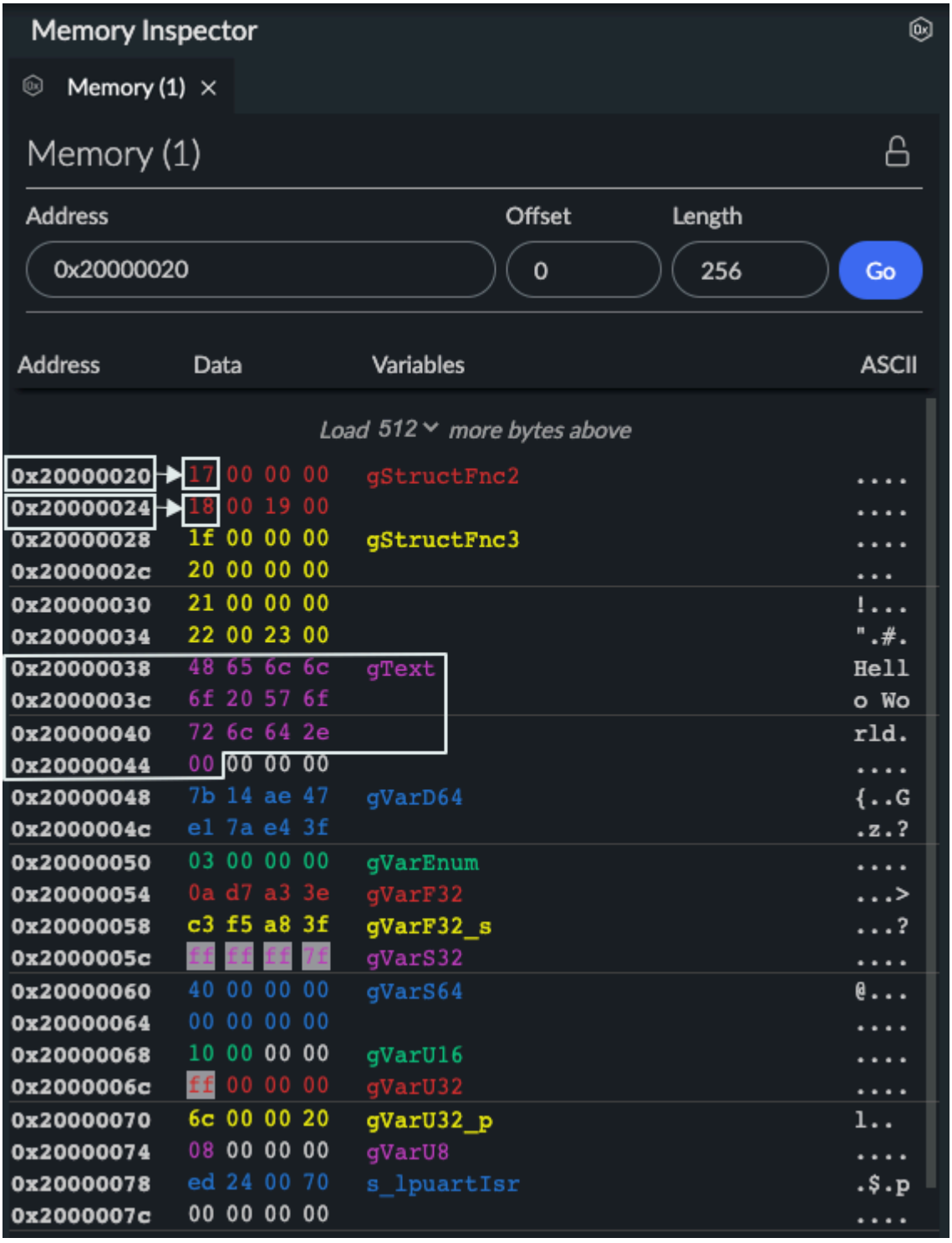
This section describes the **Memory Inspector** view and explains how to monitor the memory usage of your board as you step through the code of your project during a debug session.

The **Memory Inspector** view allows you to see the changes as they occur. You can also open multiple memory tabs to compare memory at different times or memory from different regions.

