Debug XMC7000 MCU in ModusToolbox™ environment

About this document

Scope and purpose

This document explains how to set up and use the XMC7000 Evaluation Kit, which mounts the XMC7200D-E272K8384 device. This document also describes debugging with single-core and multi-core applications in the ModusToolbox™ environment.

Intended audience

This document is intended for anyone using XMC7000 family XMC7100/7200 series MCUs.

Associated part family

XMC7000 family XMC7100/XMC7200 series of XMC™ Industrial microcontrollers.

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1 Getting started

This section explains the hardware setup. Table 1 lists the prerequisites for the setup.

Table 1   Prerequisites

Quantity	Description	Remarks
1	KIT_XMC72_EVK	XMC7200 Evaluation Kit
1	Micro USB cable	For power and communication
1	PC	With USB port
1	ModusToolbox 3.1	Downloaded from the web
-	Firmware	Pre-installed XMC7000 out-of-the-box (OOB) application

1.1 Connection setup

Connect the USB cable from the PC to the Evaluation Kit. The PC powers the evalution kit via the USB cable (5 V). Check if the KitProg3 status LED (D5) and the power LED (D6) are turned ON.
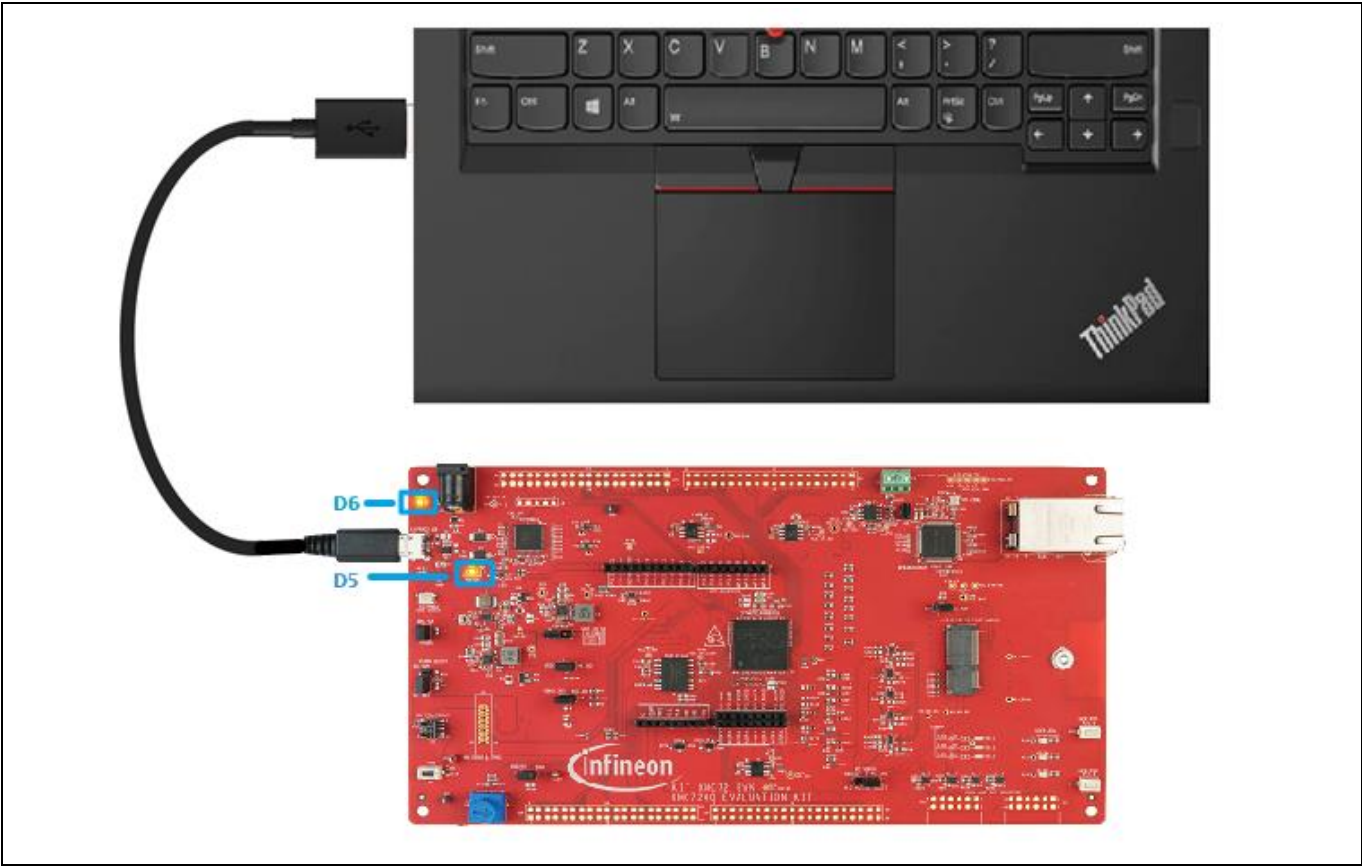

Figure 1   Connection between PC and Evaluation Kit

1.2 Power up

When powered ON, the device will start executing the pre-installed out-of-the-box (OOB) firmware, which is indicated by the blinking user LEDs (LED1, LED2, and LED3 are controlled by core Arm® Cortex®-M7 (CM7_0)).

Note: To indicate that the evaluation kit is powered ON and the USB controller is starting in the correct mode, the amber-colored status D5 must be permanently ON. But, D5 does not indicate a successful USB driver installation.
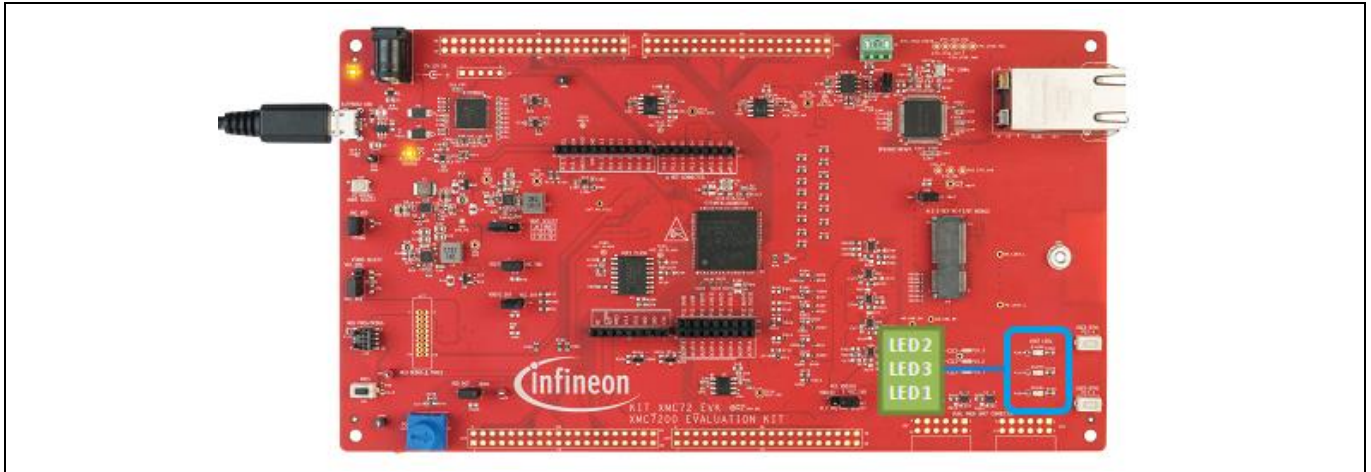

Figure 2   User LEDs of evaluation kit

1.3 Installing kit driver

Install the ModusToolbox™ or CYPRESS™ Programmer before using the kit with KitProg3. Any required driver is installed by the tools that use KitProg3. There is no separate installer for KitProg3.

To get the latest version of KitProg3 delivered with the Firmware Loader is available at the GitHub repository. The Firmware Loader does not install any drivers, but it can be used to upgrade (or downgrade) the KitProg firmware on the kit. See KitProg3 user guide [4] for more details on installation and to upgrade.

When you plug in the kit, a message is displayed that the drivers are installed depending upon your circumstances and the host operating system. KitProg3 enumerates as a root USB Composite Device with subordinate CMSIS-DAP, Bridge, and USB-UART interfaces.

Confirm that the Evaluation Kit is recognized as a KitProg3 device on Windows (open Device Manager, follow the menu path **View** > **Devices by container**) as shown in Figure 3. This completes the hardware setup.
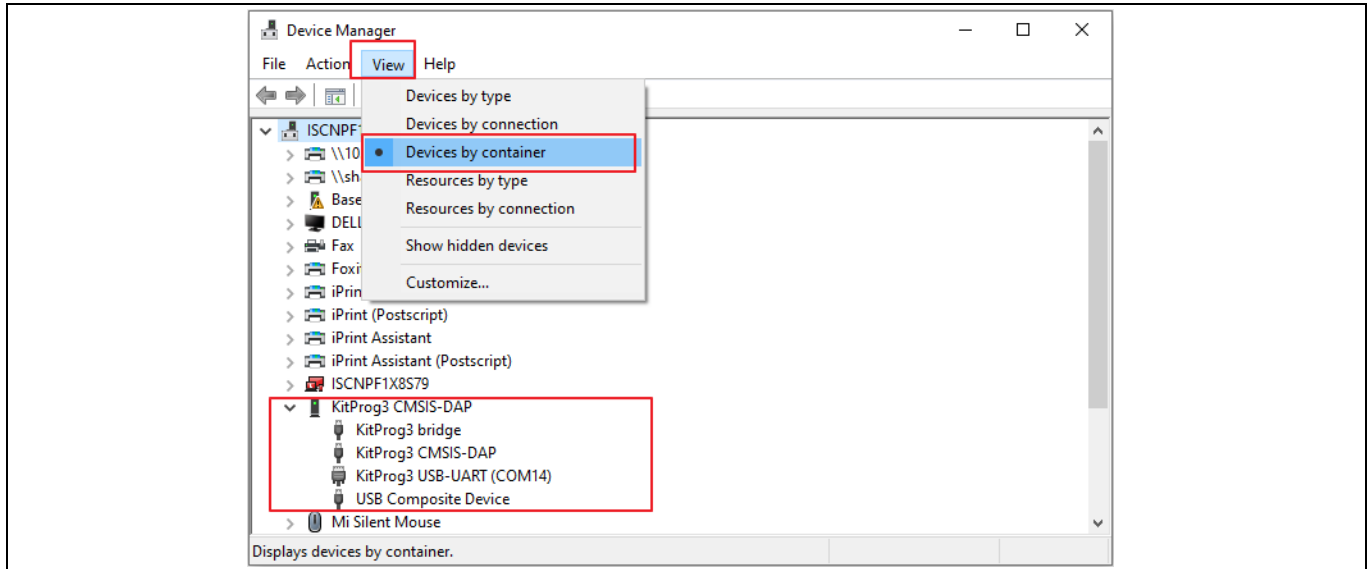
Getting started

Figure 3 **Viewing KitProg3 driver in Device Manager**

Note: Do not press SW3. Pressing SW3 changes the mode of the USB controller. This is necessary only for upgrading the USB driver firmware and other activities. For more details, see the KitProg3 user guide [4].

