

Getting started with Hardware Abstraction Layer (HAL) on PSOC™ Edge MCU

About this document

Scope and purpose

This document introduces the new Hardware Abstraction Layer (HAL) library for Infineon PSOC™ Edge MCUs.

Intended audience

This document is intended for users who are looking to migrate their applications to use the new HAL library or use it in their applications in ModusToolbox™ applications.

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1 Introduction to Infineon's new Hardware Abstraction Layer (HAL)

1 Introduction to Infineon's new Hardware Abstraction Layer (HAL)

The Infineon device support library combines content from several distinct software packages into a single package which includes the following software packages: The Peripheral Driver library (PDL), Device utilities, Device information and Hardware abstraction Layer (HAL). [Figure 1](#) shows a high-level overview of the software stack used in a ModusToolbox™ application.

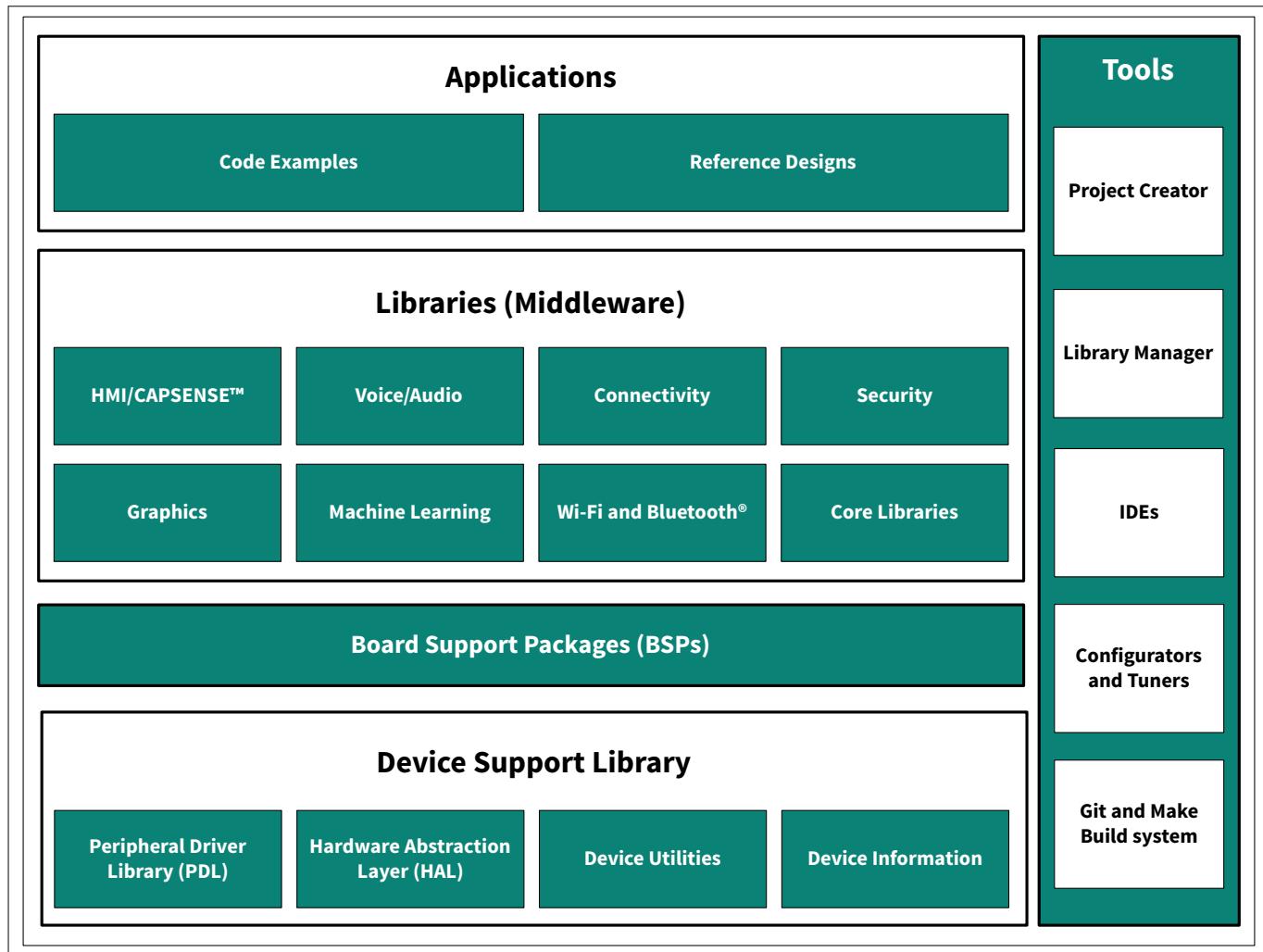


Figure 1 ModusToolbox™ software stack

The Infineon Hardware Abstraction Layer (HAL) for PSOC™ Edge device family has undergone significant changes compared to the legacy HAL supported for PSOC™ 6 and other device families, refocusing on the needs of middleware and streamlining its functionality.

The new HAL eliminates unnecessary APIs and drivers, de-emphasizing its usage in the application layer while focusing on middleware support. Configuration can be handled via the Device Configurator, with initialization performed by the Peripheral Driver Library (PDL). Hardware resource management, peripheral initialization and routing configurations including pins and clocks, and other higher-level functionalities, previously abstracted by legacy HAL, is now completely handled at the PDL level, with improved transparency and customization.

Some of these responsibilities are handled by the configurator tools running on the desktop. The tasks which previously consumed MCU resources to perform at runtime are now performed once at the design configuration stage itself, thereby improving runtime performance.

The HAL now focuses on portability, providing a consistent interface across different hardware platforms. This guide will walk users through the changes, new procedures, and best practices for using the updated HAL, ensuring a smooth transition and optimal performance.

1 Introduction to Infineon's new Hardware Abstraction Layer (HAL)

1.1 What is the new HAL?

The functionality of legacy HAL is now split into different components as shown in [Figure 2](#).

