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Getting Started with MCUXpresso SDK

1 Overview

The MCUXpresso Software Development Kit (SDK) provides comprehensive software support for Kinetis and LPC Microcontrollers. The MCUXpresso SDK includes a flexible set of peripheral drivers designed to speed up and simplify development of embedded applications. Along with the peripheral drivers, the MCUXpresso SDK provides an extensive and rich set of example applications covering everything from basic peripheral use case examples to full demo applications. The MCUXpresso SDK contains FreeRTOS, a USB host and device stack, and various other middleware to support rapid development.

For supported toolchain versions, see *MCUXpresso SDK Release Notes* (document MCUXSDKRN).

For more details about MCUXpresso SDK, refer to MCUXpresso-SDK: Software Development Kit for MCUXpresso.

Contents

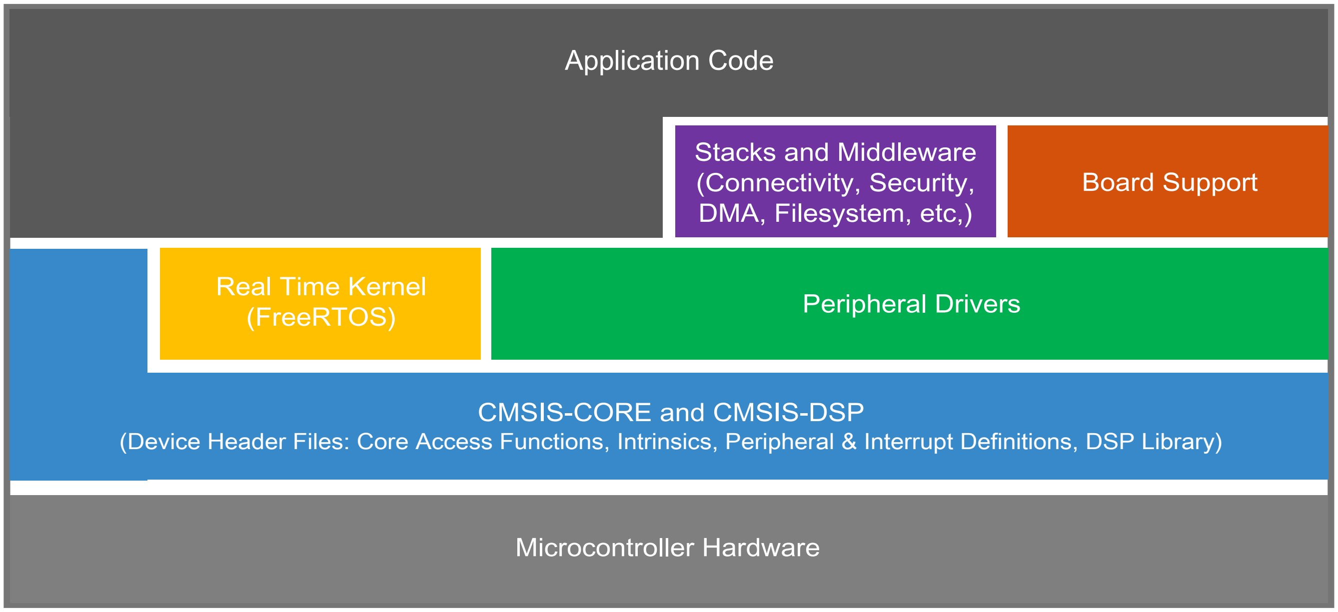


Figure 1. MCUXpresso SDK layers

2 MCUXpresso SDK board support package folders

MCUXpresso SDK board support package provides example applications for NXP development and evaluation boards for Arm® Cortex®-M cores including Freedom, Tower System, and LPCXpresso boards. Board support packages are found inside the top level boards folder and each supported board has its own folder (an MCUXpresso SDK package can support multiple boards). Within each `<board_name>` folder, there are various sub-folders to classify the type of examples it contain. These include (but are not limited to):

- `cmsis_driver_examples`: Simple applications intended to show how to use CMSIS drivers.
- `demo_apps`: Full-featured applications that highlight key functionality and use cases of the target MCU. These applications typically use multiple MCU peripherals and may leverage stacks and middleware.
- `driver_examples`: Simple applications that show how to use the MCUXpresso SDK's peripheral drivers for a single use case. These applications typically only use a single peripheral but there are cases where multiple peripherals are used (for example, SPI conversion using DMA).
- `emwin_examples`: Applications that use the emWin GUI widgets.
- `rtos_examples`: Basic FreeRTOS™ OS examples that show the use of various RTOS objects (semaphores, queues, and so on) and interfaces with the MCUXpresso SDK's RTOS drivers
- `usb_examples`: Applications that use the USB host/device/OTG stack.
- `multicore_examples`: Applications for both cores showing the usage of multicore software components and the interaction between cores.
- `mmcau_examples`: Simple applications intended to concisely illustrate how to use middleware/mmcau stack.
- `wireless_examples`: Applications that use the Zigbee and OpenThread stacks.
- `usb_dongle_examples`: Simple applications to be used on the PCB2459-2 JN5189 USB DONGLE.

2.1 Example application structure

This section describes how the various types of example applications interact with the other components in the MCUXpresso SDK. To get a comprehensive understanding of all MCUXpresso SDK components and folder structure, see *MCUXpresso SDK API Reference Manual*.

Each `<board_name>` folder in the boards directory contains a comprehensive set of examples that are relevant to that specific piece of hardware. Although we use the `hello_world` example (part of the `demo_apps` folder), the same general rules apply to any type of example in the `<board_name>` folder.

In the `hello_world` application folder you see the following contents:

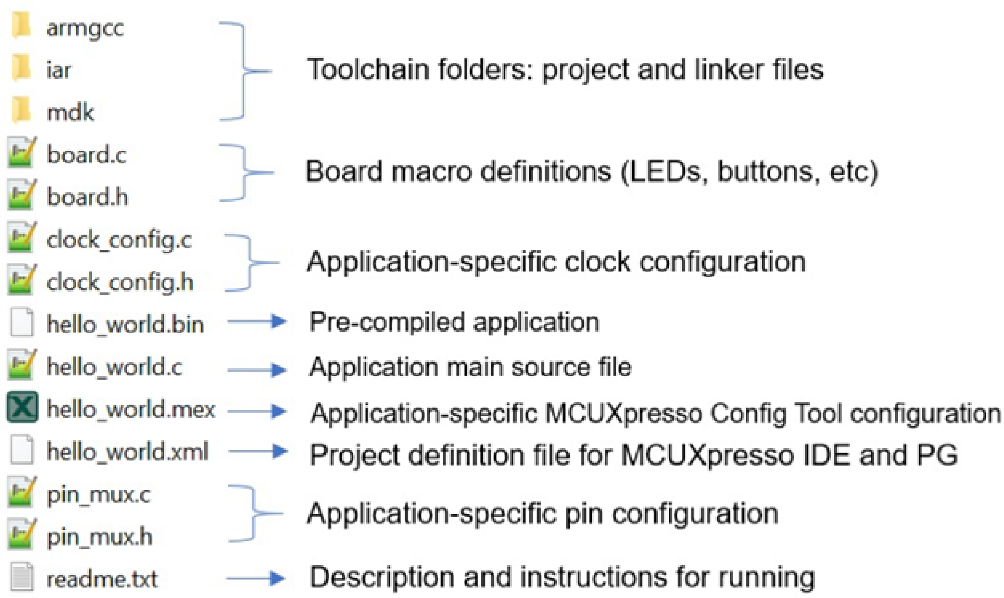


Figure 2. Application folder structure

All files in the application folder are specific to that example, so it is easy to copy and paste an existing example to start developing a custom application based on a project provided in the MCUXpresso SDK.

2.2 Locating example application source files

When opening an example application in any of the supported IDEs, a variety of source files are referenced. The MCUXpresso SDK devices folder is the central component to all example applications. It means the examples reference the same source files and, if one of these files is modified, it could potentially impact the behavior of other examples.

The main areas of the MCUXpresso SDK tree used in all example applications are:

- `devices/<device_name>`: The device's CMSIS header file, MCUXpresso SDK feature file and a few other files
- `devices/<device_name>/cmsis_drivers`: All the CMSIS drivers for your specific MCU
- `devices/<device_name>/drivers`: All of the peripheral drivers for your specific MCU
- `devices/<device_name>/<tool_name>`: Toolchain-specific startup code, including vector table definitions
- `devices/<device_name>/utilities`: Items such as the debug console that are used by many of the example applications
- `devices/<devices_name>/project` Project template used in CMSIS PACK new project creation

For examples containing middleware/stacks or an RTOS, there are references to the appropriate source code. Middleware source files are located in the `middleware` folder and RTOSes are in the `rtos` folder. The core files of each of these are shared, so modifying one could have potential impacts on other projects that depend on that file.

3 Run a demo using MCUXpresso IDE

NOTE

Ensure that the MCUXpresso IDE toolchain is included when generating the MCUXpresso SDK package.

This section describes the steps required to configure MCUXpresso IDE to build, run, and debug example applications. The `hello_world` demo application targeted for the FRDM-K64F Freedom hardware platform is used as an example, though these steps can be applied to any example application in the MCUXpresso SDK.

3.1 Select the workspace location

Every time MCUXpresso IDE launches, it prompts the user to select a workspace location. MCUXpresso IDE is built on top of Eclipse which uses workspace to store information about its current configuration, and in some use cases, source files for the projects are in the workspace. The location of the workspace can be anywhere, but it is recommended that the workspace be located outside of the MCUXpresso SDK tree.

3.2 Build an example application

To build an example application, follow these steps.

1. Drag and drop the SDK zip file into the **Installed SDKs** view to install an SDK. In the window that appears, click **OK** and wait until the import has finished.

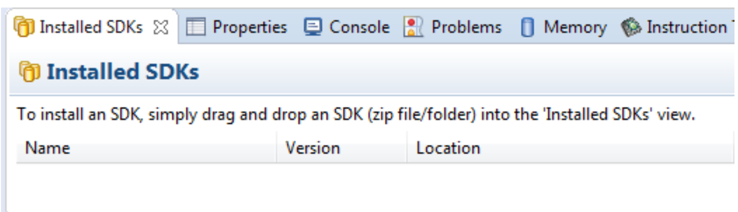


Figure 3. Install an SDK

2. On the **Quickstart Panel**, click **Import SDK example(s)…**.

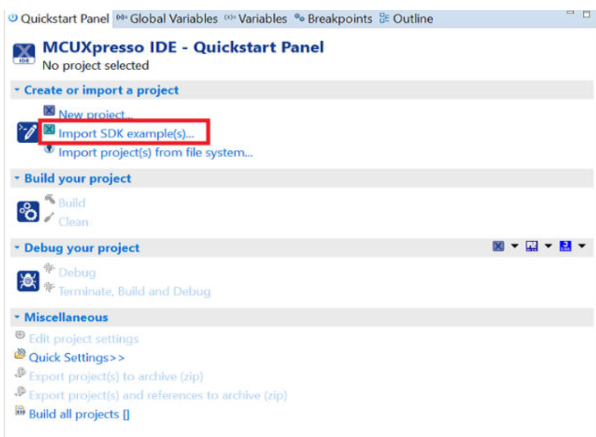


Figure 4. Import an SDK example

3. In the window that appears, expand the **K6x** folder and select **MK64FN1M0xxx12** . Then, select **frdmk64f** and click **Next**.

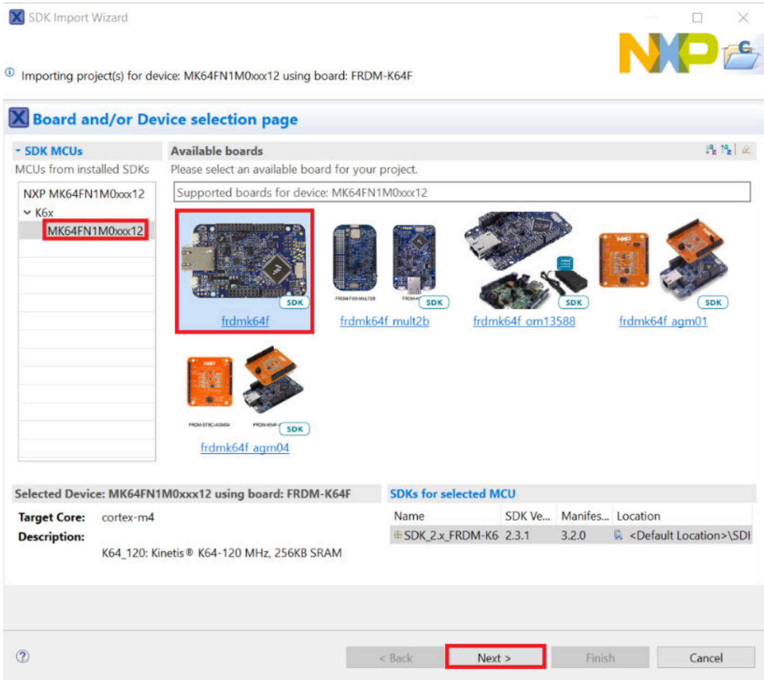


Figure 5. Select FRDM-K64F board

4. Expand the `demo_apps` folder and select `hello_world`. Then, click **Next**.

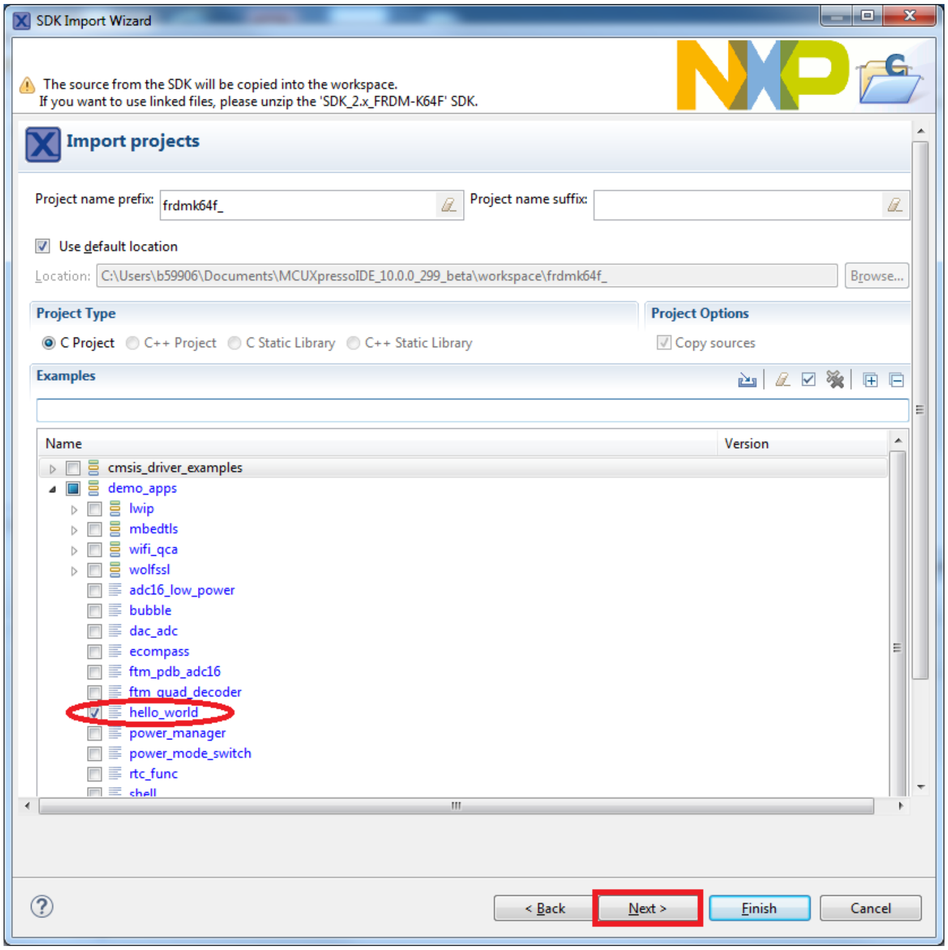


Figure 6. Select `hello_world`

5. Ensure **Redlib: Use floating point version of printf** is selected if the example prints floating point numbers on the terminal for demo applications such as `adc_basic`, `adc_burst`, `adc_dma`, and `adc_interrupt`. Otherwise, it is not necessary to select this option. Then, click **Finish**.

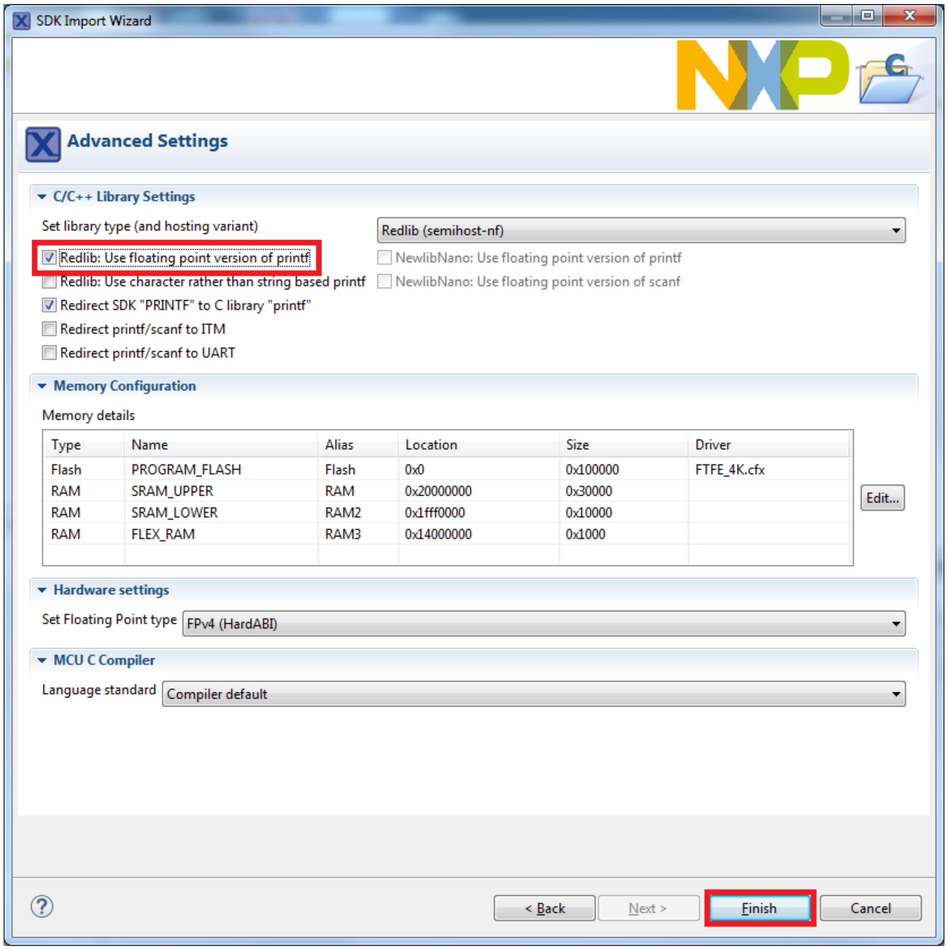


Figure 7. Select `Use floating point version of printf`

3.3 Run an example application

For more information on debug probe support in the MCUXpresso IDE see community.nxp.com.