For more information related to the Evaluation Kit, see the KIT_XMC72_EVK XMC7200 evaluation kit guide.

2 ModusToolbox™ set up

This section explains how to launch ModusToolbox™ and create the hello world application and multi-core application which is used to demonstrate debug process with the `KIT_XMC72_EVK XMC7200` Evaluation Kit.

2.1 Launch ModusToolbox™

See the instructions in the ModusToolbox™ tools package installation Guide to download and install ModusToolbox™ software.

In v3.1.0, the ModusToolbox™ tools package includes a new tool called the Dashboard. The Dashboard provides links to various sources of documentation and training materials. It also contains two starting points: create a new application and create/edit a BSP.

See Dashboard User Guide for more information about the dashboard.

To launch the Dashboard, create a new application for the IDE of your choice, such as VS Code, IAR, Eclipse or µVision.

Note: *This document will use Eclipse IDE to demonstrate how to debug single-core and multi-core applications. See the ModusToolbox™ tools package User Guide to debug in other IDE.*

On Windows, launch the Dashboard immediately after installing the ModusToolbox™ tools package by leaving the check box enabled on the final step of the installation process.

For all OS, launch the Dashboard by running its executable as applicable for the operating system (for example, select it using the Windows **Start** menu or use the Finder in macOS). By default, the executable is installed here:

<install_dir>/ModusToolbox/tools_<version>/dashboard/

Note: *If the software is not installed in the default location, you will need to set an environment variable. See the ModusToolbox™ tools package installation Guide for more details.*

On the Dashboard window, in the right pane, in the **Target IDE** drop-down list, select **Eclipse IDE for ModusToolbox™**, and click **Launch Eclipse IDE for ModusToolbox™**.

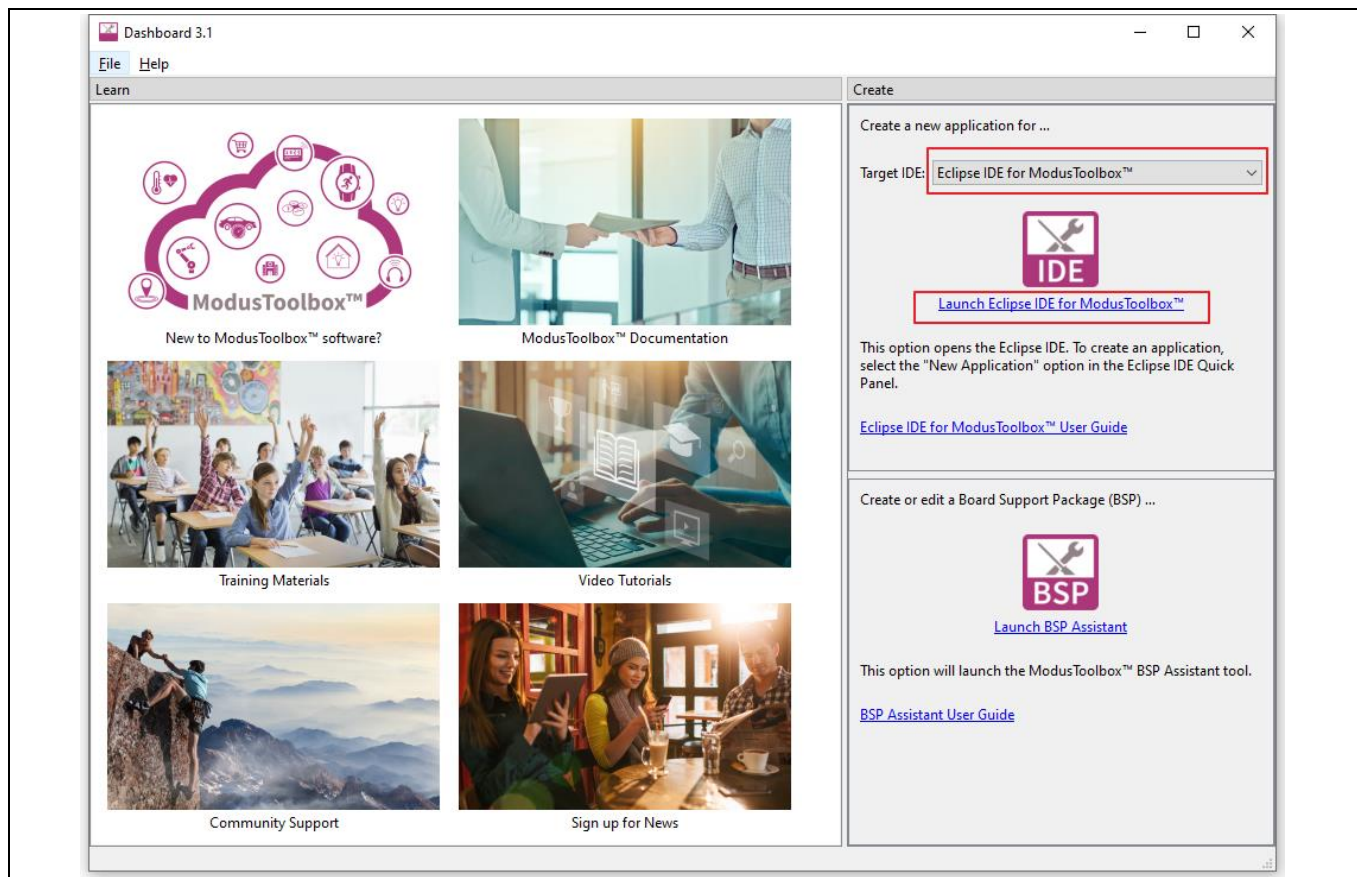**ModusToolbox™ set up**

Figure 4   Open the Dashboard

When launching the Eclipse IDE, it provides an option to select the workspace location on your machine. This location is used by the IDE for creating and storing the files as part of application creation for a particular platform. The default workspace location is a folder called "mtw" in your home directory. You may add additional folders under the "mtw" folder or to choose any other location for each workspace.

For more details about Eclipse, see the Eclipse documentation and the Eclipse survival Guide.

2.2 Create an application

2.2.1 Choose Board Support Package

To choose Board Support Package, do the following:

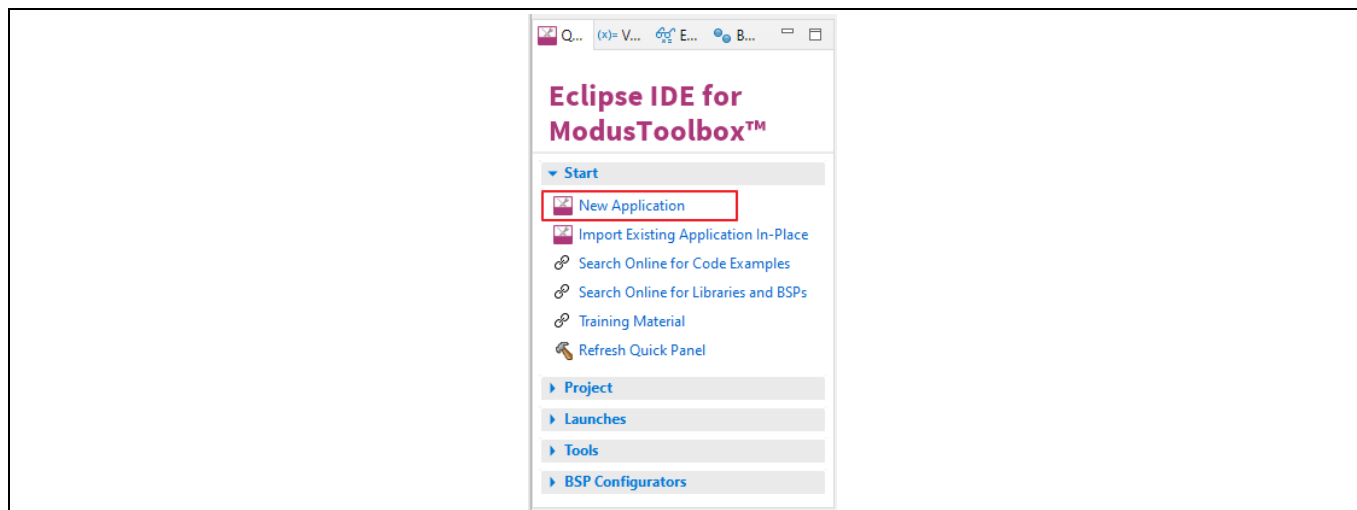- Click the New Application link in the **Eclipse IDE Quick Panel**.

