AN14120

Debugging Cortex-M with VS Code on i.MX 8M, i.MX 8ULP, and i.MX 93

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Document information

Information	Content
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Abstract	This document describes cross-compiling, deploying, and debugging an application for the i.MX 8M Family, i.MX 8ULP, and i.MX 93 Cortex-M processor using Microsoft Visual Studio Code.

1 Introduction

This document describes cross-compiling, deploying, and debugging an application for the i.MX 8M Family, i.MX 8ULP, and i.MX 93 Cortex-M processor using Microsoft Visual Studio Code.

1.1 Software environment

The solution could be implemented both on the Linux and Windows host. For this application note, a Windows PC is assumed, but not mandatory.

Linux BSP release 6.1.22_2.0.0 is used in this application note. The following prebuild images are used:

- **i.MX 8M Mini**: `imx-image-full-imx8mmevk.wic`
- **i.MX 8M Nano**: `imx-image-full-imx8mnevk.wic`
- **i.MX 8M Plus**: `imx-image-full-imx8mpevk.wic`
- **i.MX 8ULP**: `imx-image-full-imx8ulpevk.wic`
- **i.MX 93**: `imx-image-full-imx93evk.wic`

For detailed steps on how to build these images, refer to *i.MX Linux User's Guide* (document IMXLUG) and *i.MX Yocto Project User's Guide* (document IMXLXYOCTOUG).

If a Windows PC is used, write the prebuild image on the SD card using Win32 Disk Imager (https://win32diskimager.org/) or Balena Etcher (https://etcher.balena.io/).

If an Ubuntu PC is used, write the prebuild image on the SD card using the below command:

```
$  sudo dd if=<image_name>.wic of=/dev/sd<x> bs=1M status=progress conv=fsync
```

Note: *Check your card reader partition and replace* `sd<x>` *with your corresponding partition.*

1.2 Hardware setup and equipment

- Development kit:
  - NXP i.MX 8MM EVK LPDDR4
  - NXP i.MX 8MN EVK LPDDR4
  - NXP i.MX 8MP EVK LPDDR4
  - NXP i.MX 93 EVK for 11x11 mm LPDDR4
  - NXP i.MX 8ULP EVK LPDDR4
- Micro SD card: SanDisk Ultra 32-GB Micro SDHC I Class 10 is used for the current experiment.
- Micro-USB (i.MX 8M) or Type-C (i.MX 93) cable for debug port.
- SEGGER J-Link debug probe.

2 Prerequisites

Before starting to debug, several prerequisites must be met to have a properly configured debug environment.

2.1 PC Host – i.MX board debug connection

To establish the hardware debug connection, perform the following steps:

1. Connect the i.MX board to the host PC via the DEBUG USB-UART and PC USB connector using a USB cable. The Windows OS finds the serial devices automatically.
2. In *Device Manager*, under *Ports (COM & LPT)* find two or four connected USB Serial Port (COM <port_number>). One of the ports is used for the debug messages generated by the Cortex-A core, and the other is for the Cortex-M core.
   Before determining the right port needed, remember:
   - **[i.MX 8MP, i.MX 8ULP, i.MX 93]**: There are four ports available in *Device Manger*. The last port is for Cortex-M debug and the second to last port is for Cortex-A debug, counting debug ports in ascending order.
   - **[i.MX 8MM, i.MX 8MN]**: There are two ports available in *Device Manager*. The first port is for Cortex-M debug and the second port is for Cortex-A debug, counting debug ports in ascending order.
3. Open the right debug port using your preferred serial terminal emulator (for example PuTTY) by setting the following parameters:
   - Speed to 115200 bps
   - 8 data bits
   - 1 stop bit (115200, 8N1)
   - No parity
4. Connect the SEGGER debug probe USB to the host, then connect the SEGGER JTAG connector to i.MX board JTAG interface.

If the i.MX board JTAG interface has no guided connector, the orientation is determined by aligning the red wire to the pin 1, as in Figure 1.

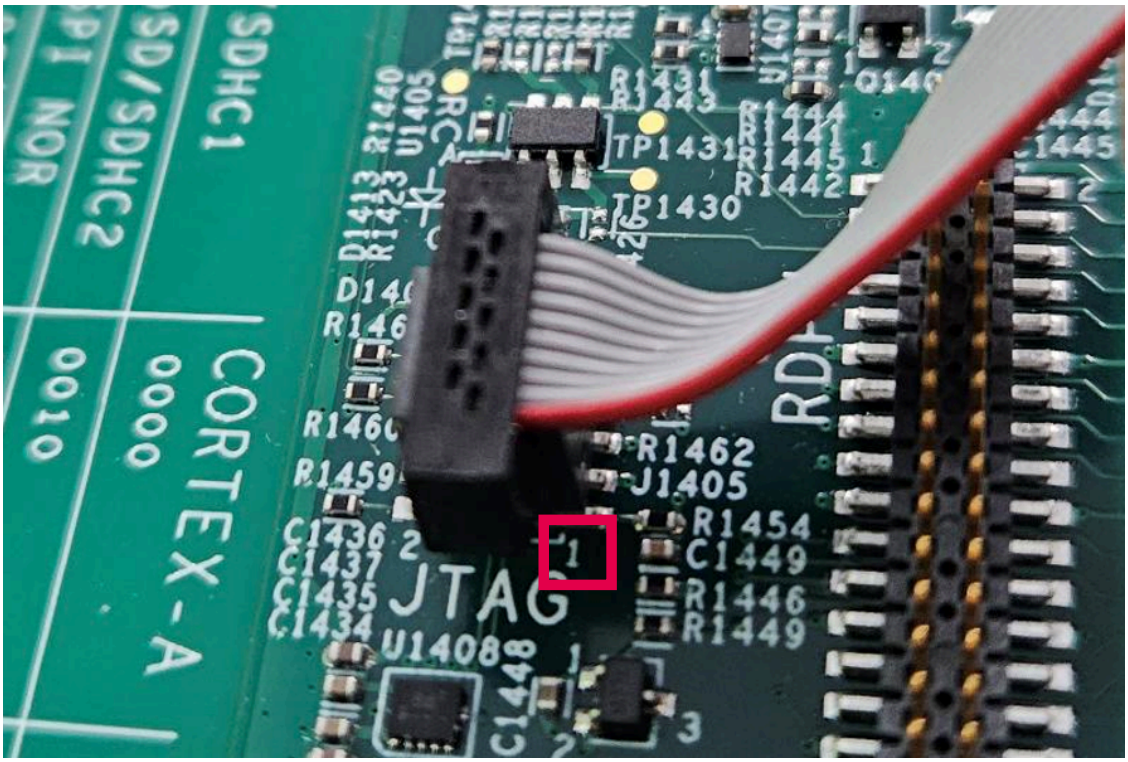

Figure 1. JTAG connection

2.2 VS Code configuration

To download and configure the VS Code, perform the following steps:

1. Download and install the latest version of Microsoft Visual Studio Code from the official website. In case of using Windows as the host OS, choose the "Download for Windows" button from the Visual Studio Code main page.

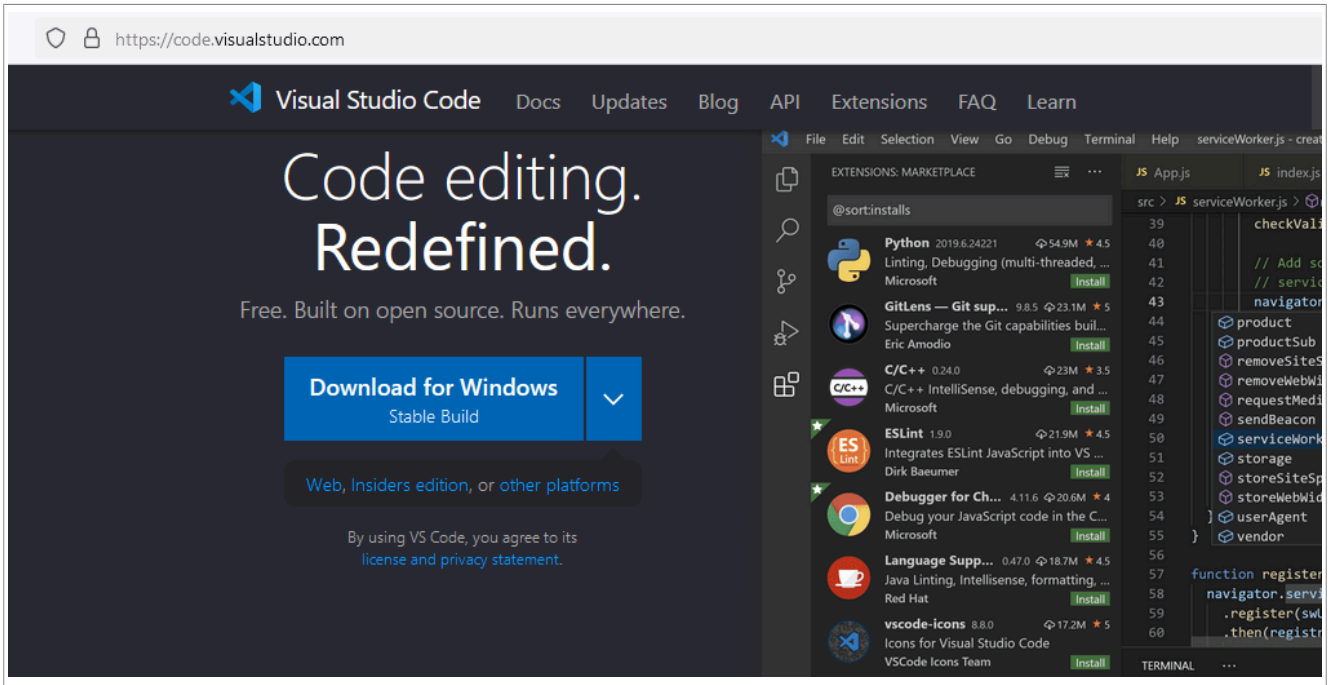

Figure 2. Download Microsoft Visual Studio Code

2. After installing Visual Studio Code, open it and choose the "Extensions" tab or press the Ctrl + Shift + X combination.

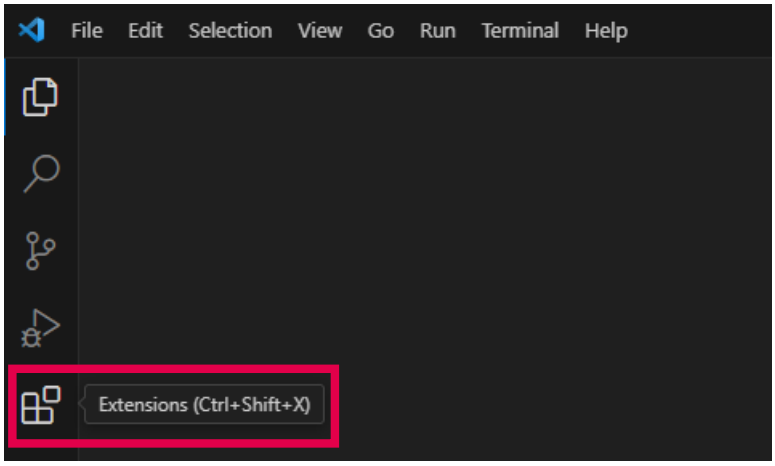

Figure 3. Microsoft Visual Studio Code Extensions tab

3. In the dedicated Search bar, type *MCUXpresso for VS Code* and install the extension. A new tab appears in the left side of VS Code window.