To download and run the application, perform the following steps:

1. See the table in Default debug interfaces to determine the debug interface that comes loaded on your specific hardware platform. For LPCXpresso boards, install the DFU jumper for the debug probe, then connect the debug probe USB connector.
    - For boards with a P&E Micro interface, see www.pemicro.com/support/downloads_find.cfm to download and install the P&E Micro Hardware Interface Drivers package.
    - For the MRB-KW01 board, see www.nxp.com/USB2SER to download the serial driver. This board does not support the OpenSDA. Therefore, an external debug probe (such as a J-Link) is required. The steps below referencing the OpenSDA do not apply because there is only a single USB connector for the serial output.
    - If using J-Link with either a standalone debug pod or OpenSDA, install the J-Link software (drivers and utilities) from www.segger.com/jlink-software.html.
    - For boards with the OSJTAG interface, install the driver from www.keil.com/download/docs/408.
2. Connect the development platform to your PC via a USB cable.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug serial port number (to determine the COM port number, see How to determine COM port). Configure the terminal with these settings:

a. 115200 or 9600 baud rate, depending on your board (reference `BOARD_DEBUG_UART_BAUDRATE` variable in `board.h` file)
b. No parity
c. 8 data bits
d. 1 stop bit

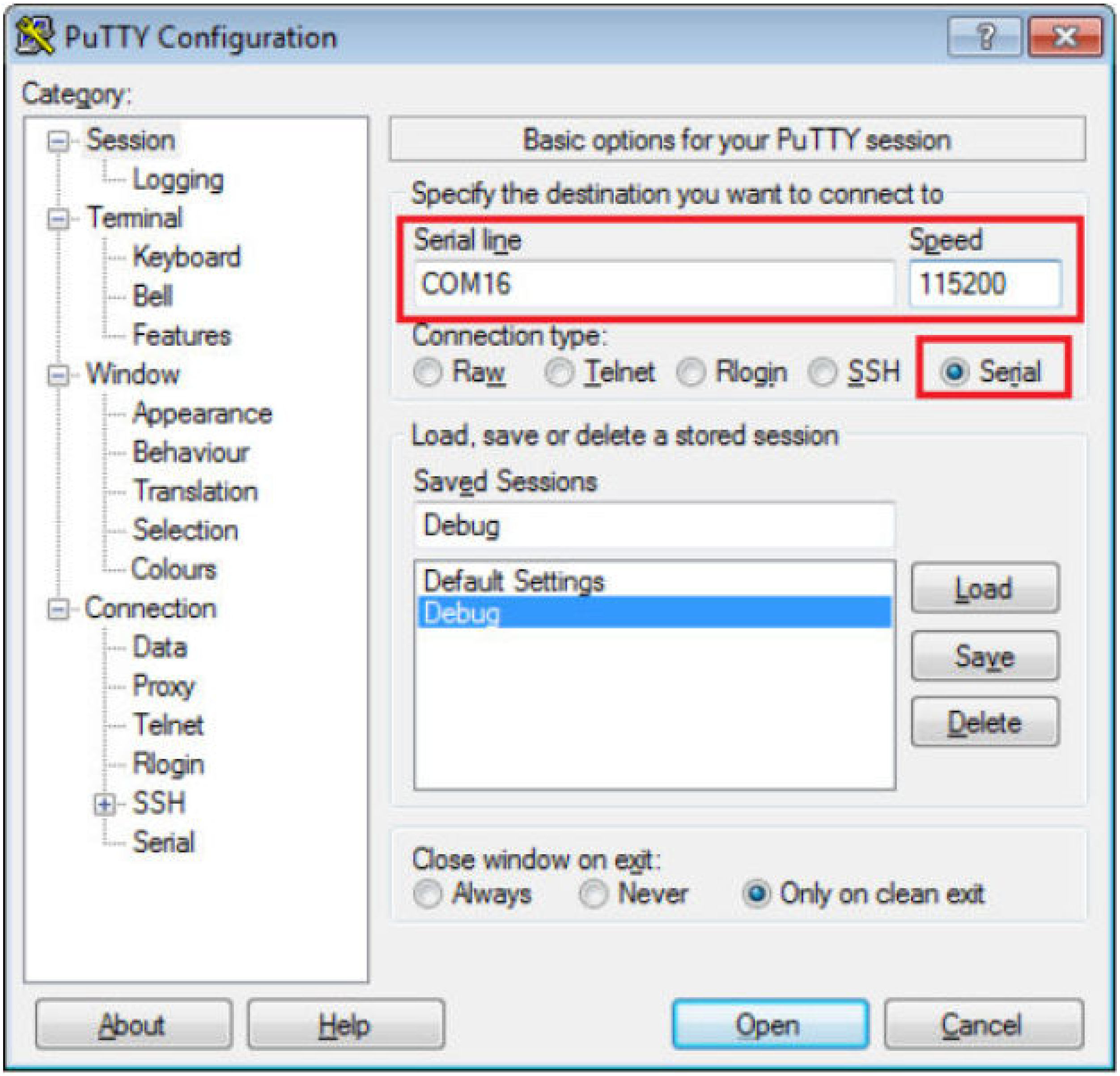


Figure 8. Terminal (PuTTY) configurations

4. On the **Quickstart Panel**, click on **Debug** **`frdmk64f_demo_apps_hello_world [Debug]`** to launch the debug session.

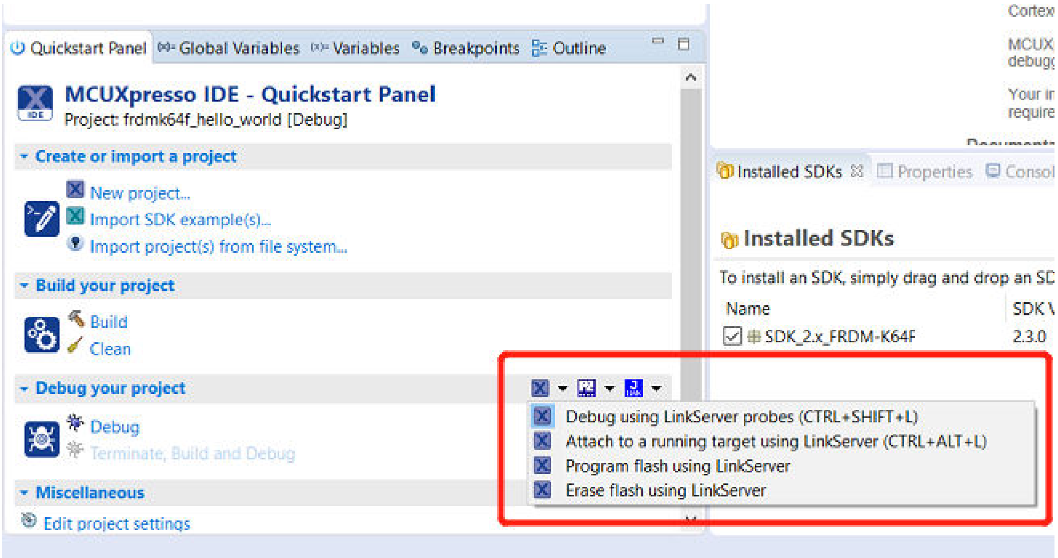


Figure 9. Debug `hello_world` case

5. The first time you debug a project, the **Debug Emulator Selection** dialog is displayed, showing all supported probes that are attached to your computer. Select the probe through which you want to debug and click **OK**. (For any future debug sessions, the stored probe selection is automatically used, unless the probe cannot be found.)

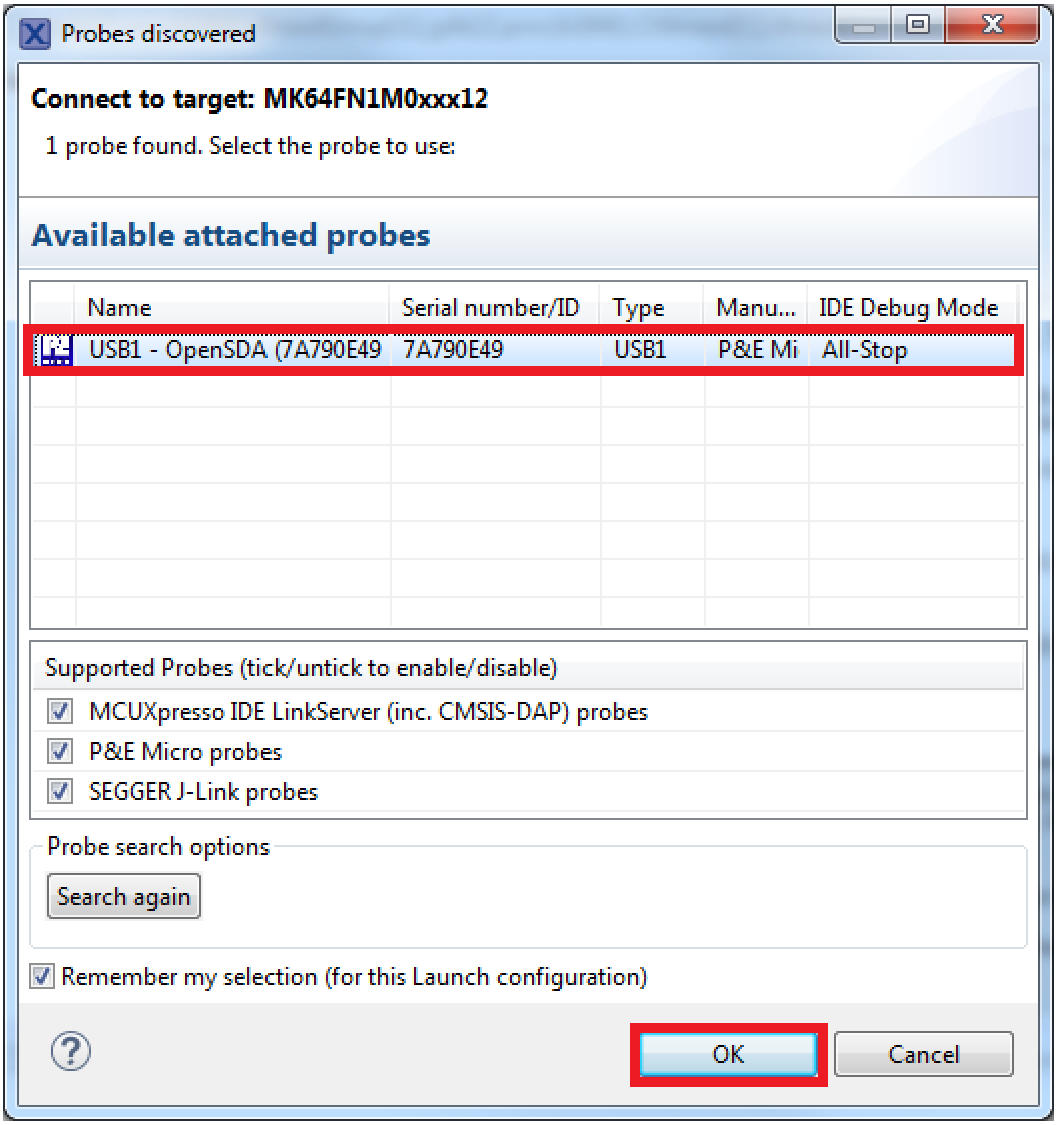


Figure 10. Attached Probes: debug emulator selection

6. The application is downloaded to the target and automatically runs to `main()`.

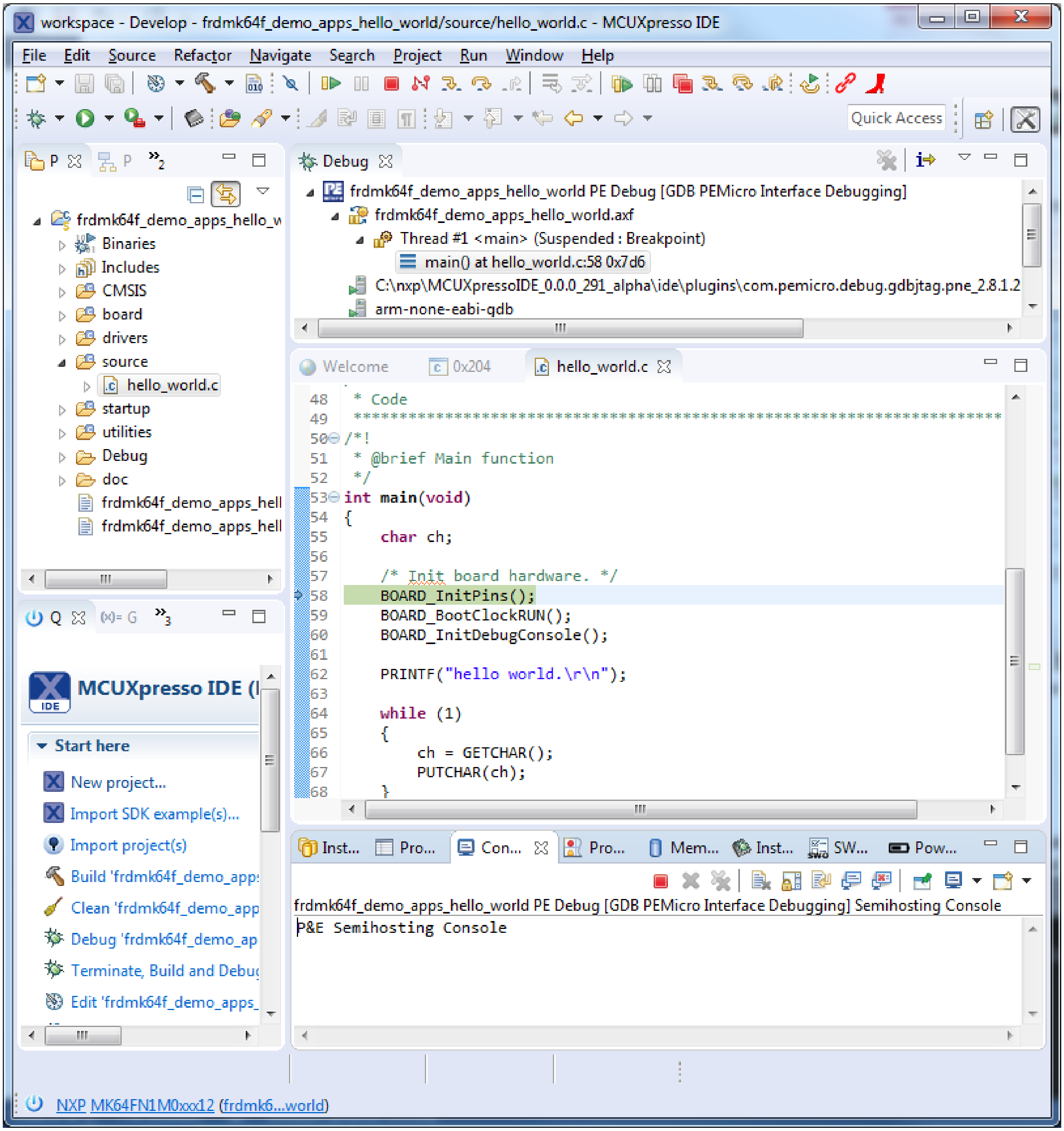


Figure 11. Stop at `main()` when running debugging

7. Start the application by clicking **Resume**.

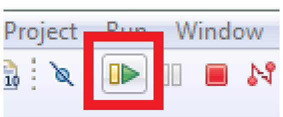


Figure 12. Resume button

The `hello_world` application is now running and a banner is displayed on the terminal. If this is not the case, check your terminal settings and connections.

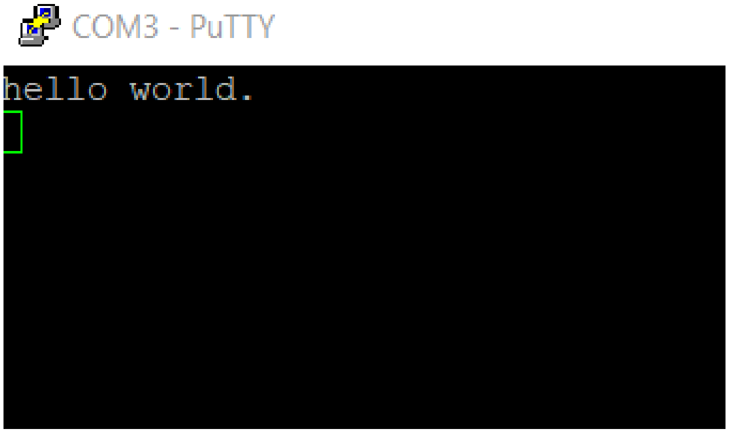


Figure 13. Text display of the `hello_world` demo

3.4 Build a multicore example application

This section describes the steps required to configure MCUXpresso IDE to build, run, and debug multicore example applications. The following steps can be applied to any multicore example application in the MCUXpresso SDK. Here, the dual-core version of hello_world example application targeted for the LPCXpresso54114 hardware platform is used as an example.