Figure 5   New application

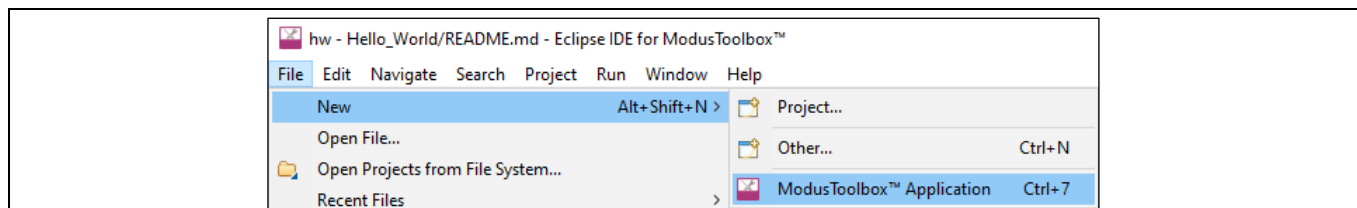- Select **File > New > ModusToolbox™ Application**.

Figure 6   New application in the file

These commands launch the Project Creator tool, which provides several applications for use with different development kits, and the kits change over time. Select **KIT_XMC72_EVK** Kit.
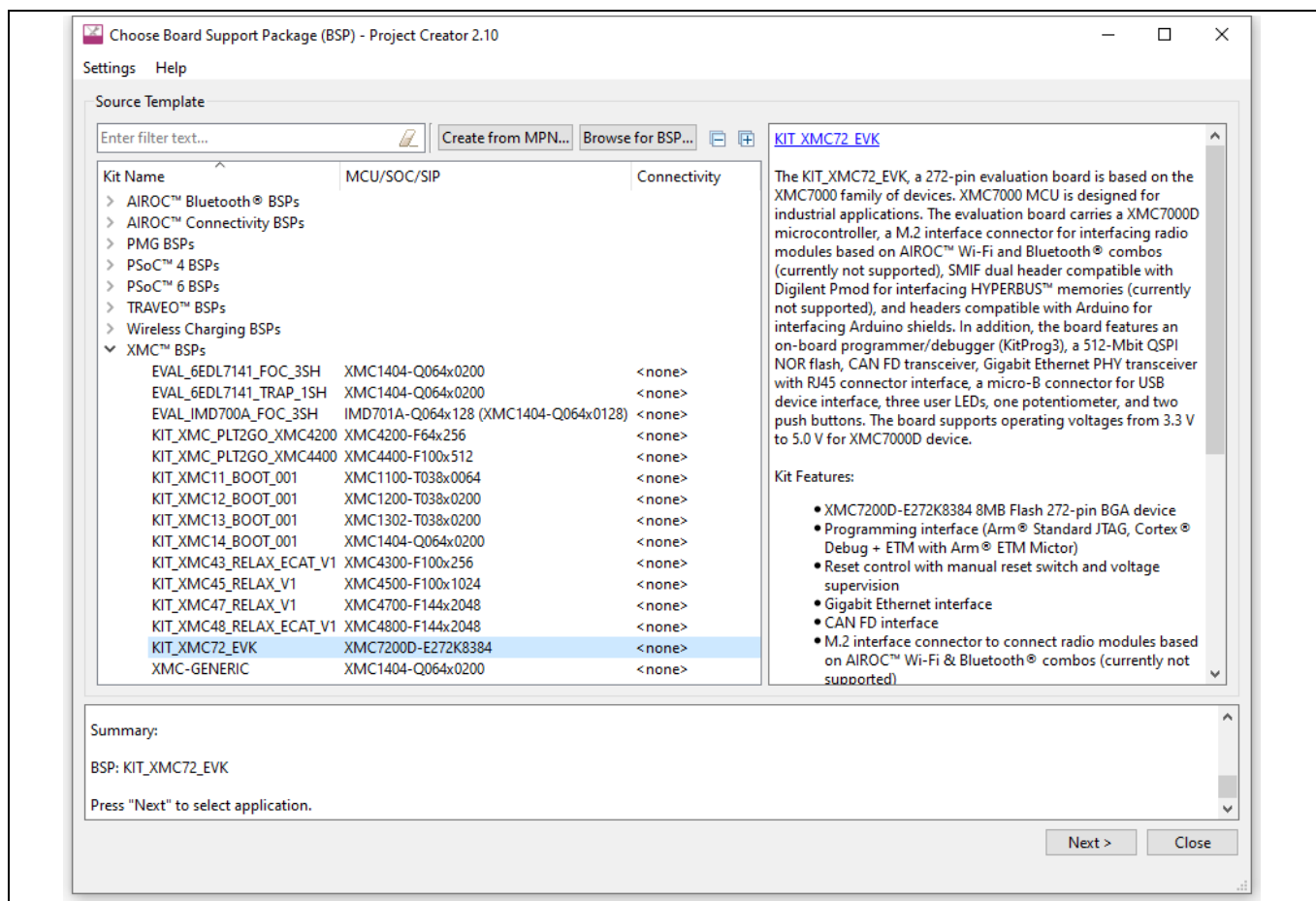
Figure 7   Choose KIT_XMC72_EVK BSP

For more details to use the tool, see the Project Creator user guide.

2.2.2   Select application

On the **Choose Board Support Package (BSP) – Project Creator 2.10** window, click **Next >** to open the **Select Application** page.

This page lists the various applications available for the selected kit. As you choose an application, a description displays on the right. To select multiple applications for the selected BSP enable the check box next to the applicable applications.
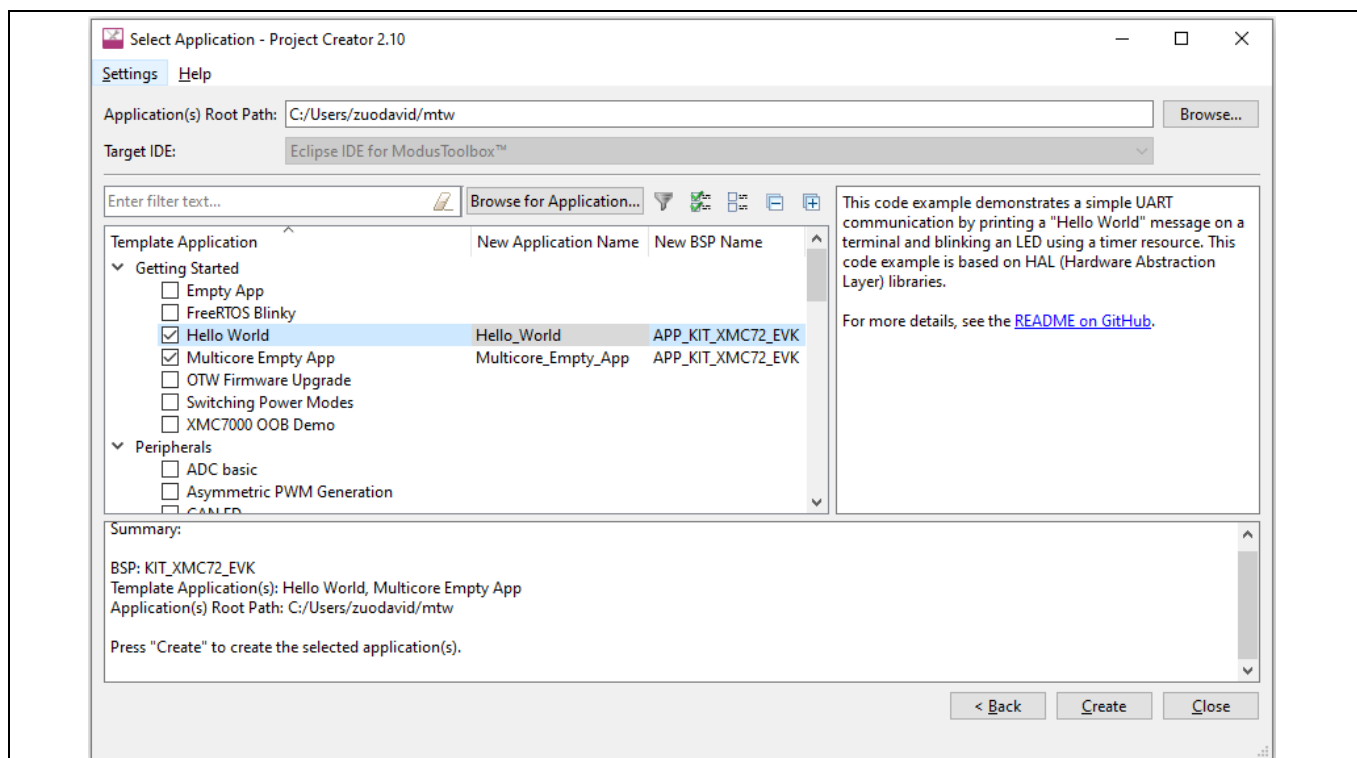
Figure 8   Select application

For this example:

- Select the check box next to the "*Hello World*" application and "*Multicore Empty APP*" application.
- If desired, type a name for the application under **New Application Name**, and type a BSP name under **New BSP Name**. Do not use spaces in the application and BSP name. In this case, use the default "*Hello_World*" and "*Multicore_Empty_App*" as the application name, *"APP_KIT_XMC72_EVK"* as the BSP name.

Note: *Use the **Browse for Application** button to select other examples to download from the web or received from a colleague. In the Open dialog, select only examples that are supported by the BSP chosen for this application. Then, the example will be shown in the dialog with all the other applications. See ModosToolbox IDE User Guide for import application/code example details.*

2.2.3   Create application

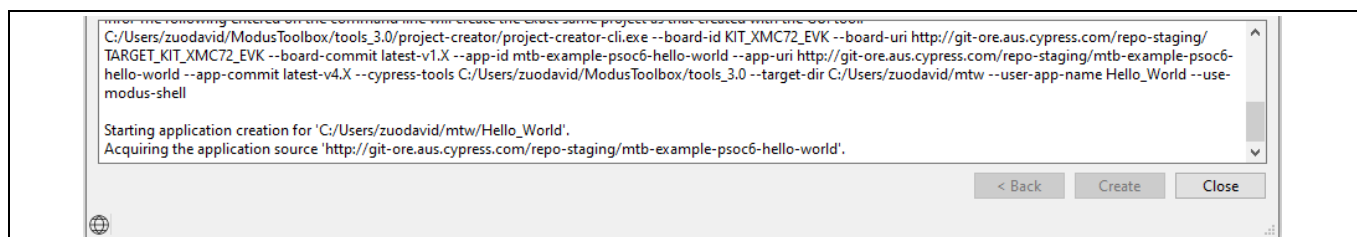Click **Create** to begin the project creation process.