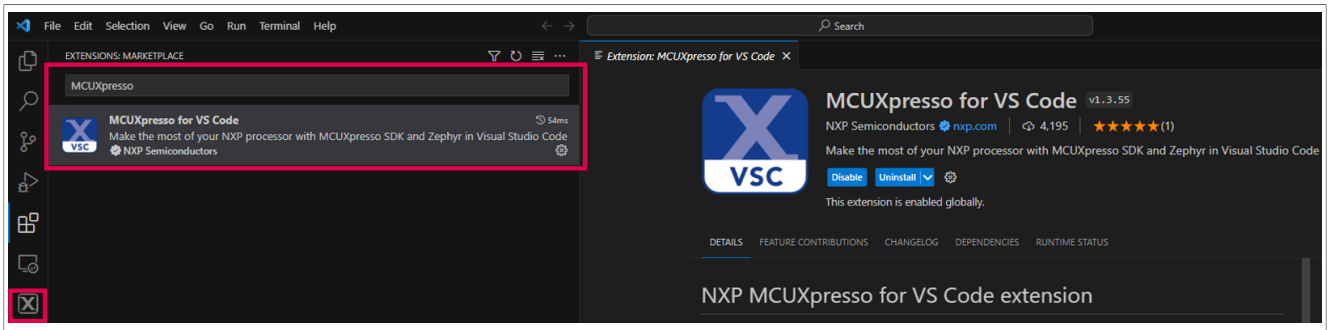

Figure 4. Install MCUXpresso for VS Code extension

2.3 MCUXpresso extension configuration

To configure MCUXpresso extension, perform the following steps:

1. Click the MCUXpresso extension dedicated tab from the left side bar. From the *QUICKSTART PANEL*, click *Open MCUXpresso Installer* and give permission for downloading the installer.
2. The installer window appears in a short time. Click *MCUXpresso SDK Developer* and on *SEGGER J-Link* then click the *Install* button. The installer installs the needed software for archives, toolchain, Python support, Git, and debug probe.

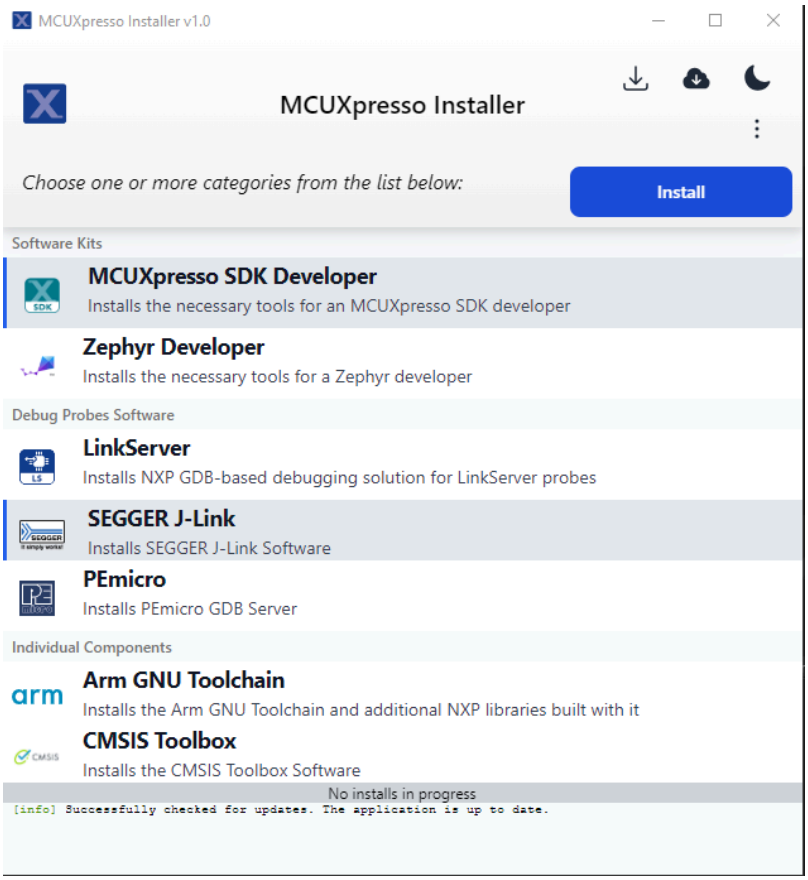

Figure 5. Install SEGGER J-Link software

After all packages are installed, be sure that the J-Link probe is connected to the host PC. Then, check if the probe is also available in the MCUXpresso extension under *DEBUG PROBES* view, as shown in Figure 6.

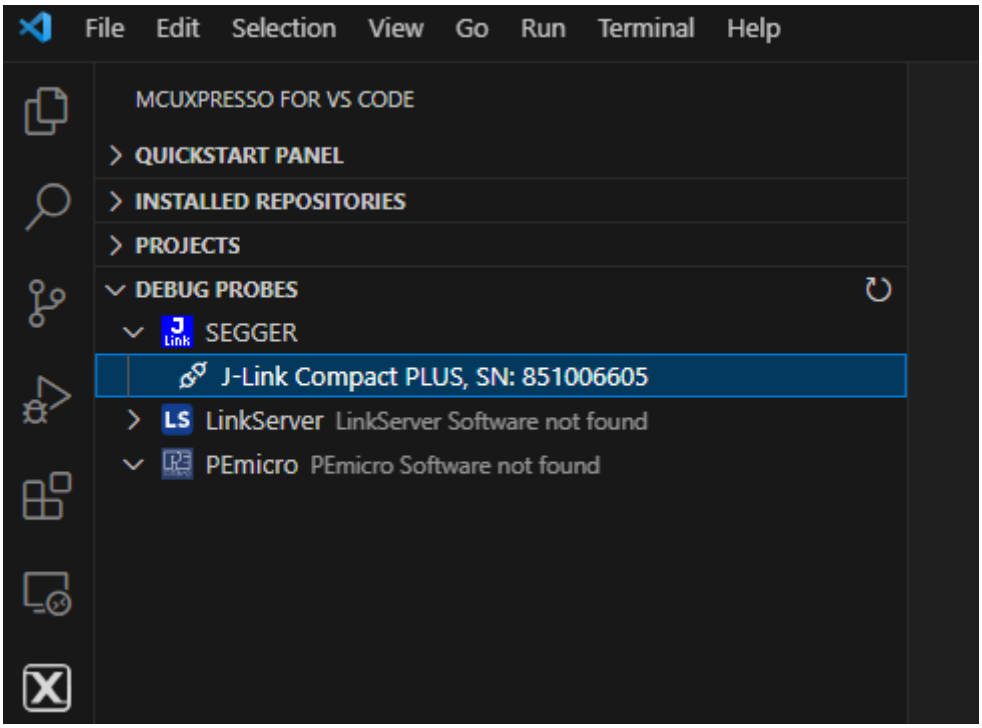

Figure 6. J-Link probe available under DEBUG PROBES view

2.4 Import MCUXpresso SDK

Depending on what board you are running, build and download the specific SDK from NXP official website. For this application note, the following SDKs have been tested:

- SDK_2.14.0_EVK-MIMX8MM
- SDK_2.14.0_EVK-MIMX8MN
- SDK_2.14.0_EVK-MIMX8MP
- SDK_2.14.0_EVK-MIMX8ULP
- SDK_2.14.0_MCIMX93-EVK

To build an example for i.MX 93 EVK, see Figure 7:

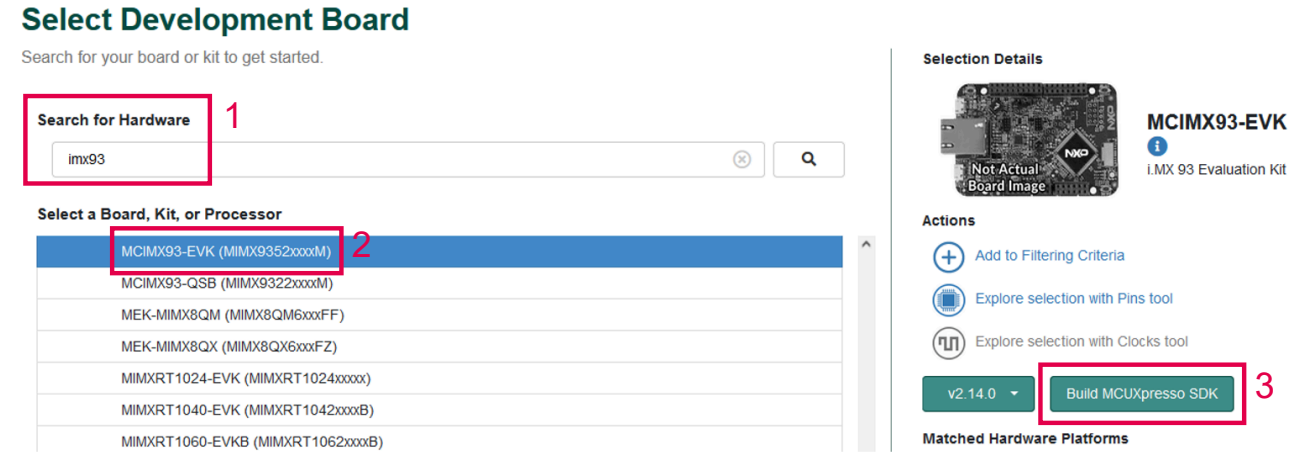

Figure 7. Download the MCUXpresso SDK

To import an MCUXpresso SDK repository in VS Code, perform the following steps:

1. After downloading the SDK, open Visual Studio Code. Click the MCUXpresso tab from the left side, and expand the *INSTALLED REPOSITORIES* and *PROJECTS* views.
2. Click the *Import Repository* and select *LOCAL ARCHIVE*. Click the *Browse…* corresponding to the *Archive* field and select the recently downloaded SDK archive.
3. Select the path where the archive is unzipped and fill in the *Location* field.
4. The *Name* field can be left by default, or you can choose a custom name.
5. Check or uncheck *Create Git repository* based on your needs and then click *Import*.

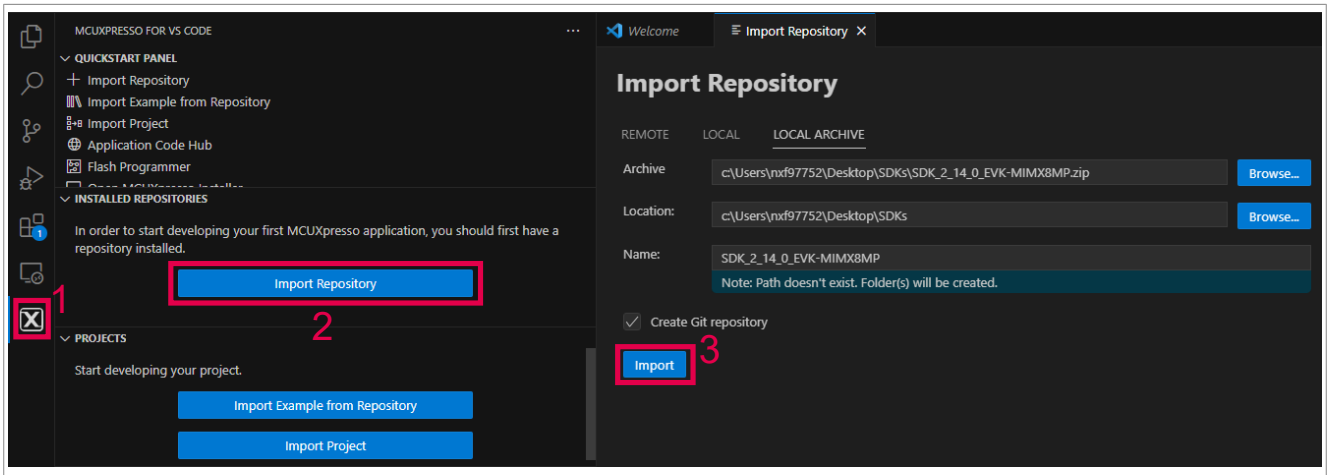

Figure 8. Import the MCUXpresso SDK repository

2.5 Import an example application

When the SDK is imported, it appears under the *INSTALLED REPOSITORIES* view.

To import an example application from the SDK repository, perform the following steps:

1. Click the *Import Example from Repository* button from the *PROJECTS* view.
2. Choose a repository from the drop-down list.
3. Choose the toolchain from the drop-down list.
4. Choose the target board.