Interface

Here are the details you can see in the **Memory Inspector** view:

Figure 14-2: The Memory Inspector view



- The **Address** column shows the addresses of memory locations (or cells in memory) in hexadecimal format. The addresses provided correspond to the first memory location on each line.
- The **Data** column shows the values stored in each memory location in hexadecimal format. When you hover over one memory location, the value stored is also available in binary, decimal, or UTF8 format.
- The **Variables** column shows the names of the variables stored in memory. Colors help you distinguish the memory locations used by variables. For example: `gText` uses 13 bytes in memory.
- The **ASCII** column shows the ASCII character equivalents of the values stored.

Monitor the memory usage of your board

You must first start a debug session and set breakpoints to be able to monitor the memory usage of your board.

To start a debug session and check the **Memory Inspector** view:

1. Set the project you want to debug as the active project and start a debug session as explained in Debug first steps.

   The debugger stops at the function “main” of your application.

2. Click the **Memory Inspector** button  in the top right-hand corner of the screen to display the **Memory Inspector** view.

   The **Memory Inspector** view opens with an empty **Memory (1)** tab. You can rename that tab.

3. Set breakpoints on the parts of code you want to examine as explained in Set breakpoints.

4. Click the **Continue** button  .

   The debugger runs to the first breakpoint it encounters and stops.

5. In the **Variables** list, find the variable you want to check.

6. Right-click the variable and select **Show variable in memory**.

   Note that you can also directly type the address of a variable in the **Address** field and click the **Go** button. You can use addresses of pointers too.

   The **Memory Inspector** view initially shows a 256-byte region that starts from the chosen address, with higher memory addresses at the bottom of the tab.

7. To navigate the memory locations, you can modify the **Offset** and **Length**.

   For example, if the current address is `0x2000006c` and you type `2` in the **Offset** field, the **Memory Inspector** view displays a memory region that starts at `0x2000006e`. If you type 64 (bytes) in the **Length** field, the **Memory Inspector** view displays 64 bytes from the current memory location, so 4-byte values per line * 16 lines.

   Note that you can also display more lines using the **Load more bytes above** and **Load more bytes below** drop-down lists.

8. Step through the code and observe the changes.

   Memory tabs are dynamic and update as you step through the code. Memory locations that have changed from one frame to the next are highlighted.

   You can write a new value to any memory location displayed by typing over the value shown in the **Data** column and clicking the **Apply Changes** button. Updated memory values are highlighted with a yellow square.

Compare memory locations

You can open multiple memory tabs to compare memory at different times or memory from different regions. It is particularly helpful when you are copying or moving data from one region to another and must verify an operation is occurring as it should.

To compare memory locations:

1. Follow the steps in Monitor the memory usage of your board and look for the address you want to check.
2. Click the **Create new memory inspector**  icon to open a new memory tab and look for the same address (to compare memory at different times) or a different address (to compare memory from different regions).
3. You can click the **Freeze memory view**  icon on a tab to freeze the data displayed.
4. Drag and drop the new tab next to the first tab.
5. Step through the code and observe the changes.

To visually compare memory locations easily, you can also display a diff view:

1. Click the **Toggle Comparison Widget Visibility**  icon.

   A comparison panel opens at the bottom of the screen.
2. If you have more than two tabs open, select the tabs you want to compare in the drop-down lists and click **Go**.

   Note that you must load memory in both tabs to be able to display a diff. The content of the tabs is displayed side by side and differences are highlighted in red (before) and green (after).

15. Supported hardware and Arm Virtual Hardware

This chapter describes the hardware that Keil Studio supports and how to run projects on Arm Virtual Hardware.

15.1 Supported development boards

This section describes the development boards that Keil studio supports.

For CMSIS projects, Keil Studio supports the following development boards.

For Mbed projects, Keil Studio supports the following development boards.

15.2 Supported debug probes

This section describes the debug probes that Keil studio supports.

WebUSB-enabled CMSIS-DAP debug probes

Keil Studio supports debug probes that implement the CMSIS-DAP protocol. See the CMSIS-DAP documentation for general information.

Such implementations are for example:

- The DAPLink implementation: see the ARMmbed/DAPLink repository.
- The Nu-Link2 implementation: see the Nuvoton repository.
- The ULINKplus (firmware version 2) implementation: see the Keil MDK documentation.