Figure 9   Create application

ModusToolbox™ set up

When complete, the Project Creator tool closes automatically. After several moments, the application opens with the *Hello_World* and *Multicore_Empty_App* in Project Explorer, and the *README.md* file opens in the file viewer.
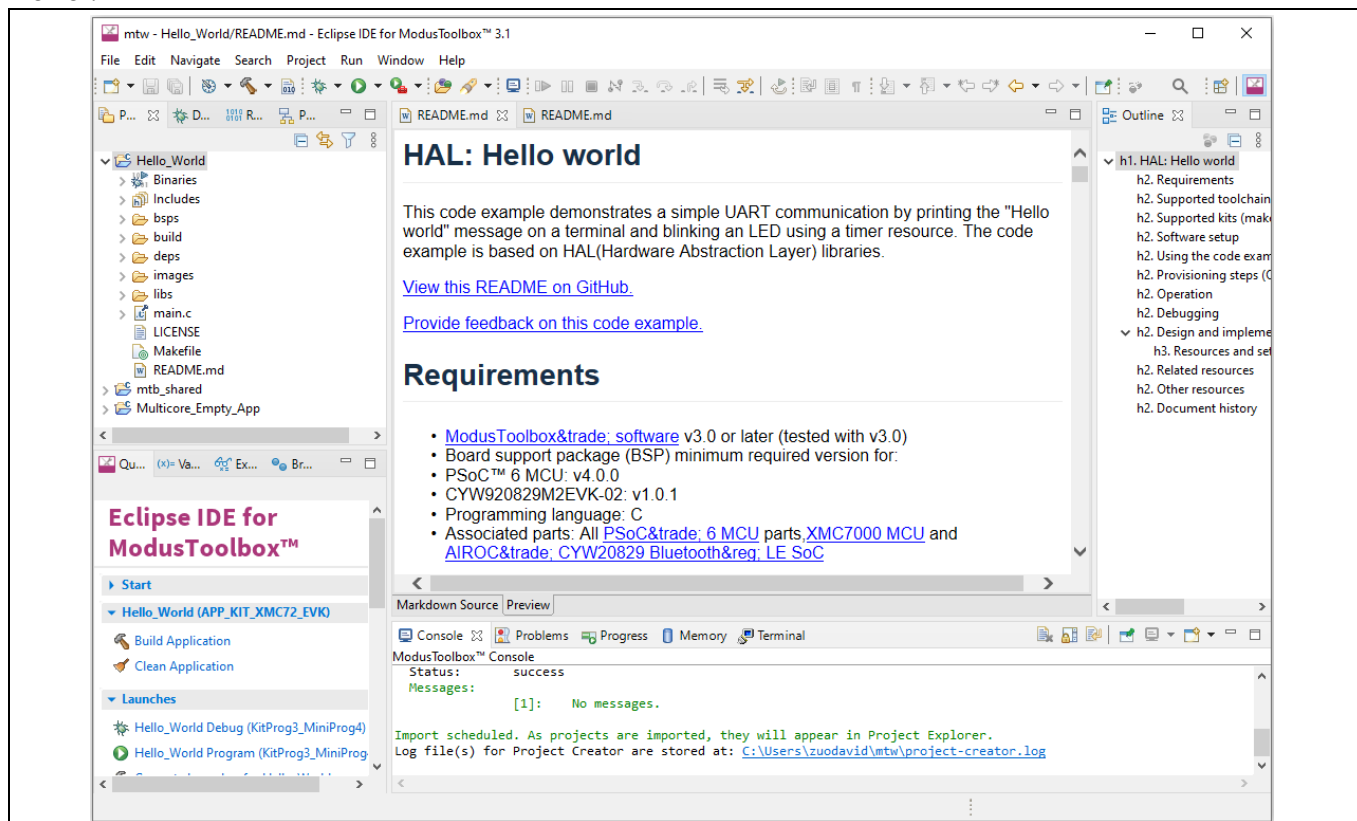

Figure 10   Application created in IDE

3 Download and debug with Evaluation Kit

There are two types of applications created in the Create an application chapter:

- Single core application (*Hello_World*): This application contains the pre-built CM0+ image, and the main application function runs on the CM7_0 core. The pre-built CM0P image only starts the CM7 cores and puts CM0+ core into Deep Sleep mode.

  For more detail on the pre-built CM0+ image, see the CAT1 Cortex M0+ prebuilt images.

- Multi-core application (*Multicore_Empty_App*): This application contains the CM0+ project, CM7_0 project, and CM7_1 project.

  CM0+ and CM7 does the normal code execution, but from an architectural point, only CM7 is considered the application core (CM7 cores for primary processing and CM0+ core for peripheral and security processing). After a reset, the default core is always the CM0+ core. To enable the CM7 core, CM0+ must call `Cy_SysEnableCM7()`.

The following sections show how to debug the single application and multi-core application in the ModusToolbox™ IDE:

3.1 Debugging with single core application
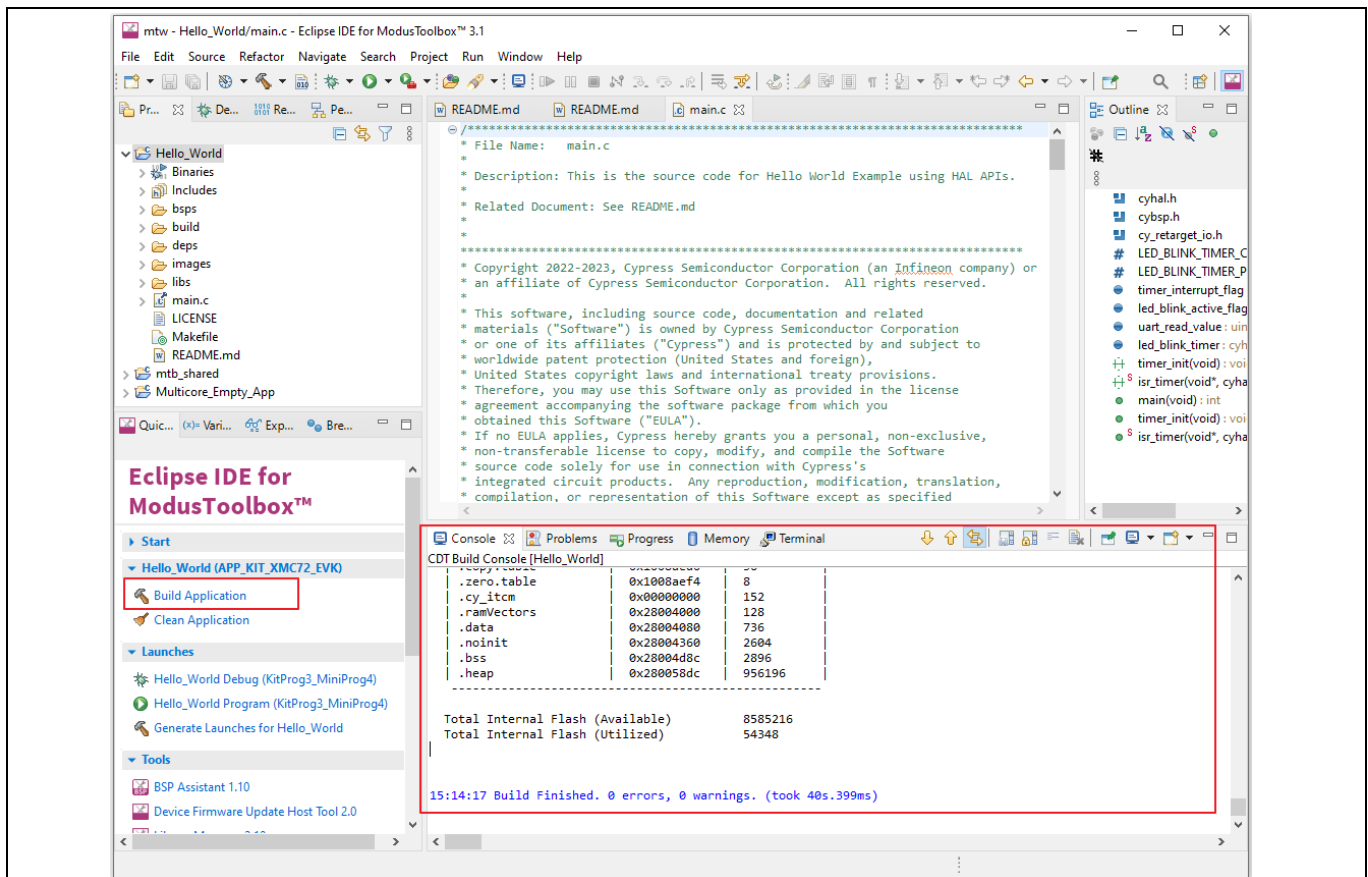
1. Build the application:

Figure 11   Build the single application

a) Select the Hello_World project in the Project Explorer window and click on the **Build Application** shortcut under the **Hello_World** group in the Quick Panel. It selects the **Debug** build configuration and compiles/links all projects that constitute the application.

b) The **Console** view lists the results of the build operation, shown in Figure 11.

