

# Getting started with PSoC™ 6 MCU on ModusToolbox™ software

## About this document

### Scope and purpose

This application note introduces the PSoC™ 6 microcontroller (MCU), a low power, secured MCU with dual CPU Arm® Cortex®-M4 and Cortex®-M0+ processors. This application note helps you explore the PSoC™ 6 MCU architecture and development tools and shows you how to create your first application using ModusToolbox™ software. This application note also guides you to more resources available online to accelerate your learning about PSoC™ 6 MCU.

### Intended audience

This document is intended for the users who are new to PSoC™ 6 MCU and ModusToolbox™ software.

### Associated part family

All PSoC™ 6 MCU devices

### Software version

ModusToolbox™ software 3.2 or above.

### More code examples? We heard you.

To access an ever-growing list of PSoC™ PSoC™ 6 code examples using ModusToolbox™, please visit the [GitHub](#) site.

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## 1 Introduction

### 1 Introduction

PSoC™ 6 MCU is an ultra-low-power PSoC™ device with a dual-core architecture and low-power design techniques tailored for battery-powered applications. The dual-core Arm® Cortex®-M4 and Cortex®-M0+ architecture lets designers optimize for power and performance simultaneously. With integrated on-chip flash/SRAM memory, encrypted external flash memory expansion, configurable memory and peripheral protection units, and a cryptographic accelerator, the PSoC™ 6 MCU supports standard embedded security features like secured boot, secured provisioning, secured key storage, run-time security, and secured firmware updates.

Designers can use the MCU's rich analog and digital peripherals to create custom analog front-ends (AFEs) or digital interfaces for innovative system components such as MEMS sensors and electronic-ink displays. The PSoC™ 6 MCU features the fourth generation of industry-leading CAPSENSE™ capacitive-sensing technology, enabling modern touch and gesture-based interfaces that are robust and reliable. PSoC™ 6 MCU, paired with Infineon's AIROC™ Wi-Fi, AIROC™ Bluetooth®, or AIROC™ combo radio modules, is the perfect solution for secure, low-power, feature-rich IoT products.

Due to the versatile features of the PSoC™ 6 MCU, it can be used in a wide variety of applications, spanning consumer electronics, industrial applications, smart homes, IoT, and general-purpose embedded applications.

#### 1.1 PSoC™ 6 architecture and portfolio overview

The PSoC™ 6 architecture block diagram, as shown in the following figure, is a unified block diagram covering the entire PSoC™ 6 MCU portfolio. Refer to the respective product family datasheets for the features offered for a specific device in the PSoC™ 6 portfolio. For example, Flash/SRAM memory density, IO count, peripheral features/count, and supported packages vary based on the product family chosen in the PSoC™ 6 portfolio.

1 Introduction

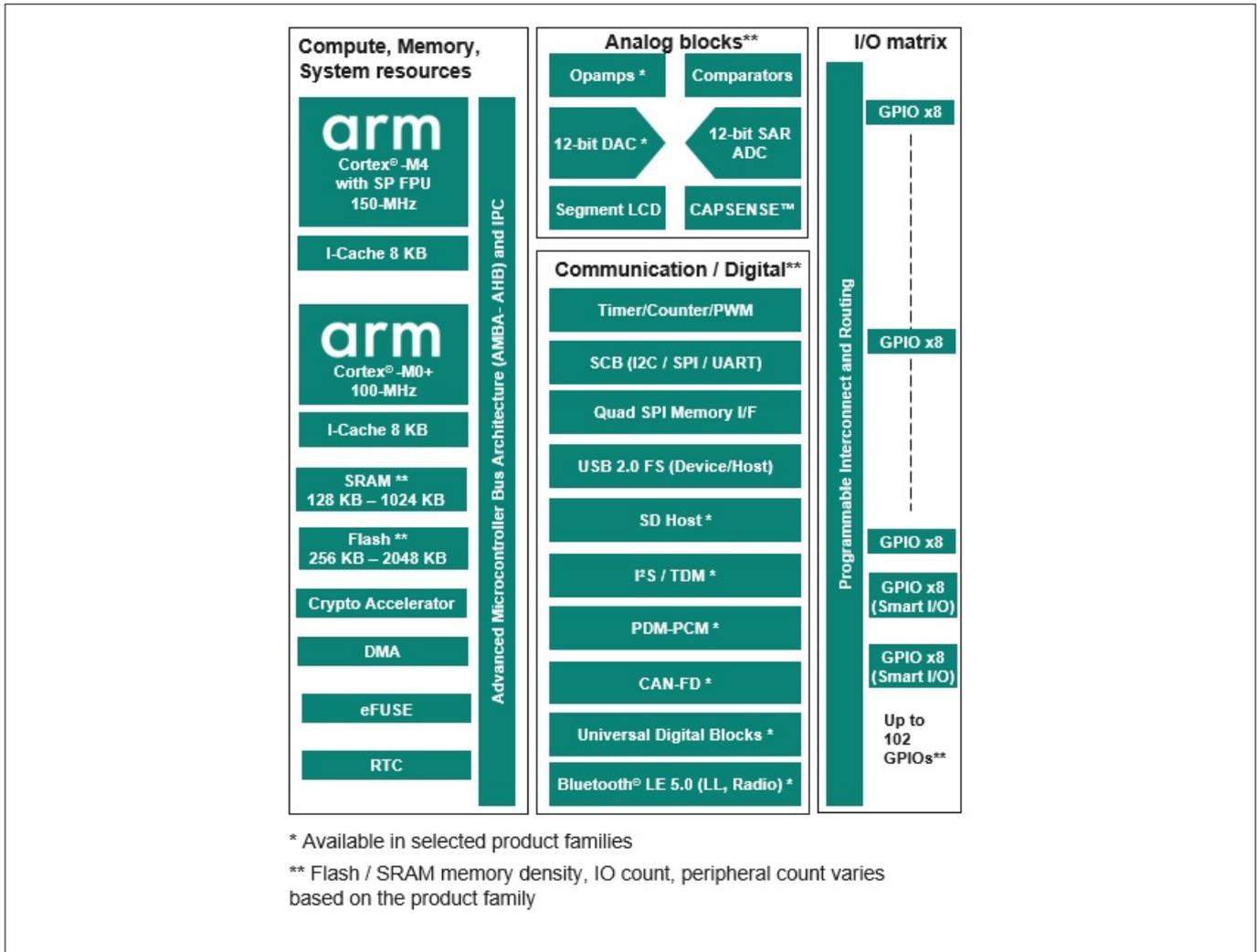


Figure 1 PSoC™ 6 architecture

PSoC™ 6 MCU portfolio segmentation

The PSoC™ 6 MCU portfolio consists of multiple product families, which fall under four different product lines.

- 1. PSoC™ 61 (Programmable line)** consists of product families in which only the Arm® Cortex® M4 is available for user applications. Orderable part numbers (OPN) in the PSoC™ 61 line start with the “CY8C61” prefix
- 2. PSoC™ 62 (Performance line)** consists of product families in which both the Arm® Cortex® M4 and Arm® Cortex®-M0+ are available for user applications (dual CPU architecture). Orderable part numbers (OPN) in the PSoC™ 62 line start with the “CY8C62” prefix
- 3. PSoC™ 63 (Connectivity line)** consists of product families that include the Bluetooth® LE radio PHY and MAC integrated as part of the MCU. Orderable part numbers (OPN) in the PSoC™ 63 line start with the “CY8C63” prefix
- 4. PSoC™ 64 (Secured line)** consists of product families in which the Arm® Cortex® M0+ is configured as a secured processing environment (SPE) and the Arm® Cortex® M4 acts as a non-secured processing environment (NSPE). Orderable part numbers (OPN) in the PSoC™ 64 line start with the “CYB064” or “CYS064” prefix. This product family is primarily intended for applications that require secured factory provisioning of the firmware, including security keys and certificates

## 1 Introduction

### 1.2 Device features

PSoC™ 6 MCUs have extensive features, as shown in [Figure 1](#). The following is a list of major features. For more information, see the device [datasheet](#), the [technical reference manual \(TRM\)](#), and [References](#) section.

#### High-performance, low-power compute system

- Dual-core architecture: 150-MHz Arm® Cortex®-M4, and 100-MHz Arm® Cortex®-M0+
- On-chip memory: up to 1024 KB SRAM, up to 2048 KB flash
- Ultra-low-power (0.9 V) and low-power (1.1 V) operation modes
- Multiple device low power modes: Hibernate, Deep Sleep, Sleep, and Active. Low-power analog operation

#### Robust security features

- Advanced cryptographic accelerator and true random number generator
- One-time programmable eFUSE for secure key storage
- Secured boot, secured provisioning, and image authentication
- Secure over-the-air (OTA) firmware update with read-while-write flash technology for firmware updates

#### Integration

- 4<sup>th</sup> generation CAPSENSE™ to integrate a robust touch user interface into a single MCU
- Segment LCD drive, serial interface display drivers
- Quad SPI Memory I/F for memory expansion
- Smart I/O to integrate external digital glue logic in the MCU
- Universal Digital Blocks (UDBs) to implement CPLD and mini-FPGA logic in MCU

#### Rich analog peripherals

- 12-bit SAR ADC, 12-bit DAC, OpAmps, low-power comparators. Low-power analog operation

#### Digital blocks and communication interfaces

- Highly configurable 16-bit and 32-bit timers, counters, and PWMs
- Serial Communication Blocks (I2C/SPI/UART) for digital sensor/host MCU interfaces
- I2S/TDM, PDM-PCM converter for audio applications
- SD Host Controller (SDHC), USB 2.0 full speed (host and device)
- CAN-FD for industrial applications

#### Wide variety of IO and package options

- 124-BGA, 100-WLCSP, 80-WLCSP, 80-M-CSP, 49-WLCSP, 68-QFN, 128-TQFP, 100-TQFP, 80-TQFP, 64-TQFP
- Up to 102 GPIOs
- -40 to 85°C operation with support for extended temperature operation (105°C) in select devices

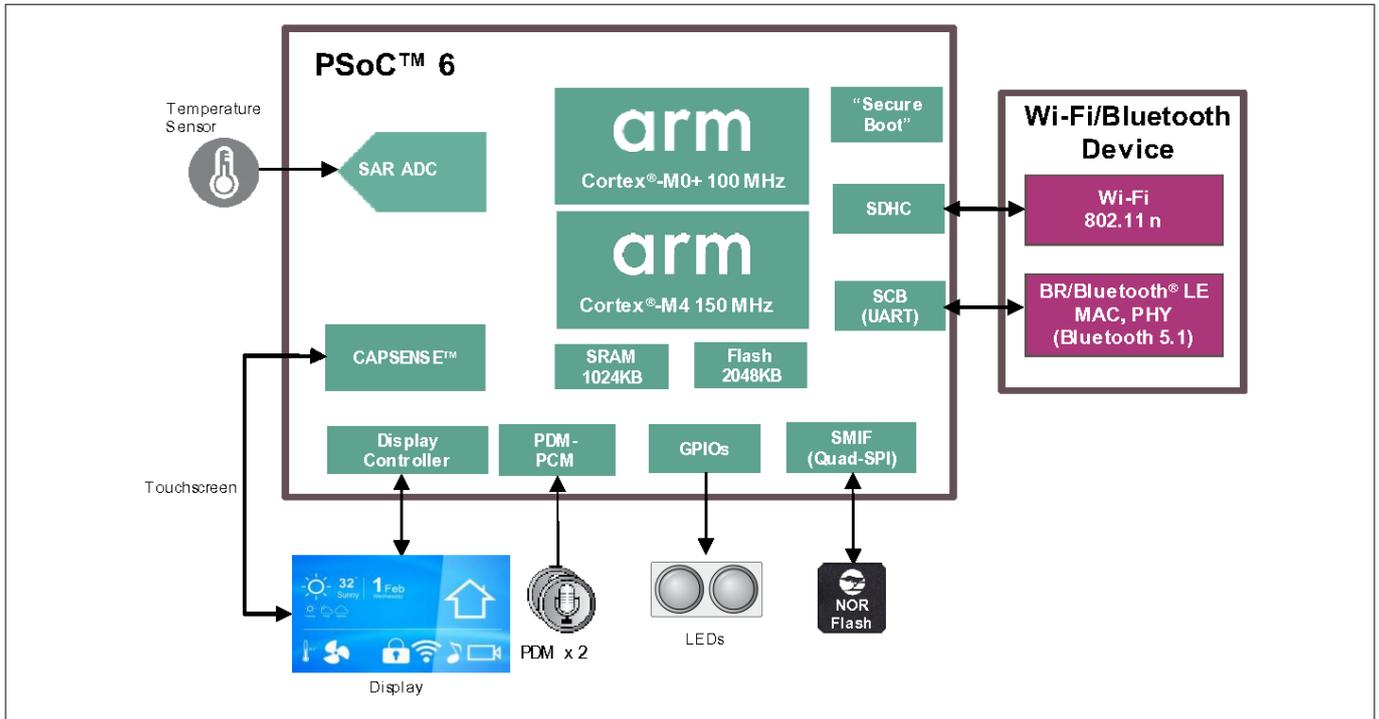
### 1.3 Target applications

The versatile, secured, low-power, feature-rich offerings in the PSoC™ 6 MCU make it the ideal choice of microcontroller for a wide variety of end applications. Some of these applications are listed below.