ST-LINK debug probes

Keil Studio supports ST-LINK/V2 probes and later, and the ST-LINK firmware available for these probes.

The recommended debug implementation versions of the ST-LINK firmware are:

- For ST-LINK/V2 and ST-LINK/V2-1 probes: J36 and later.
- For STLINK-V3 probes: J6 and later.

See “Firmware naming rules” in Overview of ST-LINK derivatives for more details on naming conventions.

Warning

Keil Studio notifies you when older firmware versions are detected but does not stop you from using them. To stay up to date with the latest firmware versions, visit the STSW-LINK007 page.

15.3 Arm Virtual Hardware

Keil Studio supports Arm Virtual Hardware (AVH).

Arm Virtual Hardware provides simulation models that allow you to quickly test and validate a software project without having to connect to real hardware.

For more details on Arm Virtual Hardware, check the product overview available.

Note

Arm Virtual Hardware is available for CMSIS projects only. Note that this feature is still under development and updates will be available soon.

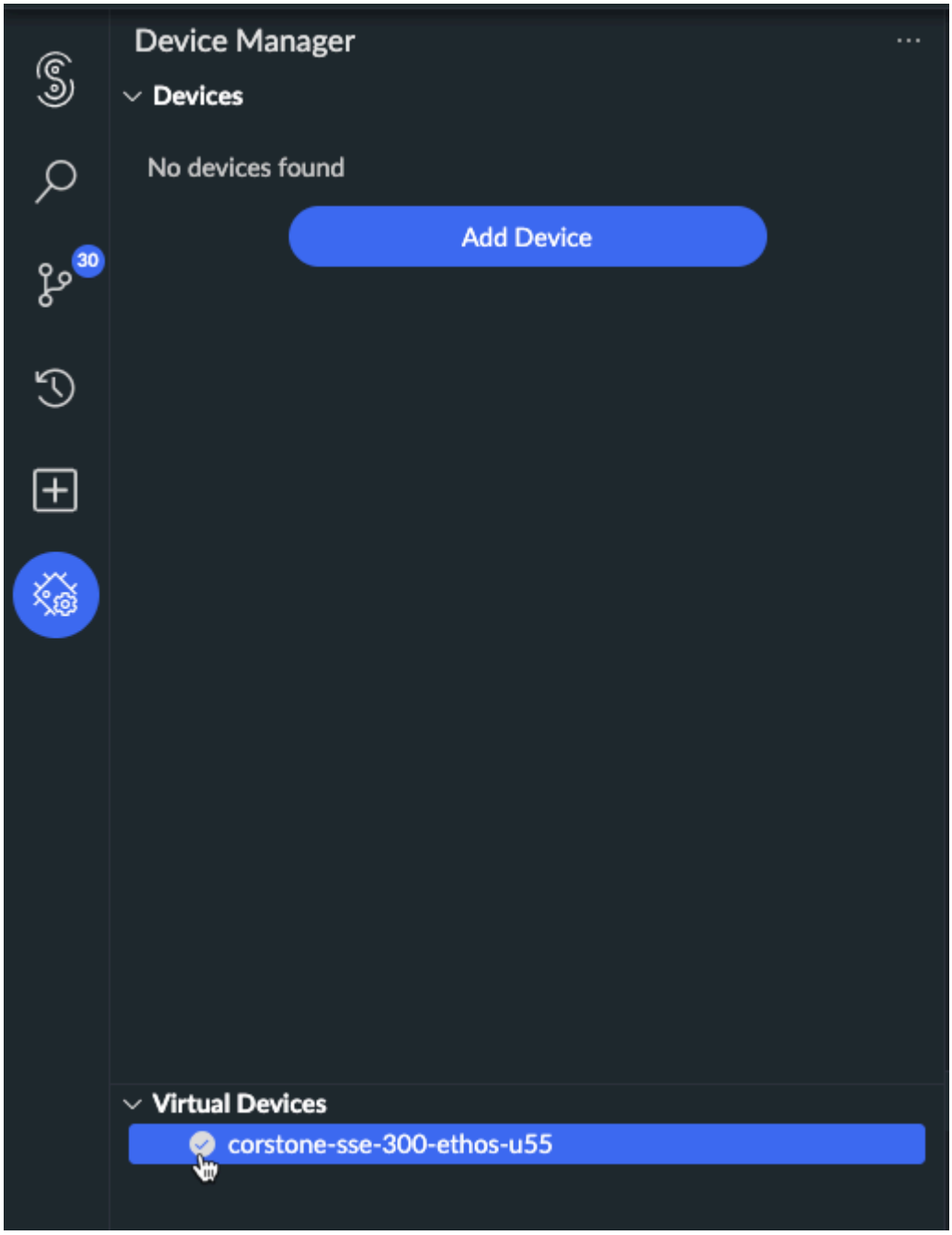
15.3.1 Run a project on Arm Virtual Hardware