If the Hello_World project is selected, select the **Build Project** from the **Project** menu or the right-click menu, as shown in Figure 12 .
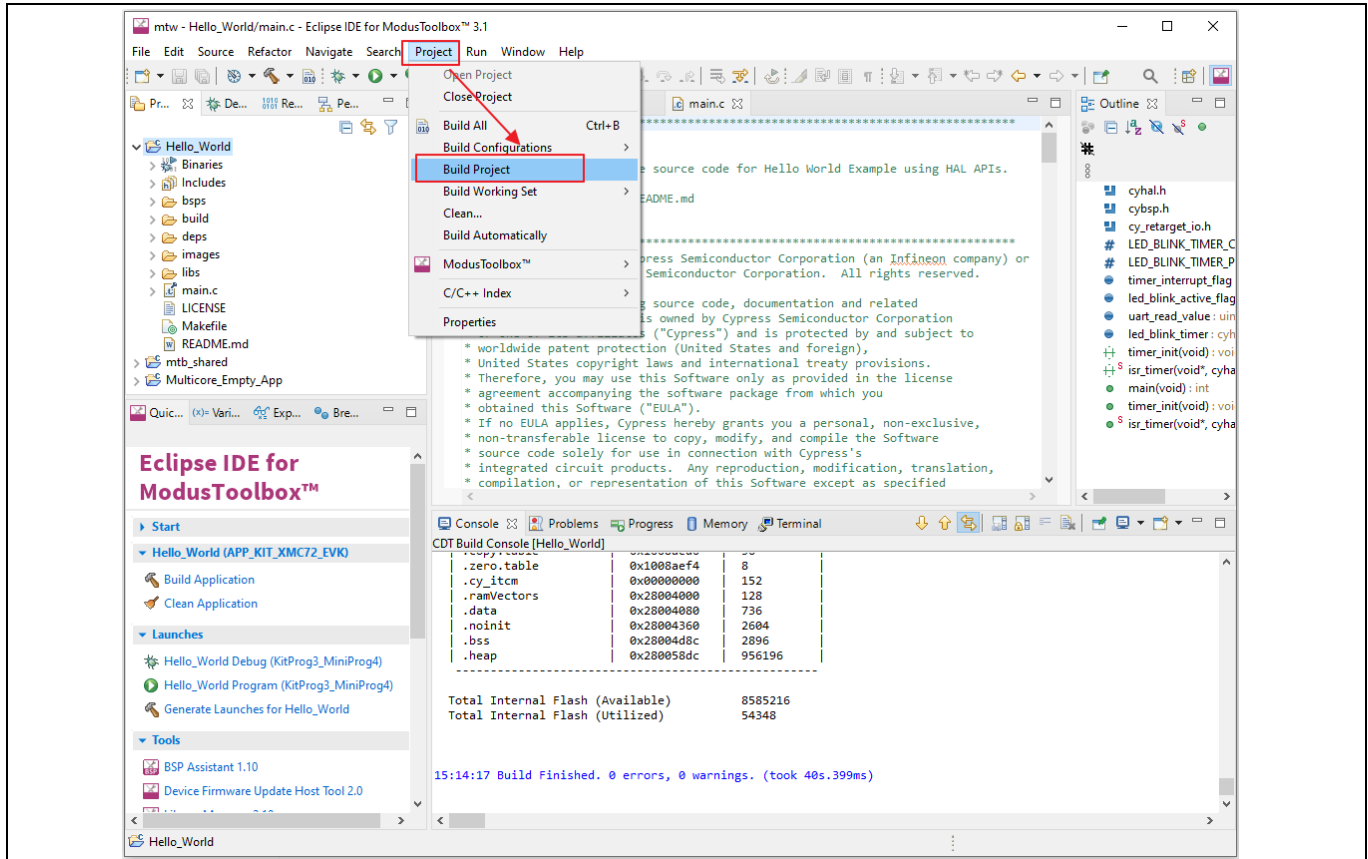

Figure 12   Build the single application in Project menu

If you encounter errors, revisit previous steps to ensure that you accomplished all the required tasks.

Note: The command line interface (CLI) is used to build the application. See the "Using the command-line" section in the ModusToolbox™ User Guide. This document is located in the /ide_<version>/docs/ folder in the ModusToolbox™ installation.

2. Debug the application:

The XMC7200 Evaluation Kit has a KitProg3 onboard programmer/debugger. It supports Cortex® microcontroller software interface standard - Debug Access Port (CMSIS-DAP). See the KitProg3 User Guide [4] for more details.

The ModusToolbox™ software uses the OpenOCD protocol to program and debug applications on XMC7000 MCU devices. For the ModusToolbox™ software to identify the device on the kit, the kit runs the KitProg3.

In the **Quick Panel**, click the **Hello_World Debug (KitProg3)** link under **Launches**.
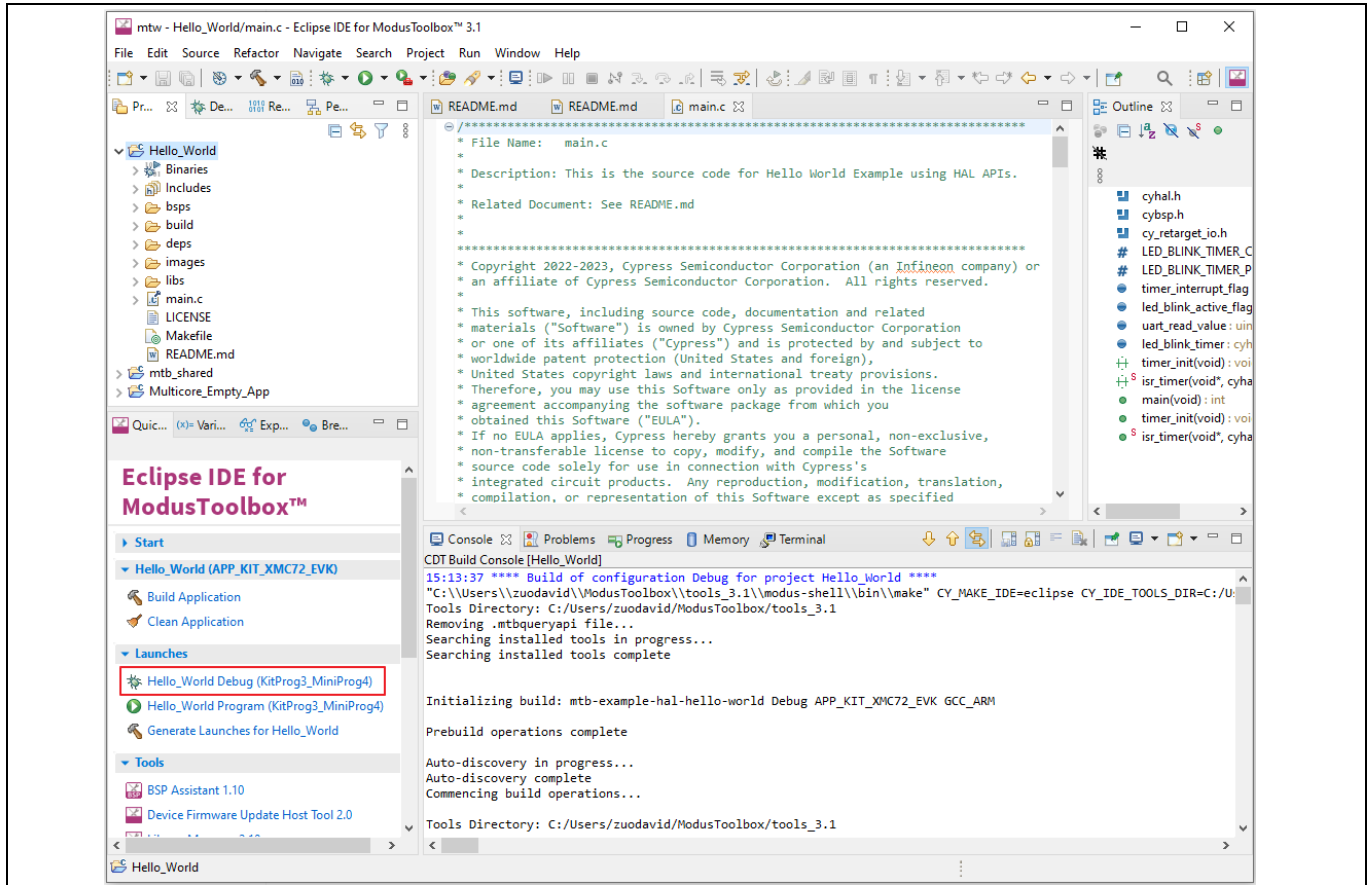
Download and debug with Evaluation Kit

Figure 13   Launch the single application debug

If needed, the IDE builds the application, and messages display in the Console. If the build is successful, the IDE switches to debug mode automatically, as shown in Figure 15.

To open the disassembly window, please click **Window > Show View > Disassembly**.
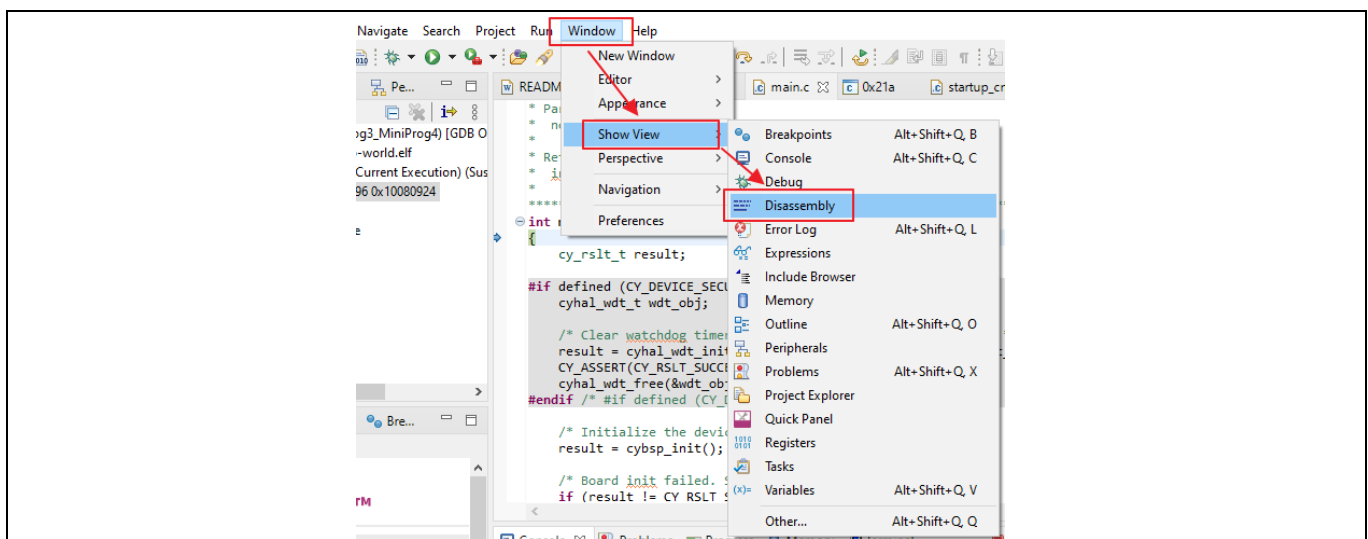