1. Multicore examples are imported into the workspace in a similar way as single core applications, explained in Build an example application. When the SDK zip package for LPCXpresso54114 is installed and available in the **Installed SDKs** view, click **Import SDK example(s)…** on the Quickstart Panel. In the window that appears, expand the **LPCxx** folder and select **LPC54114J256**. Then, select **lpcxpresso54114** and click **Next**.
2. Expand the `multicore_examples/hello_world` folder and select **cm4**. The `cm0plus` counterpart project is automatically imported with the `cm4` project, because the multicore examples are linked together and there is no need to select it explicitly. Click **Finish**.

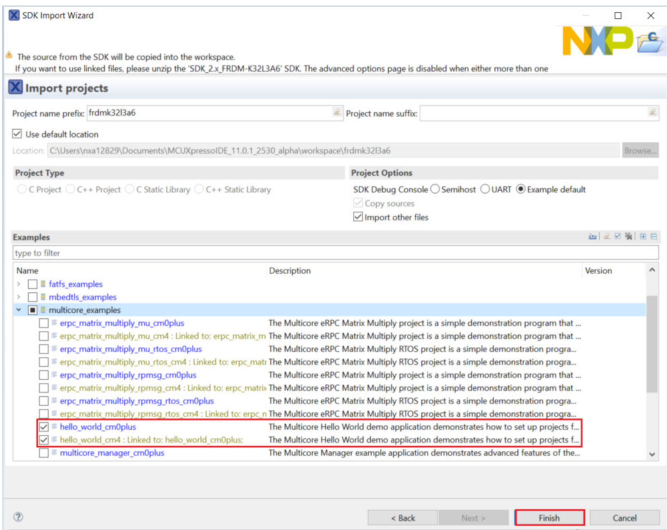


Figure 14. Select the hello_world multicore example

3. Now, two projects should be imported into the workspace. To start building the multicore application, highlight the `lpcxpresso54114_multicore_examples_hello_world_cm4` project (multicore master project) in the Project Explorer. Then choose the appropriate build target, **Debug** or **Release**, by clicking the downward facing arrow next to the hammer icon, as shown in Figure 15. For this example, select **Debug**.

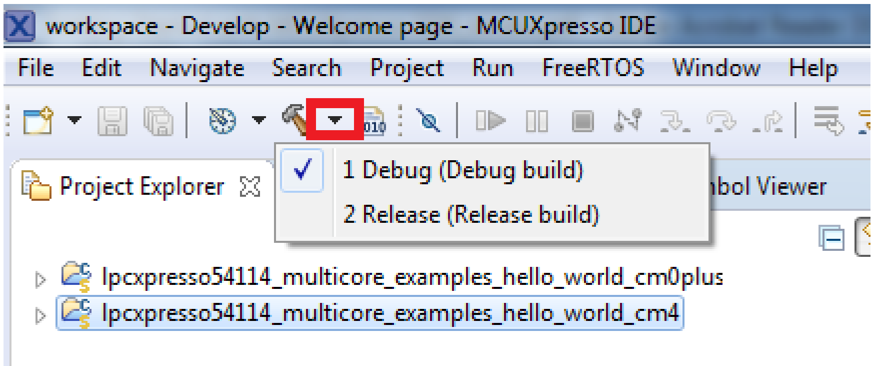


Figure 15. Selection of the build target in MCUXpresso IDE

The project starts building after the build target is selected. Because of the project reference settings in multicore projects, triggering the build of the primary core application (`cm4`) also causes the referenced auxiliary core application (`cm0plus`) to build.

NOTE

When the **Release** build is requested, it is necessary to change the build configuration of both the primary and auxiliary core application projects first. To do this, select both projects in the Project Explorer view and then right click which displays the context-sensitive menu. Select **Build Configurations** -> **Set Active** -> **Release**. This alternate navigation using the menu item is **Project** -> **Build Configuration** -> **Set Active** -> **Release**. After switching to the **Release** build configuration, the build of the multicore example can be started by triggering the primary core application (`cm4`)build.

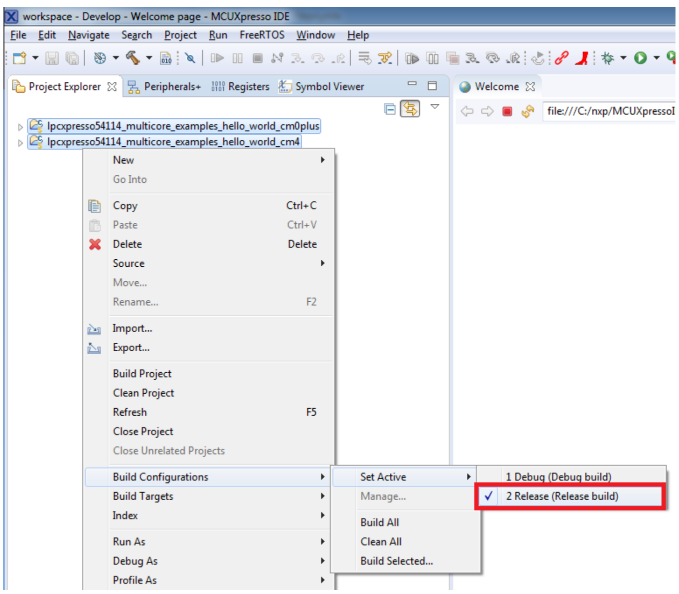


Figure 16. Switching multicore projects into the Release build configuration

3.5 Run a multicore example application

The primary core debugger handles flashing of both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform all steps as described in *Run an example application*. These steps are common for both single-core applications and the primary side of dual-core applications, ensuring both sides of the multicore application are properly loaded and started. However, there is one additional dialogue that is specific to multicore examples which requires selecting the target core. See the following figures as reference.

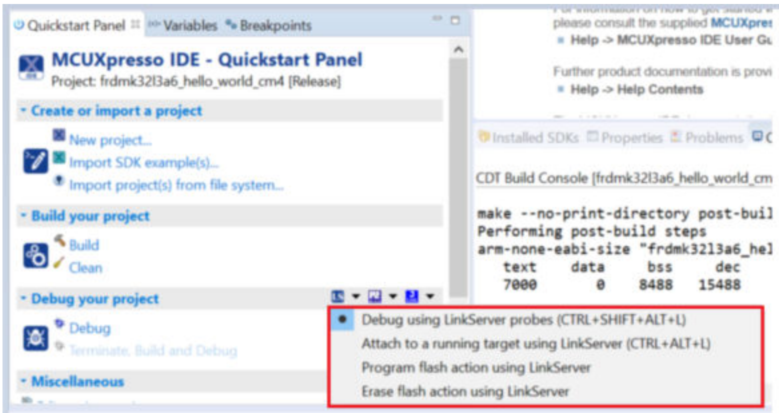


Figure 17. Debug "frdmk32l3a6_hello_world_cm4" case

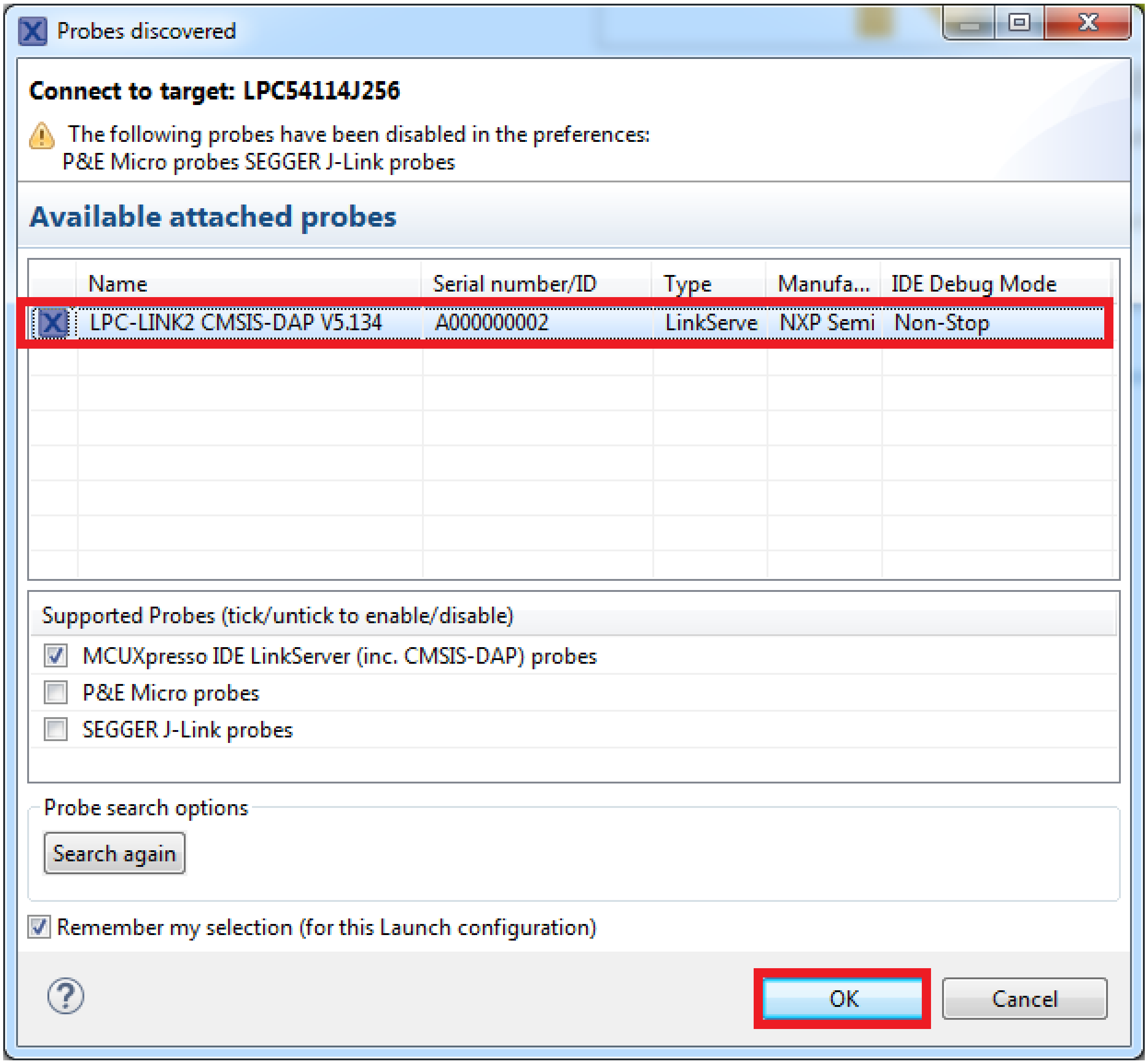


Figure 18. Attached Probes: debug emulator selection

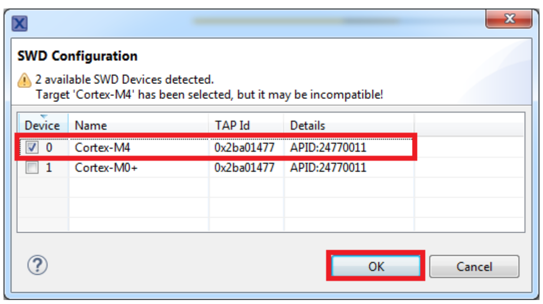


Figure 19. Target core selection dialogue

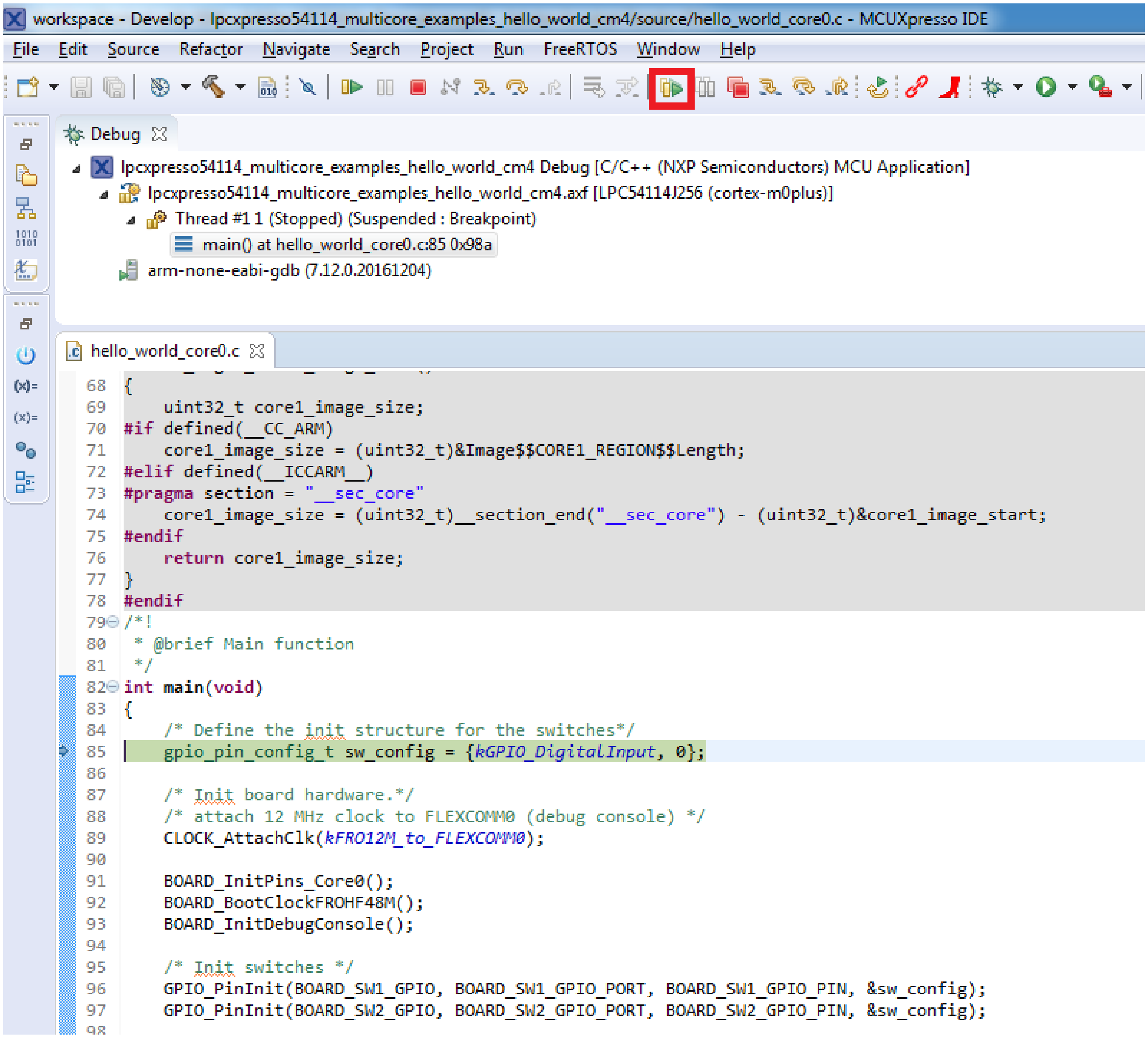


Figure 20. Stop the primary core application at main() when running debugging

After clicking the "Resume All Debug sessions" button, the hello_world multicore application runs and a banner is displayed on the terminal. If this is not the case, check your terminal settings and connections.

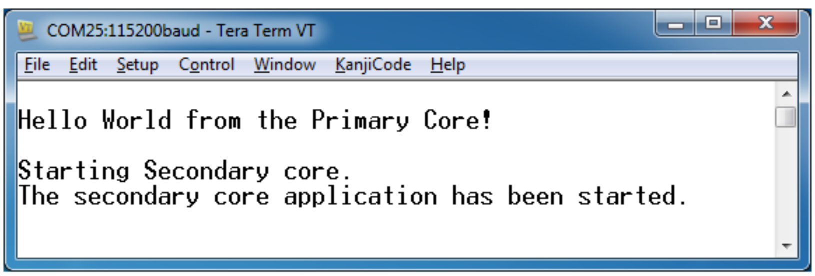


Figure 21. Hello World from the primary core message

An LED controlled by the auxiliary core starts flashing, indicating that the auxiliary core has been released from the reset and running correctly. It is also possible to debug both sides of the multicore application in parallel. After creating the debug session for the primary core, perform same steps also for the auxiliary core application. Highlight the lpcxpresso54114_multicore_examples_hello_world_cm0plus project (multicore slave project) in the Project Explorer. On the Quickstart Panel, click "Debug 'lpcxpresso54114_multicore_examples_hello_world_cm0plus' [Debug]" to launch the second debug session.