Describes how to run a project on Arm Virtual Hardware in Keil Studio.

Procedure

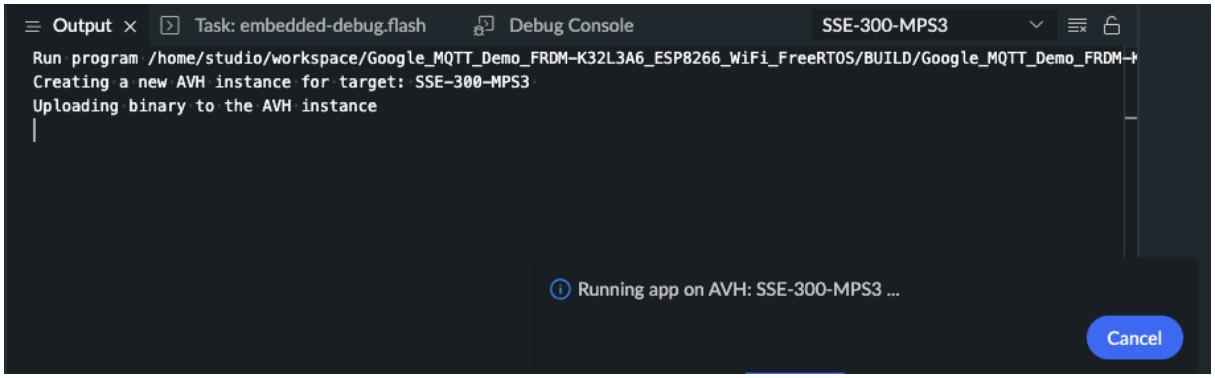
1. Check that your project is set as the active project (right-click the project and select **Set Active Project**).
2. Click the **Device Manager** icon  in the Keil Studio activity bar.
3. Click the **Virtual Devices** header below **Devices** to open the panel and select a virtual device.

Figure 15-1: Select a virtual device



4. From the **Explorer**, click the **Run project** button to build the example and run it on the virtual device.
   The output of the build displays in the **Output** view.

Figure 15-2: Output



5. Click the **Cancel** button in the popup message that displays in the bottom right-hand corner of the screen to stop the virtual device.

16. Extensions

Keil Studio supports a fixed list of Visual Studio Code compatible extensions to take your programming experience to the next level. Extensions can add support for programming languages, integrate with cloud service providers, or help configure your MCU.

The **AWS Toolkit** is the first extension made available to you to support your Amazon Web Services IoT workflows.

16.1 Install the AWS Toolkit extension

The **AWS Toolkit** extension is available from the **Extensions** view.

Procedure

1. To open the **Extensions** view, click the **Extensions** icon in the Keil Studio activity bar.
   The **AWS Toolkit** extension is ready to be installed.
2. Switch on the toggle button to install the extension.
   A popup message appears to indicate that the Toolkit collects metrics.
3. Click **OK** in the popup message.

   Once the **AWS Toolkit** extension has been installed, an **AWS** icon displays in the activity bar.
4. Click the **AWS** icon.
   It opens the AWS Explorer and CDK Explorer. Another popup message appears to indicate which version of the Toolkit has been installed. Click the **View Quick Start** button in the popup message to check the Readme available and learn about the **AWS Toolkit**. Next, follow the steps to Connect to AWS from Keil Studio.

   Notes:

   - The Readme is also available when you click the extension from the **Extensions** view.
   - To uninstall the **AWS Toolkit** extension, switch off the toggle button from the **Extensions** view.