- Wearable devices like smart watches and fitness trackers
- Smart home devices like smart locks, thermostats, and integrated alarm systems
- Smart home appliances like washing machines, refrigerators, and cooktops
- Datacenter and computing applications for the system management function
- Power tools, e-bikes, and other motor control applications
- Industrial IoT applications
- Battery powered devices

The following figure illustrates an application-level block diagram for a real-world use case using PSoC™ 6 MCU.

1 Introduction



**Figure 2 Application-level block diagram using PSoC™ 6 MCU**

Depending on the end application use case, the PSoC™ 6 MCU can perform a wide variety of system functions, as listed below.

- Main system application MCU
- Wi-Fi MCU integrating analog front end (AFE), CAPSENSE™ (touch), display, and audio functionality
- Low-power sensor co-processor to Arm® A-class based SoCs and MPUs
- Motor control MCU with integration of CAPSENSE™ (touch) and other user interface features
- System management controllers like fan control, power sequencing, and server backplane management

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## 2 PSoC™ 6 resources

### 2 PSoC™ 6 resources

A wealth of technical resources are available to develop applications with PSoC™ 6 MCU4. These resources are listed below.

- [PSoC™ 6 video library](#)
- [PSoC™ 6 MCU webpage](#)
- Product selectors: [PSoC™ 6 MCU](#)
- [Datasheets](#) describe and provide electrical specifications for each device family.
- [Application notes](#) and [Code examples](#) cover a broad range of topics, from basic to advanced level. You can also browse our collection of code examples.
- [Technical reference manuals \(TRMs\)](#) provide detailed descriptions of the architecture and registers in each device family.
- [PSoC™ 6 MCU programming specification](#) provides the information necessary to program the nonvolatile memory of PSoC™ 6 MCU devices.
- [CAPSENSE™ design guides](#): Learn how to design capacitive touch-sensing applications with PSoC™ devices.
- Development tools: Many low-cost [kits and shield boards](#) are available for evaluation, design, and development of different applications using PSoC™ 6 MCUs.
- Training videos: [Video training](#) on our products and tools, including a dedicated series on [PSoC™ 6 MCUs](#).
- Technical Support: [PSoC™ 6 community forum](#), [Knowledge base articles](#).

### 3 PSoC™ 6 MCU development kits

## 3 PSoC™ 6 MCU development kits

Infineon provides a wide variety of hardware development kits in various form factors to enable easy and rapid evaluation and prototyping of PSoC™ 6 based applications. The prototyping kits are low-cost, small-form factor evaluation kits for prototyping applications that do not need additional hardware shields to be connected to the kit. The Pioneer/Evaluation kits are more full featured kits that provide various hardware expansion capabilities, like the Arduino shield and M.2 interface for wireless radio interface.

The following table lists the PSoC™ 6 kits for the various product families. For a general evaluation of the PSoC™ 6 MCU portfolio, it is recommended to either use the super-set PSoC™ 6 prototyping kit (CY8CPROTO-062S2-43439) or the super-set PSoC™ 6 Pioneer kit (CY8CKIT-062S2-43012). ModusToolbox™ software is the software development platform for creating embedded applications using the development kits.

**Table 1 PSoC™ 6 kits**

Kit MPN	Applicable PSoC™ 6 product families	Kit type	Board support package GitHub repository
<a href="#">CY8CPROTO-062S2-43439</a> <b>(Default recommended Proto kit)</b>	CY8C61x8, CY8C61xA, CY8C62x8, CY8C62xA	prototyping	<a href="#">BSP</a>
<a href="#">CY8CKIT-062S2-43012</a> <b>(Default recommended Pioneer kit)</b>	CY8C61x8, CY8C61xA, CY8C62x8, CY8C62xA	Pioneer	<a href="#">BSP</a>
<a href="#">CY8CEVAL-062S2</a>	CY8C61x8, CY8C61xA, CY8C62x8, CY8C62xA	Evaluation	<a href="#">BSP</a>
<a href="#">CY8CKIT-062S4</a>	CY8C61x4, CY8C62x4	Pioneer	<a href="#">BSP</a>
<a href="#">CY8CPROTO-062S3-4343W</a>	CY8C61x5, CY8C62x5	prototyping	<a href="#">BSP</a>
<a href="#">CY8CKIT-062-WIFI-BT</a>	CY8C61x6, CY8C61x7, CY8C62x6, CY8C62x7	Pioneer	<a href="#">BSP</a>
<a href="#">CY8CPROTO-064B0S3</a>	CYB064x5	prototyping	<a href="#">BSP</a>
<a href="#">CY8CPROTO-064S1-SB</a>	CYB064x7	prototyping	<a href="#">BSP</a>
<a href="#">CY8CKIT-064B0S2-4343W</a>	CYB064xA	Pioneer	<a href="#">BSP</a>

For the complete list of kits for the PSoC™ 6 MCU along with the shield modules, see the [Microcontroller \(MCU\) kits](#) page.

4 PSoC™ 6 software ecosystem and firmware/application development

## 4 PSoC™ 6 software ecosystem and firmware/application development

Infineon provides the ModusToolbox™ software for firmware/application development based on PSoC™ 6 MCUs. ModusToolbox™ Software is a modern, extensible development ecosystem supporting a wide range of Infineon microcontroller devices, including PSoC™ Arm® Cortex® Microcontrollers, TRAVEO™ T2G Arm® Cortex® Microcontroller, XMC™ Industrial Microcontrollers, AIROC™ Wi-Fi devices, AIROC™ Bluetooth® devices, and USB-C Power Delivery Microcontrollers. This software includes configuration tools, low-level drivers, middleware libraries, and other packages that enable you to create MCU and wireless applications. All tools run on Windows, macOS, and Linux. ModusToolbox™ includes an Eclipse IDE, which provides an integrated flow with all the ModusToolbox™ tools. Other IDEs such as Visual Studio Code, IAR Embedded Workbench and Arm® MDK (µVision) are also supported.

ModusToolbox™ software supports stand-alone device and middleware configurators. Use the configurators to set the configuration of different blocks in the device and generate code that can be used in firmware development.

Libraries and enablement software are available at the [GitHub](#) site.

ModusToolbox™ tools and resources can also be used on the command line. See the build system chapter in the [ModusToolbox™ tools package user guide](#) for detailed documentation.

### 4.1 Installing the ModusToolbox™ tools package

Refer to the [ModusToolbox™ tools package installation guide](#) for details.

### 4.2 Choosing an IDE

ModusToolbox™ software, the latest-generation toolset, is supported across Windows, Linux, and macOS platforms. ModusToolbox™ software supports 3rd-party IDEs, including the Eclipse IDE, Visual Studio Code, Arm® MDK (µVision), and IAR Embedded Workbench. The tools package includes an implementation for all the supporting IDE's. The tools support all PSoC™ 6 MCUs. The associated BSP and library configurators also work on all three host operating systems.

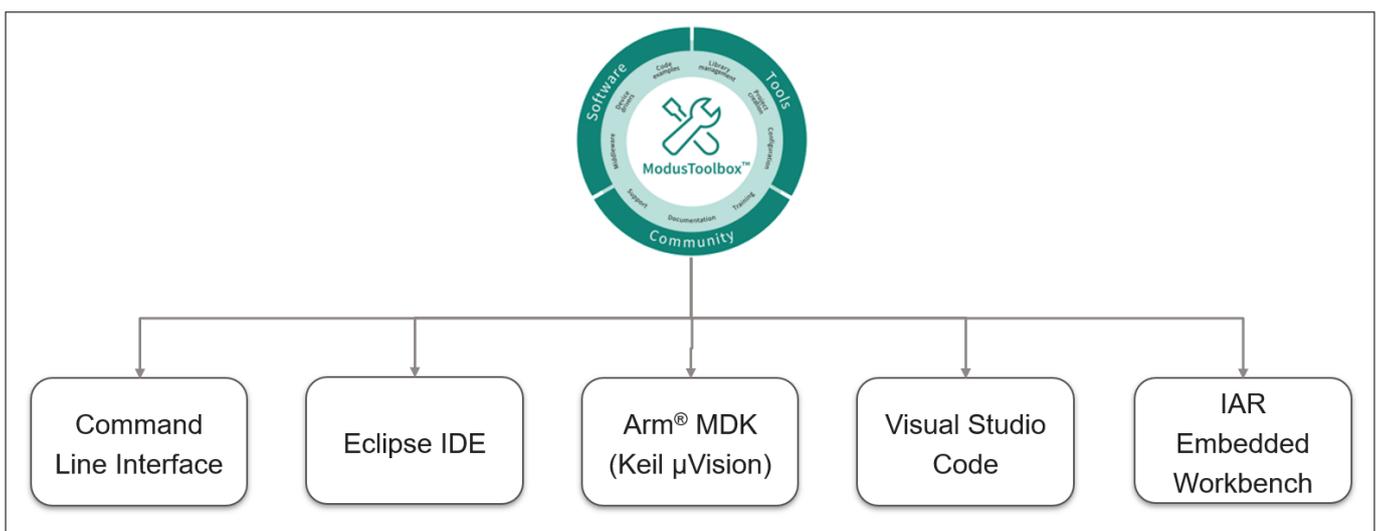


Figure 3 ModusToolbox™ environment

## 5 Getting started with PSoC™ 6 MCU design

### 5 Getting started with PSoC™ 6 MCU design

This section provides the following:

- Demonstrate how to build a simple PSoC™ 6 MCU-based design and program it on to the development kit
- Makes it easy to learn PSoC™ 6 MCU design techniques and how to use the ModusToolbox™ software with different IDE's.

#### 5.1 Prerequisites

Before you get started, make sure that you have the appropriate development kit for your PSoC™ 6 MCU product line and have installed the required software. You also need internet access to the GitHub repositories during project creation.

##### 5.1.1 Hardware

The example design shown below is developed for the [PSoC™ 62S2 Wi-Fi Bluetooth® prototyping kit \(CY8CPROTO-062S2-43439\)](#). However, you can build the application for other development kits. See the [PSoC™ 6 MCU development kits](#) section for list of kits that you can use to get started with PSoC™ 6 MCU.

##### 5.1.2 Software

[ModusToolbox™ software](#) 3.2 or above.

After installing the software, see the [ModusToolbox™ tools package user guide](#) to get an overview of the software.

#### 5.2 Using these instructions

These instructions are grouped into several sections. Each section is dedicated to a phase of the application development workflow. The major sections are:

1. [Create a new application](#)
2. [View and modify the design configuration](#)
3. [Write firmware](#)
4. [Build the application](#)
5. [Program the device](#)
6. [Test your design](#)

This design is developed for the [PSoC™ 62S2 Wi-Fi Bluetooth® Prototyping Kit \(CY8CPROTO-062S2-43439\)](#). You can use other supported kits to test this example by selecting the appropriate kit while creating the application.

#### 5.3 About the design

This design uses the CM4 core of the PSoC™ 6 MCU to execute two tasks: UART communication and LED control. At device reset, the Infineon-supplied pre-built CM0+ application image enables the CM4 core and configures the CM0+ core to go to sleep. The CM4 core uses the UART to print a “Hello World” message to the serial port stream, and starts blinking the user LED on the kit. When the user presses the enter key on the serial console, the blinking is paused or resumed.

#### 5.4 Create a new application

This section takes you on a step-by-step guided tour of the new application process. It uses the **Empty App** starter application and manually adds the functionality from the **Hello World** starter application.

As mentioned in section [Choosing an IDE](#), ModusToolbox™ software supports the following third-party IDEs:

## 5 Getting started with PSoC™ 6 MCU design

1. [Eclipse IDE](#)
2. [Visual Studio Code \(VS Code\)](#)
3. [IAR Embedded Workbench](#)
4. [Keil µvision](#)

The following sections provide details on how to create a new application on different IDEs.

### 5.4.1 Eclipse IDE for ModusToolbox™

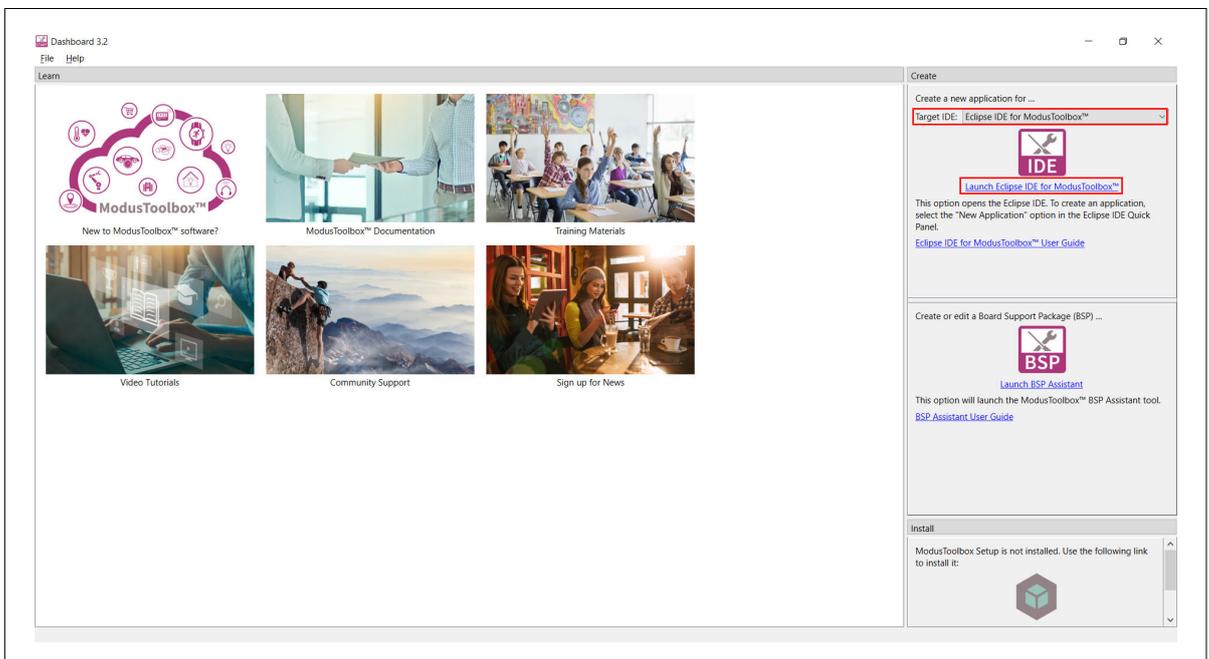
If you are familiar with developing projects with ModusToolbox™ software, you can use the **Hello World** starter application directly. It is a complete design, with all the firmware written for the supported kits. You can walk through the instructions and observe how the steps are implemented in the code example.