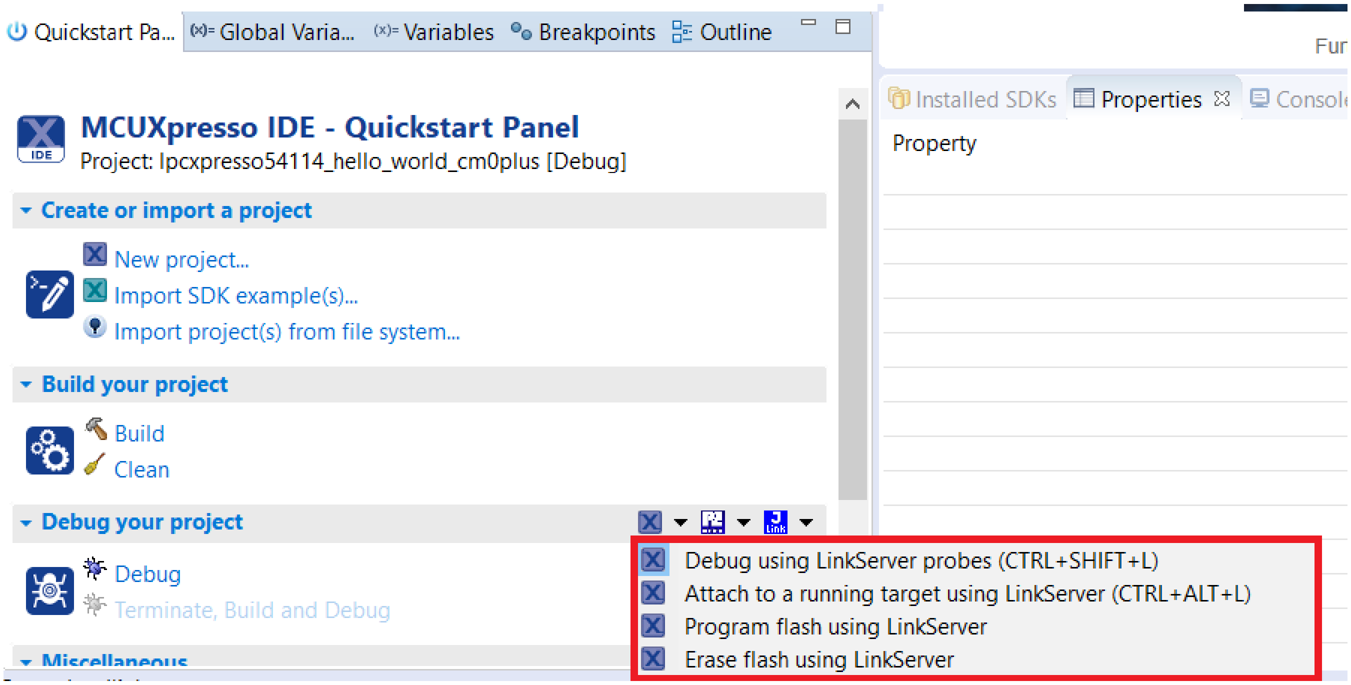


Figure 22. Debug "lpcxpresso54114_multicore_examples_hello_world_cm0plus" case

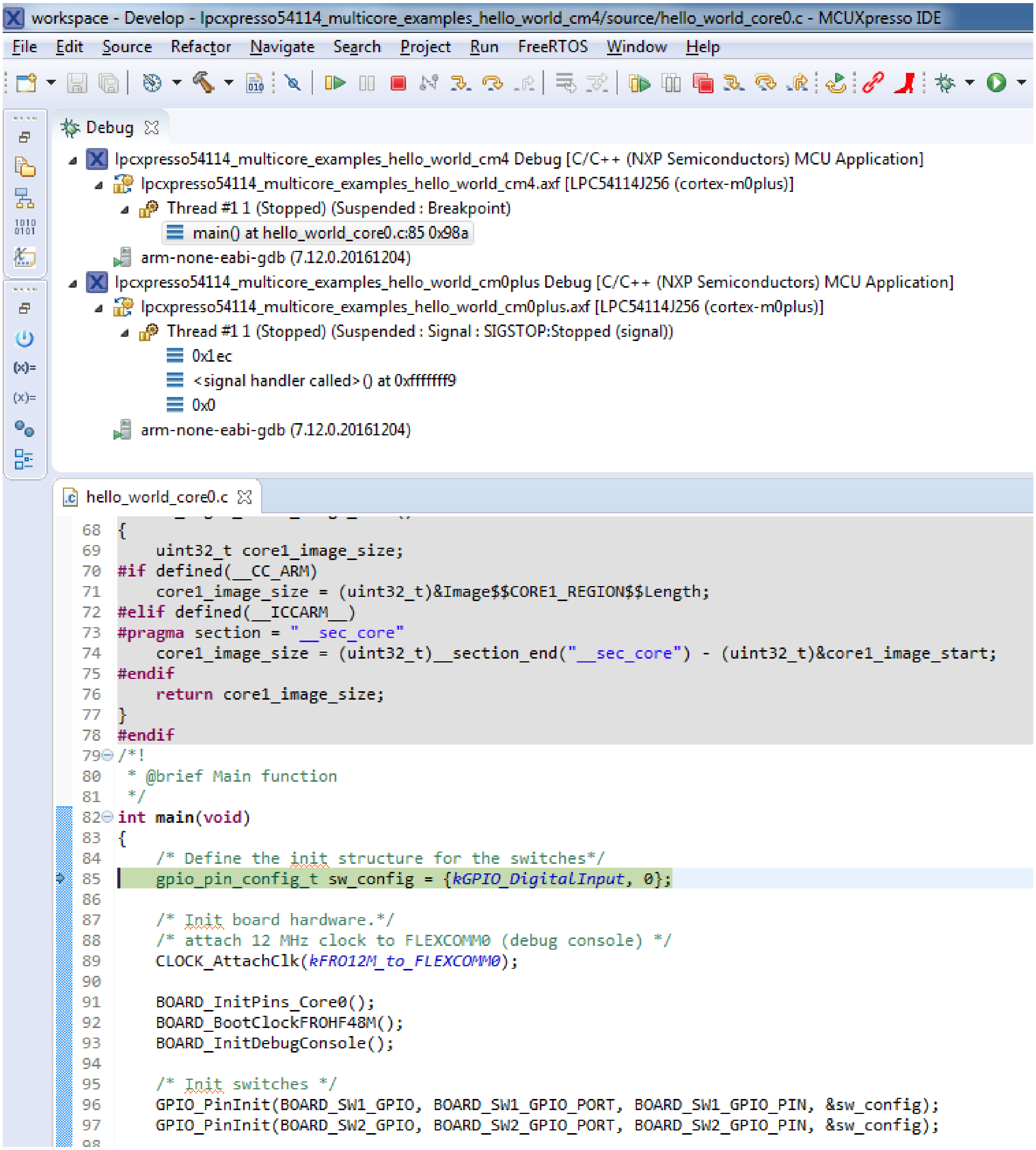


Figure 23. Two opened debug sessions

Now, the two debug sessions should be opened, and the debug controls can be used for both debug sessions depending on the debug session selection. Keep the primary core debug session selected by clicking the "Resume" button. The hello_world multicore application then starts running. The primary core application starts the auxiliary core application during run time, and the auxiliary core application stops at the beginning of the main() function. The debug session of the auxiliary core application is highlighted. After clicking the “Resume” button, it is applied to the auxiliary core debug session. Therefore, the auxiliary core application continues its execution.

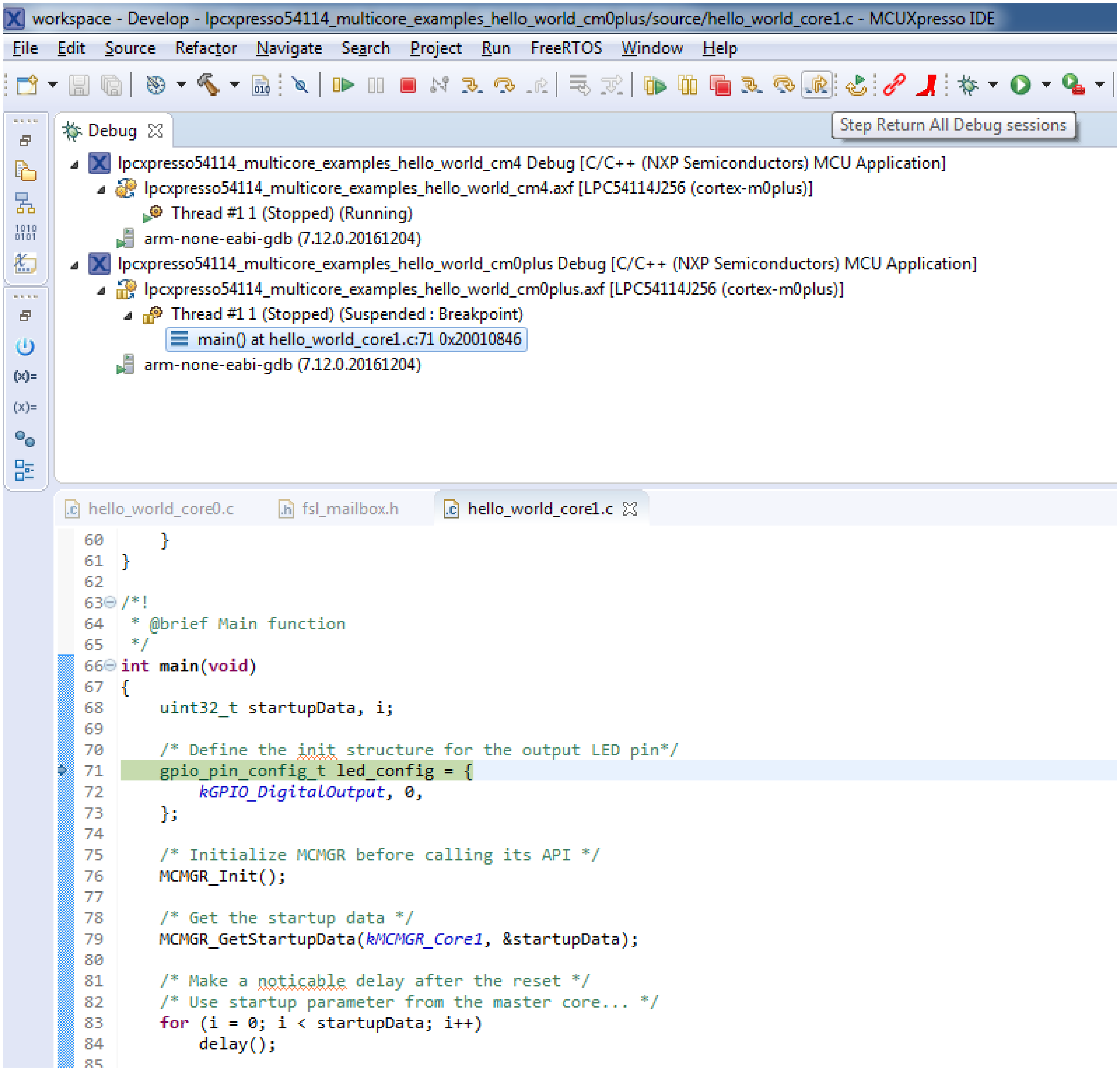


Figure 24. Auxiliary core application stops at the main function

At this point, it is possible to suspend and resume individual cores independently. It is also possible to make synchronous suspension and resumption of both the cores. This is done either by selecting both opened debug sessions (multiple selection) and clicking the “Suspend” / "Resume” control button, or just using the “Suspend All Debug sessions” and the “Resume All Debug sessions” buttons.

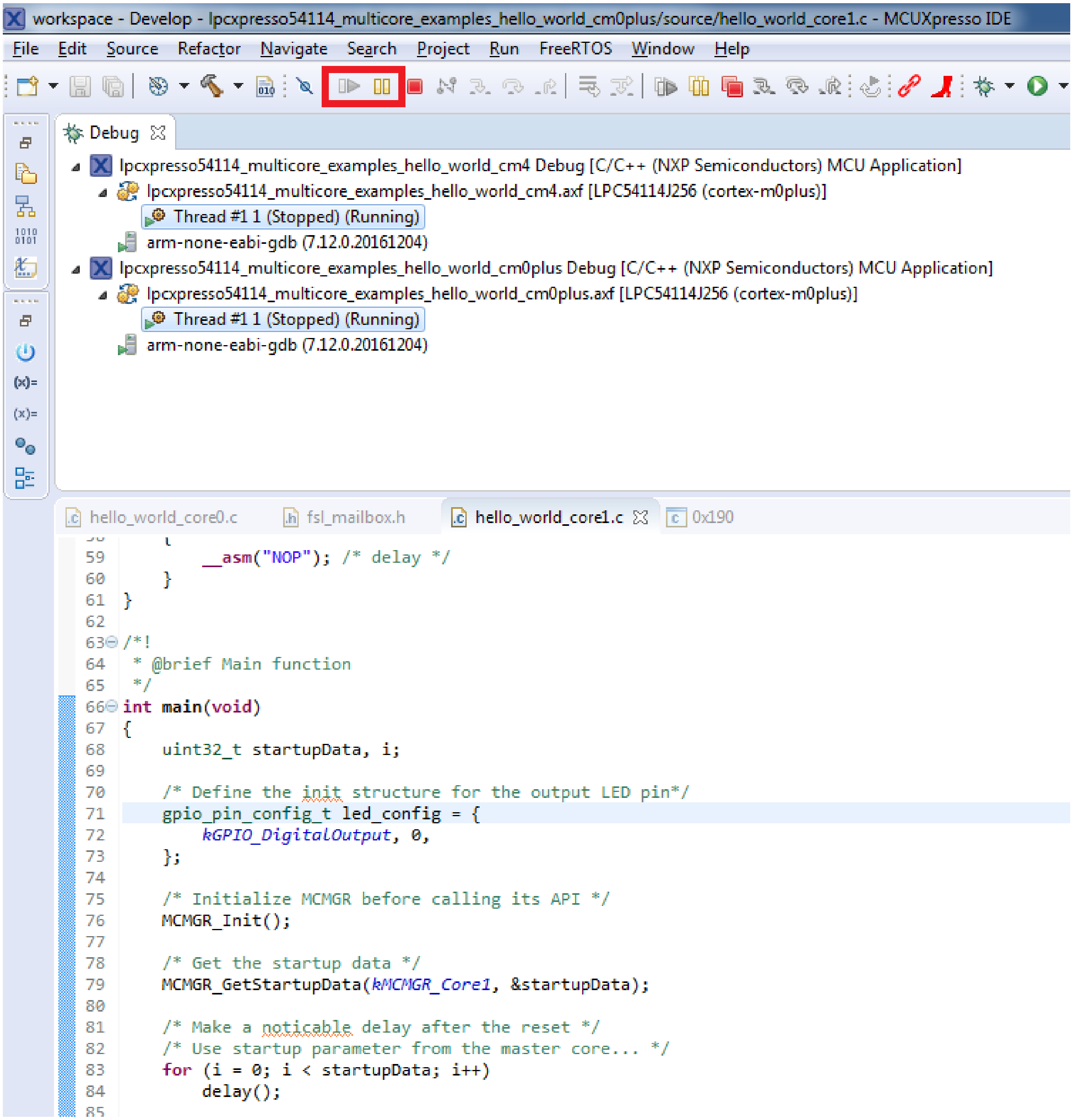


Figure 25. Synchronous suspension/resumption of both cores using the multiple selection of debug sessions and “Suspend”/"Resume” controls

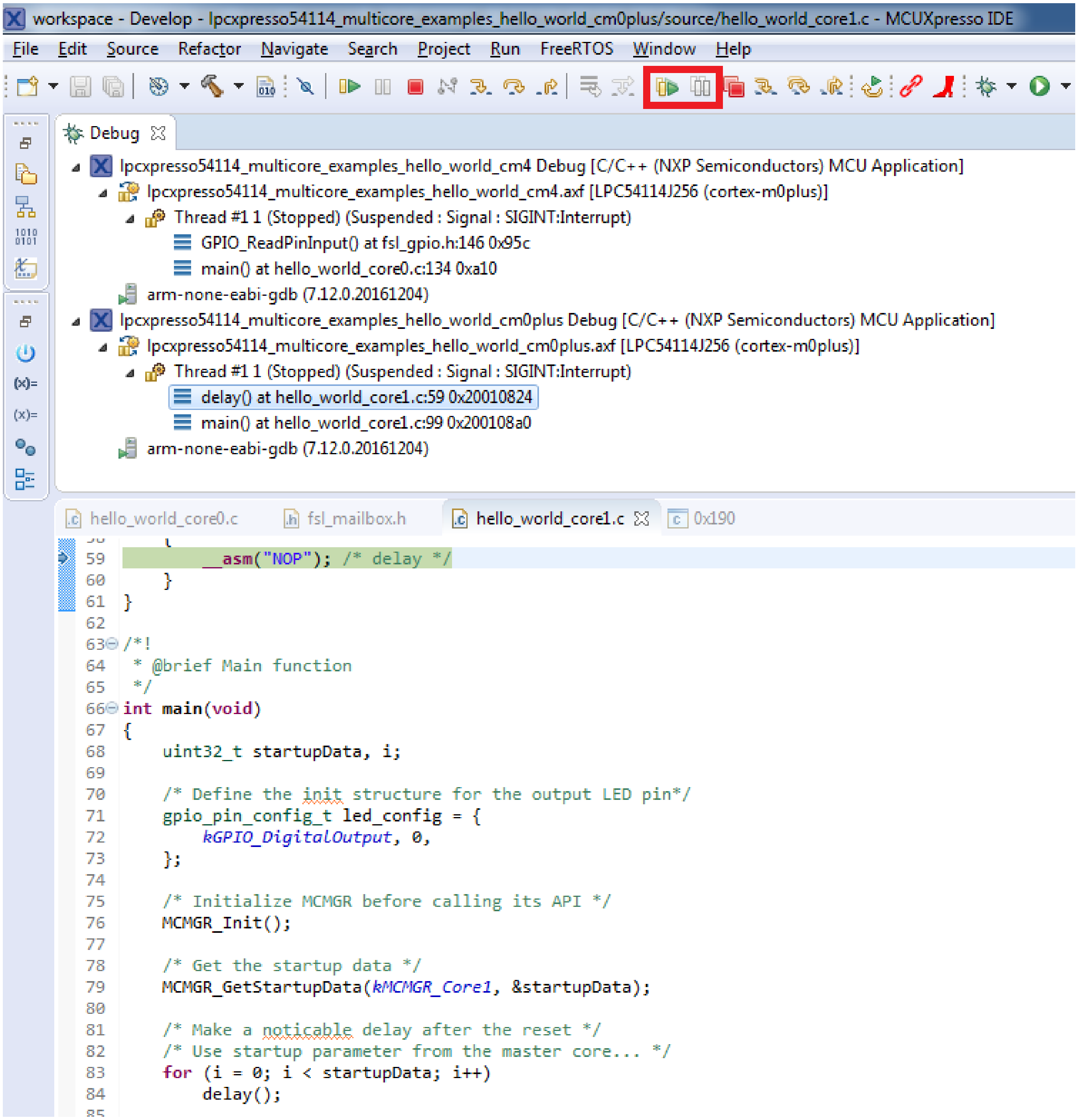


Figure 26. Synchronous suspension/resumption of both cores using the "Suspend All Debug sessions" and the "Resume All Debug sessions" controls

4 Run a demo application using IAR

This section describes the steps required to build, run, and debug example applications provided in the MCUXpresso SDK.

NOTE

IAR Embedded Workbench for Arm version 8.32.3 is used in the following example, and the IAR toolchain should correspond to the latest supported version, as described in the *MCUXpresso SDK Release Notes*.

4.1 Build an example application

Do the following steps to build the `hello_world` example application.

1. Open the desired demo application workspace. Most example application workspace files can be located using the following path:

   ```
   <install_dir>/boards/<board_name>/<example_type>/<application_name>/iar
   ```

   Using the FRDM-K64F Freedom hardware platform as an example, the `hello_world` workspace is located in:

   ```
   <install_dir>/boards/frdmk64f/demo_apps/hello_world/iar/hello_world.eww
   ```

   Other example applications may have additional folders in their path.