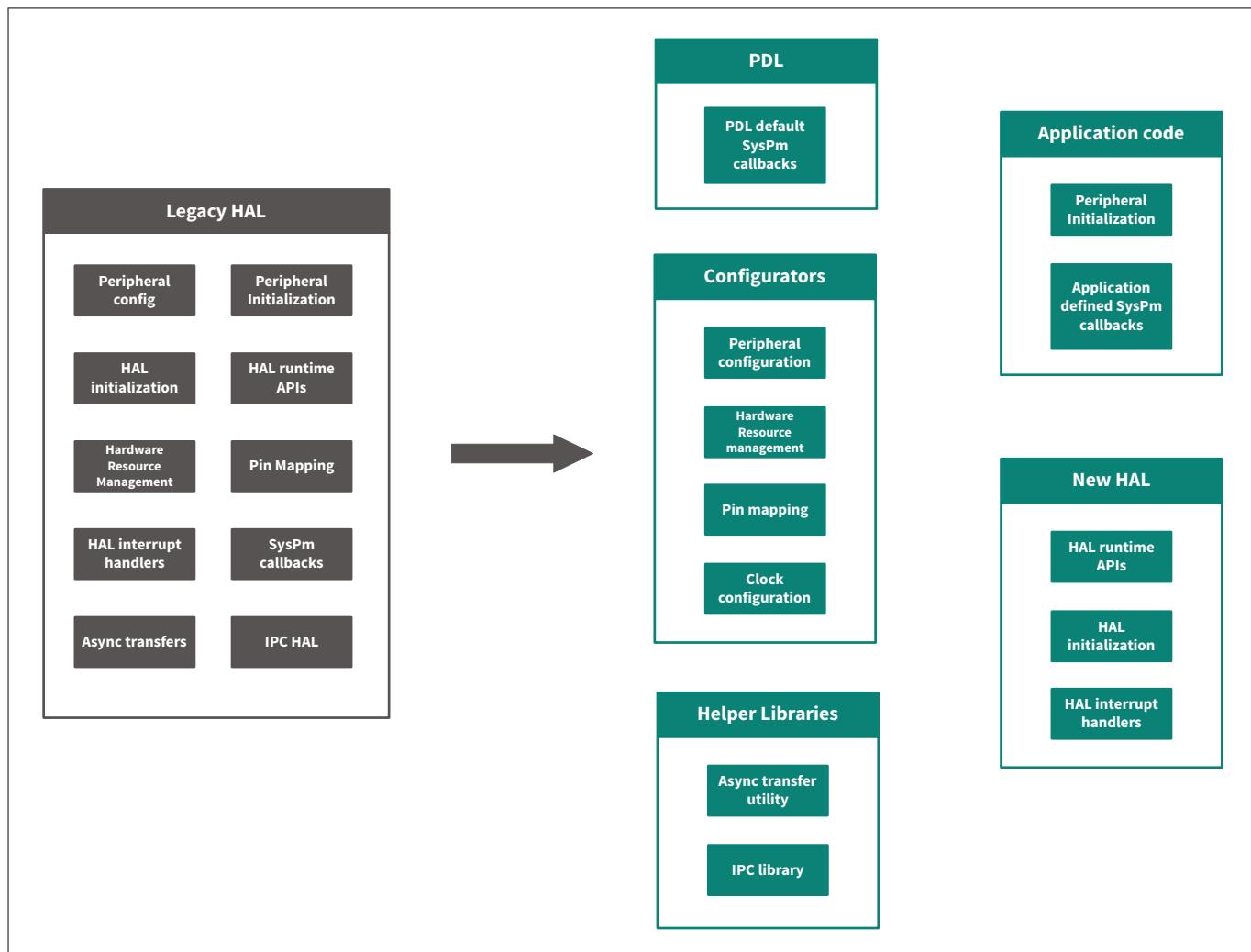


Figure 2 Comparison between legacy and new HAL

[Table 1](#) below captures the high-level functional differences between legacy and new HAL and also establishes the reasoning behind the update.

Table 1 Comparison between legacy and new HAL

Parameter	Legacy HAL	new HAL
Purpose and layering clarity	Legacy HAL often blended features and hidden setup steps that sometimes hid what was happening at the device level	The new HAL becomes a separate layer focused on serving the middleware
Configuration and initialization split	The configuration and initialization patterns were often mixed, or done via HAL helpers that abstracted device setup	The new HAL expects that the resource must be enabled either in the configurator or directly in the application code using PDL APIs. Middleware talks to a consistent HAL API once the device is set up

(table continues...)

1 Introduction to Infineon's new Hardware Abstraction Layer (HAL)

Table 1 (continued) Comparison between legacy and new HAL

Parameter	Legacy HAL	new HAL
Moving functionality down to PDL	Some higher-level functionality lived in the HAL, potentially masking device differences	This new design re-centers device-dependent behavior in the PDL layer, where it belongs. This improves predictability, performance tuning, and debug experience of applications Some high-level HAL functionality (like IPC and Async Transfer) is split into separate libraries that can be used together with either HAL or PDL
Enables transparency	The legacy HAL relied on behind-the-scenes 'magic' like auto-allocation, implicit power or clock steps	The new HAL defines explicit code paths and clearer control. This helps certification, analysis, and maintenance specially for safety and security sensitive applications

1.2 Using new HAL with ModusToolbox™ code examples

As discussed in the earlier section, ModusToolbox™ code examples will no longer directly interface with the HAL drivers. All code examples supporting the PSOC™ Edge family of devices use the new design flow for HAL usage.

In case of middleware usage, the expected flow is as follows:

1. Application initializes and enables the peripheral using configurator-generated PDL configuration structures or via the PDL APIs
2. Application then sets up the peripheral with a context object using HAL APIs. Note that this step only initializes the HAL data structures and does not initialize the hardware
3. The HAL object is then passed on to the middleware which performs the requested operations using configurator-generated HAL API

See the sequence diagram in the [Figure 3](#) for the expected ModusToolbox™ application flow.

1 Introduction to Infineon's new Hardware Abstraction Layer (HAL)

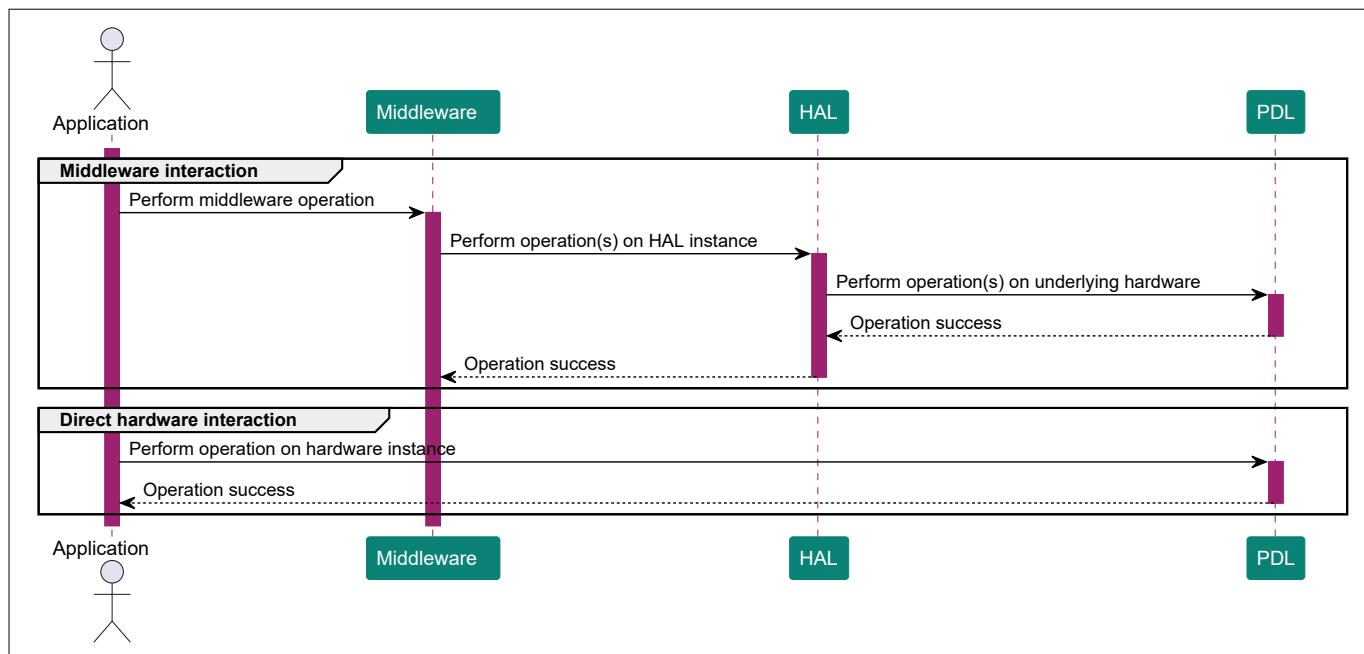


Figure 3 Application flow diagram for usage with or without middleware

This application note guides you about the workflows necessary for setting up and using HAL in code examples. This document covers a high-level overview of necessary concepts for understanding HAL, and provides pointers to migrate an existing HAL-based code example to new HAL-based approach featuring example code snippets.