If you start from scratch and follow all the instructions in this application note, you can use the **Hello World** code example as a reference while following the instructions.

Launch the **Dashboard 3.2** application to get started. Please note that the **Dashboard 3.2** application needs access to the internet to successfully clone the starter application onto your machine.

The **Dashboard 3.2** application helps you get started using the various tools with easy access to documentation and training material, a simple path for creating applications and creating and editing BSPs.

1. Open the **Dashboard 3.2** application.  
To open the **Dashboard 3.2** application, click [ModusToolbox installation path]/ModusToolbox folder/dashboard 3.2.0
2. On the **Dashboard 3.2** window, in the right pane, in the **Target IDE** drop-down list, select **Eclipse IDE for ModusToolbox™**, and click **Launch Eclipse IDE for ModusToolbox™**

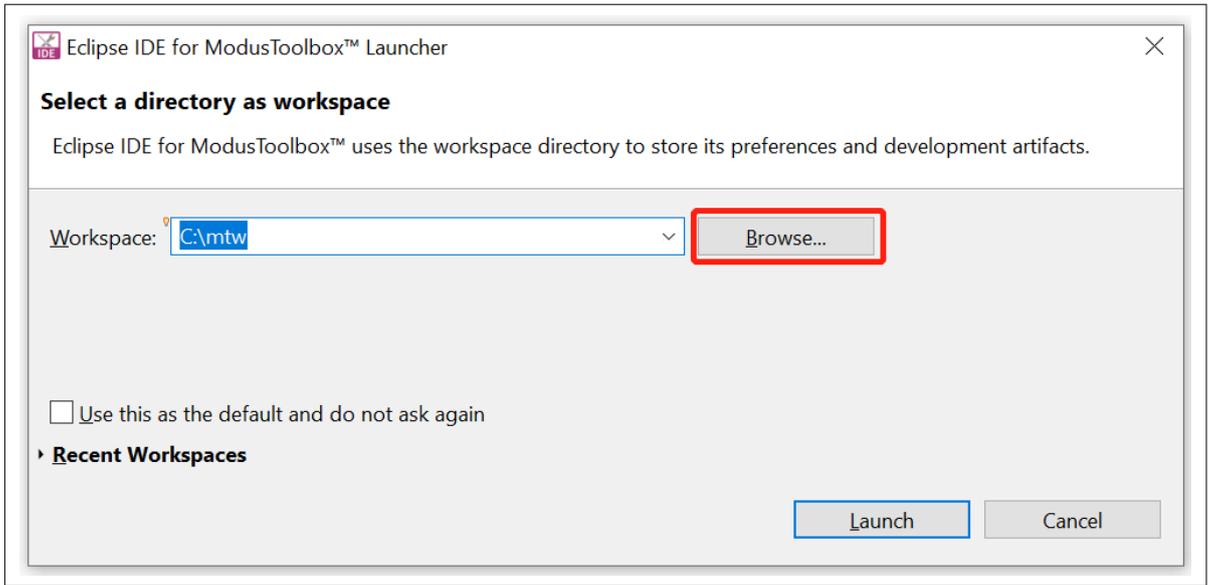


**Figure 4 Dashboard 3.2 application**

3. **Select a new workspace.**

At launch, Eclipse IDE for ModusToolbox™ presents a dialog to choose a directory for use as the workspace directory. The workspace directory is used to store workspace preferences and development artifacts. You can choose an existing empty directory by clicking the **Browse** button, as shown in the following figure. Alternatively, you can type in a directory name to be used as the workspace directory along with the complete path, and the IDE will create the directory for you.

5 Getting started with PSoC™ 6 MCU design

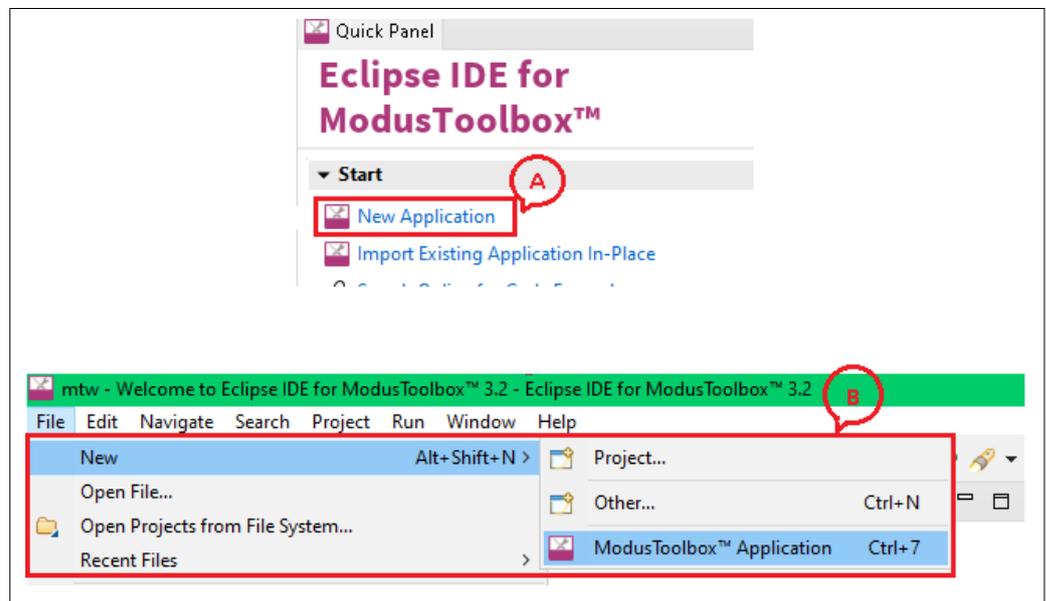


**Figure 5** Select a directory as the workspace

4. Create a new ModusToolbox™ application.

- a. Click **New Application** in the Start group of the Quick Panel
- b. Alternatively, you can choose **File > New > ModusToolbox™ Application**, as shown in the following figure

The Project Creator opens.



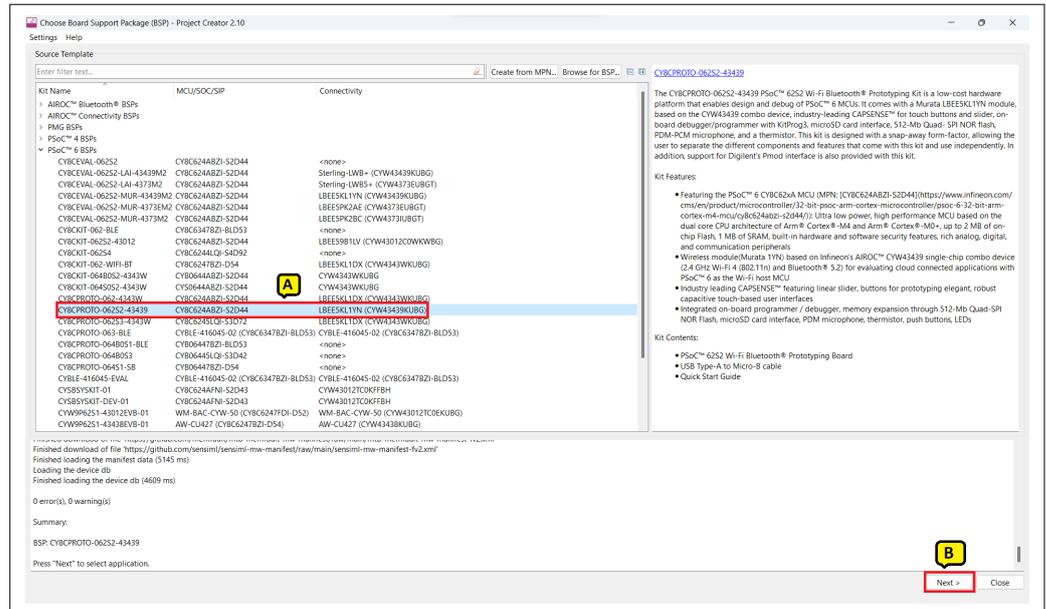
**Figure 6** Create a new ModusToolbox™ application

5. Select a target PSoC™ 6 MCU development kit.

ModusToolbox™ speeds up the development process by providing BSPs that set various workspace/project options for the specified development kit in the new application dialog.

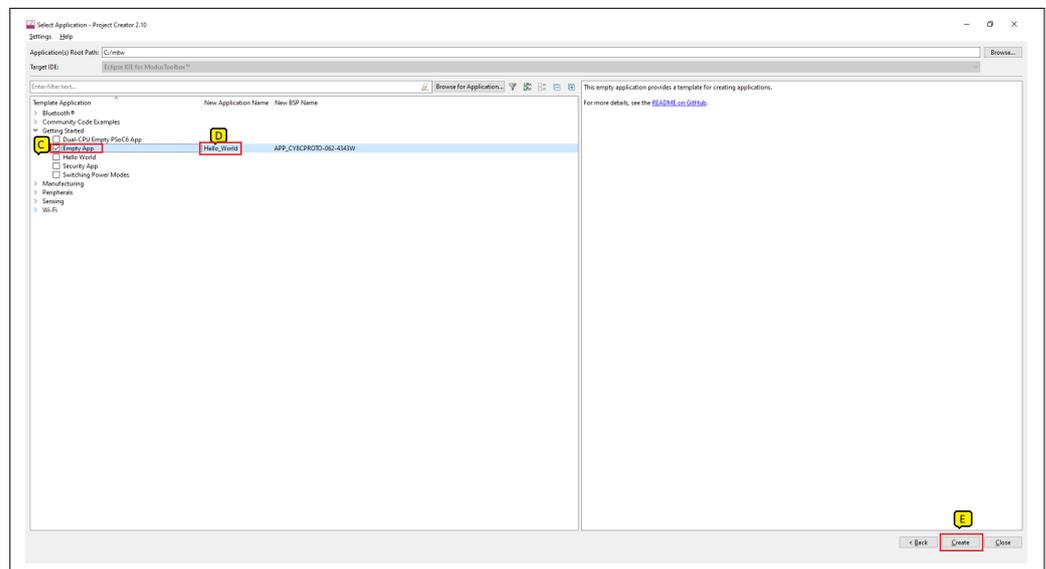
- a. In the **Choose Board Support Package (BSP)** dialog, choose the **Kit Name** that you have. The steps that follow use **CY8CPROTO-062S2-43439**. See [Figure 7](#) for help with this step
- b. Click **Next**

## 5 Getting started with PSoC™ 6 MCU design



**Figure 7 Choose target hardware**

- c. In the **Select Application** dialog, select **Empty App** starter application, as shown in the following figure
- d. In the **Name** field, type in a name for the application, such as **Hello\_World**. You can choose to leave the default name if you prefer
- e. Click **Create** to create the application, as shown in the following figure, wait for the Project Creator to automatically close once the project is successfully created



**Figure 8 Creating a new application**

You have successfully created a new ModusToolbox™ application for a PSoC™ 6 MCU.

The BSP uses CY8C624ABZI-D54 as the default device that is mounted on the **PSoC™ 62S2 Wi-Fi-Bluetooth® prototyping kit (CY8CPROTO-062S2-43439)** along with the **CY43439KUBG Wi-Fi/Bluetooth® radio**.

If you are using custom hardware based on PSoC™ 6 MCU or a different PSoC™ 6 MCU part number, refer to the Custom BSP App Note or the **BSP Assistant user guide**.

Refer to the **Eclipse IDE for ModusToolbox™ user guide** for more information.

5 Getting started with PSoC™ 6 MCU design

5.4.1.1 View and modify the design configuration

Figure 9 shows the Eclipse IDE Project Explorer interface displaying the structure of the application project. A PSoC™ 6 MCU application consists of a project to develop code for the CM4 core. A project folder consists of various subfolders – each denoting a specific aspect of the project.