16.2 Connect to AWS from Keil Studio

Create an AWS account, if you do not already have one, and configure credentials to access AWS services and resources from Keil Studio.

Before you begin

To create an account, see How do I create and activate a new AWS account?.

To access AWS services and resources, you need an access key. An access key consists of an access key ID and a secret access key. This access key is used to sign programmatic requests that you make to AWS. See Obtaining AWS access keys to create an access key.

Procedure

1. Open the **AWS Toolkit** extension in Keil Studio and go to the AWS Explorer.
   A "Connect to AWS..." message displays.
2. Click the message.
   A popup message appears to indicate that no credentials were found and invite you to create credentials.
3. Click **Yes** to create credentials.
   A popup appears and asks you for a credential profile name.
4. Type a profile name and press **Enter**.
   A popup appears and asks you for an AWS Access Key (it is the access key ID and looks like this: `AKIAIOSFODNN7EXAMPLE`).
5. Provide your access key and press **Enter**.
   A popup appears and asks you for an AWS Secret Key (it is the secret access key and looks like this: `wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY`).
6. Provide your secret key and press **Enter**.
   A popup appears and asks you if you want to show the default region your profile is associated with in the AWS Explorer.
7. Click **Yes**.
   The region is added to the AWS Explorer. You can now start using the AWS services and resources available. Next, try out our AWS MQTT Demo tutorial to understand how to connect your device to AWS cloud services.

17. Known issues and troubleshooting

This chapter describes Keil Studio known issues, how to troubleshoot some common issues, and how to contact Arm to report issues or suggest enhancements.

17.1 Known issues

This section describes the known issues in Keil Studio.

Keil Studio has the following known issues:

- Some users have reported licensing issues for Arm Compiler 6. These issues might be related to the system clock and region format.
- On Linux, there is a limit on the number of files that can be watched in the workspace. To increase the limit, follow the instructions available in the Visual Studio Code documentation.
- On Linux, source control management requires the `libcurl4` package to work correctly.

17.2 Troubleshooting

Provides solutions to some common issues you might experience when you use Keil Studio.

17.2.1 Keil Studio does not load

Keil Studio hangs on the loading screen.

Solution

Keil Studio takes longer to load when you have many tabs opened in your browser and change tabs while Keil Studio is loading. Stay on the tab where Keil Studio is loading to solve the issue. You can also try to clear your browser cache to solve the problem.

17.2.2 Cannot log into Keil Studio

You are unable to log into Keil Studio.

Solution

Ensure that your Arm account or Mbed account credentials are correct.

17.2.3 Connected development board or debug probe not found

You have connected your development board or debug probe, but Keil Studio cannot detect the device.

Solution

- Run **Device Manager** (Windows), **System Information** (Mac), or a Linux system utility tool like **hardinfo** (Linux) and check for warnings beside your devices. Warnings can indicate that device drivers are not installed. If necessary, obtain and install the appropriate drivers for your device.
- Check that the firmware version of your board or debug probe is supported and update the firmware to the latest version. See the Out-of-date firmware section for more details.

17.2.4 Out-of-date firmware

You have connected your development board or debug probe and a popup message appears mentioning that the firmware is out of date.

Solution

Update the firmware of the board or debug probe to the latest version:

- DAPLink. If you cannot find your board or probe on daplink.io, then check the website of the manufacturer for your device.
- ST-LINK. Note that ST development boards and probes on Windows require extra drivers. You can download them from the ST site.
- For other WebUSB-enabled CMSIS-DAP firmware updates, please contact your board or debug probe vendor.

If you are using an FRDM-KL25Z board and the standard DAPLink firmware update procedure does not work, follow this procedure (requires Windows 7 or Windows XP).

17.2.5 Connection fails when clicking Run project or Debug project

Keil Studio has correctly detected your development board or debug probe and the device shows as active, but the connection fails when you click **Run project** or **Debug project**. There can be multiple reasons for a connection failure.

Solution: check your hardware setup

Cables:

- Check that all USB cables and power cables are connected correctly.
- Check that no cable is damaged. Note that low-quality cables can also impact the debug connectivity.

- Disconnect and reconnect the board or the debug probe, or both, to recover from an unexpected state.

Jumpers and switches:

Check that all jumpers and switches are configured correctly. Development boards often have different jumpers and switches that can be set for specific use cases.