2 Important concepts for understanding HAL

2 Important concepts for understanding HAL

2.1 Typical HAL setup sequence

There are two broad buckets of HAL driver API organization:

- Setup functions: Initialize a HAL object for a specific hardware instance
- Runtime functions: Perform operations after setup (read, write, start, stop, etc.)

This section describes how to use the setup function in PSOC™ Edge applications. The setup function has the following signature:

```
mtb_hal_<functional_block>_setup(mtb_hal_<functional_block>_t* obj,
                                    mtb_hal_<functional_block>_config_t* cfg,
                                    cy_stc_<functional_block>_context_t* context,
                                    mtb_hal_clock_t* clock);
```

Table 2 Setup parameter description

Parameter	Description
Pointer to a driver-specific HAL object (for example, <code>mtb_hal_uart_t*</code>)	You must allocate this object in the application and then pass it into the setup function. This HAL object should be treated as a handle and its fields should not be modified by the application. The setup function will use this object to initialize the instance for usage by subsequent runtime HAL functions
Pointer to the HAL configuration structure (for example, <code>mtb_hal_uart_configurator_t*</code>)	<p>You must always pass the same object to all subsequent runtime APIs for that hardware instance. If this HAL object is passed into other libraries that use the HAL, it must be passed as a pointer reference</p> <p>This is generally generated by the Infineon Device Configurator tool at build time for the configured resource. You can also define this structure at application level when required. This structure contains the hardware configuration parameters needed for HAL operations. The configuration structures are available in the <code><application-directory>/bsps/TARGET_<BSP>/config/GeneratedSource/</code> folder</p> <p>For drivers that support clock configuration, this structure includes a pointer to an <code>mtb_hal_clock_t</code> that provides the HAL's default clock interface functions</p>
(table continues...)	

2 Important concepts for understanding HAL

Table 2 (continued) Setup parameter description

Parameter	Description
Pointer to the PDL context structure (for example, <code>cy_stc_scb_uart_context_t*</code>)	<p>Some drivers require this additional context object for low-level implementation. It is an internal, opaque object used by the driver. The firmware should not read from it or write to it</p> <p>The application is responsible for allocating the context and passing it by reference to the driver's setup and runtime functions. The same context pointer must also be passed to the PDL initialization function which is called before the HAL setup</p> <p>The application must ensure that the allocated context structure is valid and in scope while the peripheral instance is in use</p>
Pointer to a custom clock instance (for example, <code>mtb_hal_clock_t*</code>)	<p>Optional parameter. You may pass this if a custom clock interface function is required. A common use case is split responsibilities across security domains:</p> <ul style="list-style-type: none"> • The secure partition owns and manages the clock • The non-secure partition controls the peripheral <p>If a custom clock interface is not required, you may pass <code>NULL</code> for this parameter. In this case, the HAL uses the default clock interface from the HAL configuration structure</p>

The following is an example code snippet for UART initialization using HAL:

```

/* Application code starts */

/* Application-owned instances */
mtb_hal_uart_t uart_obj; /* Opaque handle for the UART */
const mtb_hal_config_t* uart_cfg = ... /* Generated by the device configurator */
cy_stc_scb_uart_context_t uart_context = ... /* Opaque context structure for PDL */
const mtb_hal_clock_t custom_clock = ... /* Optional custom clock interface */

/* Setup: provide the object, configuration, and optionally a custom clock */
mtb_hal_uart_setup(&uart_obj, &hal_cfg, &uart_context, &custom_clock);

/* If not overriding the clock, pass NULL: */
// mtb_hal_uart_setup(&uart_obj, &hal_cfg, &uart_context, NULL);

/* Application code ends */

/* Middleware code starts */

/* Use the same object for all runtime operations */
mtb_hal_uart_write(&uart_obj, tx_buf, tx_len);
mtb_hal_uart_read(&uart_obj, rx_buf, rx_len);

/* Middleware code ends */

```

2 Important concepts for understanding HAL

For a more detailed discussion, see section [Examples for HAL usage with middleware](#).

2.2 Initialization sequence

The application is responsible for initializing the hardware that middleware libraries will access through the HAL. You may refer to the retarget-io initialization sequence in the [PSOC Edge MCU: Hello World](#) code example. The HAL instance should be initialized in the following sequence:

1. Initialize the peripheral with the PDL APIs
2. Enable the peripheral using the PDL APIs
3. Set up the corresponding HAL object using the `_setup` function
4. Initialize the middleware using the same HAL object
5. If applicable, configure and enable the interrupt handler using the PDL APIs
6. If present, register the `SysPm` callback handler using the PDL APIs

When the Device Configurator is used to set up the hardware, it automatically generates configuration structures. The application may ignore these generated structures and define them manually if required.

2.3 RTOS integration

Some HAL drivers can behave differently in an RTOS environment, especially for operations that need to wait for a significant amount of time. In an RTOS-aware configuration, these functions perform waits through the RTOS API so other threads can continue running. In non-RTOS (bare-metal) environments, they use busy-wait loops instead. To indicate that an RTOS is in use, enable the `RTOS_AWARE` component (`COMPONENTS+=RTOS_AWARE`) in the project Makefile. When this is set, the HAL uses the [RTOS Abstraction APIs](#) to handle waits.

When using the HAL in an RTOS environment with the `RTOS_AWARE` component enabled, HAL driver setup must occur after the RTOS has been initialized to ensure that RTOS resources, such as semaphores used by the HAL drivers, are properly initialized.

It is not safe to invoke more than one operation on the same HAL driver instance at the same time. If multiple threads access a HAL driver instance, the caller is responsible for enforcing mutual exclusion (for example, with an RTOS mutex or semaphore) so that only one thread interacts with that instance at any given time.

2.4 SysPm callbacks

Two kinds of APIs exist in the legacy system power management (SysPm) HAL:

1. Power state transitions: The functions like `cyhal_syspm_enter_deepsleep()` that help in transitioning across the device's power mode
2. Callback support: These APIs help to decide if it's safe to change power modes and to prepare/restore peripherals around those transitions

The new HAL keeps the power mode transition functions (e.g., enter Sleep/DeepSleep) but does not keep the functions to transition between different active power states like (Low Power (LP), Ultra Low Power (ULP) and High performance (HP)). Middleware (for example, an RTOS) can call these APIs to enter low-power modes. The application must take care of all steps (including changing the core voltage and system clock frequencies) necessary to prepare for or restore after a transition to a low-power state.