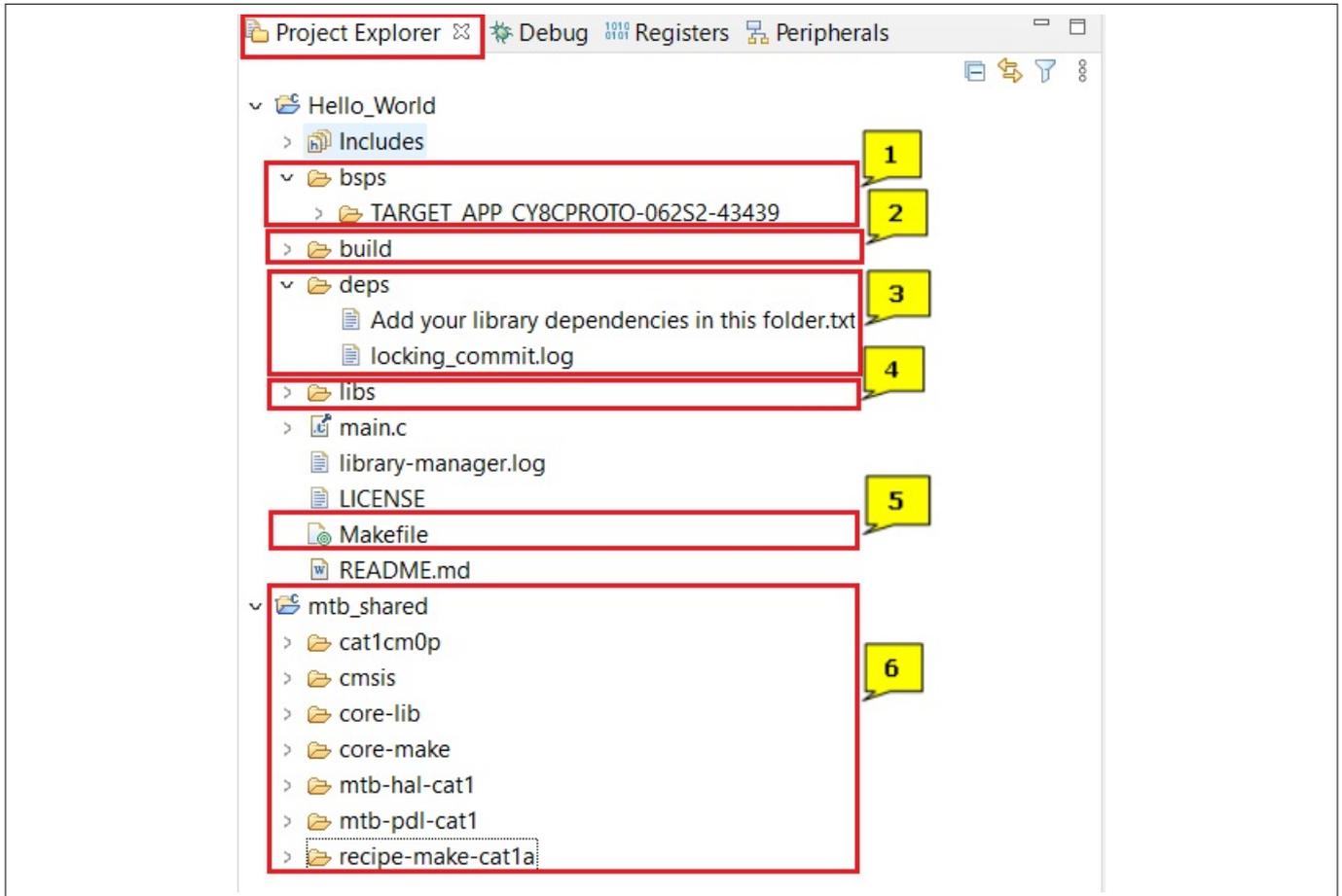


Figure 9 Project Explorer view

1. The files provided by the BSP are in the `bsps` folder and are listed under `TARGET_<bsp name>` subfolders. All the input files for the device and peripheral configurators are in the `config` folder inside the BSP. The `GeneratedSource` folder in the BSP contains the files that are generated by the configurators and are prefixed with `cycfg_`. These files contain the design configuration as defined by the BSP. From ModusToolbox™ 3.x or later, you can directly customize configurator files of BSP for your application rather than overriding the default design configurator files with custom design configurator files since BSPs are completely owned by the application.

The BSP folder also contains the linker scripts and the start-up code for the PSoC™ 6 MCU used on the board.

2. The `build` folder contains all the artifacts resulting from a build of the project. The output files are organized by target BSPs.
3. The `deps` folder contains `.mtb` files, which provide the locations from which ModusToolbox™ pulls the libraries that are directly referenced by the application. These files typically each contain the GitHub location of a library. The `.mtb` files also contain a git Commit Hash or Tag that tells which version of the library is to be fetched and a path as to where the library should be stored locally.

For example, Here, `retarget-io.mtb` points to `mtb://retarget-io#latest-v1.X#$$ASSET_REPO$$/retarget-io/latest-v1.x`. The variable `$$ASSET_REPO$$` points to the root of the shared location which defaults

## 5 Getting started with PSoC™ 6 MCU design

to `mtb_shared`. If the library must be local to the application instead of shared, use `$$LOCAL$$` instead of `$$ASSET_REPO$$`.

- The `libs` folder also contains `.mtb` files. In this case, they point to libraries that are included indirectly as a dependency of a BSP or another library. For each indirect dependency, the Library Manager places a `.mtb` file in this folder. These files have been populated based on the targets available in `deps` folder. The `libs` folder contains the file `mtb.mk`, which stores the relative paths of all the libraries required by the application. The build system uses this file to find all the libraries required by the application. Everything in the `libs` folder is generated by the Library Manager so you should not manually edit anything in that folder.
- An application contains a Makefile which is at the application's root folder. This file contains the set of directives that the make tool uses to compile and link the application project. There can be more than one project in an application. In that case there is a Makefile at the application level and one inside each project. See [AN215656 - PSoC™ 6 MCU dual-core system design](#) for details related to multi-project applications
- By default, when creating a new application or adding a library to an existing application and specifying it as shared, all libraries are placed in an `mtb_shared` directory adjacent to the application directories. The `mtb_shared` folder is shared between different applications within a workspace. Different applications may use different versions of shared libraries if necessary.

### 5.4.1.1.1 Open the Device Configurator

BSP configurator files are in the `bsps/TARGET_<BSP-name>/config` folder. For example, click **<Application-name>** from **Project Explorer** then click **Device Configurator** link in the **Quick Panel** to open the file `design.modus` in the **Device Configurator** as shown in the following figure. You can also open other configuration files in their respective configurators or click the corresponding links in the **Quick Panel**.

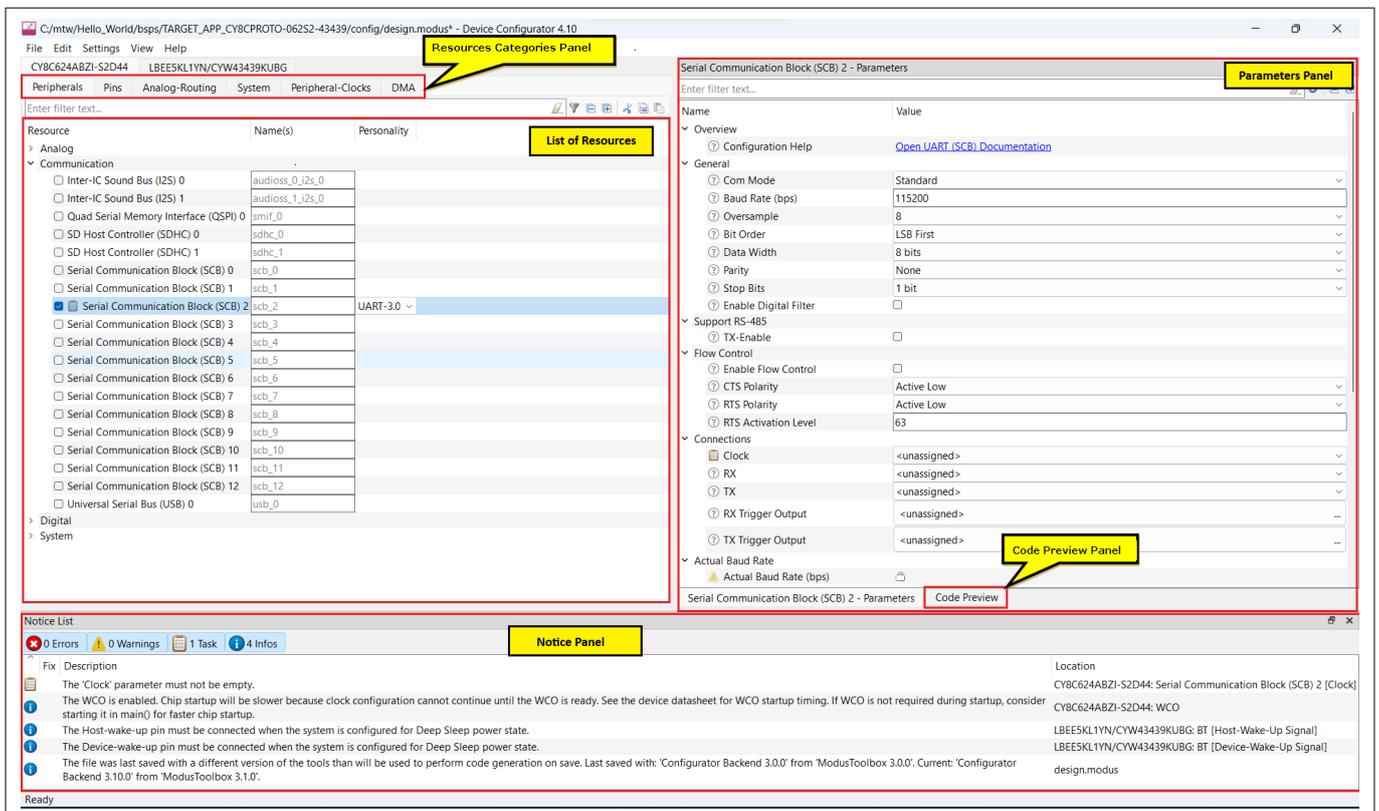


Figure 10 Device Configurator

## 5 Getting started with PSoC™ 6 MCU design

The **DeviceConfigurator** provides a set of **Resources Categories** tabs. Here you can choose between different resources available in the device such as peripherals, pins, and clocks from the **List of Resources**.

You can choose how a resource behaves by choosing a **Personality** for the resource. For example, a **serial communication block (SCB)** resource can have **EZI2C**, **I2C**, **SPI**, or **UART** personalities. The **Alias** is your name for the resource, which is used in firmware development. One or more aliases can be specified by using a comma to separate them (with no spaces).

The **Parameters** pane is where you enter the configuration parameters for each enabled resource and the selected personality. The **Code Preview** pane shows the configuration code generated per the configuration parameters selected. This code is populated in the `cycfg_` files in the `GeneratedSource` folder. The Parameters pane and Code Preview pane may be displayed as tabs instead of separate windows but the contents will be the same.

Any errors, warnings, and information messages arising out of the configuration are displayed in the **Notices** pane.

Currently, the Device Configurator supports configurations using the PDL source. If you choose to use HAL libraries in your application, then you do not need to do any device configuration changes in here. The application project contains source files that help you create an application for the CM4 core (for example, `main.c`), while the CM0+ application is supplied as a default c file (`psoc6_02_cm0p_sleep.c` for the CY8C624ABZI-D44 device). See the [cat1cm0p](#) library. This c file is compiled and linked with the CM4 image as part of the normal build process.

At this point in the development process, the required middleware is ready to be added to the design. The only middleware required for the Hello World application is the [retarget-io](#) library.

### 5.4.1.1.2 Add retarget-io middleware

In this section, you will add the [retarget-io](#) middleware to redirect standard input and output streams to the UART configured by the BSP. The initialization of the middleware will be done in `main.c` file.

1. In the **Quick Panel**, click the **Library Manager** link.
2. In the subsequent dialog, click **Add Libraries**.
3. Under **Peripherals**, select and enable [retarget-io](#).
4. Click **OK** and then **Update**.

The files necessary to use the [retarget-io](#) middleware are added in the `mtb_shared > retarget_io` folder, and the `.mtb` file is added to the `deps` folder, as shown in the following figure.