5. Choose the `demo_apps/hello_world` example from the *Choose a template* list.
6. Choose a name for the project (the default can be used) and set the path to project *Location*.
7. Click *Create*.
8. Perform the following steps for i.MX 8M Family only. Under the *PROJECTS* view, expand the imported project. Go to the *Settings* section and click the `mcuxpresso-tools.json` file.
   a. Add "interface": "JTAG" under "debug" > "segger"
   b. For i.MX 8MM, add the following configuration:
   "device": "MIMX8MM6_M4" under "debug" > "segger"
   c. For i.MX 8MN, add the following configuration:
   "device": "MIMX8MN6_M7" under "debug" > "segger"
   d. For i.MX 8MP, add the following configuration:
   "device": "MIMX8ML8_M7" under "debug" > "segger"

The following code shows an example for i.MX8MP "debug" section after the above modifications of `mcuxpresso-tools.json` were performed:

```
"debug": {
    "linkserver": {},
    "pemicro": {},
    "segger": {
      "device": "MIMX8ML8_M7",
      "interface": "JTAG"
      },
  },
```

After importing the example application successfully, it must be visible under the *PROJECTS* view. Also, the project source files are visible in the *Explorer* (Ctrl + Shift + E) tab.

3 Building the application

To build the application, press the left *Build Selected* icon, as shown in Figure 9.

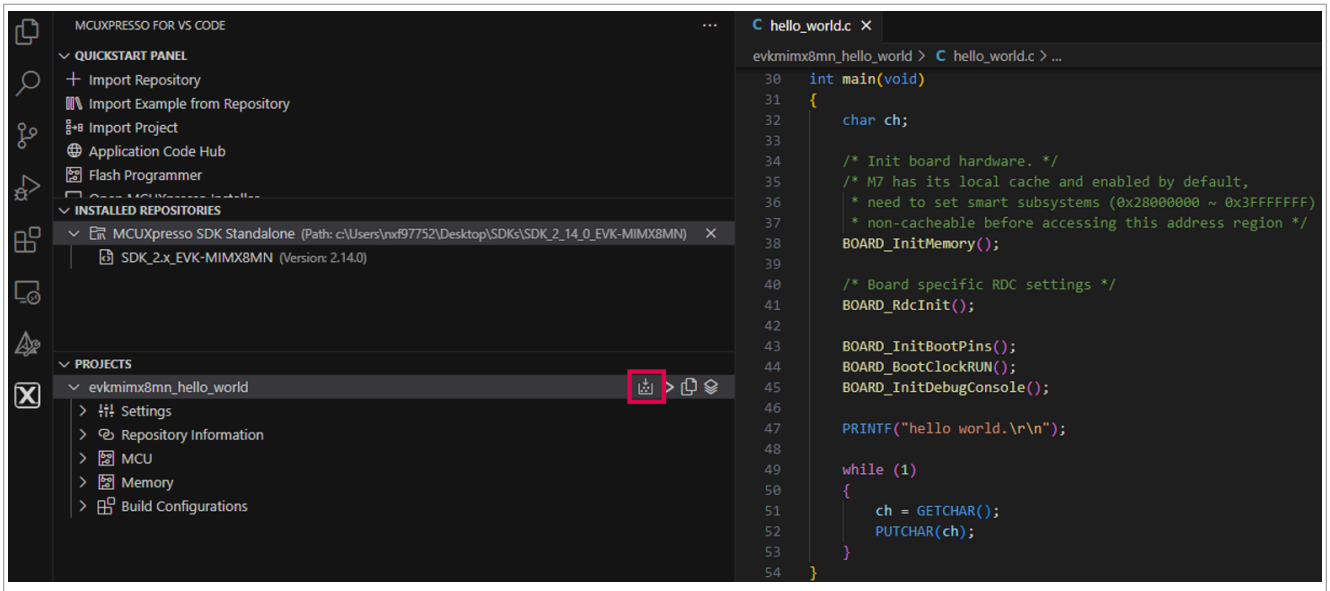

Figure 9. Build application

4 Prepare the board for the debugger

To use the JTAG for debugging Cortex-M applications, there are a few prerequisites depending on the platform:

1. **For i.MX 93**
   To support i.MX 93, the patch for SEGGER J-Link must be installed: SDK_MX93_3RDPARTY_PATCH.zip.
   Note: *This patch must be used, even if it is installed in the past.*
   After the download has finished, unzip the archive and copy the *Devices* directory and the `JLinkDevices.xml` file to `C:\Program Files\SEGGER\JLink`. If a Linux PC is used, the target path is `/opt/SEGGER/JLink`.
   - **Debugging Cortex-M33 while only Cortex-M33 is running**
     In this mode, the boot mode switch **SW1301[3:0]** must be set to **[1010]**. Then the M33 image can be directly loaded and debugged using the debug button. For more details, see Section 5.

   If Linux running on Cortex-A55 is needed in parallel with Cortex-M33, there are two ways of debugging Cortex-M33:
   - **Debugging Cortex-M33 while Cortex-A55 is in U-Boot**
     First, copy the `sdk20-app.bin` file (located in the `armgcc/debug` directory) generated in Section 3 into the boot partition of the SD card.
     Boot the board and stop it in U-Boot. When the boot switch is configured to boot Cortex-A, the boot sequence does not start the Cortex-M. It has to be kicked off manually using the commands below. If Cortex-M is not started, JLink fails to connect to the core.