The new HAL no longer auto-registers the System Power Management (sysPm) callbacks. It is the application's responsibility to register callbacks where necessary. The PDL provides ready-made, default callback implementations for common peripherals. The Device Utilities (device-utils) handles the pre-defined SysPm callback implementations for peripherals which require special handling when the MCU enters or exits DeepSleep. This helps in having a reliable and controlled power management experience.

2 Important concepts for understanding HAL

2.5 Clock management

The application is responsible for setting up and initializing clocks, either directly through PDL API or through Device Configurator GUI. Some HAL drivers may need to adjust a clock at run time (for example, changing a UART baud rate). To enable this, each driver's `_setup` function accepts an optional `mtb_hal_clock_t` pointer that provides a clock interface the driver can use. See section [Initialization sequence](#) for details.

There are now two ways to provide the clock interface

- The configurator generates a structure (often referenced as `_hal_config`) for all initialized peripherals that includes a pointer to the HAL's default clock interface (`mtb_hal_clock_t`). If no custom clock interface is supplied (parameter passed as `NULL`), the driver will use this default interface automatically. This is ideal for simple applications that don't need special clock handling
- In case custom clock control is required for a peripheral, you must pass the relevant custom clock interface to the `_setup` function. A common use case is when the secure partition owns clock management, while a non-secure partition owns the peripheral. The custom clock interface can enforce that separation

2.6 Interrupt handling

HAL drivers that support interrupt handling expose a function to process peripheral interrupts (commonly named `process_interrupts` or `_process_interrupt`). Any middleware that relies on such a HAL driver provides its own wrapper around the driver's interrupt-processing functions.

For every peripheral instance used by a middleware (and typically for instances the application uses directly as well), the application is responsible for implementing and registering the interrupt handler. That handler must invoke the corresponding middleware-level interrupt processing function for that specific instance. This instance-by-instance linkage ensures that interrupts are routed correctly, preserves the separation of concerns among the application, middleware, and HAL, and keeps the interrupt path consistent across the code base.

See [Figure 4](#) for a sequence diagram on the interrupt handling mechanism in Modustoolbox™ applications which use HAL through middlewares.

2 Important concepts for understanding HAL

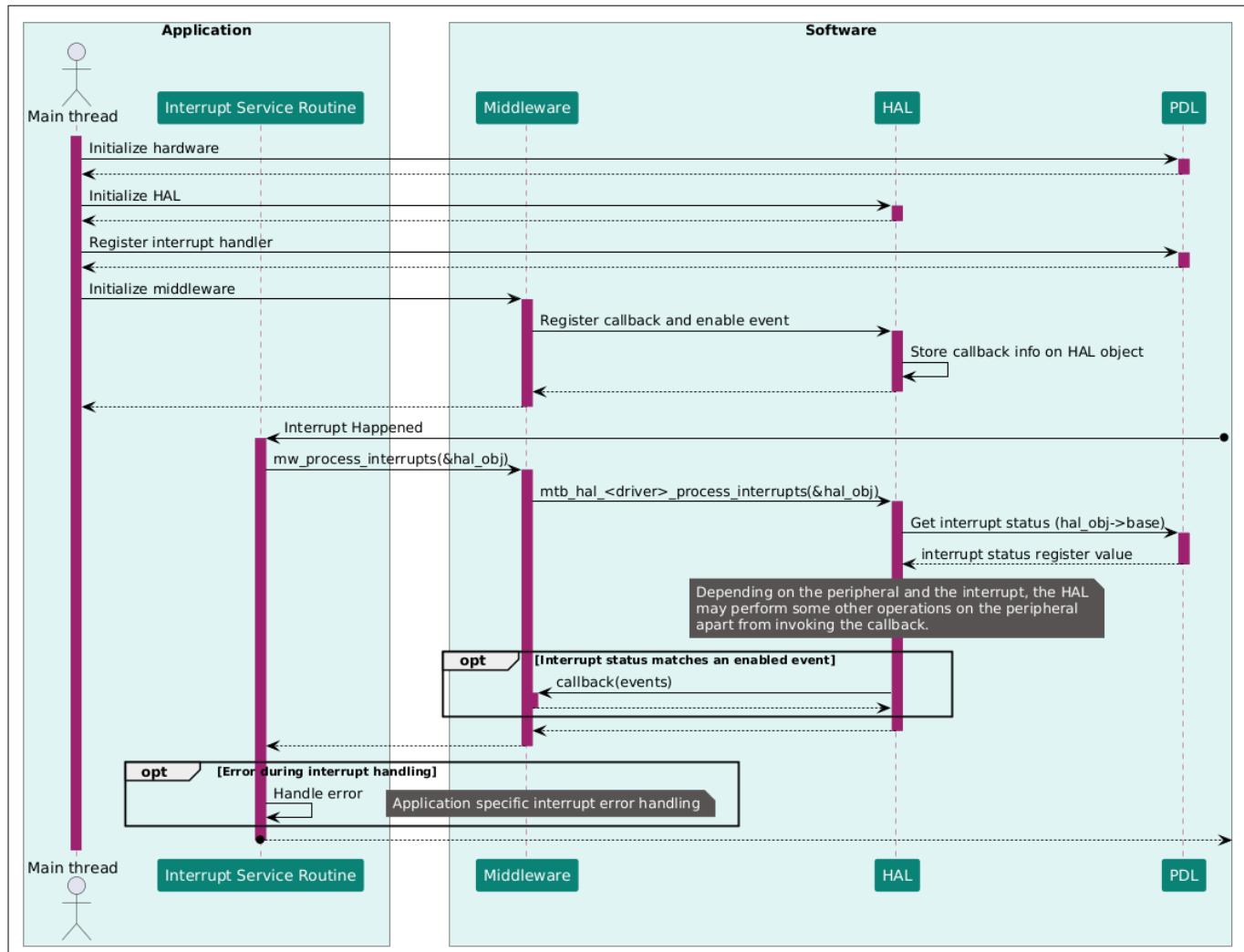


Figure 4 **Interrupt handling using HAL**

3 Guide to migrate code examples from legacy HAL-based code examples

3 Guide to migrate code examples from legacy HAL-based code examples

This section provides tips and suggestions to migrate existing HAL-based code examples to either completely PDL-based or PDL with HAL for middleware setup. All PSOC™ Edge code examples available in ModusToolbox™ already follow this strategy.

The legacy Infineon HAL provided a generic interface which was supposed to be used across multiple MCU product families. This was achieved by having the HAL as a layer built on top of platform-specific Peripheral Driver Libraries (PDL). In the legacy implementation, most of the HAL APIs were wrapping PDL APIs to achieve the desired functionality (see the PDL API reference guide for details). While the new HAL is focused on the needs of middleware libraries, it can be used by an application if the functionality provided meets the application needs.

This section takes the GPIO library functions as an example because they are widely used in applications. Some inline functions (like read, write, and toggle) can directly be mapped from legacy HAL to PDL as shown in the table below.

Table 3 Legacy HAL mapping to PDL

Legacy HAL	PDL
cyhal_gpio_write(pin,value)	Cy_GPIO_Write(port,pin,value)
cyhal_gpio_read(pin)	Cy_GPIO_Read(port,pin)
cyhal_gpio_toggle(pin)	Cy_GPIO_Inv(port, pin)

Other complex functions (like initialization) might not find an exact one-to-one mapping with PDL. You can use the Infineon ModuToolbox™ Device Configurator to initialize and use the peripheral or you may write up your own custom configuration for the initialization of peripherals in the application code using PDL APIs.