5 Getting started with PSoC™ 6 MCU design

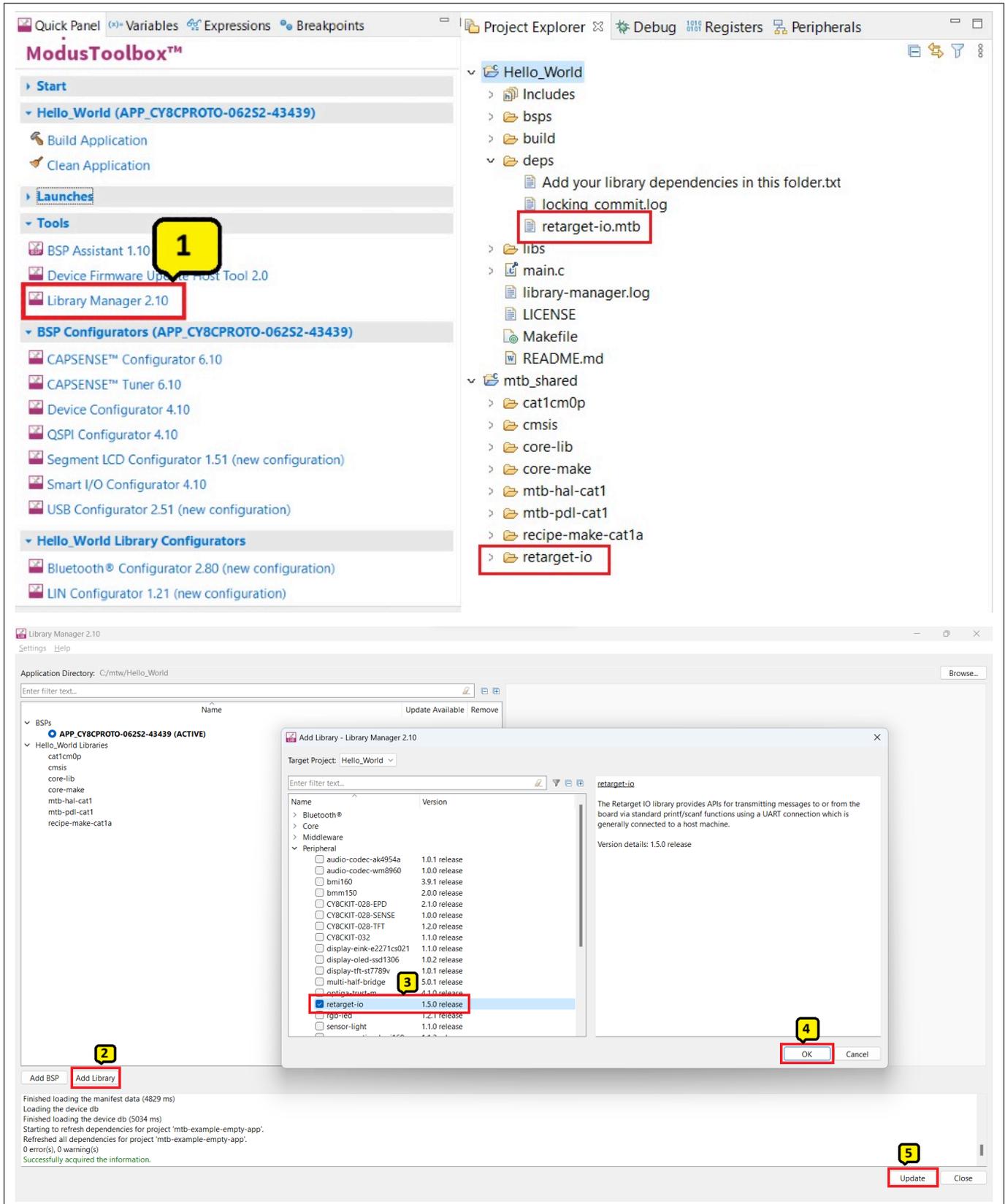


Figure 11 Add the retarget-io middleware

## 5 Getting started with PSoC™ 6 MCU design

### 5.4.1.1.3 Configuration of UART, timer peripherals, pins, and system clocks

The configuration of the debug UART peripheral, timer peripheral, pins, and system clocks can be done directly in the code using the function APIs provided by the BSP and HAL. Therefore, it is not necessary to configure them with the Device Configurator. See [Write firmware](#) section for more details.

### 5.4.1.2 Write firmware

At this point in the development process, you have created an application with the assistance of an application template and modified it to add the [retarget-io](#) middleware. In this section, you will write the firmware that implements the design functionality.

If you are working from scratch using the Empty PSoC™ 6 starter application, you can copy the respective source code to the `main.c` file of the application project from the code snippet provided in this section. If you are using the Hello World code example, all the required files are already in the application.

#### Firmware flow

Examine the code in the `main.c` file of the application. [Figure 12](#) shows the firmware flowchart.

The CM0+ core comes out of reset and enables the CM4 core. The CM0+ core is then configured to go to sleep by the provided CM0+ application. Resource initialization for this example is performed by the CM4 core. It configures the system clocks, pins, clock to peripheral connections, and other platform resources.

When the CM4 core is enabled, the clocks and system resources are initialized by the BSP initialization function. The [retarget-io](#) middleware is configured to use the debug UART, and the user LED is initialized. The debug UART prints a “Hello World!” message on the terminal emulator – the on-board KitProg3 acts the USB-UART bridge to create the virtual COM port. A timer object is configured to generate an interrupt every 1000 milliseconds. At each Timer interrupt, the CM4 core toggles the LED state on the kit.

The firmware is designed to accept the 'Enter' key as an input and on every press of the 'Enter' key the firmware starts or stops the blinking of the LED.

Note that the application code uses BSP/HAL/middleware functions to execute the intended functionality.

`cybsp_init()`- This BSP function sets up the HAL hardware manager and initializes all the system resources of the device including but not limited to the system clocks and power regulators.

`cy_retarget_io_init()`- This function from the [retarget-io](#) middleware uses the aliases set up in the BSP for the debug UART pins to configure the debug UART with a standard baud rate of 115200 and also redirects the input/output stream to the debug UART.

**Note:** You can open the Device Configurator to view the aliases that are set up in the BSP.

`cyhal_gpio_init()`- This function from the GPIO HAL initializes the physical pin to drive the LED. The LED used is derived from the alias for the pin set up in the BSP.

`timer_init()`- This function wraps a set of timer HAL function calls to instantiate and configure a hardware timer. It also sets up a callback for the timer interrupt.

Copy the following code snippet to the `main.c` file of your application project.

## 5 Getting started with PSoC™ 6 MCU design

### Code listing 1: main.c file

```

#include "cyhal.h"
#include "cybsp.h"
#include "cy_retarget_io.h"

/*****
 * Macros
 *****/

/* LED blink timer clock value in Hz */
#define LED_BLINK_TIMER_CLOCK_HZ      (10000)

/* LED blink timer period value */
#define LED_BLINK_TIMER_PERIOD        (9999)

/*****
 * Function Prototypes
 *****/
void timer_init(void);
static void isr_timer(void *callback_arg, cyhal_timer_event_t event);

/*****
 * Global Variables
 *****/
bool timer_interrupt_flag = false;
bool led_blink_active_flag = true;

/* Variable for storing character read from terminal */
uint8_t uart_read_value;

/* Timer object used for blinking the LED */
cyhal_timer_t led_blink_timer;

/*****
 * Function Name: main
 *****/
 * Summary:
 * This is the main function for CM4 core. It sets up a timer to trigger a
 * periodic interrupt. The main while loop checks for the status of a flag set
 * by the interrupt and toggles an LED at 1Hz to create an LED blinky. The
 * while loop also checks whether the 'Enter' key was pressed and
 * stops/restarts LED blinking.
 *
 * Parameters:
 * none
 *
 * Return:
 * int

```

## 5 Getting started with PSoC™ 6 MCU design

```

*
*****/
int main(void)
{
    cy_rslt_t result;

    /* Initialize the device and board peripherals */
    result = cybsp_init();

    /* Board init failed. Stop program execution */
    if (result != CY_RSLT_SUCCESS)
    {
        CY_ASSERT(0);
    }

    /* Enable global interrupts */
    __enable_irq();

    /* Initialize retarget-io to use the debug UART port */
    result = cy_retarget_io_init(CYBSP_DEBUG_UART_TX, CYBSP_DEBUG_UART_RX,
                                CY_RETARGET_IO_BAUDRATE);

    /* retarget-io init failed. Stop program execution */
    if (result != CY_RSLT_SUCCESS)
    {
        CY_ASSERT(0);
    }

    /* Initialize the User LED */
    result = cyhal_gpio_init(CYBSP_USER_LED, CYHAL_GPIO_DIR_OUTPUT,
                             CYHAL_GPIO_DRIVE_STRONG, CYBSP_LED_STATE_OFF);

    /* GPIO init failed. Stop program execution */
    if (result != CY_RSLT_SUCCESS)
    {
        CY_ASSERT(0);
    }

    /* \x1b[2J\x1b[;H - ANSI ESC sequence for clear screen */
    printf("\x1b[2J\x1b[;H");

    printf("***** "
           "Hello World! Example "
           "***** \r\n\n");

    printf("Hello World!!!\r\n\n");

    printf("For more projects, "
           "visit our code examples repositories:\r\n\n");

    printf("https://github.com/Infineon/"
           "Code-Examples-for-ModusToolbox-Software\r\n\n");

```

## 5 Getting started with PSoC™ 6 MCU design

```

/* Initialize timer to toggle the LED */
timer_init();

printf("Press 'Enter' key to pause or "
      "resume blinking the user LED \r\n\r\n");

for (;;)
{
    /* Check if 'Enter' key was pressed */
    if (cyhal_uart_getc(&cy_retarget_io_uart_obj, &uart_read_value, 1)
        == CY_RSLT_SUCCESS)
    {
        if (uart_read_value == '\r')
        {
            /* Pause LED blinking by stopping the timer */
            if (led_blink_active_flag)
            {
                cyhal_timer_stop(&led_blink_timer);

                printf("LED blinking paused \r\n");
            }
            else /* Resume LED blinking by starting the timer */
            {
                cyhal_timer_start(&led_blink_timer);

                printf("LED blinking resumed\r\n");
            }

            /* Move cursor to previous line */
            printf("\x1b[1F");

            led_blink_active_flag ^= 1;
        }
    }

    /* Check if timer elapsed (interrupt fired) and toggle the LED */
    if (timer_interrupt_flag)
    {
        /* Clear the flag */
        timer_interrupt_flag = false;

        /* Invert the USER LED state */
        cyhal_gpio_toggle(CYBSP_USER_LED);
    }
}

/*****
* Function Name: timer_init
*****/
* Summary:
* This function creates and configures a Timer object. The timer ticks

```

## 5 Getting started with PSoC™ 6 MCU design

```

* continuously and produces a periodic interrupt on every terminal count
* event. The period is defined by the 'period' and 'compare_value' of the
* timer configuration structure 'led_blink_timer_cfg'. Without any changes,
* this application is designed to produce an interrupt every 1 second.
*
* Parameters:
* none
*
*****/
void timer_init(void)
{
    cy_rslt_t result;

    const cyhal_timer_cfg_t led_blink_timer_cfg =
    {
        .compare_value = 0,           /* Timer compare value, not used */
        .period = LED_BLINK_TIMER_PERIOD, /* Defines the timer period */
        .direction = CYHAL_TIMER_DIR_UP, /* Timer counts up */
        .is_compare = false,         /* Don't use compare mode */
        .is_continuous = true,       /* Run timer indefinitely */
        .value = 0                   /* Initial value of counter */
    };

    /* Initialize the timer object. Does not use input pin ('pin' is NC) and
    * does not use a pre-configured clock source ('clk' is NULL). */
    result = cyhal_timer_init(&led_blink_timer, NC, NULL);

    /* timer init failed. Stop program execution */
    if (result != CY_RSLT_SUCCESS)
    {
        CY_ASSERT(0);
    }

    /* Configure timer period and operation mode such as count direction,
    duration */
    cyhal_timer_configure(&led_blink_timer, &led_blink_timer_cfg);

    /* Set the frequency of timer's clock source */
    cyhal_timer_set_frequency(&led_blink_timer, LED_BLINK_TIMER_CLOCK_HZ);

    /* Assign the ISR to execute on timer interrupt */
    cyhal_timer_register_callback(&led_blink_timer, isr_timer, NULL);

    /* Set the event on which timer interrupt occurs and enable it */
    cyhal_timer_enable_event(&led_blink_timer, CYHAL_TIMER_IRQ_TERMINAL_COUNT,
        7, true);

    /* Start the timer with the configured settings */
    cyhal_timer_start(&led_blink_timer);
}

/*****

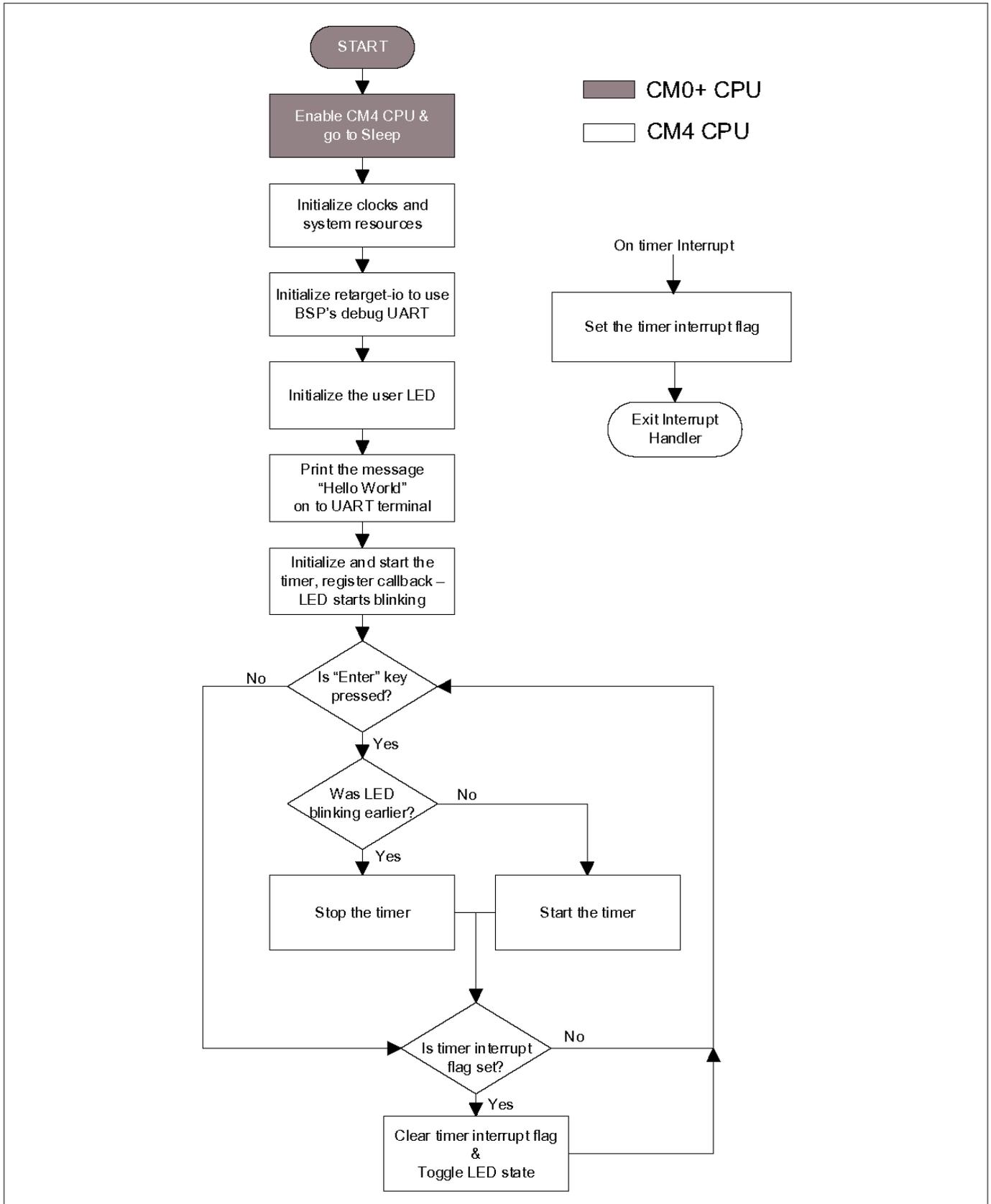
```

## 5 Getting started with PSoC™ 6 MCU design

```
* Function Name: isr_timer
*****
* Summary:
* This is the interrupt handler function for the timer interrupt.
*
* Parameters:
*   callback_arg   Arguments passed to the interrupt callback
*   event           Timer/counter interrupt triggers
*
*****/
static void isr_timer(void *callback_arg, cyhal_timer_event_t event)
{
    (void) callback_arg;
    (void) event;

    /* Set the interrupt flag and process it from the main while(1) loop */
    timer_interrupt_flag = true;
}
```

5 Getting started with PSoC™ 6 MCU design



**Figure 12 Firmware flowchart**

This completes the summary of how the firmware works in the code example. Feel free to explore the source files for a deeper understanding.