2. Select the desired build target from the drop-down menu.

   For this example, select **hello_world – debug**.

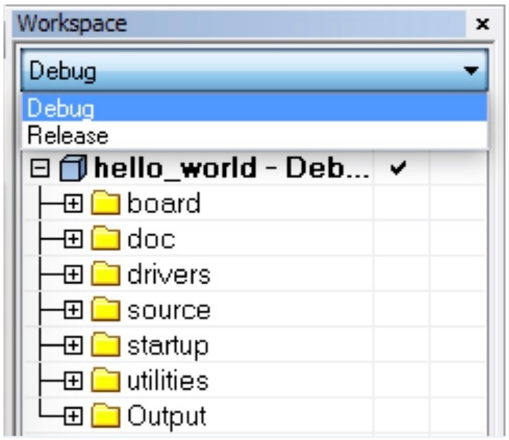


Figure 27. Demo build target selection

3. To build the demo application, click **Make**, highlighted in red in Figure 28.

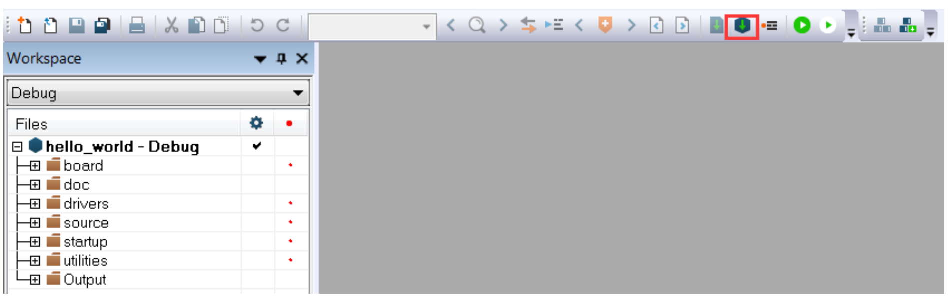


Figure 28. Build the demo application

4. The build completes without errors.

4.2 Run an example application

To download and run the application, perform these steps:

1. See the table in Default debug interfaces to determine the debug interface that comes loaded on your specific hardware platform.
   - For boards with CMSIS-DAP/mbed/DAPLink interfaces, visit developer.mbed.org/handbook/Windows-serial-configuration and follow the instructions to install the Windows® operating system serial driver. If running on Linux® OS, this step is not required.
   - The user should install LPCScrypt or MCUXpresso IDE to ensure LPC board drivers are installed.
   - For boards with P&E Micro interfaces, visit www.pemicro.com/support/downloads_find.cfm and download the P&E Micro Hardware Interface Drivers package.
2. Connect the development platform to your PC via USB cable.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug COM port (to determine the COM port number, see How to determine COM port). Configure the terminal with these settings:

   a. 115200 or 9600 baud rate, depending on your board (reference `BOARD_DEBUG_UART_BAUDRATE` variable in the `board.h` file)
   b. No parity
   c. 8 data bits
   d. 1 stop bit

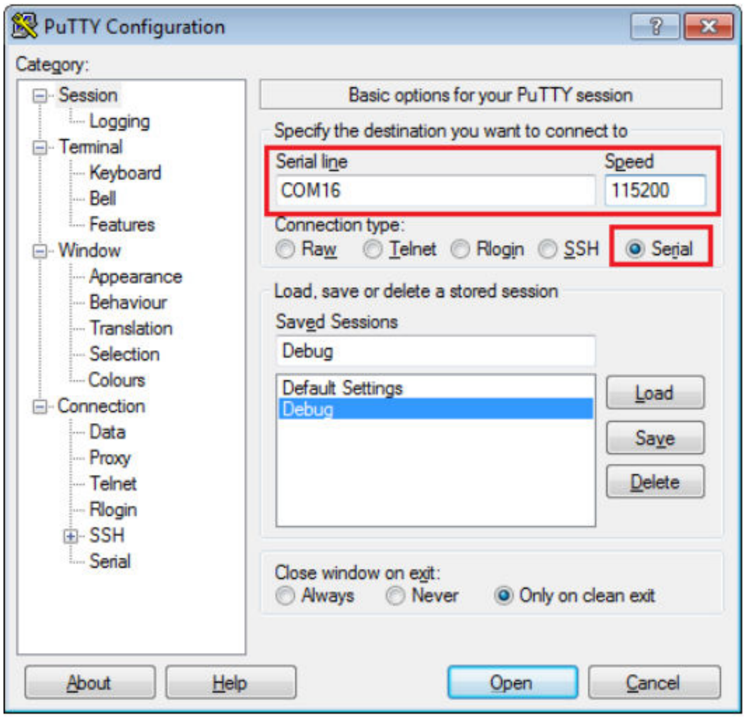


Figure 29. Terminal (PuTTY) configuration

4. In IAR, click the **Download and Debug** button to download the application to the target.

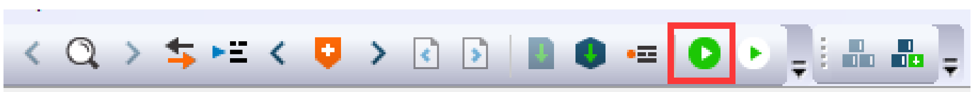


Figure 30. Download and Debug button

5. The application is then downloaded to the target and automatically runs to the `main()` function.

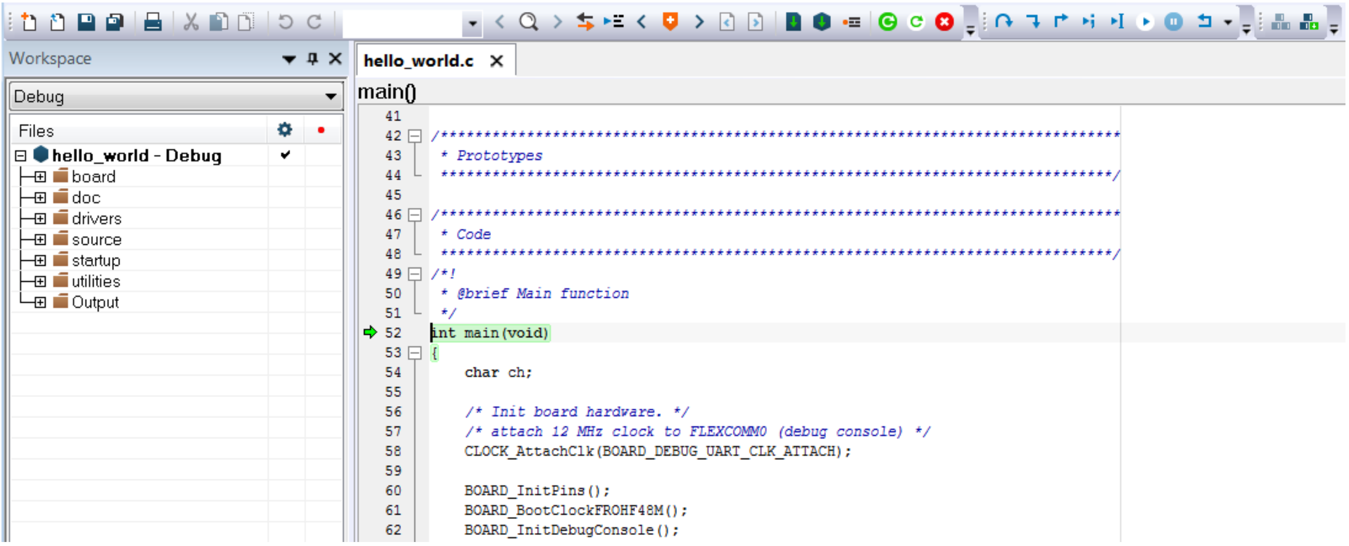


Figure 31. Stop at `main()` when running debugging

6. Run the code by clicking the **Go** button.

Figure 32. Go button

7. The `hello_world` application is now running and a banner is displayed on the terminal. If it does not appear, check your terminal settings and connections.

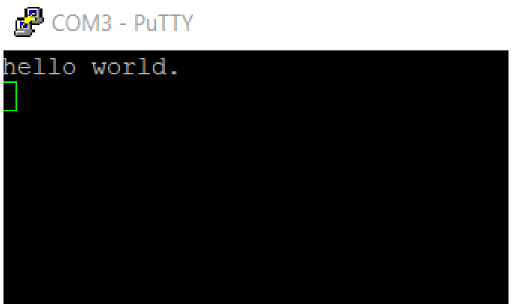


Figure 33. Text display of the `hello_world` demo

4.3 Build a multicore example application

This section describes the steps to build and run a dual-core application. The demo applications workspace files are located in this folder:

<install_dir>/boards/<board_name>/multicore_examples/<application_name>/<core_type>/iar

Begin with a simple dual-core version of the Hello World application. The multicore Hello World IAR workspaces are located in this folder:

<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm0plus/iar/hello_world_cm0plus.eww

<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm4/iar/hello_world_cm4.eww

Build both applications separately by clicking the **Make** button. Build the application for the auxiliary core (cm0plus) first, because the primary core application project (cm4) needs to know the auxiliary core application binary when running the linker. It is not possible to finish the primary core linker when the auxiliary core application binary is not ready.

4.4 Run a multicore example application

The primary core debugger handles flashing both primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform steps 1 – 4 as described in *Run an example application*. These steps are common for both single core and dual-core applications in IAR.

After clicking the “Download and Debug" button, the auxiliary core project is opened in the separate EWARM instance. Both the primary and auxiliary image are loaded into the device flash memory and the primary core application is executed. It stops at the default C language entry point in the *main()* function.

Run both cores by clicking the "Start all cores" button to start the multicore application.

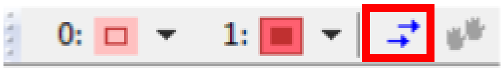


Figure 34. Start all cores button

During the primary core code execution, the auxiliary core is released from the reset. The hello_world multicore application is now running and a banner is displayed on the terminal. If this does not appear, check the terminal settings and connections.

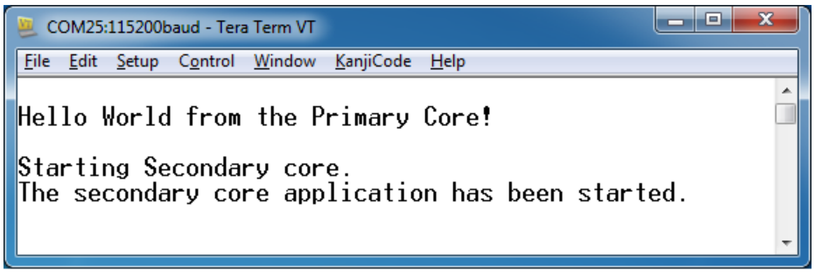


Figure 35. Hello World from primary core message

An LED controlled by the auxiliary core starts flashing, indicating that the auxiliary core has been released from the reset and is running correctly. When both cores are running, use the "Stop all cores" and "Start all cores" control buttons to stop or run both cores simultaneously.

Figure 36. "Stop all cores" and "Start all cores" control buttons

5 Run a demo using Keil® MDK/μVision

This section describes the steps required to build, run, and debug example applications provided in the MCUXpresso SDK. The `hello_world` demo application targeted for the FRDM-K64F Freedom hardware platform is used as an example, although these steps can be applied to any demo or example application in the MCUXpresso SDK.

5.1 Install CMSIS device pack

After the MDK tools are installed, Cortex® Microcontroller Software Interface Standard (CMSIS) device packs must be installed to fully support the device from a debug perspective. These packs include things such as memory map information, register definitions, and flash programming algorithms. Follow these steps to install the appropriate CMSIS pack.

1. Open the MDK IDE, which is called µVision. In the IDE, select the **Pack Installer** icon.

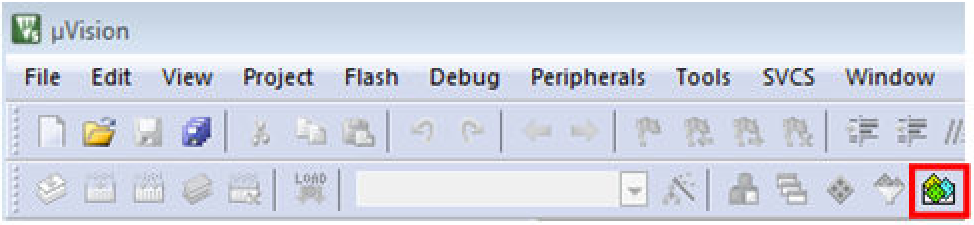


Figure 37. Launch the Pack Installer

2. After the installation finishes, close the Pack Installer window and return to the µVision IDE.

5.2 Build an example application

1. Open the desired example application workspace in:

   `<install_dir>/boards/<board_name>/<example_type>/<application_name>/mdk`

   The workspace file is named as `<demo_name>.uvmpw`. For this specific example, the actual path is:

   `<install_dir>/boards/frdmk64f/demo_apps/hello_world/mdk/hello_world.uvmpw`
2. To build the demo project, select **Rebuild**, highlighted in red.

Figure 38. Build the demo

3. The build completes without errors.

5.3 Run an example application

To download and run the application, perform these steps:

1. See the table in Default debug interfaces to determine the debug interface that comes loaded on your specific hardware platform.

   - For boards with the CMSIS-DAP/mbed/DAPLink interface, visit mbed Windows serial configuration and follow the instructions to install the Windows operating system serial driver. If running on Linux OS, this step is not required.
   - The user should install LPCScrypt or MCUXpresso IDE to ensure LPC board drivers are installed.
   - For boards with a P&E Micro interface, visit www.pemicro.com/support/downloads_find.cfm and download and install the P&E Micro Hardware Interface Drivers package.
   - If using J-Link either a standalone debug pod or OpenSDA, install the J-Link software (drivers and utilities) from www.segger.com/jlink-software.html.
   - For boards with the OSJTAG interface, install the driver from www.keil.com/download/docs/408.
2. Connect the development platform to your PC via USB cable using OpenSDA USB connector.

3. Open the terminal application on the PC, such as PuTTY or TeraTerm and connect to the debug serial port number (to determine the COM port number, see How to determine COM port). Configure the terminal with these settings:
    a. 115200 or 9600 baud rate, depending on your board (reference `BOARD_DEBUG_UART_BAUDRATE` variable in the `board.h` file)
    b. No parity
    c. 8 data bits
    d. 1 stop bit

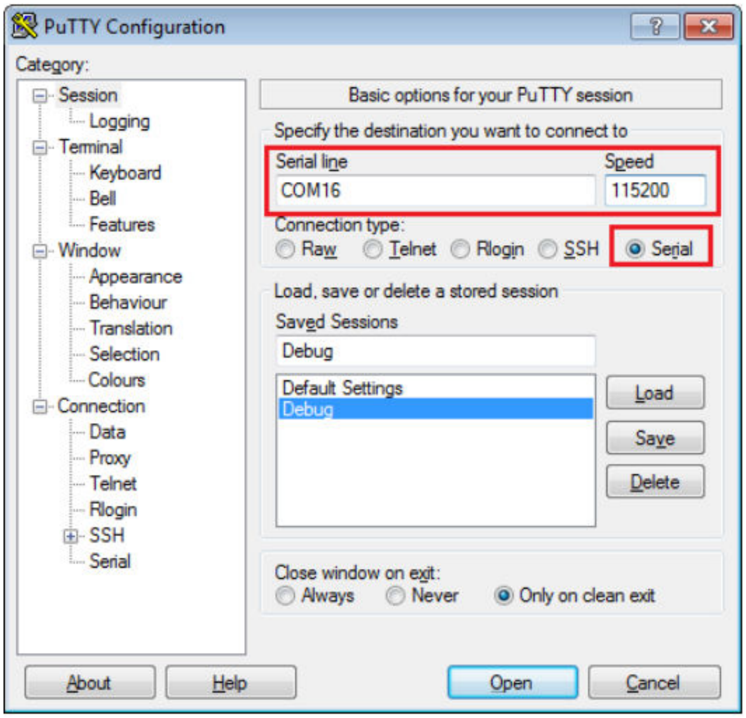


Figure 39. Terminal (PuTTY) configurations

4. In μVision, after the application is built, click the **Download** button to download the application to the target.

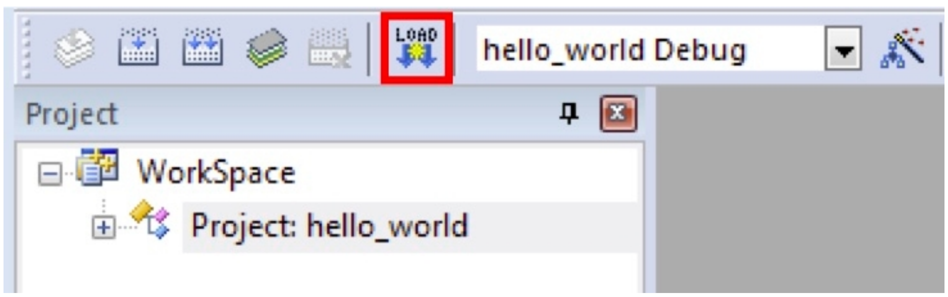


Figure 40. Download button

5. After clicking the **Download** button, the application downloads to the target and is running. To debug the application, click the **Start/Stop Debug Session** button, highlighted in red.