To configure a GPIO using ModuToolbox™ Device Configurator, follow the steps:

1. Open Device Configurator and navigate to the **Pins** tab and select the port and pin which need to be configured

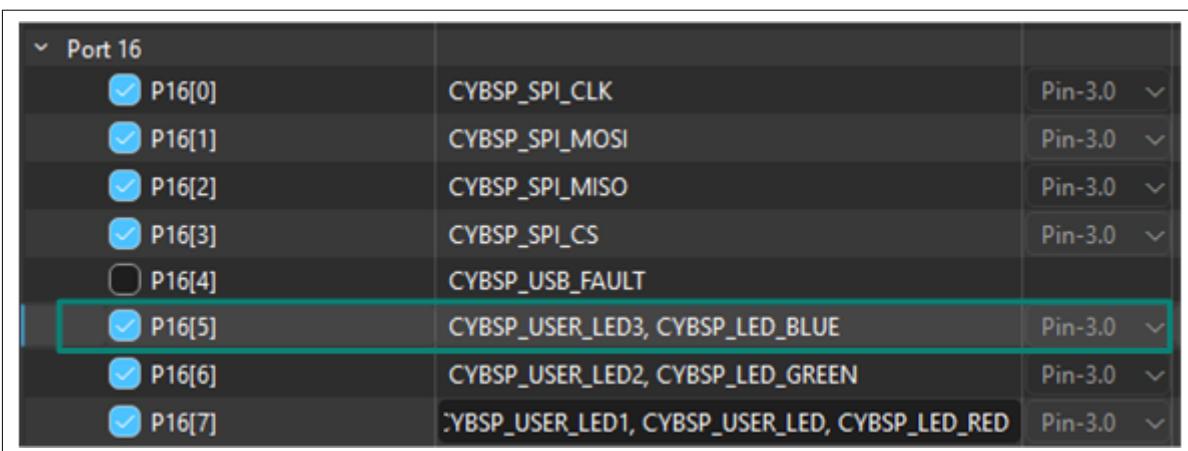


Figure 5 Select the port and pin number for the GPIO

2. Click the checkbox to enable the pin. All pins have a default alias which is used as reference in the configuration structures and application code. You may optionally define a custom alias for your pin
3. When the pin is selected, use the **Parameters** pane to define the configurations for the pin like the drive mode, drive strength, and slew rate.

3 Guide to migrate code examples from legacy HAL-based code examples

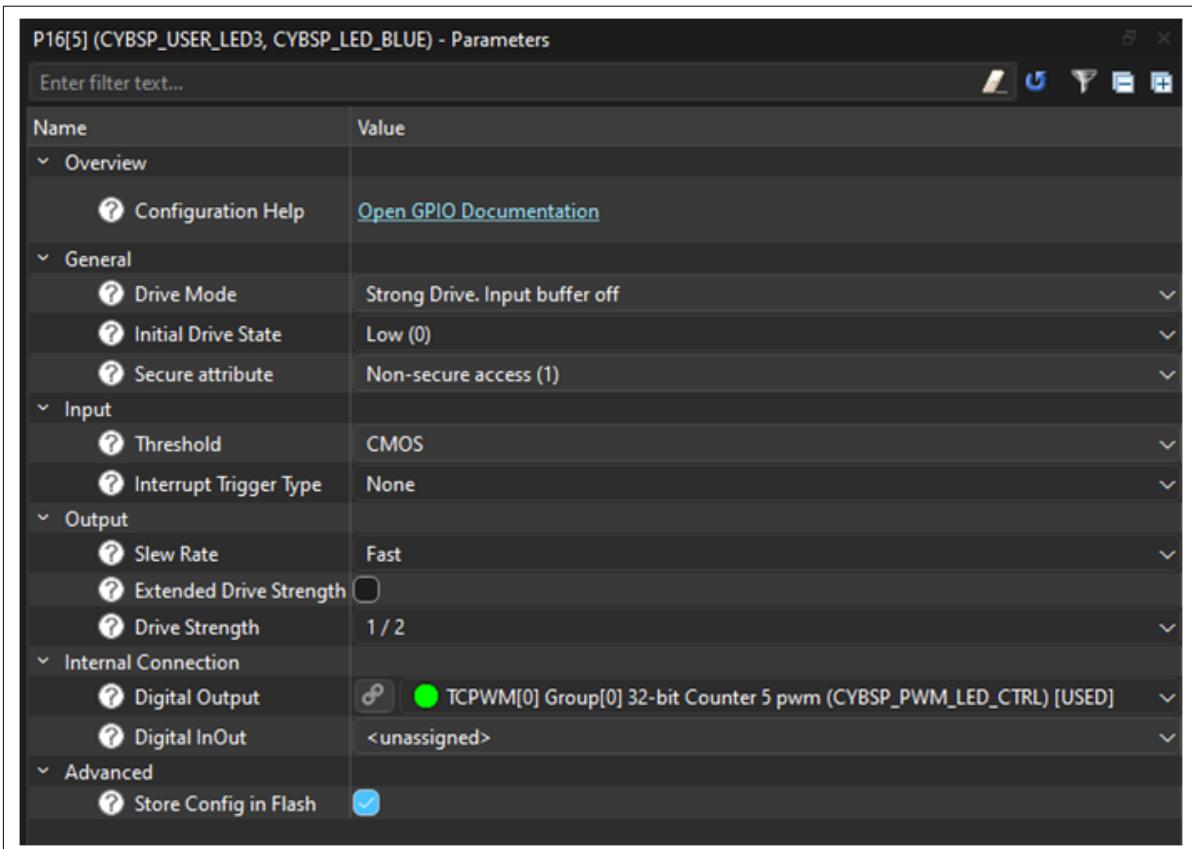


Figure 6 Define the configurations in the Parameters pane

- The pin is now enabled and set up with the desired configurations. You can use the same alias to use the pin

A GPIO can also be configured using PDL bypassing the Device Configurator. In this case, you will need to write your own configuration structure and use it in the application code. See the following code snippet for reference.

```
static const cy_stc_gpio_pin_config_t LED1_config =
{
    .outVal      = 0u,                      /* Start low (adjust to 1u if LED is active-low and
you want it off) */
    .driveMode   = CY_GPIO_DM_STRONG,        /* Push-pull output */
    .hsiom       = HSIOM_SEL_GPIO,           /* Route to GPIO function */
    .slewRate    = CY_GPIO_SLEW_FAST,         /* Optional: fast edge rate */
    .driveSel    = CY_GPIO_DRIVE_1_2,         /* Optional: 1/2 drive to reduce EMI/current */
    .nonSec     = 1u                          /* Mark pin as Non-Secure */
};
```

```
/* Initialize the LED pin with the configuration structure. */
Cy_GPIO_Pin_Init(CYBSP_USER_LED1_PORT, CYBSP_USER_LED1_PIN, &LED1_config);

/* Toggle the LED */
Cy_GPIO_Inv(CYBSP_USER_LED1_PORT, CYBSP_USER_LED1_PIN);
```