## 5 Getting started with PSoC™ 6 MCU design

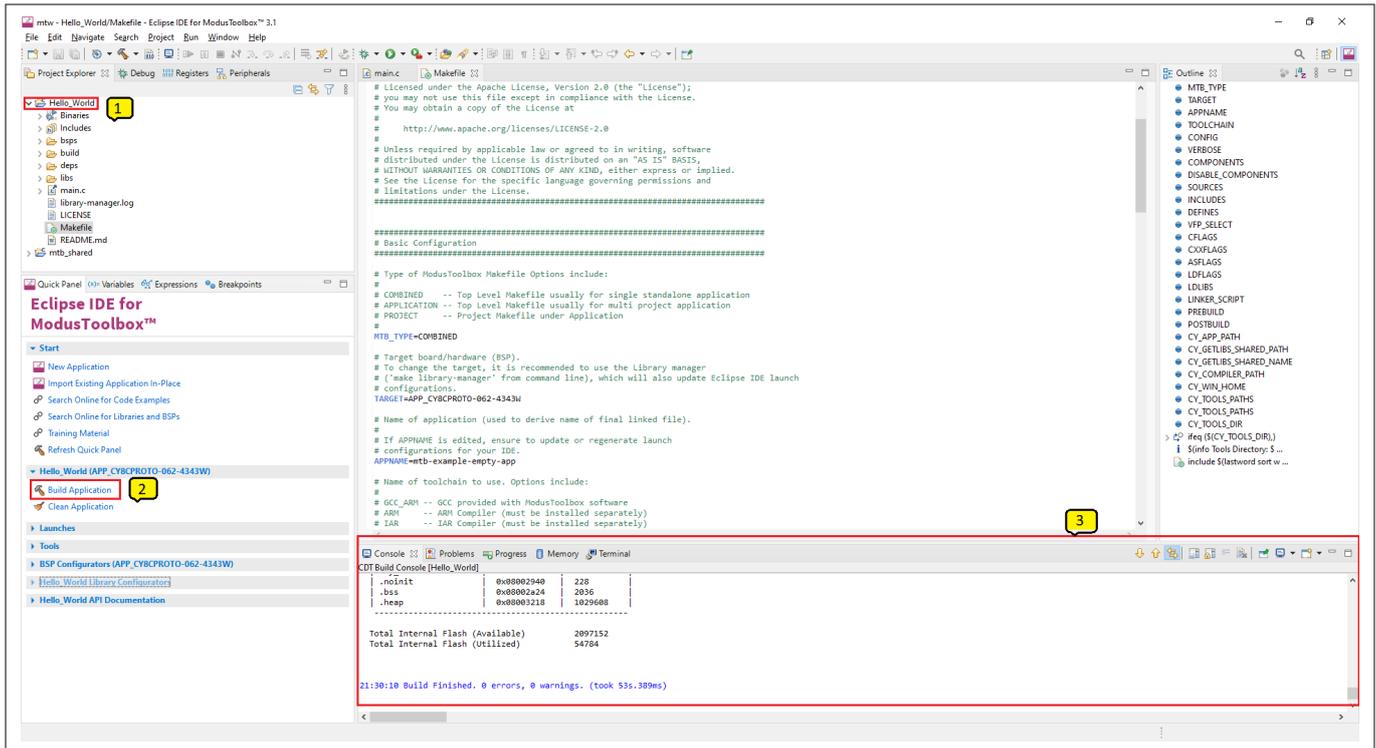
### 5.4.1.3 Build the application

This section shows how to build the application.

1. Select the application project in the **Project Explorer** view.
2. Click **Build Application** shortcut under the <name> group in the **Quick Panel**.

It selects the build configuration from the Makefile and compiles/links all projects that constitute the application. By default, Debug configurations are selected.

3. The **Console view** lists the results of the build operation, as [Figure 13](#) shows.



**Figure 13** Build the application

If you encounter errors, revisit earlier steps to ensure that you completed all the required tasks.

**Note:** You can also use the command-line interface (CLI) to build the application. See the **Build system** section in the [ModusToolbox™ tools package user guide](#). This document is located in the / docs\_<version>/ folder in the ModusToolbox™ installation.

### 5.4.1.4 Program the device

This section shows how to program the PSoC™ 6 MCU.

ModusToolbox™ software uses the OpenOCD protocol to program and debug applications on PSoC™ 6 MCUs. The kit must be running KitProg3. Some kits are shipped with KitProg2 firmware instead of KitProg3. See [Debugging the application using KitProg3/MiniProg4](#) for details. The ModusToolbox™ tools package includes the fw-loader command-line tool to switch the KitProg firmware from KitProg2 to KitProg3. See the PSoC™ 6 MCU KitProg Firmware Loader section in the [Eclipse IDE for ModusToolbox™ user guide](#) for more details.

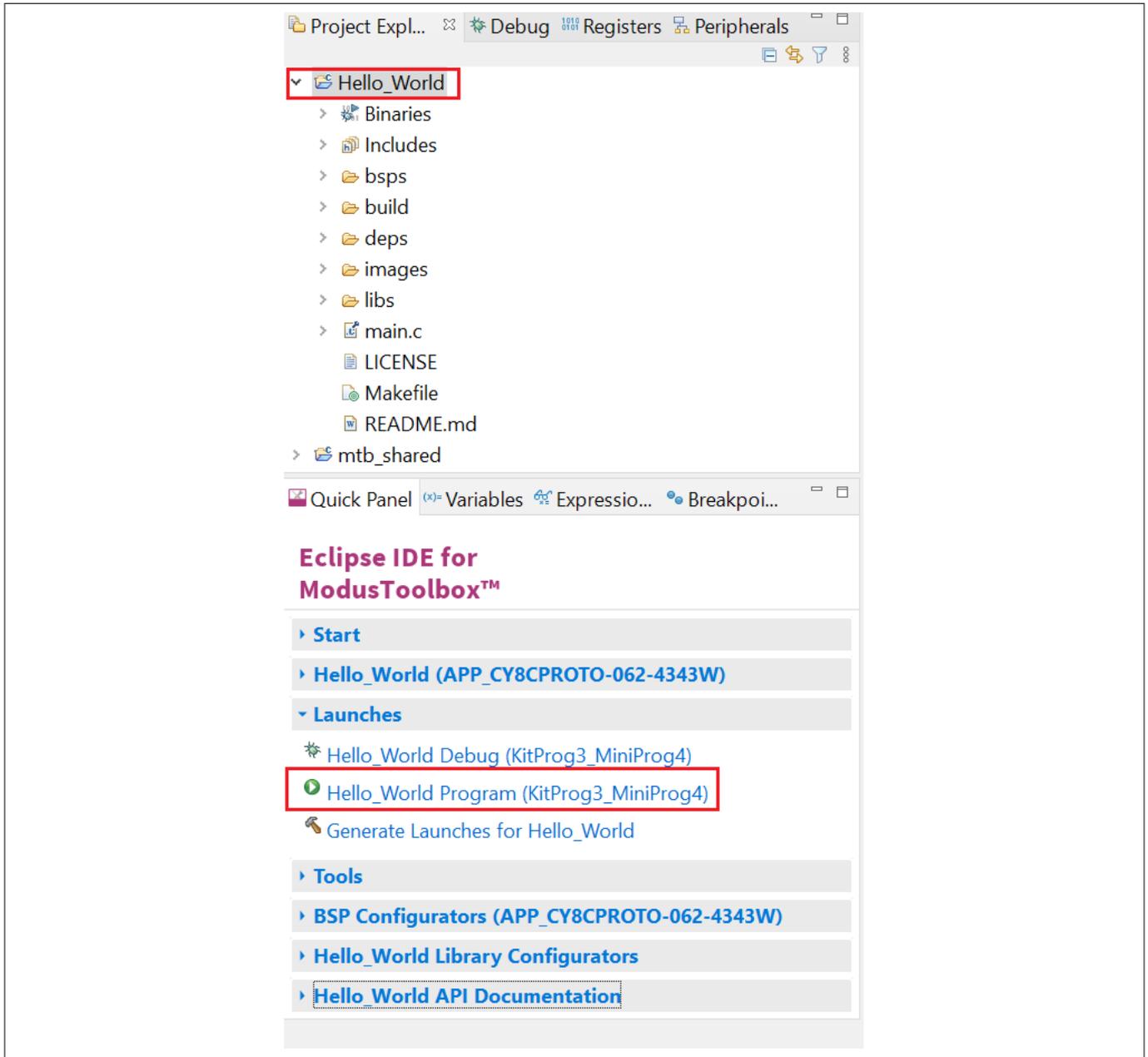
If you are using a development kit with a built-in programmer connect the board to your computer using the USB cable.

If you are developing on your own hardware, you can use a hardware programmer/debugger; for example, a , <https://www.segger.com/products/debug-probes/j-link/>, or <https://www2.keil.com/mdk5/ulink/ulinkpro/>.

## 5 Getting started with PSoC™ 6 MCU design

Select the application project and click the **<application name> Program (KitProg3\_MiniProg4)** shortcut under the **Launches** group in the **Quick Panel**, as [Figure 14](#) shows. The IDE will select and run the appropriate run configuration.

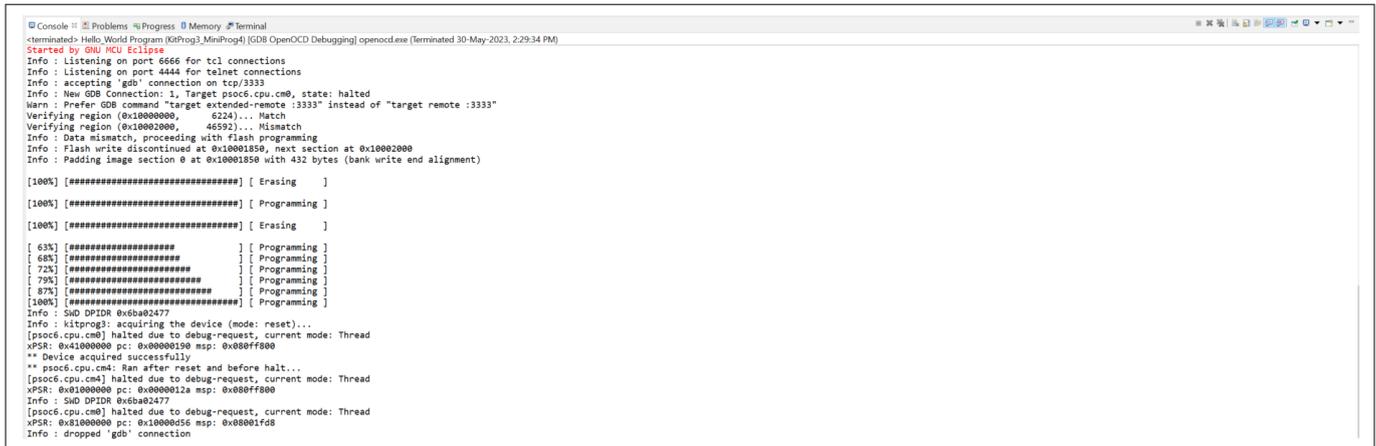
**Note:** This step also performs a build if any files have been modified since the last build.



**Figure 14** Programming an application to a device

The **Console** view lists the results of the programming operation, as shown in the following figure.