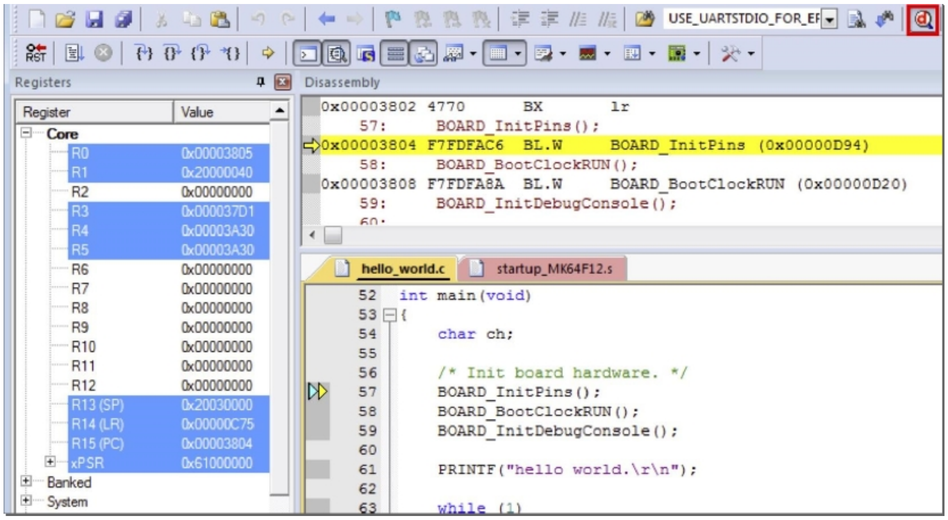


Figure 41. Stop at `main()` when run debugging

6. Run the code by clicking the **Run** button to start the application.

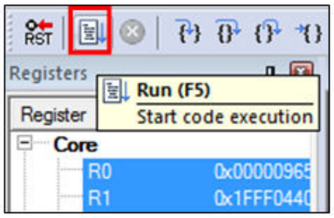


Figure 42. Go button

The `hello_world` application is now running and a banner is displayed on the terminal. If this does not appear, check your terminal settings and connections.

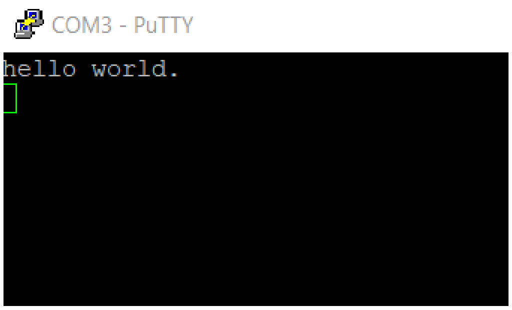


Figure 43. Text display of the hello_world demo

5.4 Build a multicore example application

This section describes the steps to build and run a dual-core application. The demo applications workspace files are located in this folder:

<install_dir>/boards/<board_name>/multicore_examples/<application_name>/<core_type>/mdk

Begin with a simple dual-core version of the Hello World application. The multicore Hello World Keil MSDK/µVision® workspaces are located in this folder:

<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm0plus/mdk/hello_world_cm0plus.uvmpw

<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm4/mdk/hello_world_cm4.uvmpw

Build both applications separately by clicking the **Rebuild** button. Build the application for the auxiliary core (cm0plus) first because the primary core application project (cm4) needs to know the auxiliary core application binary when running the linker. It is not possible to finish the primary core linker when the auxiliary core application binary is not ready.

5.5 Run a multicore example application

The primary core debugger flashes both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform steps 1 – 5 as described in *Run an example application*. These steps are common for both single-core and dual-core applications in µVision.

Both the primary and the auxiliary image is loaded into the device flash memory. After clicking the “Run" button, the primary core application is executed. During the primary core code execution, the auxiliary core is released from the reset. The hello_world multicore application is now running and a banner is displayed on the terminal. If this does not appear, check your terminal settings and connections.

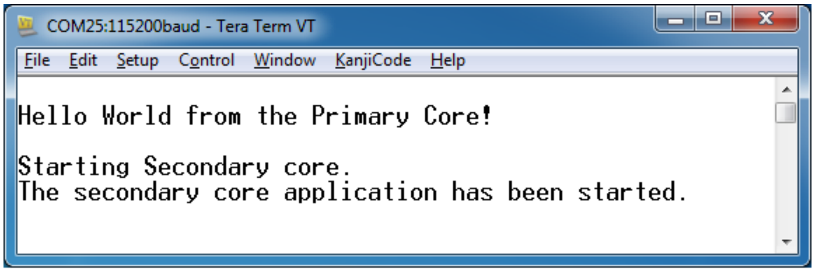


Figure 44. Hello World from primary core message

An LED controlled by the auxiliary core starts flashing indicating that the auxiliary core has been released from the reset and is running correctly.

Attach the running application of the auxiliary core by opening the auxiliary core project in the second µVision instance and clicking the “Start/Stop Debug Session” button. After this, the second debug session is opened and the auxiliary core application can be debugged.

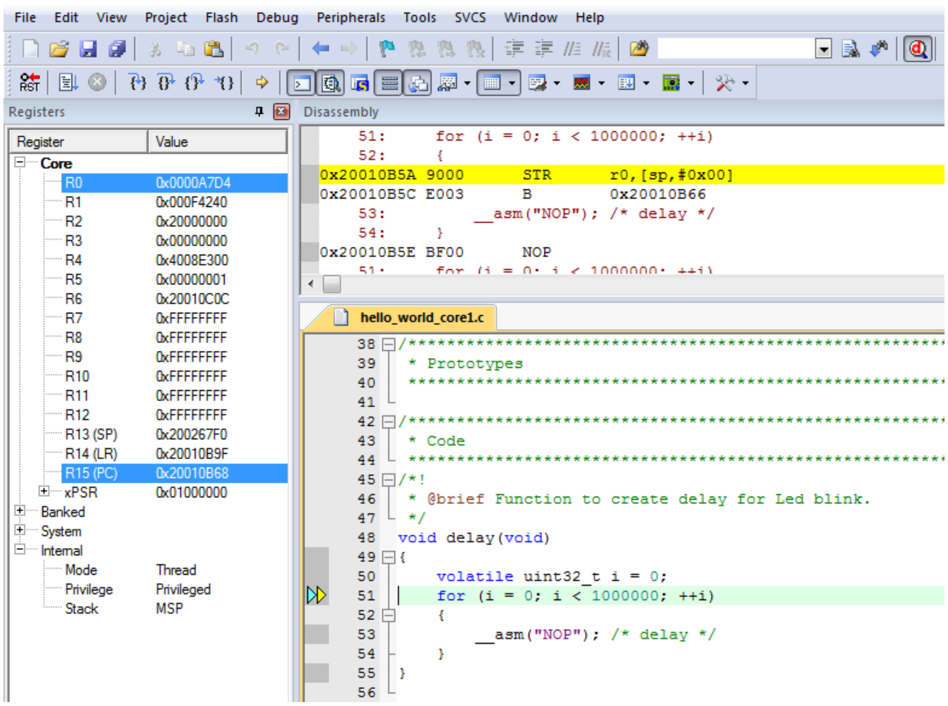


Figure 45. Debugging the auxiliary core application

Arm describes multi-core debugging using the NXP LPC54114 Cortex-M4/M0+ dual-core processor and Keil uVision IDE in Application Note 318 at www.keil.com/appnotes/docs/apnt_318.asp. The associated video can be found here.

6 Run a demo using Arm® GCC

This section describes the steps to configure the command line Arm® GCC tools to build, run, and debug demo applications and necessary driver libraries provided in the MCUXpresso SDK. The `hello_world` demo application is targeted for the FRDM-K64F Freedom hardware platform which is used as an example.

NOTE

GCC ARM Embedded 8.2.1 is used as an example in this document. The latest GCC version for this package is as described in the *MCUXpresso SDK Release Notes*.

6.1 Set up toolchain

This section contains the steps to install the necessary components required to build and run an MCUXpresso SDK demo application with the Arm GCC toolchain, as supported by the MCUXpresso SDK. There are many ways to use Arm GCC tools, but this example focuses on a Windows operating system environment.

6.1.1 Install GCC Arm Embedded tool chain

Download and run the installer from developer.arm.com/open-source/gnu-toolchain/gnu-rm. This is the actual toolset (in other words, compiler, linker, and so on). The GCC toolchain should correspond to the latest supported version, as described in *MCUXpresso SDK Release Notes*.

6.1.2 Install MinGW (only required on Windows OS)

The Minimalist GNU for Windows (MinGW) development tools provide a set of tools that are not dependent on third-party C-Runtime DLLs (such as Cygwin). The build environment used by the MCUXpresso SDK does not use the MinGW build tools, but does leverage the base install of both MinGW and MSYS. MSYS provides a basic shell with a Unix-like interface and tools.

1. Download the latest MinGW mingw-get-setup installer from sourceforge.net/projects/mingw/files/Installer/.
2. Run the installer. The recommended installation path is `C:\MinGW`, however, you may install to any location.

NOTE

The installation path cannot contain any spaces.

3. Ensure that the **mingw32-base** and **msys-base** are selected under **Basic Setup**.

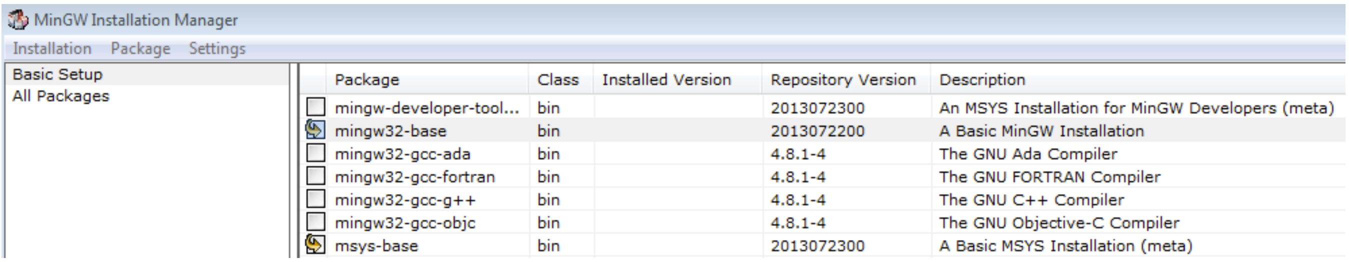


Figure 46. Set up MinGW and MSYS

4. In the **Installation** menu, click **Apply Changes** and follow the remaining instructions to complete the installation.

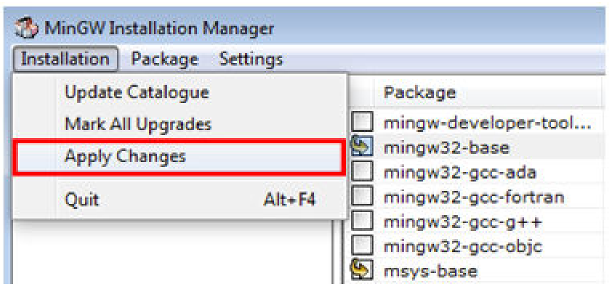


Figure 47. Complete MinGW and MSYS installation

5. Add the appropriate item to the Windows operating system path environment variable. It can be found under **Control Panel->System and Security->System->Advanced System Settings** in the **Environment Variables...** section. The path is:

   ```
   <mingw_install_dir>\bin
   ```

   Assuming the default installation path,`C:\MinGW`, an example is shown below. If the path is not set correctly, the toolchain will not not work.

NOTE

If you have `C:\MinGW\msys\x.x\bin` in your PATH variable (as required by Kinetis SDK 1.0.0), remove it to ensure that the new GCC build system works correctly.

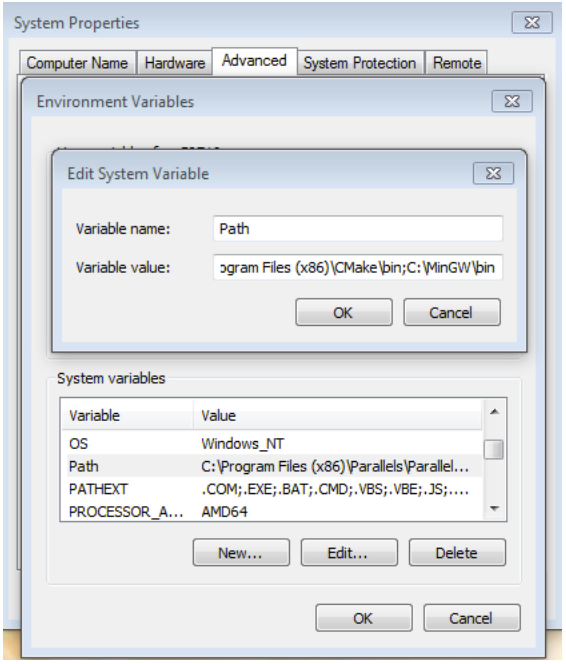


Figure 48. Add Path to systems environment

6.1.3 Add a new system environment variable for `ARMGCC_DIR`

Create a new *system* environment variable and name it as `ARMGCC_DIR`. The value of this variable should point to the Arm GCC Embedded tool chain installation path. For this example, the path is:

```
C:\Program Files (x86)\GNU Tools ARM Embedded\8 2018-q4-major
```

See the installation folder of the GNU Arm GCC Embedded tools for the exact path name of your installation.

Short path should be used for path setting, you could convert the path to short path by running command *"for %I in (.) do echo %~sI"* in above path.

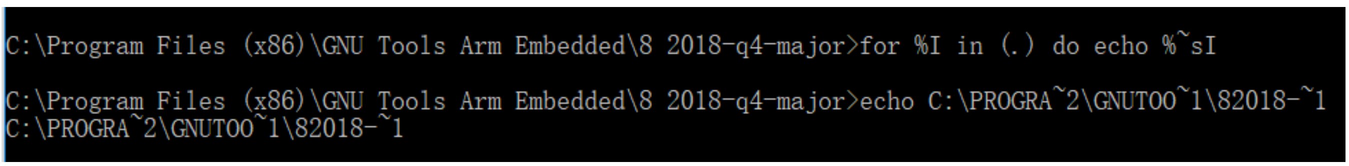


Figure 49. Convert path to short path

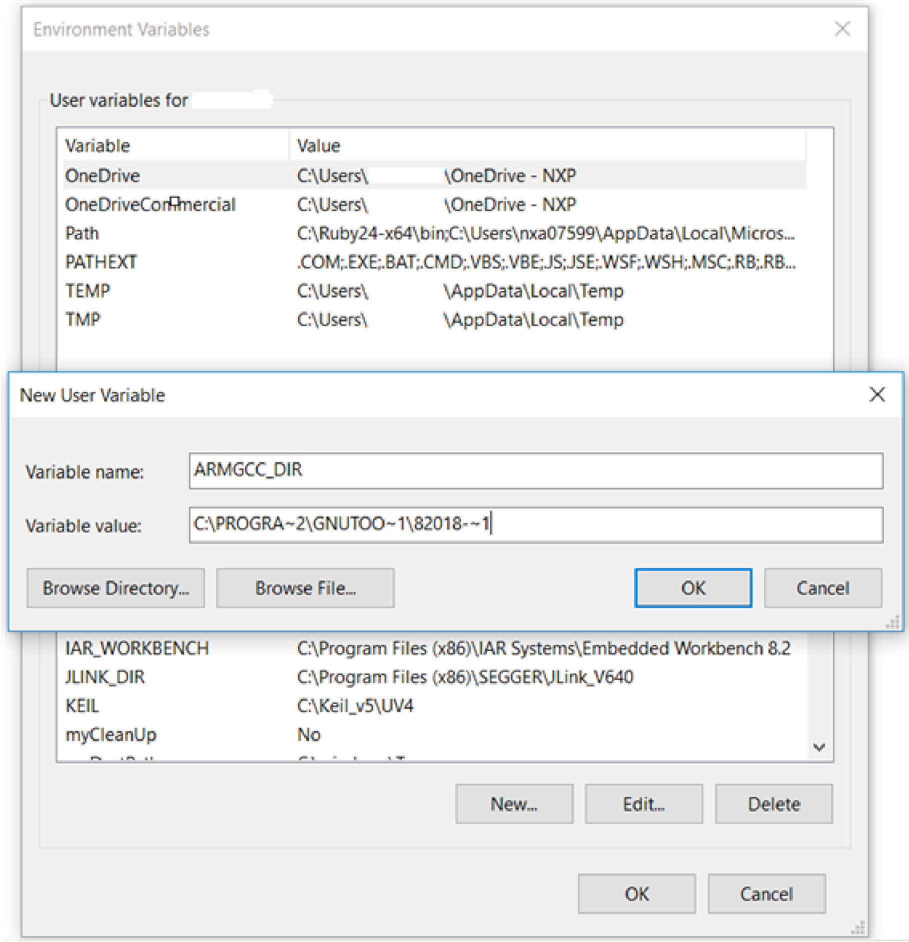


Figure 50. Add ARMGCC_DIR system variable

6.1.4 Install CMake

1. Download CMake 3.0.x from www.cmake.org/cmake/resources/software.html.
2. Install CMake, ensuring that the option **Add CMake to system PATH** is selected when installing. The user chooses to select whether it is installed into the PATH for all users or just the current user. In this example, it is installed for all users.

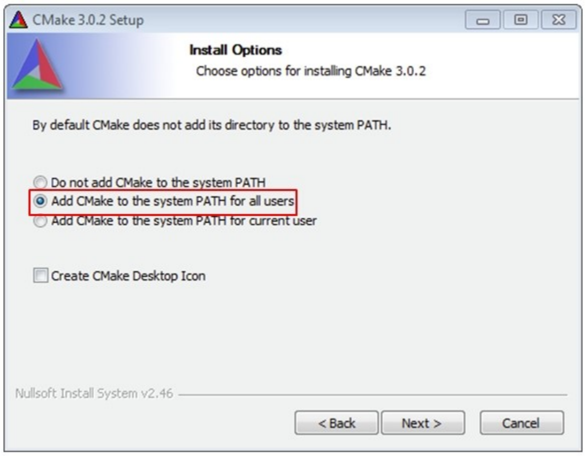


Figure 51. Install CMake

3. Follow the remaining instructions of the installer.
4. You may need to reboot your system for the PATH changes to take effect.
5. Make sure `sh.exe` is not in the Environment Variable PATH. This is a limitation of `mingw32-make`.

6.2 Build an example application

To build an example application, follow these steps.

1. Open a GCC Arm Embedded tool chain command window. To launch the window, from the Windows operating system Start menu, go to **Programs ->GNU Tools ARM Embedded <version>** and select **GCC Command Prompt**.

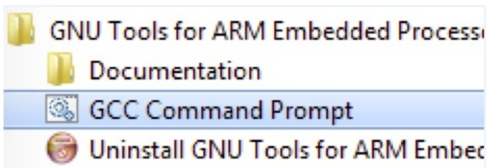


Figure 52. Launch command prompt

2. Change the directory to the example application project directory which has a path similar to the following:

```
<install_dir>/boards/<board_name>/<example_type>/<application_name>/armgcc
```

For this example, the exact path is:

```
<install_dir>/examples/frdmk64f/demo_apps/hello_world/armgcc
```

NOTE

To change directories, use the `cd` command.