For example:

- Jumpers to select or connect to the power supply (for example, there can be different USB connectors or external power supply units).
- Multiple jumpers to enable, connect, or configure different subsystems (core, peripherals, GPIO pad) or allow different voltage levels.
- Jumpers to enable and disable, or configure connections to other on-board chips like code flash devices (for example, address lines).
- Jumpers that connect and disconnect the on-board debugger to and from the target device.
- Switches to configure the target device boot mode (for example, to select the code memory device to boot from).
- On and off switch or switches (for example, if the on-board debug probe is continuously powered after plugging in the board, but the target system has to be turned on separately).

Firmware:

Check that the firmware version of your board or debug probe is supported and update the firmware to the latest version. See the Out-of-date firmware section for more details.

External debug probe:

- Check that the debug probe is connected to the correct debug connector on the board. Some boards have multiple debug connectors, for example, one to debug the target device and one to debug an on-board debugger.
- Check that the board is powered and turned on. An external debug probe can be successfully detected even if the attached target system is not connected.
- Check that there is no conflict with an on-board debugger:
  - Check if you have to change the jumper settings to disconnect the on-board debugger.
  - Check if you have to change a jumper to connect the external debug probe to the target device.
  - Check if the board is powered through the USB port for the on-board debugger. If that is the case, try to choose a different power source for the board.

Solution: check the connect mode or target device boot mode

Problems can happen with code that was flashed to your device using a specific build target. The code can be at the origin of some debug connectivity issues.

Problems can occur when:

- One or more device-specific low-power modes are used which affect the debug connectivity. It is the case for Mbed projects running on ST boards, for example.
- Watchdog timers or other device-specific peripherals that reset the system and the debug interface are activated.
- Reconfigured GPIO pins are required for a debug connection (SWD/JTAG pins).
- Faulty code runs and puts the device in a lockup state, and a debug/flash download connection cannot be established as a result.

Possible solutions to overcome this are:

- Change the debug **Connect Mode** preference to **underReset** to keep the device or the CPU or both in reset mode during the debug connection.
- If the target device does not support **underReset** connections, then change the connect mode to **preReset**. Depending on the project that is running, **preReset** can delay the execution of problematic parts of code long enough to establish a debug connection. The success of that depends however on timings in the program running on your target, your debug unit, and the host computer. For example, a fast debug unit has a higher chance to connect than a slow debug unit.
- Boot the target device in a different boot mode. It can require changing on-board switches or jumpers or both and disconnecting and reconnecting the board. For some boards, you can change the boot mode to a system boot mode (for example, you can do that with the NXP i.MX RT boards).

If the previous solutions do not work, try alternative methods to flash download your project without the code triggering debug connectivity problems:

- If you are using a DAPLink debug probe, select the **daplink** option for the **Flash Mode** setting in the **Run** category in the preferences.
- If your board allows programming with a mass storage device (MSD) or a serial connection, then download the built program from Keil Studio to your computer and use this alternative way of programming.

Solution: check that your device supports the SWD protocol

You can use an on-board debugger or an external debug unit if your board provides a suitable debug connector or provisions for it. Note that Keil Studio only currently supports the SWD protocol, not JTAG.

17.2.6 Development board not showing serial data

Serial data for a development board is not being shown in Keil studio.

Solution

- Disconnect and reconnect the board.
- Check that no other project is accessing the serial data on the board; the device can only connect to one serial monitor at a time.

- On Linux, ensure that the current user belongs to the `dialout` group. To check that the current user belongs to the `dialout` group, run the command: `sudo adduser "$USER" dialout`

17.2.7 Linker failing with file not found for Mbed OS 15.4.0 and older

Mbed OS 15.4.0 and older do not support spaces in project names. The linker fails and states `"file not found"`.

Solution

Change your project name and try to compile again.

17.3 Report an issue or suggest an enhancement

Help us improve Keil Studio.

To report any issues you experience, or suggest enhancements, go to the Keil forum or the Mbed forum.

Alternatively, you can:

1. Go to the **Help** menu and select **Report an Issue**.

   The **Report an Issue or Provide Feedback** dialog box opens.
2. Click **Report issue**.

   The **Keil forum** opens.