     ```
     u-boot=> fatload mmc 1:1 80000000 sdk20-app.bin
     u-boot=> cp.b 0x80000000 0x201e0000 0x10000
     u-boot=> bootaux 0x1ffe0000 0
     ```

     Note: *If the system cannot be debugged normally, try to right-click the project in the MCUXpresso for VS Code and choose "Attach to debug the project".*
   - **Debugging Cortex-M33 while Cortex-A55 is in Linux**
     The Kernel DTS must be modified to disable the UART5, which uses the same pins as the JTAG interface. If a Windows PC is used, the easiest is to install WSL + Ubuntu 22.04 LTS, and then to cross-compile the DTS.
     After the WSL + Ubuntu 22.04 LTS installation, open the Ubuntu machine running on WSL and install the required packages:

     ```
     $ sudo apt update
     $ sudo apt install build-essential flex bison gcc-aarch64-linux-gnu git
     ```

     Now, the Kernel sources can be downloaded:

     ```
     $ git clone https://github.com/nxp-imx/linux-imx
     $ cd linux-imx
     $ git checkout lf-6.1.22-2.0.0
     ```

     To disable the UART5 peripheral, search for `lpuart5` node in the `linux-imx/arch/arm64/boot/dts/freescale/imx93-11x11-evk.dts` file and replace the `okay` status with `disabled`:

     ```
     &lpuart5 {
             /* BT */
             pinctrl-names = "default";
             pinctrl-assert-gpios = <&pca6524 19 GPIO_ACTIVE_HIGH>;
             pinctrl-0 = <&pinctrl_uart5>;
             status = "disabled";

             bluetooth {
                     compatible = "nxp,88w8987-bt";
             };
     ```

```
};
```

Recompile the DTS:

```
$ ARCH=arm64 CROSS_COMPILE=aarch64-linux-gnu- make freescale/imx93-11x11-
evk.dtb
```

Copy the newly created `linux-imx/arch/arm64/boot/dts/freescale/imx93-11x11-evk.dtb` file on the boot partition of the SD card.
Copy the `hello_world.elf` file (located in the `armgcc/debug` directory) generated in Section 3 into the boot partition of the SD card.
Boot the board in Linux. Since boot ROM does not kick off the Cortex-M when Cortex-A boots, the Cortex-M must be manually started.

```
root@imx8mm-lpddr4-evk:/lib/firmware# cp /run/media/mmcblk2p1/
hello_world.elf /lib/firmware
root@imx93evk:~# echo hello_world.elf > /sys/class/remoteproc/remoteproc0/
firmware
root@imx93evk:~# echo start > /sys/class/remoteproc/remoteproc0/state
```

Note: *The `hello_world.elf` file must be placed in the `/lib/firmware` directory.*

2. **For i.MX 8M**
   To support i.MX 8M Plus, the patch for SEGGER J-Link must be installed:
   `iar_segger_support_patch_imx8mp.zip`.
   After the download has finished, unzip the archive and copy the *Devices* directory and the `JLinkDevices.xml` file from the *JLink* directory to `C:\Program Files\SEGGER\JLink`. If a Linux PC is used, the target path is `/opt/SEGGER/JLink`.
   - **Debugging Cortex-M while Cortex-A is in U-Boot**
     In this case, nothing special must be done. Boot the board in U-Boot and jump to Section 5.
   - **Debugging Cortex-M while Cortex-A is in Linux**
     To run and debug the Cortex-M application in parallel with Linux running on Cortex-A, the specific clock must be assigned and reserved for Cortex-M. It is done from within U-Boot.
     Stop the board in U-Boot and run the below commands:

```
u-boot=> run prepare_mcore
u-boot=> boot
```

3. **For i.MX 8ULP**
   To support the i.MX 8ULP, the patch for SEGGER J-Link must be installed:
   `SDK_MX8ULP_3RDPARTY_PATCH.zip`.
   Note: *This patch must be used even if it is installed in the past.*
   After the download, unzip the archive and copy the *Devices* directory and the `JLinkDevices.xml` file to `C:\Program Files\SEGGER\JLink`. If a Linux PC is used, the target path is `/opt/SEGGER/JLink`.
   For i.MX 8ULP, due to the Upower unit, build the `flash.bin` using `m33_image` in our "VSCode" repo first. The M33 image can be found in `{CURRENT REPO}\armgcc\debug\sdk20-app.bin`. Refer to Section 6 from the *Getting Started with MCUXpresso SDK for EVK-MIMX8ULP and EVK9-MIMX8ULP* in the `SDK_2_xx_x_EVK-MIMX8ULP/docs` on how to build the `flash.bin` image.
   Note: *Use the M33 image in the active VSCode repo. Otherwise, the program does not attach properly.*
   Right-click and choose "Attach".