3. Type **build_debug.bat** on the command line or double click on **build_debug.bat** file in Windows Explorer to build it. The output is shown in this figure:

Figure 53. `hello_world` demo build successful

6.3 Run an example application

This section describes steps to run a demo application using J-Link GDB Server application. To complete the set-up check if your board supports OpenSDA in Default debug interfaces

If your board supports OpenSDA

- The OpenSDA interface on your board is pre-programmed with the J-Link OpenSDA firmware.
- For instructions on reprogramming the OpenSDA interface, see Updating OpenSDA firmware.

If your board does not support OpenSDA

- A standalone J-Link pod is required which should be connected to the debug interface of your board.

NOTE

Some hardware platforms require hardware modification in order to function correctly with an external debug interface.

NOTE

J-Link GDB Server application is not supported for TFM examples. Use CMSIS DAP instead of J-Link for flashing and debugging TFM examples.

After the J-Link interface is configured and connected, follow these steps to download and run the demo applications:

1. Connect the development platform to your PC via USB cable between the OpenSDA USB connector (may be named OSJTAG for some boards) and the PC USB connector. If using a standalone J-Link debug pod, connect it to the SWD/JTAG connector of the board.
2. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug serial port number (to determine the COM port number, see How to determine COM port). Configure the terminal with these settings:
    a. 115200 or 9600 baud rate, depending on your board (reference `BOARD_DEBUG_UART_BAUDRATE` variable in `board.h` file)
    b. No parity
    c. 8 data bits
    d. 1 stop bit

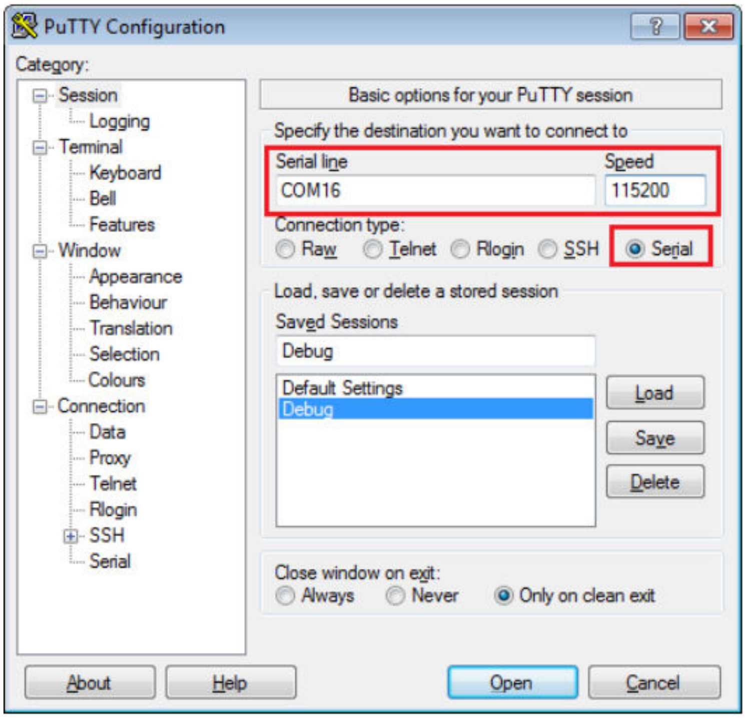


Figure 54. Terminal (PuTTY) configurations

3. Open the J-Link GDB Server application. Assuming the J-Link software is installed, the application can be launched by going to the Windows operating system Start menu and selecting **Programs** -> **SEGGER** -> **J-Link <version> J-Link GDB Server**.
4. Modify the settings as shown below. The target device selection chosen for this example is **MK64FN1M0xxx12**.
5. After it is connected, the screen should look like this figure:

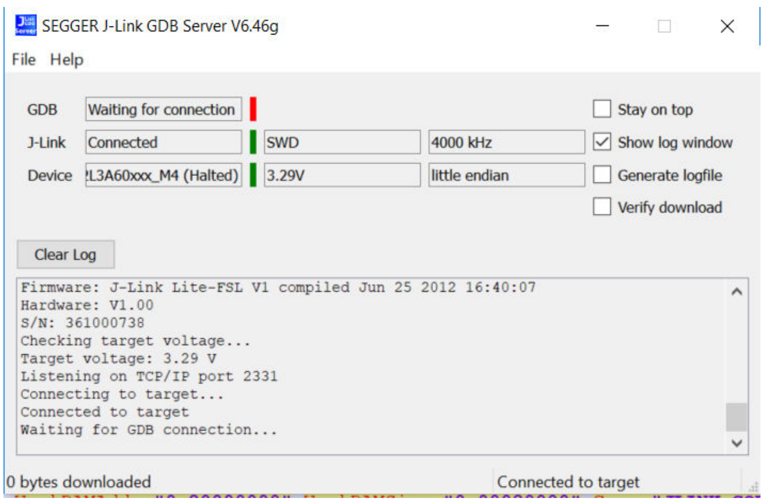


Figure 55. SEGGER J-Link GDB Server screen after successful connection

6. If not already running, open a GCC Arm Embedded tool chain command window. To launch the window, from the Windows operating system Start menu, go to **Programs** -> **GNU Tools Arm Embedded <version>** and select **GCC Command Prompt**.

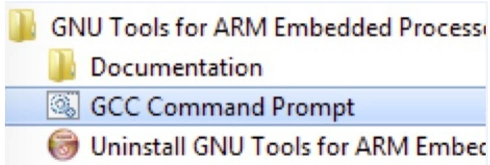


Figure 56. Launch command prompt

7. Change to the directory that contains the example application output. The output can be found in using one of these paths, depending on the build target selected:

   ```
   <install_dir>/boards/<board_name>/<example_type>/<application_name>/armgcc/debug
   ```

   ```
   <install_dir>/boards/<board_name>/<example_type>/<application_name>/armgcc/release
   ```

   For this example, the path is:

   ```
   <install_dir>/boards/frdmk3213a6/demo_apps/hello_world/cm4/armgcc/debug
   ```
8. Run the `arm-none-eabi-gdb.exe <application_name>.elf` command. For this example, it is `arm-none-eabi-gdb.exe hello_world.elf`.

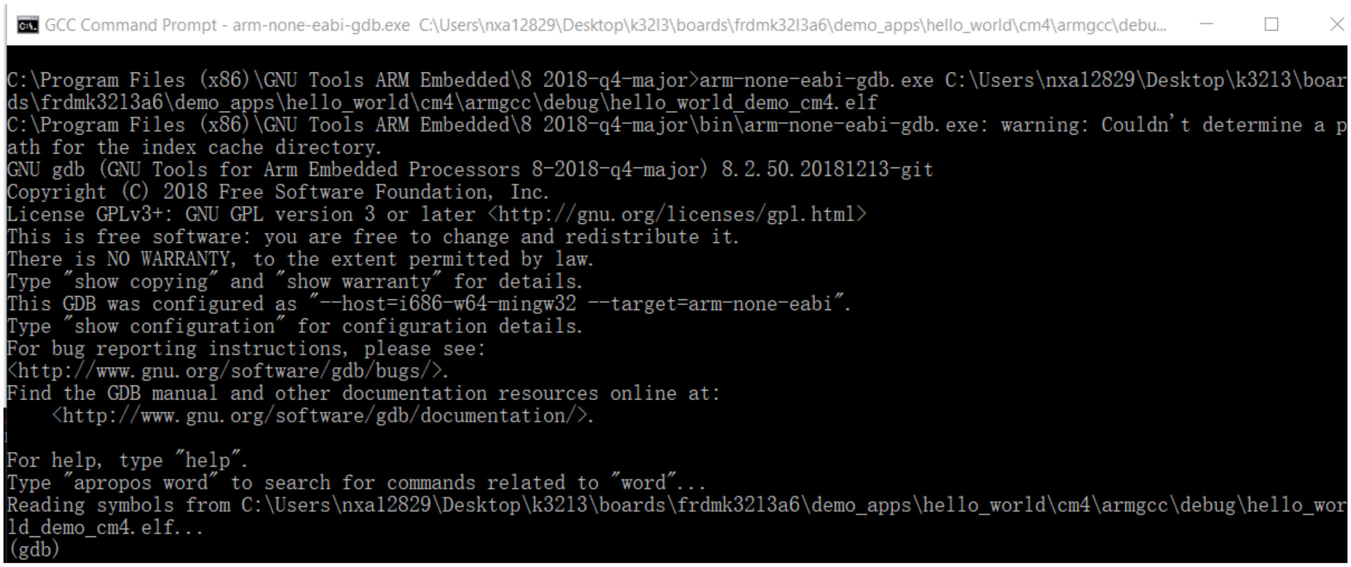


Figure 57. Run `arm-none-eabi-gdb`

9. Run these commands:
   a. `target remote localhost:2331`
   b. `monitor reset`
   c. `monitor halt`
   d. `load`
   e. `monitor reset`
10. The application is now downloaded and halted at the reset vector. Execute the `monitor go` command to start the demo application.

    The `hello_world` application is now running and a banner is displayed on the terminal. If this does not appear, check your terminal settings and connections.

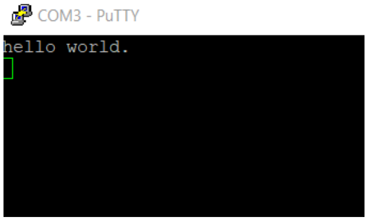


Figure 58. Text display of the hello_world demo

6.4 Build a multicore example application

This section describes the steps to build and run a dual-core application. The demo application build scripts are located in this folder:

```
<install_dir>/boards/<board_name>/multicore_examples/<application_name>/<core_type>/armgcc
```

Begin with a simple dual-core version of the Hello World application. The multicore Hello World GCC build scripts are located in this folder:

```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm0plus/armgcc/
build_debug.bat
```

```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm4/armgcc/
build_debug.bat
```

Build both applications separately following steps for single core examples as described in Build an example application.

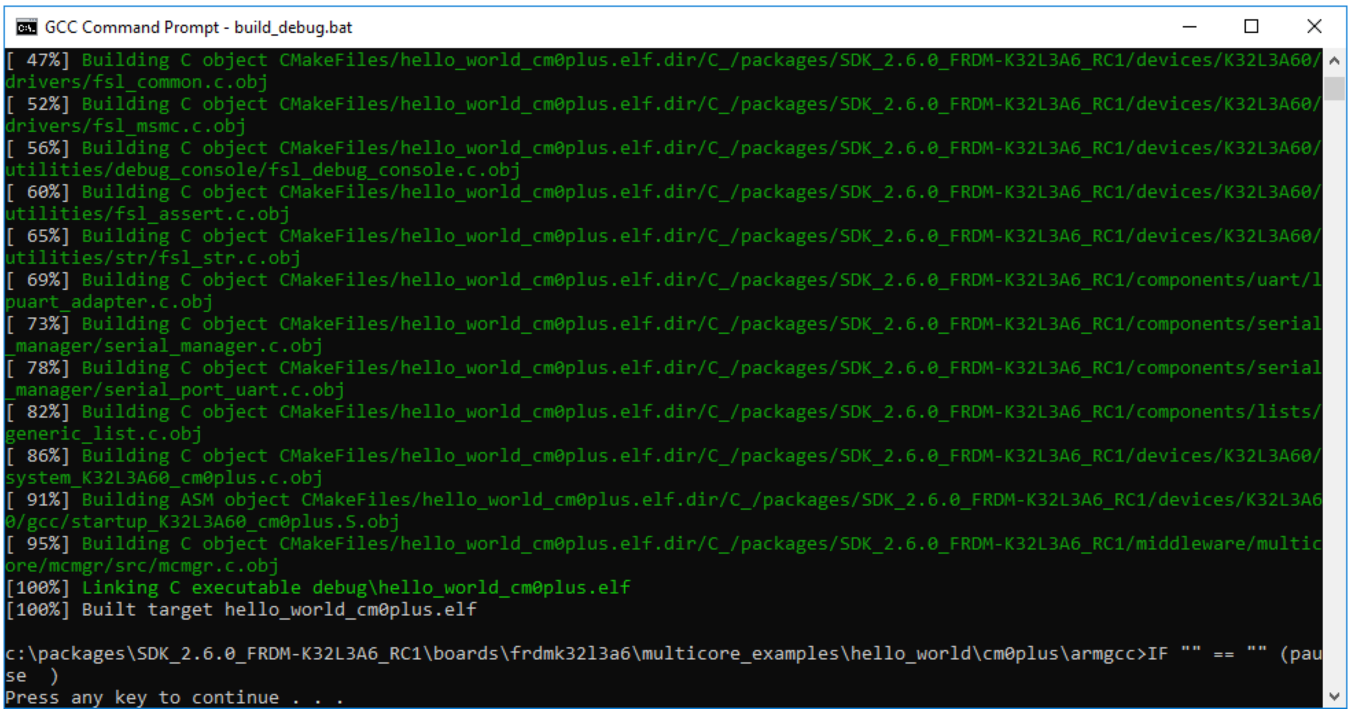


Figure 59. hello_world_cm0plus example build successful

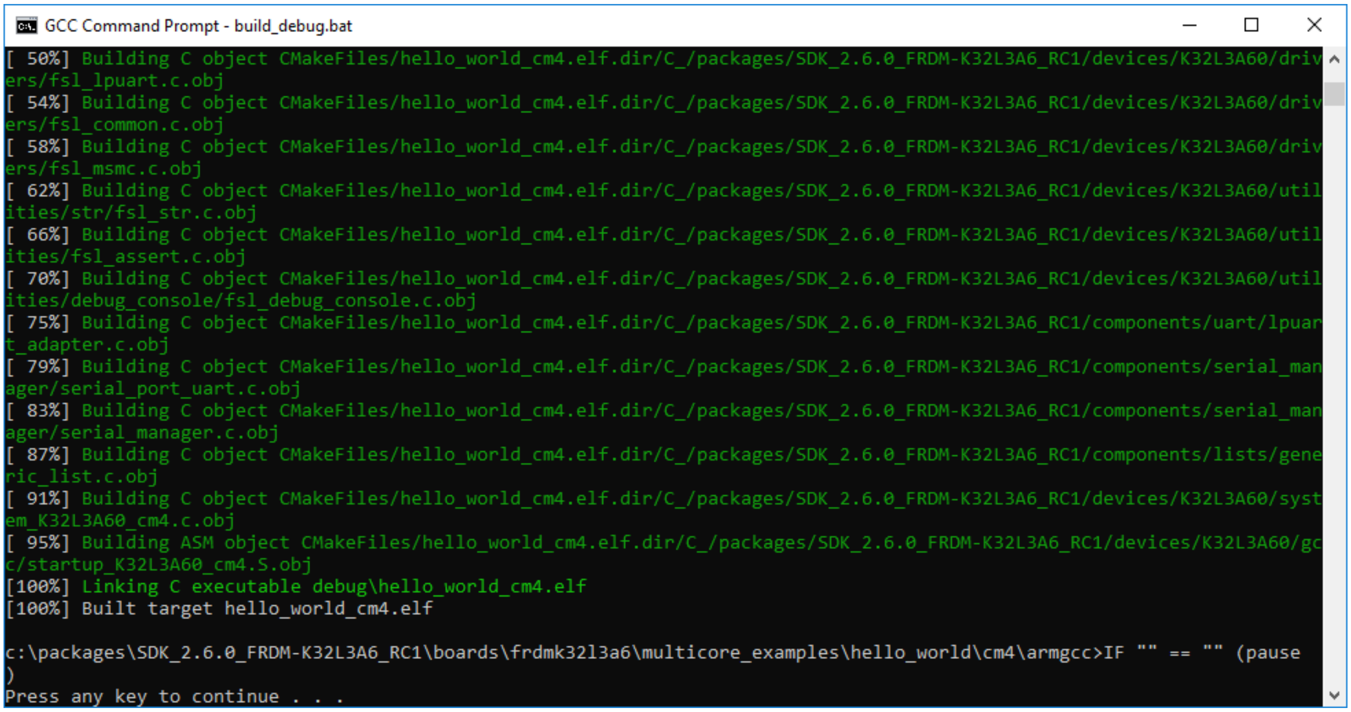


Figure 60. hello_world_cm4 example build successful

6.5 Run a multicore example application

When running a multicore application, the same prerequisites for J-Link/J-Link OpenSDA firmware, and the serial console as for the single-core application, applies, as described in Run an example application.

The primary core debugger handles flashing of both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform steps 1 to 10, as described in Run an example application. These steps are common for both single-core and dual-core applications in Arm GCC.

Both the primary and the auxiliary image is loaded into the SPI flash memory. After execution of the `monitor go` command, the primary core application is executed. During the primary core code execution, the auxiliary core code is re-allocated from the flash memory to the RAM, and the auxiliary core is released from the reset. The `hello_world` multicore application is now running and a banner is displayed on the terminal. If this is not true, check your terminal settings and connections.