Figure 14   Show the disassembly window
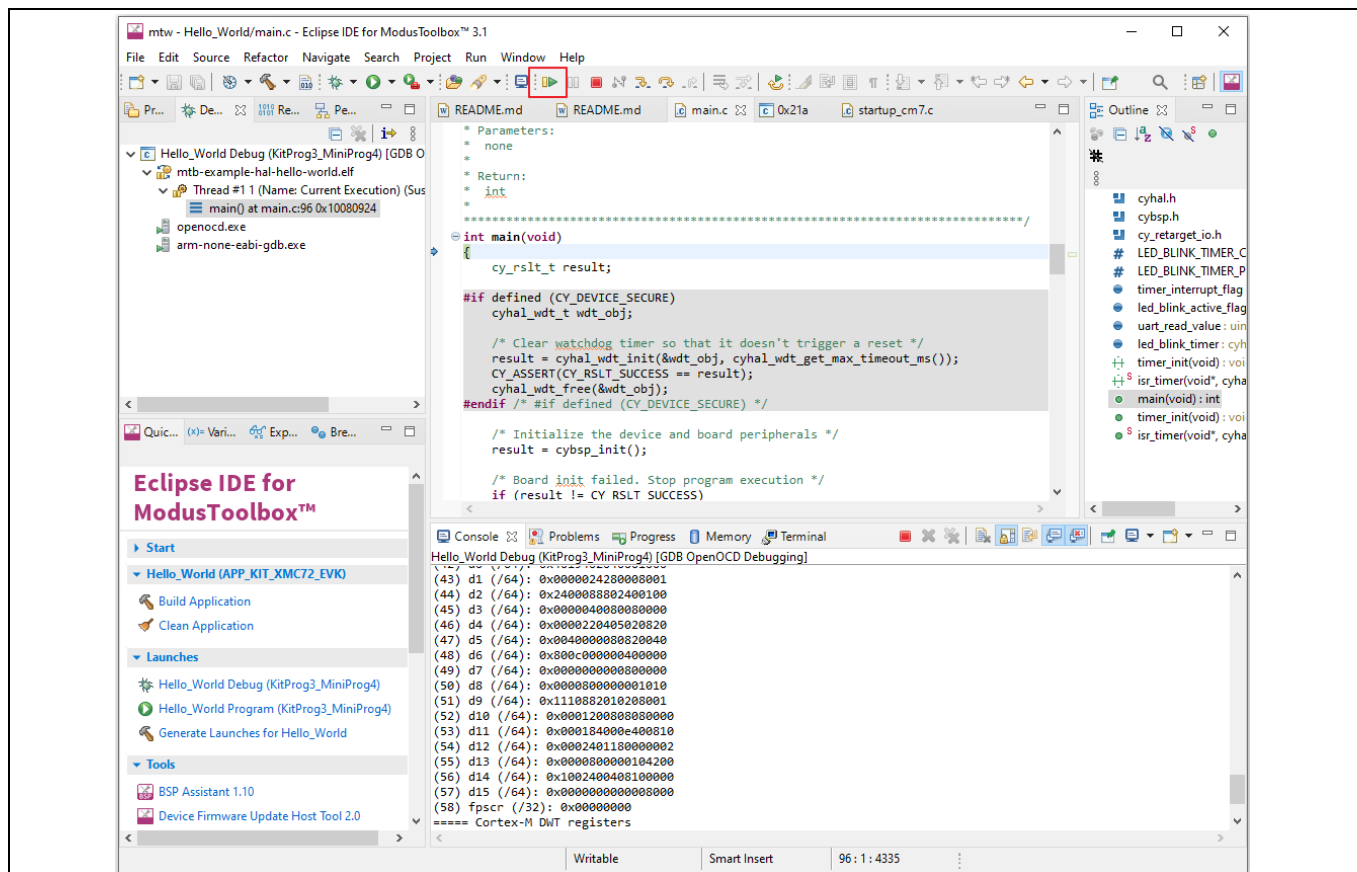
Download and debug with Evaluation Kit

Figure 15   Debug the single application with CM7_0 core in Eclipse IDE

3.   Click the **Resume** icon or press the **F8** to start execution. LED1 should start blinking.

Note: The function keys in the Debug window: Resume (F8), Step Into (F5), Step Over (F6), Terminate (Ctrl+F2).
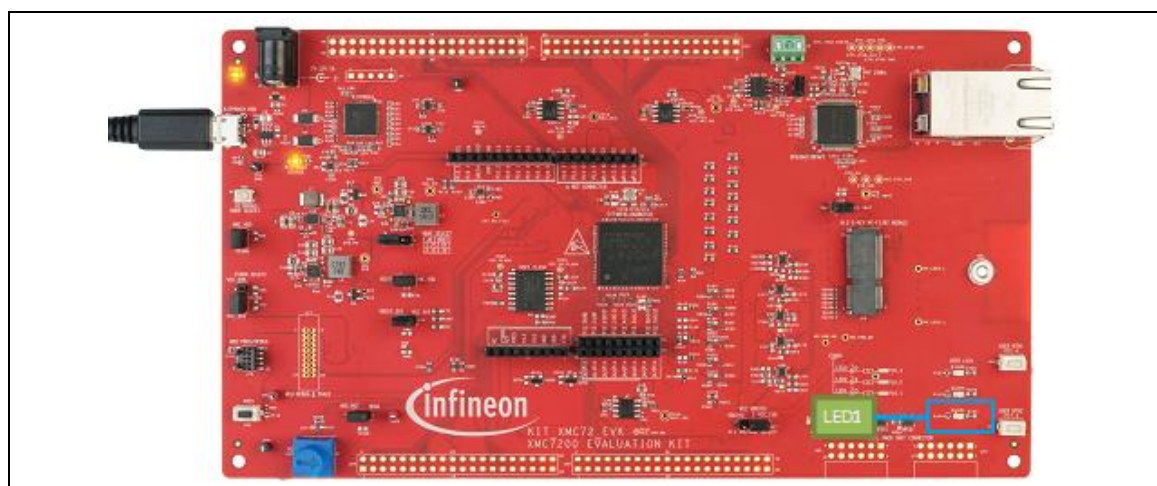

Figure 16   Blinking LED1

3.2 Debugging with multi-core application

1. Build the multi-core application

   a) In the **Project Explorer** window, click the **Multicore_Empty_App** project.

   b) Click on the **Build Application** shortcut under the **Multicore_Empty_App** group in the Quick Panel. It selects the Debug build configuration and compiles/links all projects that constitute the application.

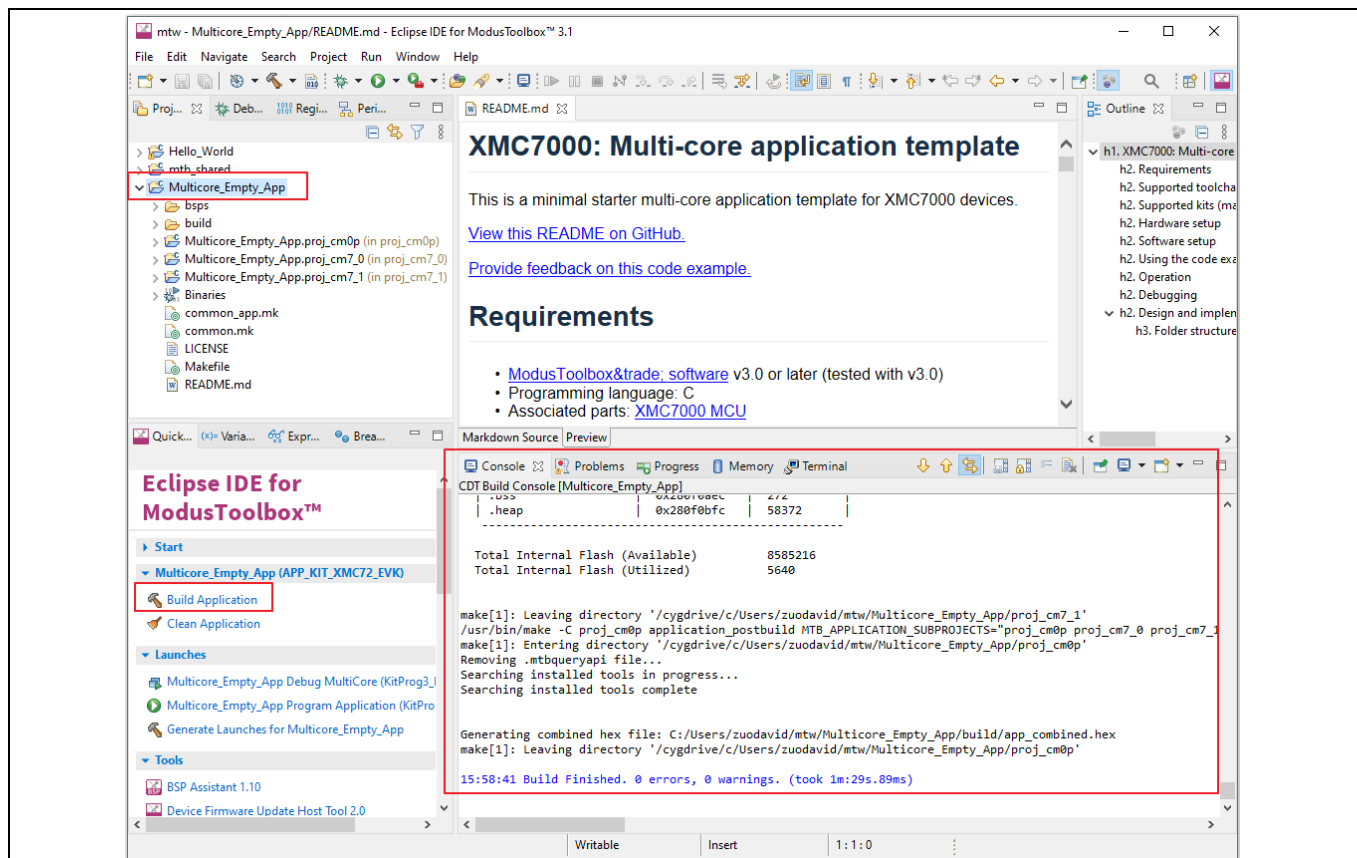   c) The **Console** view lists the results of the build operation, shown in Figure 17.