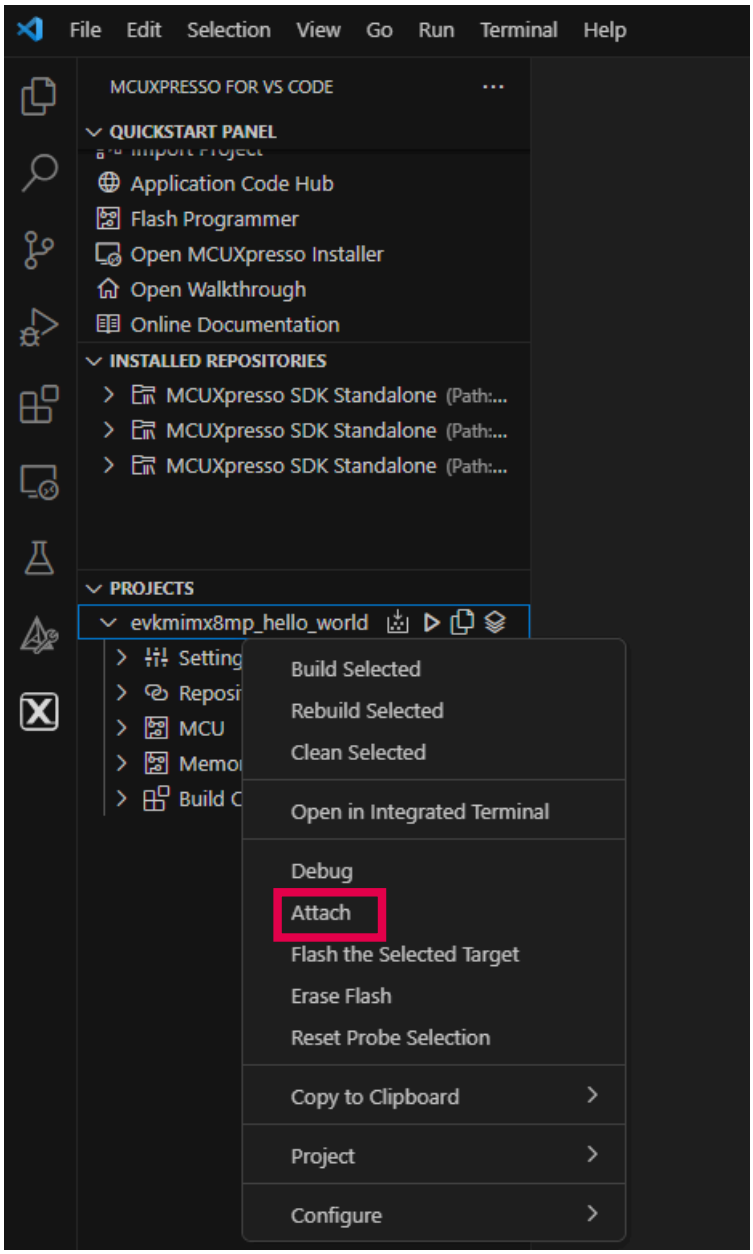

Figure 10. Attach to J-Link debugger for i.MX 8ULP

5 Running and debugging

After pressing the debug button, choose the *Debug project configuration* and the debugging session starts.