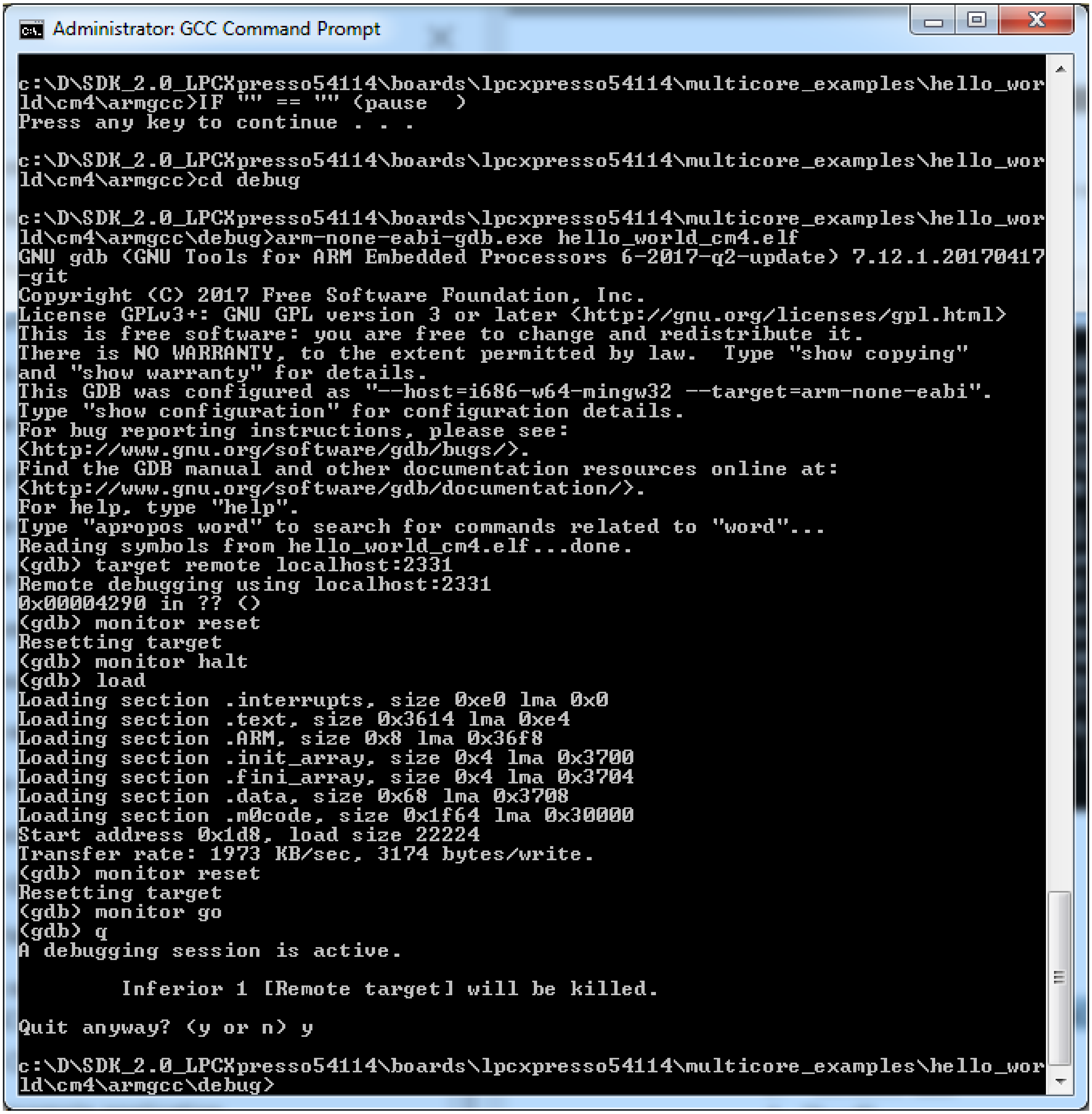


Figure 61. Loading and running the multicore example

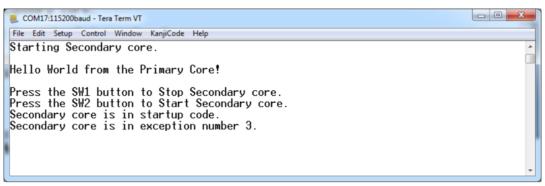


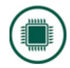
Figure 62. Hello World from primary core message

7 MCUXpresso Config Tools

MCUXpresso Config Tools can help configure the processor and generate initialization code for the on chip peripherals. The tools are able to modify any existing example project, or create a new configuration for the selected board or processor. The generated code is designed to be used with MCUXpresso SDK version 2.x.

Table 1 describes the tools included in the MCUXpresso Config Tools.

Table 1. MCUXpresso Config Tools

Config Tool	Description	Image
Pins tool	For configuration of pin routing and pin electrical properties.	
Clock tool	For system clock configuration	
Peripherals tools	For configuration of other peripherals	
TEE tool	Configures access policies for memory area and peripherals helping to protect and isolate sensitive parts of the application.	
Device Configuration tool	Configures Device Configuration Data (DCD) contained in the program image that the Boot ROM code interprets to setup various on-chip peripherals prior the program launch.	

MCUXpresso Config Tools can be accessed in the following products:

- **Integrated** in the MCUXpresso IDE. Config tools are integrated with both compiler and debugger which makes it the easiest way to begin the development.
- **Standalone version** available for download from www.nxp.com. Recommended for customers using IAR Embedded Workbench, Keil MDK µVision, or Arm GCC.
- **Online version** available on mcuxpresso.nxp.com. Recommended to do a quick evaluation of the processor or use the tool without installation.

Each version of the product contains a specific *Quick Start Guide* document MCUXpresso IDE Config Tools installation folder that can help start your work.

8 MCUXpresso IDE New Project Wizard

MCUXpresso IDE features a new project wizard. The wizard provides functionality for the user to create new projects from the installed SDKs (and from pre-installed part support). It offers user the flexibility to select and change multiple builds. The wizard also includes a library and provides source code options. The source code is organized as software components, categorized as drivers, utilities, and middleware.

To use the wizard, start the MCUXpresso IDE. This is located in the **QuickStart Panel** at the bottom left of the MCUXpresso IDE window. Select **New project**, as shown in Figure 63.

Figure 63. MCUXpresso IDE Quickstart Panel

For more details and usage of new project wizard, see the *MCUXpresso_IDE_User_Guide.pdf* in the MCUXpresso IDE installation folder.

9 How to determine COM port

This section describes the steps necessary to determine the debug COM port number of your NXP hardware development platform. All NXP boards ship with a factory programmed, on-board debug interface, whether it's based on OpenSDA or the legacy P&E Micro OSJTAG interface. To determine what your specific board ships with, see Default debug interfaces.

1. **Linux**: The serial port can be determined by running the following command after the USB Serial is connected to the host:

```
$ dmesg | grep "ttyUSB"
                    [503175.307873] usb 3-12: cp210x converter now attached to ttyUSB0
                    [503175.309372] usb 3-12: cp210x converter now attached to ttyUSB1
```

   There are two ports, one is Cortex-A core debug console and the other is for Cortex M4.

2. **Windows**: To determine the COM port open Device Manager in the Windows operating system. Click on the **Start** menu and type **Device Manager** in the search bar.

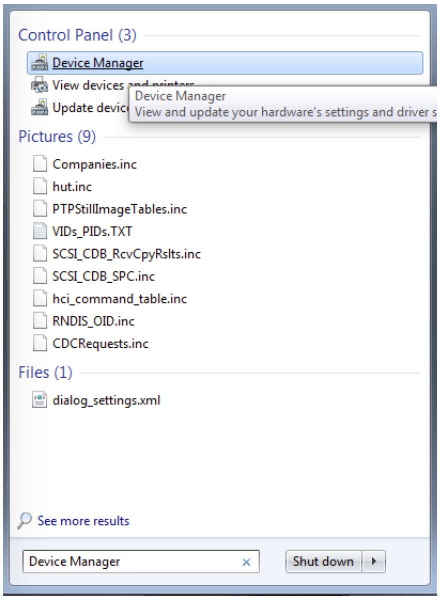


Figure 64. Device Manager

3. In the Device Manager, expand the **Ports (COM & LPT)** section to view the available ports. The COM port names will be different for all the NXP boards.

    a. **OpenSDA – CMSIS-DAP/mbed/DAPLink** interface:

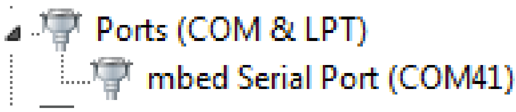


Figure 65. OpenSDA – CMSIS-DAP/mbed/DAPLink interface

    b. **OpenSDA – P&E Micro**:

Figure 66. OpenSDA – P&E Micro

    c. **OpenSDA – J-Link**:

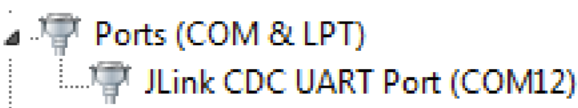


Figure 67. OpenSDA – J-Link

    d. **P&E Micro OSJTAG**:

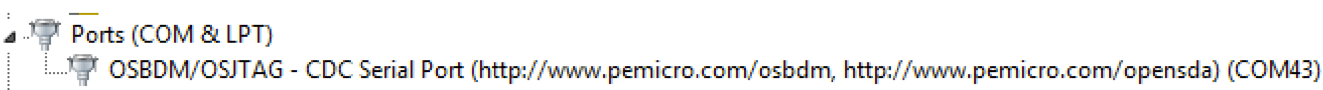


Figure 68. P&E Micro OSJTAG

    e. **MRB-KW01**:

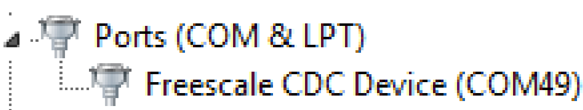


Figure 69. MRB-KW01

10 Default debug interfaces

The MCUXpresso SDK supports various hardware platforms that come loaded with a variety of factory programmed debug interface configurations. Table 2 lists the hardware platforms supported by the MCUXpresso SDK, their default debug interface, and any version information that helps differentiate a specific interface configuration.

NOTE

The OpenSDA details column in Table 2 is not applicable to LPC.

Table 2. Hardware platforms supported by MCUXpresso SDK

Hardware platform	Default interface	OpenSDA details
EVK-MC56F83000	P&E Micro OSJTAG	N/A
EVK-MIMXRT595	CMSIS-DAP	N/A
EVK-MIMXRT685	CMSIS-DAP	N/A
FRDM-K22F	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.1
FRDM-K28F	DAPLink	OpenSDA v2.1
FRDM-K32L2A4S	CMSIS-DAP	OpenSDA v2.1
FRDM-K32L2B	CMSIS-DAP	OpenSDA v2.1
FRDM-K32W042	CMSIS-DAP	N/A
FRDM-K64F	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.0
FRDM-K66F	J-Link OpenSDA	OpenSDA v2.1
FRDM-K82F	CMSIS-DAP	OpenSDA v2.1
FRDM-KE15Z	DAPLink	OpenSDA v2.1
FRDM-KE16Z	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.2
FRDM-KL02Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL03Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL25Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL26Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL27Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL28Z	P&E Micro OpenSDA	OpenSDA v2.1
FRDM-KL43Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL46Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL81Z	CMSIS-DAP	OpenSDA v2.0
FRDM-KL82Z	CMSIS-DAP	OpenSDA v2.0
FRDM-KV10Z	CMSIS-DAP	OpenSDA v2.1
FRDM-KV11Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KV31F	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KW24	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.1
FRDM-KW36	DAPLink	OpenSDA v2.2
FRDM-KW41Z	CMSIS-DAP/DAPLink	OpenSDA v2.1 or greater
Hexiwear	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.0
HVP-KE18F	DAPLink	OpenSDA v2.2

Table continues on the next page...

Table 2. Hardware platforms supported by MCUXpresso SDK (continued)

Hardware platform	Default interface	OpenSDA details
HVP-KV46F150M	P&E Micro OpenSDA	OpenSDA v1
HVP-KV11Z75M	CMSIS-DAP	OpenSDA v2.1
HVP-KV58F	CMSIS-DAP	OpenSDA v2.1
HVP-KV31F120M	P&E Micro OpenSDA	OpenSDA v1
JN5189DK6	CMSIS-DAP	N/A
LPC54018 IoT Module	N/A	N/A
LPCXpresso54018	CMSIS-DAP	N/A
LPCXpresso54102	CMSIS-DAP	N/A
LPCXpresso54114	CMSIS-DAP	N/A
LPCXpresso51U68	CMSIS-DAP	N/A
LPCXpresso54608	CMSIS-DAP	N/A
LPCXpresso54618	CMSIS-DAP	N/A
LPCXpresso54628	CMSIS-DAP	N/A
LPCXpresso54S018M	CMSIS-DAP	N/A
LPCXpresso55s16	CMSIS-DAP	N/A
LPCXpresso55s28	CMSIS-DAP	N/A
LPCXpresso55s69	CMSIS-DAP	N/A
MAPS-KS22	J-Link OpenSDA	OpenSDA v2.0
MIMXRT1170-EVK	CMSIS-DAP	N/A
TWR-K21D50M	P&E Micro OSJTAG	N/AOpenSDA v2.0
TWR-K21F120M	P&E Micro OSJTAG	N/A
TWR-K22F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K24F120M	CMSIS-DAP/mbed	OpenSDA v2.1
TWR-K60D100M	P&E Micro OSJTAG	N/A
TWR-K64D120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K64F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K65D180M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K65D180M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV10Z32	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K80F150M	CMSIS-DAP	OpenSDA v2.1
TWR-K81F150M	CMSIS-DAP	OpenSDA v2.1
TWR-KE18F	DAPLink	OpenSDA v2.1
TWR-KL28Z72M	P&E Micro OpenSDA	OpenSDA v2.1
TWR-KL43Z48M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KL81Z72M	CMSIS-DAP	OpenSDA v2.0
TWR-KL82Z72M	CMSIS-DAP	OpenSDA v2.0
TWR-KM34Z75M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KM35Z75M	DAPLink	OpenSDA v2.2
TWR-KV10Z32	P&E Micro OpenSDA	OpenSDA v1.0

Table continues on the next page...

Table 2. Hardware platforms supported by MCUXpresso SDK (continued)

Hardware platform	Default interface	OpenSDA details
TWR-KV11Z75M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV31F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV46F150M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV58F220M	CMSIS-DAP	OpenSDA v2.1
TWR-KW24D512	P&E Micro OpenSDA	OpenSDA v1.0
USB-KW24D512	N/A External probe	N/A
USB-KW41Z	CMSIS-DAP\DAPLink	OpenSDA v2.1 or greater

11 Updating debugger firmware

11.1 Updating OpenSDA firmware

Any NXP hardware platform that comes with an OpenSDA-compatible debug interface has the ability to update the OpenSDA firmware. This typically means switching from the default application (either CMSIS-DAP/mbed/DAPLink or P&E Micro) to a SEGGER J-Link. This section contains the steps to switch the OpenSDA firmware to a J-Link interface. However, the steps can be applied to restoring the original image also. For reference, OpenSDA firmware files can be found at the links below:

- J-Link: Download appropriate image from www.segger.com/opensda.html. Choose the appropriate J-Link binary based on the table in Appendix B. Any OpenSDA v1.0 interface should use the standard OpenSDA download (in other words, the one with no version). For OpenSDA 2.0 or 2.1, select the corresponding binary.
- CMSIS-DAP/mbed/DAPLink: DAPLink OpenSDA firmware is available at www.nxp.com/opensda.
- P&E Micro: Downloading P&E Micro OpenSDA firmware images requires registration with P&E Micro (www.pemicro.com).

Perform the following steps to update the OpenSDA firmware on your board for Windows and Linux OS users:

1. Unplug the board's USB cable.
2. Press the **Reset** button on the board. While still holding the button, plug the USB cable back into the board.
3. When the board re-enumerates, it shows up as a disk drive called **MAINTENANCE**.

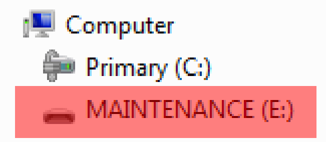


Figure 70. MAINTENANCE drive

4. Drag and drop the new firmware image onto the MAINTENANCE drive.

NOTE

If for any reason the firmware update fails, the board can always re-enter maintenance mode by holding down **Reset** button and power cycling.

These steps show how to update the OpenSDA firmware on your board for Mac OS users.

1. Unplug the board's USB cable.
2. Press the **Reset** button of the board. While still holding the button, plug the USB cable back into the board.
3. For boards with OpenSDA v2.0 or v2.1, it shows up as a disk drive called **BOOTLOADER** in **Finder**. Boards with OpenSDA v1.0 may or may not show up depending on the bootloader version. If you see the drive in **Finder**, proceed to the next step. If you do not see the drive in Finder, use a PC with Windows OS 7 or an earlier version to either update the OpenSDA firmware, or update the OpenSDA bootloader to version 1.11 or later. The bootloader update instructions and image can be obtained from P&E Microcomputer website.
4. For OpenSDA v2.1 and OpenSDA v1.0 (with bootloader 1.11 or later) users, drag the new firmware image onto the BOOTLOADER drive in **Finder**.
5. For OpenSDA v2.0 users, type these commands in a Terminal window:

```
> sudo mount -u -w -o sync /Volumes/BOOTLOADER
> cp -X  <path to update file> /Volumes/BOOTLOADER
```

NOTE

If for any reason the firmware update fails, the board can always re-enter bootloader mode by holding down the **Reset** button and power cycling.

11.2 Updating LPCXpresso board firmware

The LPCXpresso hardware platform comes with a CMSIS-DAP-compatible debug interface (known as LPC-Link2). This firmware in this debug interface may be updated using the host computer utility called LPCScrypt. This typically used when switching between the default debugger protocol (CMSIS-DAP) to SEGGER J-Link, or for updating this firmware with new releases of these. This section contains the steps to re-program the debug probe firmware.

NOTE

If MCUXpresso IDE is used and the jumper making DFUlink is installed on the board (JP5 on some boards, but consult the board user manual or schematic for specific jumper number), LPC-Link2 debug probe boots to DFU mode, and MCUXpresso IDE automatically downloads the CMSIS-DAP firmware to the probe before flash memory programming (after clicking **Debug**). Using DFU mode ensures most up-to-date/ compatible firmware is used with MCUXpresso IDE.

NXP provides the LPCScrypt utility, which is the recommended tool for programming the latest versions of CMSIS-DAP and J-Link firmware onto LPC-Link2 or LPCXpresso boards. The utility can be downloaded from www.nxp.com/lpcutilities.

These steps show how to update the debugger firmware on your board for Windows operating system. For Linux OS, follow the instructions described in LPCScrypt user guide (www.nxp.com/lpcutilities, select **LPCScrypt**, and then the documentation tab).

1. Install the LPCScript utility.
2. Unplug the board's USB cable.
3. Make the DFU link (install the jumper labelled DFUlink).
4. Connect the probe to the host via USB (use Link USB connector).
5. Open a command shell and call the appropriate script located in the LPCScrypt installation directory (`<LPCScrypt install dir>`).
   a. To program CMSIS-DAP debug firmware: `<LPCScrypt install dir>/scripts/program_CMSIS`
   b. To program J-Link debug firmware: `<LPCScrypt install dir>/scripts/program_JLINK`
6. Remove DFU link (remove the jumper installed in Step 3).
7. Re-power the board by removing the USB cable and plugging it in again.

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