3 Guide to migrate code examples from legacy HAL-based code examples

3.1 Examples for HAL usage with middleware

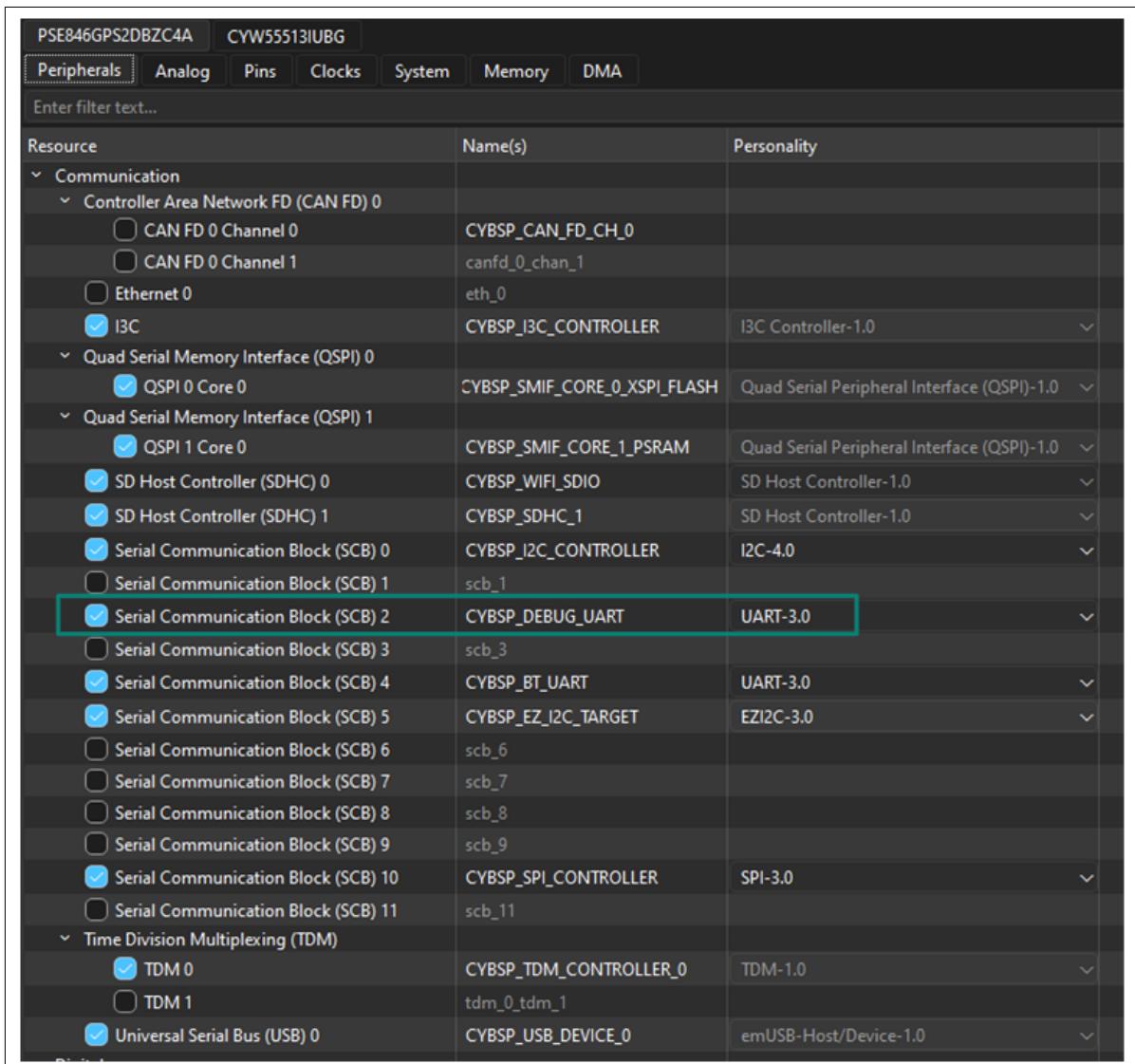
This section discusses the setup and usage of the new HAL with examples which are commonly used in PSOC™ Edge code examples.

3.1.1 Retarget-io setup (UART usage)

Retarget-io is a utility library to retarget the standard input/output (STDIO) messages to a UART port. With this library, you can directly print messages on a UART terminal using `printf()`. You can specify the TX pin, RX pin, and the baud rate when configuring the UART. See this library on GitHub: <https://github.com/Infineon/retarget-io>.

You may refer to the [PSOC Edge MCU: Hello World](#) code example for a demonstration of using the UART HAL with the retarget-io middleware.

- As the first step, enable the SCB2 peripheral under the **Peripherals** tab in the Device Configurator and select **UART** as the mode of operation. On PSOC™ Edge E84 evaluation kit, SCB2 is connected to the KitProg UART bridge. Note that the SCB2 peripheral is enabled by default and configured in the BSP with the alias `CYBSP_DEBUG_UART` as shown in the following figure



The screenshot shows the Device Configurator interface for the PSOC846GPS2DBZC4A device. The top navigation bar includes tabs for PSE846GPS2DBZC4A, CYW55513IUBG, Peripherals, Analog, Pins, Clocks, System, Memory, and DMA. A search bar labeled 'Enter filter text...' is also present. The main table lists various resources and their configurations. The 'Communication' section is expanded, showing the SCB2 peripheral configuration. The row for SCB2 is highlighted with a green border. The table columns are 'Resource', 'Name(s)', and 'Personality'. The 'Name(s)' column for SCB2 lists 'CYBSP_DEBUG_UART'. The 'Personality' column shows 'UART-3.0'. Other rows in the table include CAN FD, Ethernet, I2C, SPI, and various memory and host controller configurations.

Resource	Name(s)	Personality
Communication		
Controller Area Network FD (CAN FD) 0		
<input type="checkbox"/> CAN FD 0 Channel 0	CYBSP_CAN_FD_CH_0	
<input type="checkbox"/> CAN FD 0 Channel 1	canfd_0_chan_1	
<input type="checkbox"/> Ethernet 0	eth_0	
<input checked="" type="checkbox"/> I2C	CYBSP_I2C_CONTROLLER	I2C Controller-1.0
Quad Serial Memory Interface (QSPI) 0		
<input checked="" type="checkbox"/> QSPI 0 Core 0	CYBSP_SMIF_CORE_0_XSPI_FLASH	Quad Serial Peripheral Interface (QSPI)-1.0
Quad Serial Memory Interface (QSPI) 1		
<input checked="" type="checkbox"/> QSPI 1 Core 0	CYBSP_SMIF_CORE_1_PSRAM	Quad Serial Peripheral Interface (QSPI)-1.0
<input checked="" type="checkbox"/> SD Host Controller (SDHC) 0	CYBSP_WIFI_SDIO	SD Host Controller-1.0
<input checked="" type="checkbox"/> SD Host Controller (SDHC) 1	CYBSP_SDHC_1	SD Host Controller-1.0
<input checked="" type="checkbox"/> Serial Communication Block (SCB) 0	CYBSP_I2C_CONTROLLER	I2C-4.0
<input type="checkbox"/> Serial Communication Block (SCB) 1	scb_1	
<input checked="" type="checkbox"/> Serial Communication Block (SCB) 2	CYBSP_DEBUG_UART	UART-3.0
<input type="checkbox"/> Serial Communication Block (SCB) 3	scb_3	
<input checked="" type="checkbox"/> Serial Communication Block (SCB) 4	CYBSP_BT_UART	UART-3.0
<input checked="" type="checkbox"/> Serial Communication Block (SCB) 5	CYBSP_EZ_I2C_TARGET	EZI2C-3.0
<input type="checkbox"/> Serial Communication Block (SCB) 6	scb_6	
<input type="checkbox"/> Serial Communication Block (SCB) 7	scb_7	
<input type="checkbox"/> Serial Communication Block (SCB) 8	scb_8	
<input type="checkbox"/> Serial Communication Block (SCB) 9	scb_9	
<input checked="" type="checkbox"/> Serial Communication Block (SCB) 10	CYBSP_SPI_CONTROLLER	SPI-3.0
<input type="checkbox"/> Serial Communication Block (SCB) 11	scb_11	
Time Division Multiplexing (TDM)		
<input checked="" type="checkbox"/> TDM 0	CYBSP_TDM_CONTROLLER_0	TDM-1.0
<input type="checkbox"/> TDM 1	tdm_0_tdm_1	
<input checked="" type="checkbox"/> Universal Serial Bus (USB) 0	CYBSP_USB_DEVICE_0	emUSB-Host/Device-1.0