## 5 Getting started with PSoC™ 6 MCU design



**Figure 15** Programming an application to a device

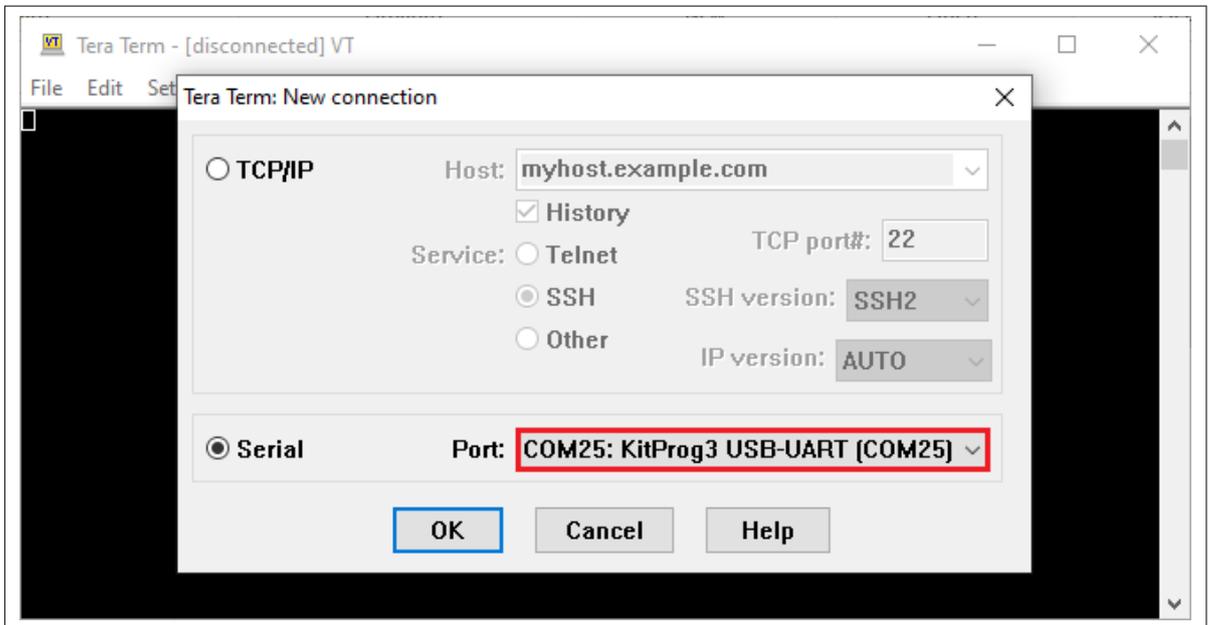
### 5.4.1.5 Test your design

This section describes how to test your design.

Follow these steps to observe the output of your design. This note uses Tera Term as the UART terminal emulator to view the results, but you can use any terminal of your choice to view the output.

#### 1. Select the serial port

Launch Tera Term and select the USB-UART COM port as [Figure 16](#) shows. Note that your COM port number may be different.



**Figure 16** Selecting the KitProg3 COM port in Tera Term

#### 2. Set the baud rate

Set the baud rate to 115200 under **Setup > Serial port** as [Figure 17](#) shows.

5 Getting started with PSoC™ 6 MCU design

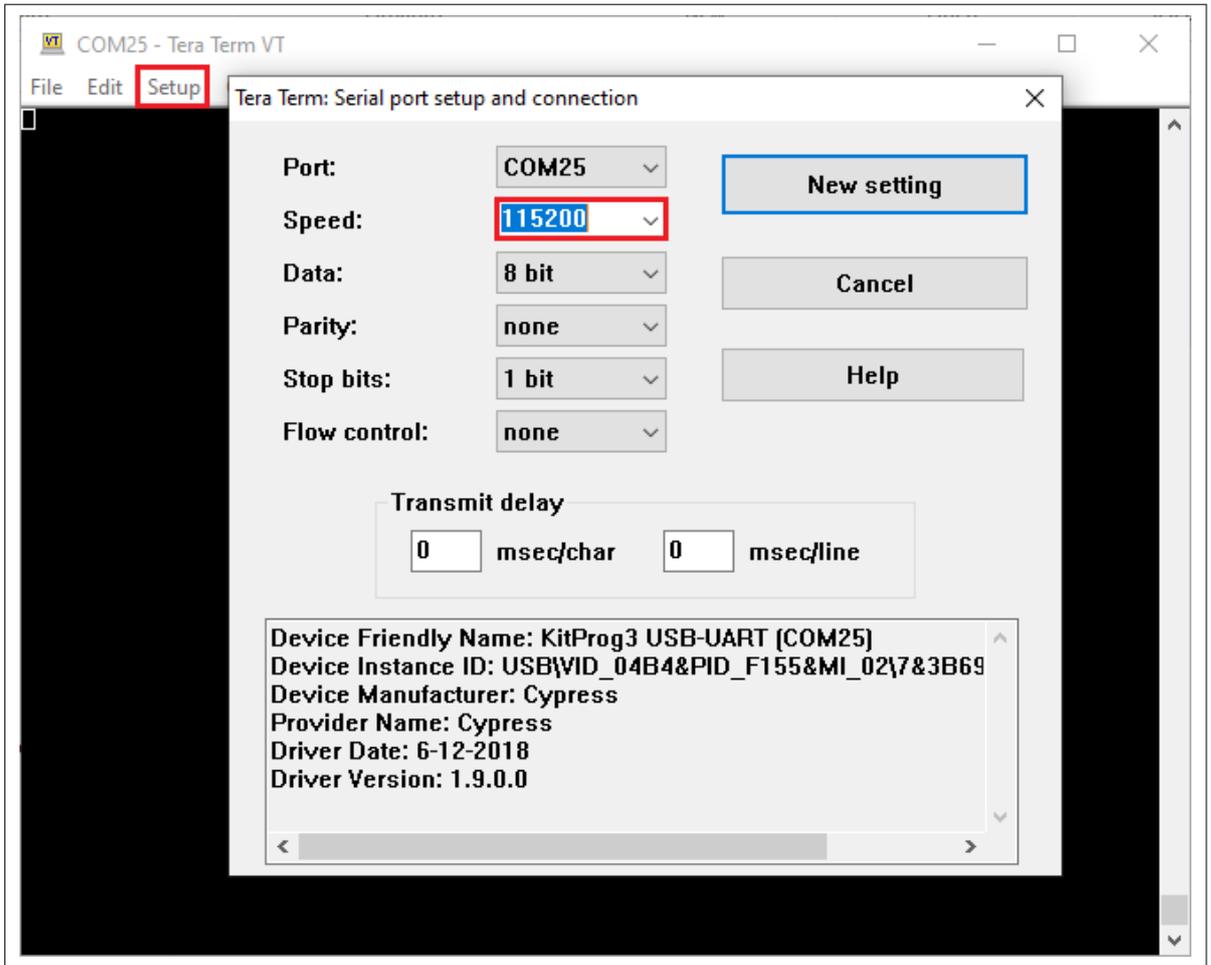


Figure 17 Configuring the baud rate in Tera Term

3. Reset the device

Press the reset switch (**SW1**) on the kit. A message appears on the terminal as [Figure 18](#) shows. The user LED on the kit will start blinking.

5 Getting started with PSoC™ 6 MCU design

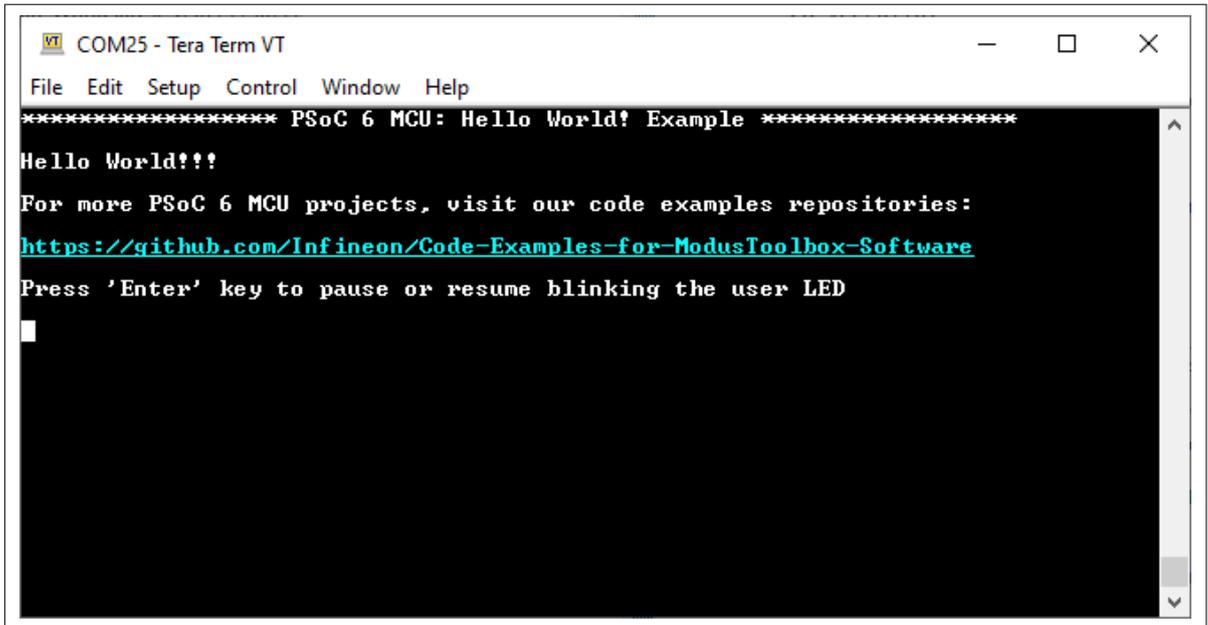


Figure 18 Printed UART message

4. Pause/resume LED blinking functionality

Press the **Enter** key to pause/resume blinking the LED. When the LED blinking is paused, a corresponding message will be displayed on the terminal as Figure 19 shows.

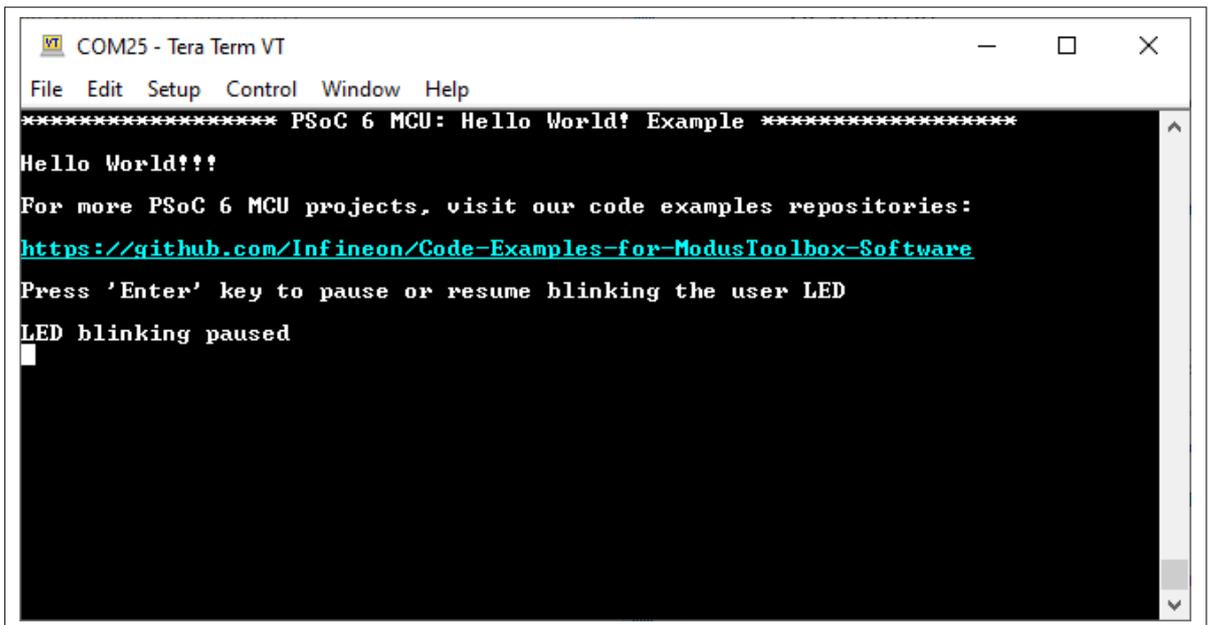


Figure 19 Printed UART message

5.4.1.6 Debugging the application using KitProg3/MiniProg4

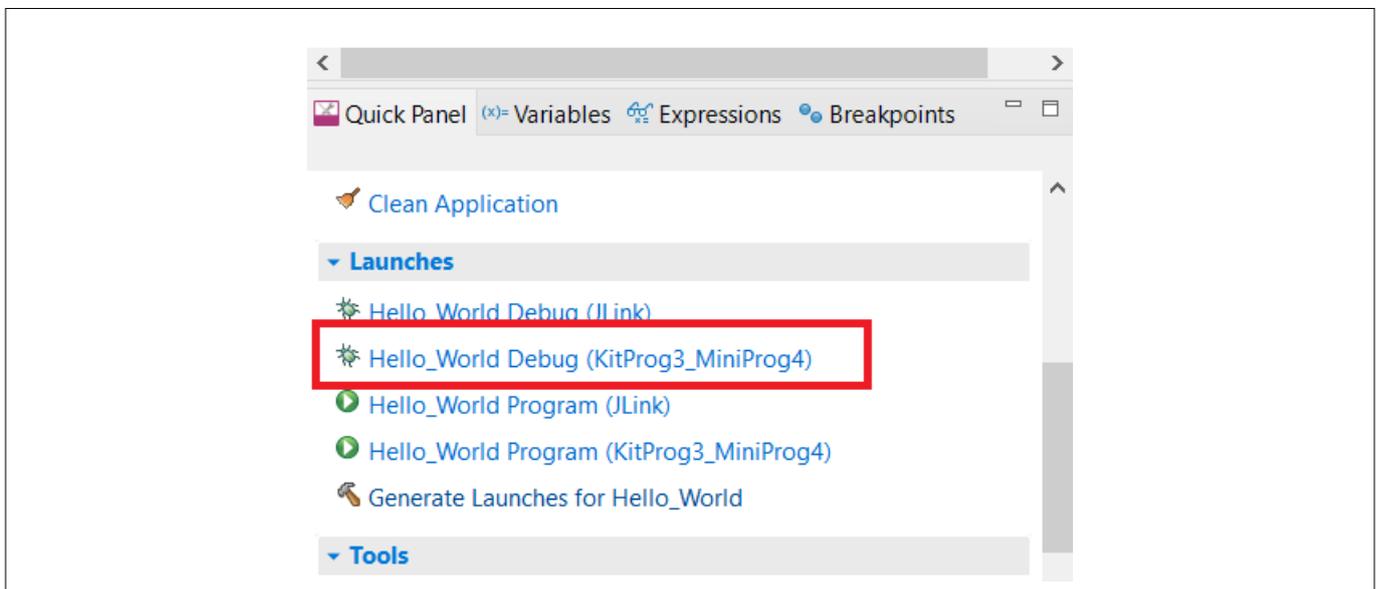
All PSoC™ 6 kits have a KitProg3 on-board programmer/debugger. It supports Cortex® Microcontroller Software Interface Standard - Debug Access Port (CMSIS-DAP). See the [KitProg3 user guide](#) for details. The Eclipse IDE requires KitProg3 and uses the OpenOCD protocol for debugging PSoC™ 6 MCU applications.