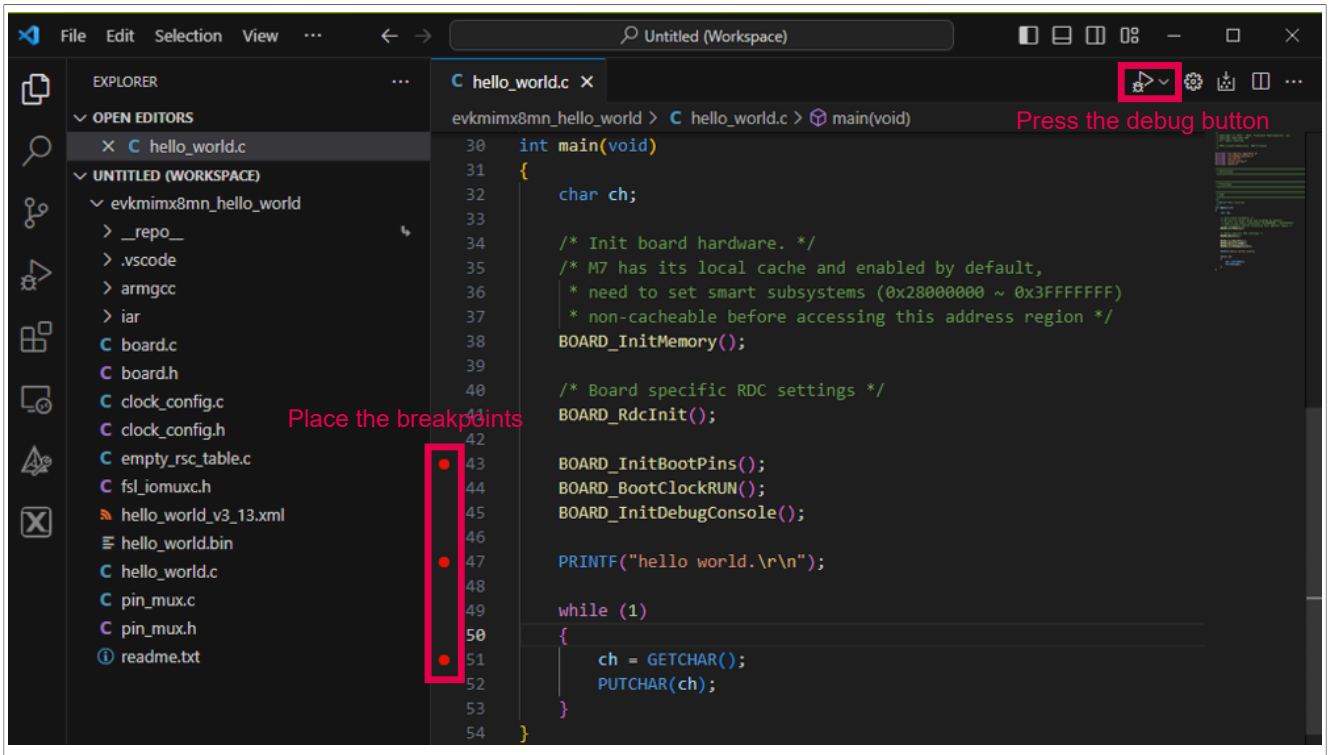

Figure 11. Start the debugging session

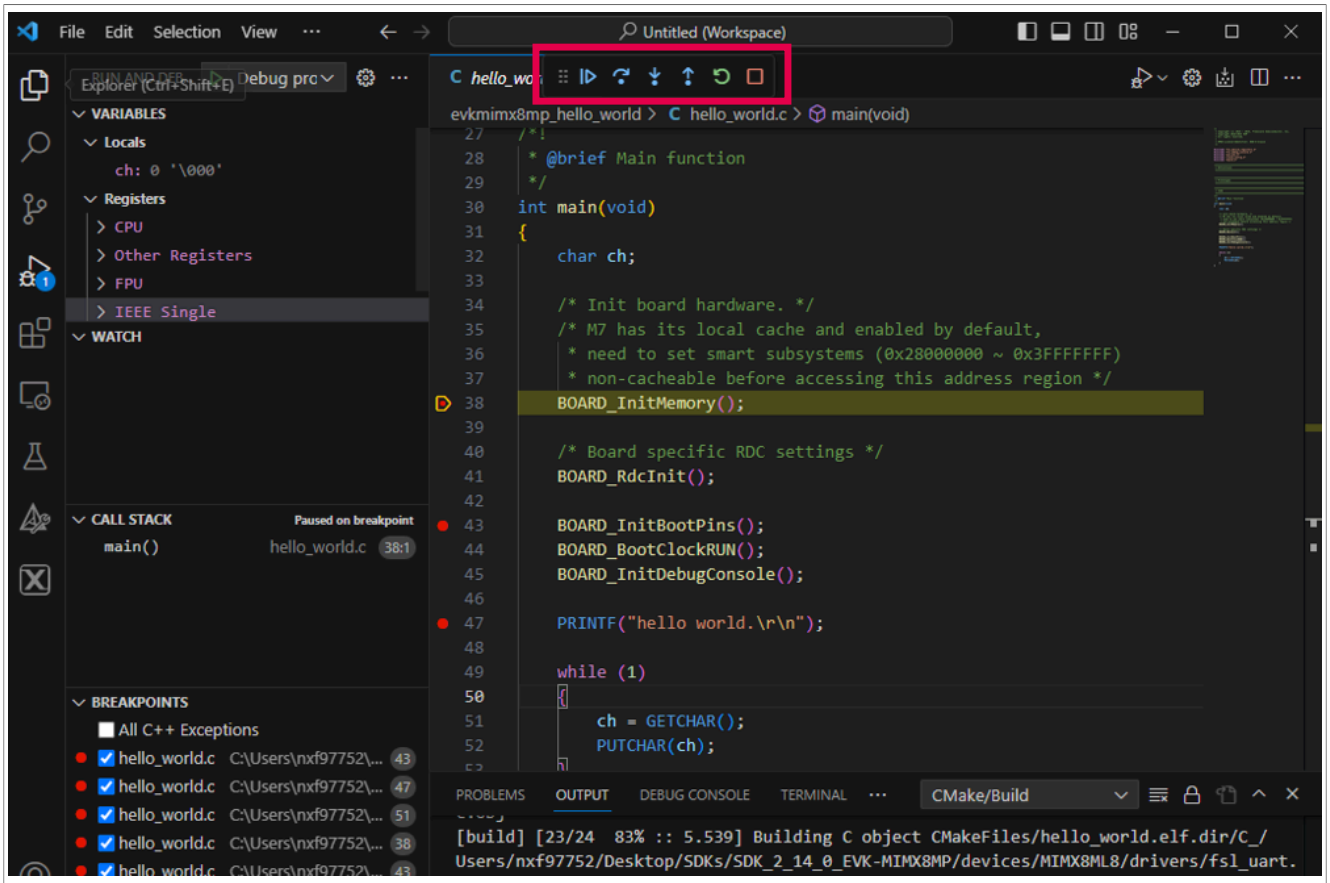

Figure 12. Debugging menu

When a debugging session starts, a dedicated menu is displayed. The debugging menu has buttons for starting the execution until a breakpoint fires up, pause the execution, step over, step into, step out, restart, and stop.

Also, we can see local variables, register values, watch some expression, and check call stack and breakpoints in the left-hand navigator. These function regions are under the "Run and Debug" tab, and not in MCUXpresso for VS Code.

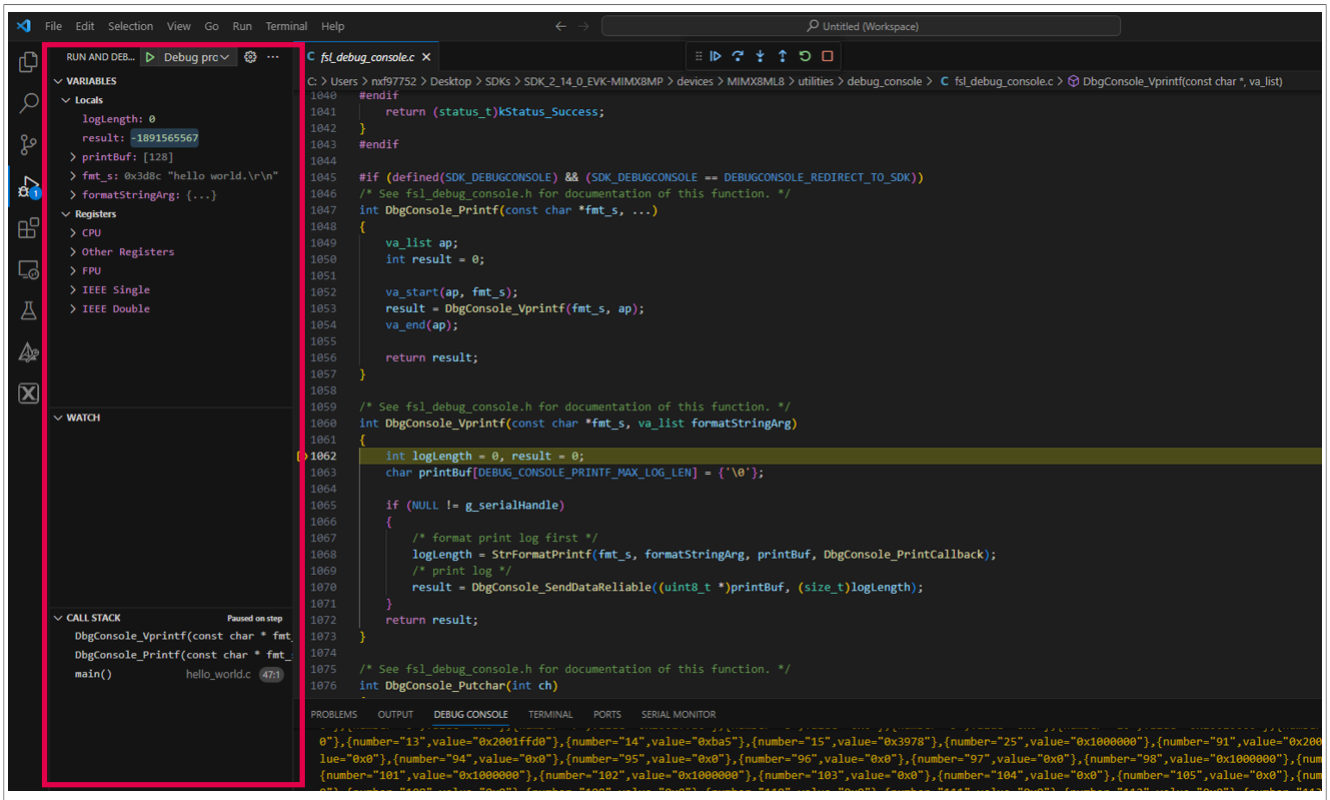

Figure 13. Variables, registers, and call stack

6 Note about the source code in the document

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7 Revision history

Table 1 summarizes the revisions done to this document.

Table 1. Revision history

Revision number	Revision date	Description
1	24 November 2023	Initial public release

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