Figure 7 SCB2 peripheral aliased and configured for UART operation

3 Guide to migrate code examples from legacy HAL-based code examples

2. Configure the SCB2 block to be used as UART with the following set of configurations in the **Parameters** pane. Configuration includes the clock source configuration for the UART peripheral, UART TX and RX pins, CTS/RTS pins if flow control is desired, baud rate, and other UART config parameters

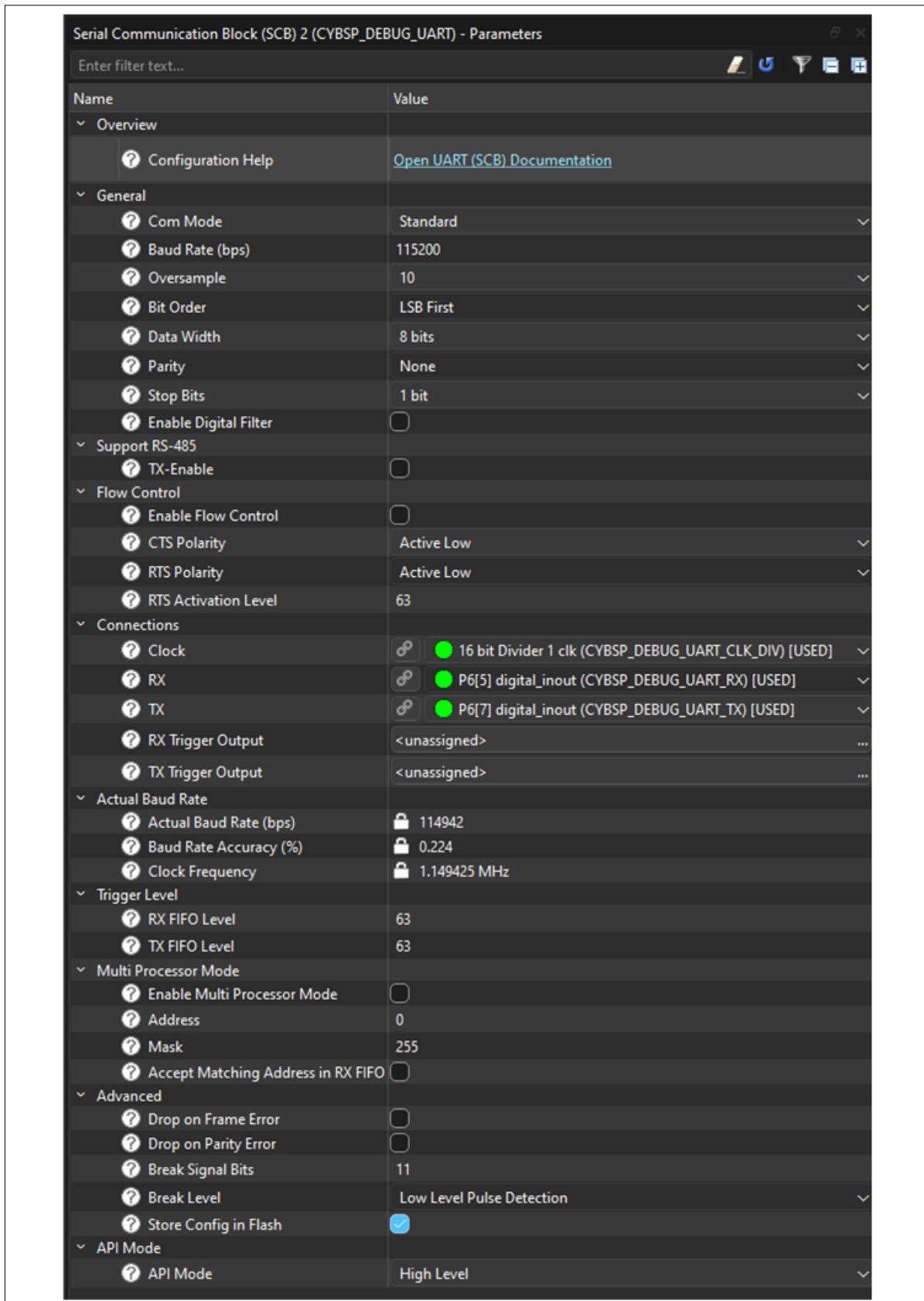


Figure 8 **UART configuration parameters**

3 Guide to migrate code examples from legacy HAL-based code examples

- Set up the clock divider value depending on the desired baud rate in the **Clocks** tab as shown in the following figure. This setting is already configured with the 16-bit divider 1 clock divider in the default BSP