Figure 17   Build the multi-core application

If the **Multicore_Empty_App** is selected, also select **Build Project** from the **Project** menu or the right-click menu.

Note: Use the command line interface (CLI) to build the application. See the "Using the command-line" section in the ModusToolbox™ user guide. This document is located in the /ide_<version>/docs/ folder in the ModusToolbox™ installation.

2. In the **Quick Panel**, click the **Multicore_Empty_App Debug MultiCore (KitProg3)** link under **Launches**.

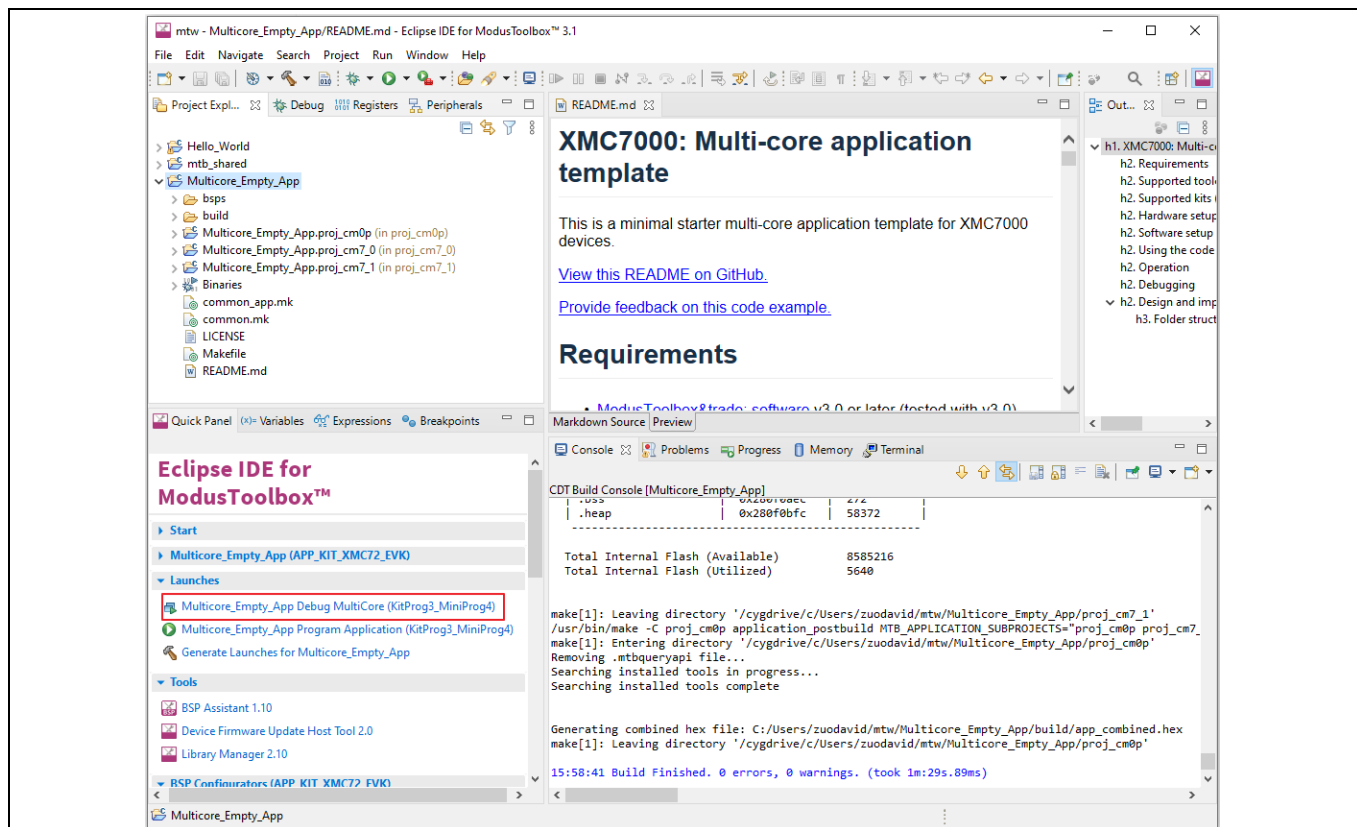**Download and debug with Evaluation Kit**

Figure 18   Launch the multi-core application debug

This will automatically program the CM0P, CM7_0, and CM7_1 code into the flash region of respective cores; then, the IDE switches to debug mode automatically, shown in Figure 19.
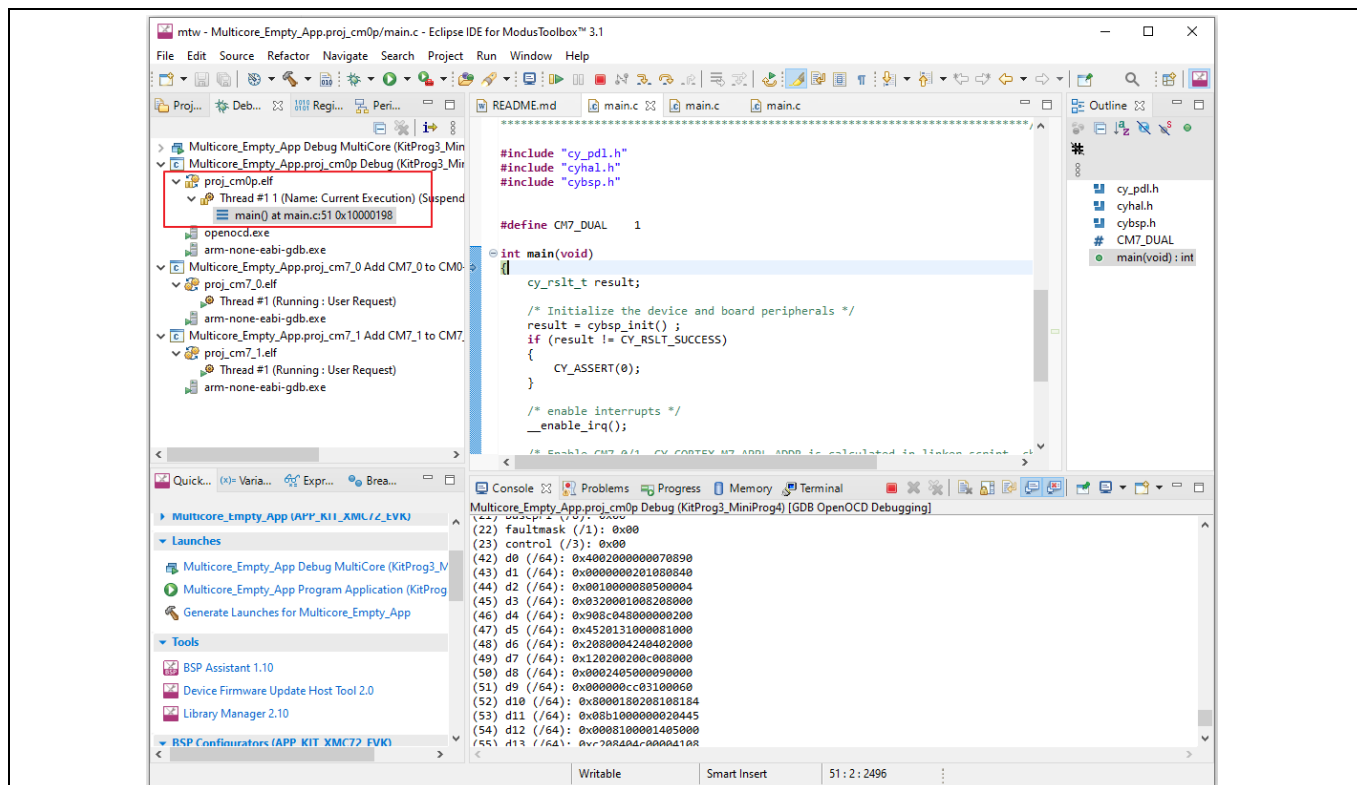

Figure 19   Downloading and debugging

Download and debug with Evaluation Kit

The CM0P debug session is started and halted at the beginning of the main () function, CM7_0 and CM7_1 debug session started, and CPU is not yet started in the above figure.

3. Place a breakpoint in the `cybsp_init()` API in the mian.c of CM7_0 core, you can also place another breakpoint in main.c of CM7_1 core. CM7_0 core and CM7_1 core will start executing after being enabled by CM0+ core. You can debug three cores simultaneously.