## 5 Getting started with PSoC™ 6 MCU design

**Note:** The PSoC™ 6 Wi-Fi-Bluetooth® pioneer kit (CY8CKIT-062-WiFi-BT) and PSoC™ 6 Bluetooth® LE pioneer kit (CY8CKIT-062-BLE) have the KitProg2 onboard programmer/debugger firmware pre-installed. To work with ModusToolbox™, upgrade the firmware to KitProg3 using the fw-loader command-line tool included in the ModusToolbox™ software. Refer to the "PSoC™ 6 Programming/Debugging - KitProg Firmware Loader" section in the [Eclipse IDE for ModusToolbox™ user guide](#) for more details.

The Eclipse IDE contains several launch configurations that control various settings for programming the devices and launching the debugger. Depending on the kit and the type of applications you are using, there are various launch configurations available. Once such configuration is KitProg3/MiniProg4 launch configuration. Refer to the "PSoC™ MCU programming/debugging" section in the [Eclipse IDE for ModusToolbox™ user guide](#) for more details on the launch configurations.

When an application is created, the tool generates the launch configurations for KitProg3\_MiniProg4 under **Launches** in the **Quick Panel**, as shown in the following figure.



**Figure 20 KitProg3/MiniProg4 launch configuration**

Connect the device to the host machine and click on the **Hello\_World Debug (KitProg3\_MiniProg4)** launch to start debugging, as shown in [Figure 20](#). Once the debugging starts, the execution halts at the main() function, and the user can start debugging from the start of main(), as shown in the following figure.

5 Getting started with PSoC™ 6 MCU design

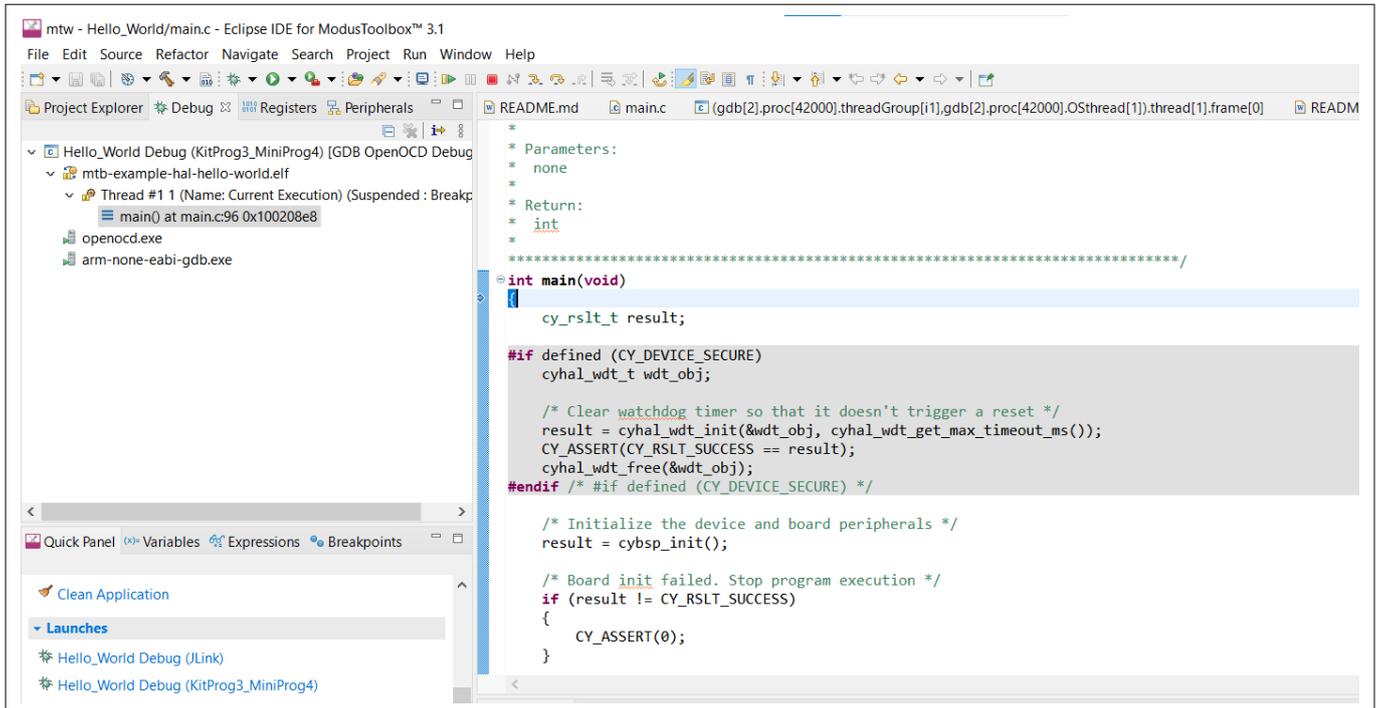


Figure 21 Debug main()

5.4.2 Visual Studio Code (VS Code) for ModusToolbox™

Refer to the [Visual Studio Code for ModusToolbox™ user guide](#) for creating a new application on VS Code.

5.4.3 IAR Embedded Workbench for ModusToolbox™

Refer to the [IAR Embedded Workbench for ModusToolbox™ user guide](#) for creating a new application on IAR.

5.4.4 Keil µVision for ModusToolbox™

Refer to the [Keil µVision for ModusToolbox™ user guide](#) for creating a new application on Keil uVision.

---

## 6 Summary

### 6 Summary

This application note explored the PSoC™ 6 MCU device architecture and the associated development tools. PSoC™ 6 MCU is a truly programmable embedded system-on-chip with configurable analog and digital peripheral functions, memory, and a dual-core system on a single chip. The integrated features, embedded security, and low-power modes make PSoC™ 6 MCU an ideal choice for smart home, IoT gateways, and other related applications.

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**References**

## References

For a complete and updated list of PSoC™ 6 MCU code examples, please visit our [GitHub](#). For more PSoC™ 6 MCU-related documents, please visit our [PSoC™ 6 MCU Digital Documentation Portal](#).

[Table 2](#) lists the system-level and general application notes that are recommended for the next steps in learning about PSoC™ 6 MCU and ModusToolbox™.

**Table 2** General and system-level application notes

Document	Document name
<a href="#">AN218241</a>	PSoC™ 6 MCU hardware design considerations

[Table 3](#) lists the application notes (AN) for specific peripherals and applications.

**Table 3** Documents related to PSoC™ 6 MCU features

Document	Document name
<b>System resources, CPU, and interrupts</b>	
<a href="#">AN215656</a>	PSoC™ 6 MCU dual-core system design
<a href="#">AN217666</a>	PSoC™ 6 MCU interrupts
<a href="#">AN235279</a>	Performing ETM and ITM Trace on PSoC™ 6 MCU
<b>CAPSENSE™</b>	
<a href="#">AN92239</a>	Proximity sensing with CAPSENSE™
<a href="#">AN85951</a>	PSoC™ 4 and PSoC™ 6 MCU CAPSENSE™ design guide
<b>Device Firmware Update</b>	
<a href="#">AN213924</a>	PSoC™ 6 MCU device firmware update software development kit guide
<b>Low-power</b>	
<a href="#">AN230938</a>	PSoC™ 6 MCU low-power analog
<a href="#">AN219528</a>	PSoC™ 6 MCU low-power modes and power reduction techniques
<b>Security</b>	
<a href="#">AN221111</a>	PSoC™ 6 MCU MCU designing a custom secured system
<a href="#">AN227860</a>	PSoC™ 64 Secure MCU Secure Boot SDK User Guide
<a href="#">AN239061</a>	PSoC™ 64 security getting started guide
<b>ModusToolbox™</b>	
<a href="#">ModusToolbox™ tools package installation</a>	
<a href="#">ModusToolbox™ tools package release notes</a>	
<a href="#">ModusToolbox™ tools package quick start guide</a>	
<a href="#">ModusToolbox™ tools package user guide</a>	
<a href="#">Eclipse IDE for ModusToolbox™ user guide</a>	
<a href="#">Visual Studio Code for ModusToolbox™ user guide</a>	
<a href="#">Keil µVision for ModusToolbox™ user guide</a>	
<a href="#">IAR Embedded Workbench for ModusToolbox™ user guide</a>	

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## Glossary

### Glossary

This section lists the most commonly used terms that you might encounter while working with PSoC™ family of devices.

- **Board support package (BSP):** A BSP is the layer of firmware containing board-specific drivers and other functions. The board support package is a set of libraries that provide firmware APIs to initialize the board and provide access to board level peripherals.
- **Cypress Programmer:** Cypress Programmer is a flexible, cross-platform application for programming Cypress devices. It can Program, Erase, Verify, and Read the flash of the target device.
- **Hardware abstraction layer (HAL):** The HAL wraps the lower level drivers (like [MTB-PDL-CAT1](#)) and provides a high-level interface to the MCU. The interface is abstracted to work on any MCU.
- **KitProg:** The KitProg is an onboard programmer/debugger with USB-I2C and USB-UART bridge functionality. The KitProg is integrated onto most PSoC™ development kits.
- **MiniProg3/MiniProg4:** Programming hardware for development that is used to program PSoC™ devices on your custom board or PSoC™ development kits that do not support a built-in programmer.
- **Personality:** A personality expresses the configurability of a resource for a functionality. For example, the SCB resource can be configured to be an UART, SPI or I2C personalities.
- **PSoC™:** A programmable, embedded design platform that includes a CPU, such as the 32-bit Arm® Cortex®-M0, with both analog and digital programmable blocks. It accelerates embedded system design with reliable, easy-to-use solutions, such as touch sensing, and enables low-power designs.
- **Middleware:** Middleware is a set of firmware modules that provide specific capabilities to an application. Some middleware may provide network protocols (e.g. MQTT), and some may provide high level software interfaces to device features (e.g. USB, audio).
- **ModusToolbox™:** An Eclipse based embedded design platform for IoT designers that provides a single, coherent, and familiar design experience combining the industry's most deployed Wi-Fi and Bluetooth® technologies, and the lowest power, most flexible MCUs with best-in-class sensing.
- **Peripheral driver library (PDL):** The peripheral driver library (PDL) simplifies software development for the PSoC™ 6 MCU architecture. The PDL reduces the need to understand register usage and bit structures, thus easing software development for the extensive set of peripherals available.

---

**Revision history**
**Revision history**

Document version	Date of release	Description of changes
**	2017-07-26	New application note
*A	2018-01-09	Updated screenshots with latest release of ModusToolbox™ Added new supported PSoC™ 6 MCU devices Added AnyCloud description under ModusToolbox™ software
*B	2019-04-16	Added new supported PSoC™ 6 MCU device – PSoC™ 62S4 Added information on PSoC™ 6 product lines and development kits available for each product line
*C	2020-05-06	Updated <a href="#">Figure 2</a> Updated Screenshots with MTB v2.2 Added mtb_shared folder description, updated application creation process with MTB flow
*D	2021-03-11	Updated to Infineon template
*E	2021-07-09	Updated the GitHub links Added reference to new PSoC™ 6 MCU low-power analog Updated <a href="#">Figure 16</a> to <a href="#">Figure 19</a> Firmware updated to the latest version
*F	2022-07-21	Template update
*G	2022-09-12	Updated the development flow as per MTB v3.0 software Updated link references Updated configurator info Added new <a href="#">Figure 2</a> and <a href="#">Figure 7</a> Updated <a href="#">Figure 8</a> and <a href="#">Figure 14</a> Added reference to new AN235279 Added a new section for ModusToolbox™ Applications Removed reference to deprecated AN225588 Updated <a href="#">Figure 17</a> to <a href="#">Figure 19</a>
*H	2023-06-09	Updated content with latest release of c™ 3.1
*I	2023-12-04	Updated with kit CY8CPROTO-062S2-43439
*J	2024-03-22	Added references to all the supporting IDEs on ModusToolbox™ and restructured the content as per the MKTG need.



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**Document reference**

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