Note: To place a breakpoint at the target instruction, click the white space between the editor window (left pane).
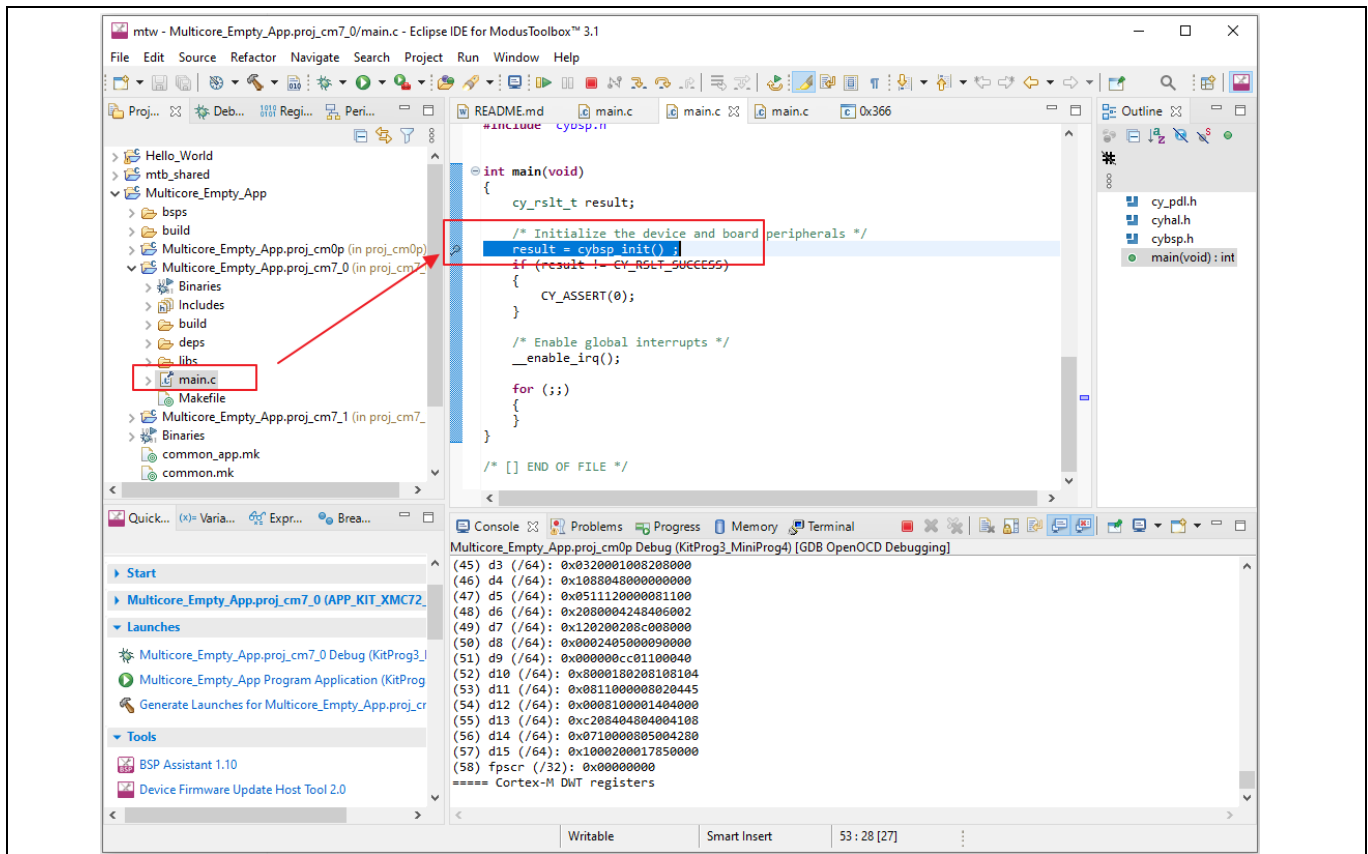
Figure 20   Multi-core debug window

4. Click the **Resume** icon or press the **F8** in the CM0P project to start execution.

After executing `Cy_SysEnableCM7(CORE_CM7_0, CY_CORTEX_M7_0_APPL_ADDR)` and `Cy_SysEnableCM7(CORE_CM7_1, CY_CORTEX_M7_1_APPL_ADDR)`, CM7_0 core and CM7_1 core is enabled and the execution haltes at the very beginning of CM7's main () function.

Click the **Resume** icon or press the **F8** in the CM7_0 and CM7_1 project, the execution reaches the breakpoint in the CM7_0 project and CM7_1 project, continue to debug the code from CM7 cores.
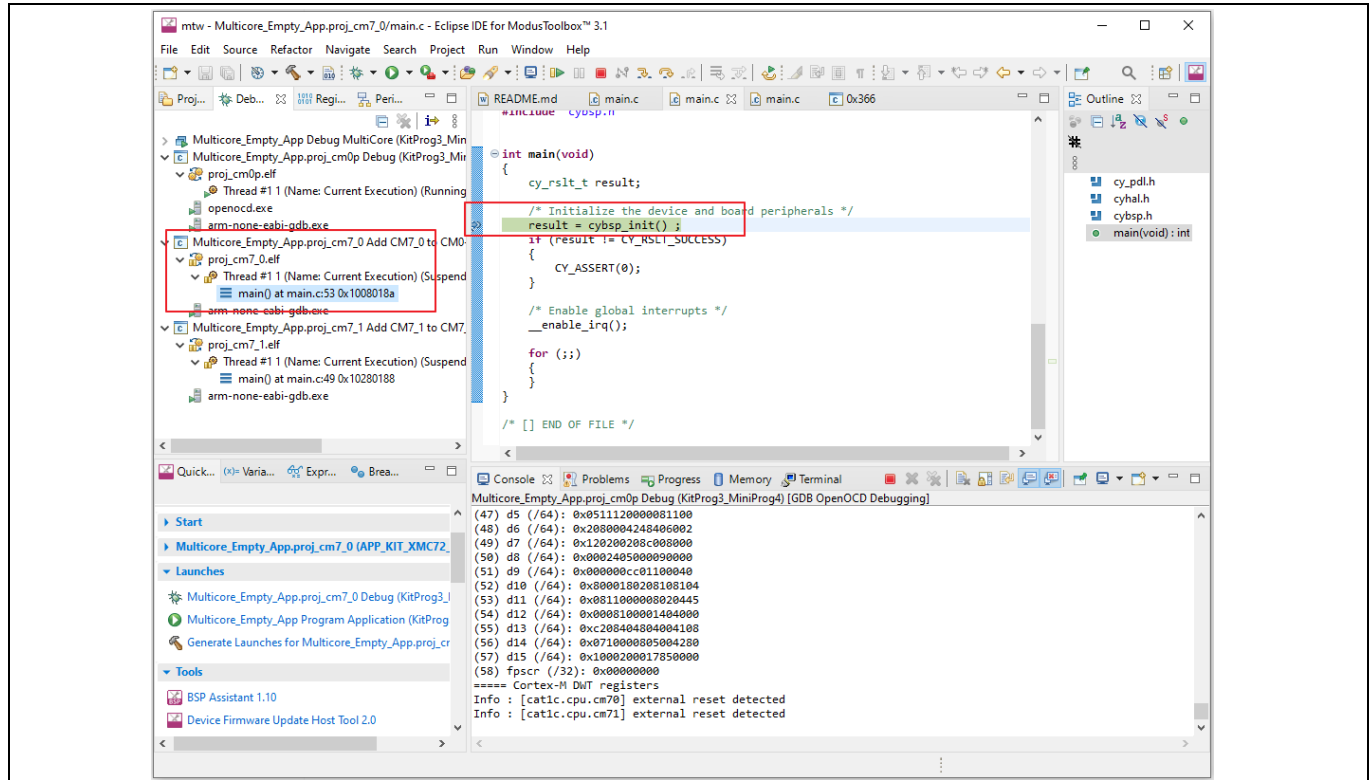
Download and debug with Evaluation Kit

Figure 21   Debugging with CM0+ and CM7 cores

4   Troubleshooting

This section explains possible issues and the workarounds.

4.1   Connection troubleshooting

Error: Evaluation Kit is not detected on the target system.

- Connect the USB cable that comes with the Evaluation Kit. Other USB cables may not connect data lines
- Make sure LED D5 is ON (CMSIS-DAP mode). If not, press SW3 to change the KitProg3 device mode
- If LED D5 is ON (CMSIS-DAP mode), change the KitProg3 device mode by pressing SW3. Now the LED3 should be blinking smoothly. Next try to reconnect the debug session. Then, wether this works or not, stop the debug session again and switch the KitProg3 device mode to LED D5 is always ON (CMSIS-DAP mode)

4.2   Driver troubleshooting

Error: Driver is not detected on the target system, or "KitProg3" is not visible.

For more information on the supported driver, see the KitProg3 User Guide [4].

4.3   Debugger troubleshooting

Error: While programming the XMC7000 device, the CMSIS-DAP device is not found.

Check the USB cable connection and the state of LED3 (LED should be ON for CMSIS-DAP mode).

4.4   Key points

The pre-built CM0+ image should be disabled with the multi-core application; add the `XMC7xDUAL_CM0P_SLEEP` to `DISABLE_COMPONENTS` for XMC7xxxD device in the project CM7_0 Makefile.

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References

The following are the XMC7000 family series datasheets and reference manuals. Contact Technical Support to obtain these documents.

[1]   Device datasheets

– XMC7100 Datasheet 32-bit Arm® Cortex®-M7 Microcontroller XMC7000 family
– XMC7200 Datasheet 32-bit Arm® Cortex®-M7 Microcontroller XMC7000 family

[2]   Reference manuals

– XMC7000 MCU family architecture reference manual (RM)
– XMC7100 registers reference manual (RM)
– XMC7200 registers reference manual (RM)

[3]   Application notes

– AN234334 – Getting started with XMC7000 MCU on ModusToolbox™ software

[4]   User guide

– KitPro3 user guide
– KIT_XMC72_EVK XMC7200 Evaluation Kit Guide

Revision history

Document revision	Date	Description of changes
**	2022-07-25	Initial release
*A	2023-09-21	Updated content with the latest release of ModusToolbox™ 3.1

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