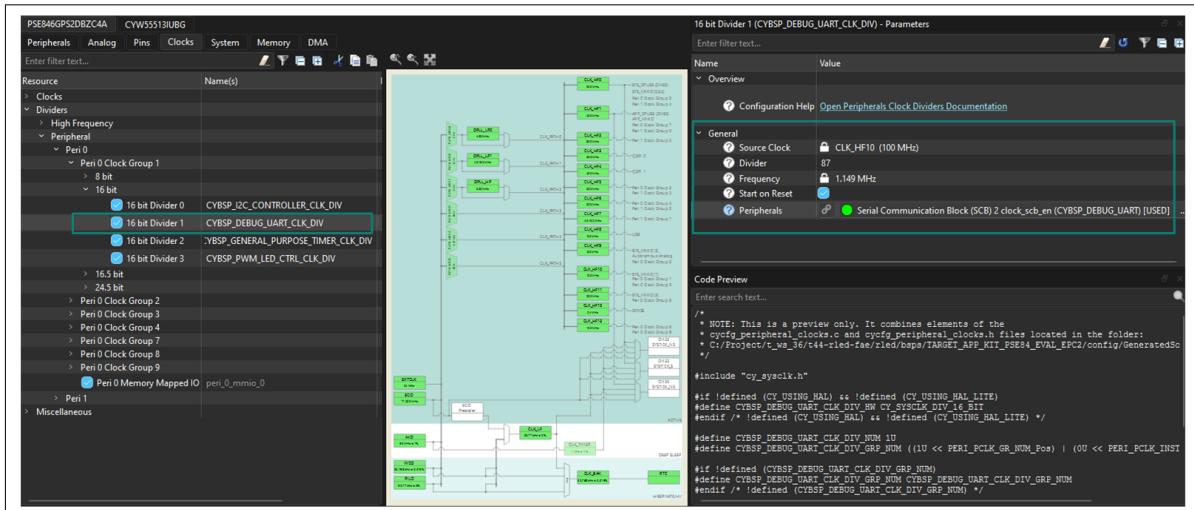


Figure 9 **UART clock divider**

- Import the 'retarget-io' middleware library using ModusToolbox™ Library Manager. See [1] on steps to add libraries to projects
- Once imported, add `#include "cy_retarget_io.h"` inclusion in the application source file
- Create and use the HAL object `DEBUG_UART_hal_obj` to set up the UART HAL and pass the same object to initialize the retarget-io middleware
- Follow the steps as highlighted in the section Initialization sequence to initialize and set up the SCB UART
 - Initialize the SCB UART

```
result = (cy_rslt_t)Cy_SCB_UART_Init(CYBSP_DEBUG_UART_HW,
                                         &CYBSP_DEBUG_UART_config,
                                         &DEBUG_UART_context);

/* Check Result */
```

- Enable the UART peripheral

```
Cy_SCB_UART_Enable(CYBSP_DEBUG_UART_HW);
```

- Set up the HAL UART object

```
result = mtb_hal_uart_setup(&DEBUG_UART_hal_obj,
                            &CYBSP_DEBUG_UART_hal_config,
                            &DEBUG_UART_context, NULL);

/* Check result */
```

- Initialize the middleware using the HAL object

```
result = cy_retarget_io_init(&DEBUG_UART_hal_obj);
/* Check result */
```

3 Guide to migrate code examples from legacy HAL-based code examples

9. If required, register a callback to handle the transitions to low-power modes. If the system idle power mode is set as Sleep or Deep Sleep, it is essential to register the `sysPm` callback for the peripheral. This can be done by registering with `Cy_SysPm_RegisterCallback` either the predefined callbacks from the `SysPm` callbacks under Device Utilities (device-utils) library or a new callback function specific to your application needs. This callback will manage the necessary procedures for the peripheral while transitioning in and out of low-power modes like Sleep or Deep Sleep gracefully. For more information, refer to `Cy_SysPm_RegisterCallback` in PDL documentation. See the [PSOC Edge MCU: Hello World](#) code example for `SysPm` callback implementation for the retarget-io middleware
10. Start printing to UART using `printf()`

3 Guide to migrate code examples from legacy HAL-based code examples

See the following code snippets for implementation details.

```
/* For the RetargetIO (Debug UART) usage. */
static cy_stc_scb_uart_context_t    DEBUG_UART_context;
static mtb_hal_uart_t              DEBUG_UART_hal_obj;

/* Retarget-io deepsleep callback parameters */
#ifndef (CY_CFG_PWR_SYS_IDLE_MODE == CY_CFG_PWR_MODE_DEEPSLEEP)

/* Context reference structure for Debug UART */
static mtb_syspm_uart_deepsleep_context_t retarget_io_syspm_ds_context =
{
    .uart_context      = &DEBUG_UART_context,
    .async_context     = NULL,
    .tx_pin =
    {
        .port          = CYBSP_DEBUG_UART_TX_PORT,
        .pinNum        = CYBSP_DEBUG_UART_TX_PIN,
        .hsiom         = CYBSP_DEBUG_UART_TX_HSIOM
    },
    .rts_pin =
    {
        .port          = DEBUG_UART_RTS_PORT,
        .pinNum        = DEBUG_UART_RTS_PIN,
        .hsiom         = HSIOM_SEL_GPIO
    }
};

/* SysPm callback parameter structure for Debug UART */
static cy_stc_syspm_callback_params_t retarget_io_syspm_cb_params =
{
    .context          = &retarget_io_syspm_ds_context,
    .base             = CYBSP_DEBUG_UART_HW
};

/* SysPm callback structure for Debug UART */
static cy_stc_syspm_callback_t retarget_io_syspm_cb =
{
    .callback          = &mtb_syspm_scb_uart_deepsleep_callback,
    .skipMode         = SYSPM_SKIP_MODE,
    .type             = CY_SYSPM_DEEPSLEEP,
    .callbackParams   = &retarget_io_syspm_cb_params,
    .prevItm          = NULL,
    .nextItm          = NULL,
    .order            = SYSPM_CALLBACK_ORDER
};

#endif /* (CY_CFG_PWR_SYS_IDLE_MODE == CY_CFG_PWR_MODE_DEEPSLEEP) */
```

```
void init_retarget_io(void)
{
```

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```
cy_rslt_t result = CY_RSLT_SUCCESS;

/* Initialize the SCB UART */
result = (cy_rslt_t)Cy_SCB_UART_Init(CYBSP_DEBUG_UART_HW,
                                       &CYBSP_DEBUG_UART_config,
                                       &DEBUG_UART_context);

/* UART initialization failed. Stop program execution. */
if (CY_RSLT_SUCCESS != result)
{
    handle_app_error();
}

/* Enable the SCB UART */
Cy_SCB_UART_Enable(CYBSP_DEBUG_UART_HW);

result = mtb_hal_uart_setup(&DEBUG_UART_hal_obj,
                           &CYBSP_DEBUG_UART_hal_config,
                           &DEBUG_UART_context, NULL);

/* UART setup failed. Stop program execution. */
if (CY_RSLT_SUCCESS != result)
{
    handle_app_error();
}

/* Initialize retarget-io to use the debug UART port. */
result = cy_retarget_io_init(&DEBUG_UART_hal_obj);

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

#if (CY_CFG_PWR_SYS_IDLE_MODE == CY_CFG_PWR_MODE_DEEPSLEEP)
/* UART SysPm callback registration for retarget-io */
Cy_SysPm_RegisterCallback(&retarget_io_syspm_cb);
#endif /* (CY_CFG_PWR_SYS_IDLE_MODE == CY_CFG_PWR_MODE_DEEPSLEEP) */
}
```

3.1.2 BMI 270 motion sensor (I2C usage)

The BMI270 inertial measurement unit (IMU) motion sensor library provides functions for interfacing with the Bosch BMI270 I2C 16-bit inertial measurement unit (IMU) with 3-axis accelerometer and 3-axis gyroscope. The sensor-motion-bmi270 is a middleware library and can be set up to be used with the new HAL workflow. The Bosch BMI270 sensor is available on the PSOC™ Edge E84 Evaluation Kit and is interfaced to the MCU through I2C (SCB0). The same sensor may connect to some other I2C instance on a different evaluation board. See the board documentation for details. See this library on GitHub: <https://github.com/Infineon/sensor-motion-bmi270>.

You may refer to the [PSOC Edge MCU: Sensor hub data acquisition](#) code example for a demonstration of using the I2C HAL with the BMI 270 motion sensor library.

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1. As the first step, enable the SCB0 peripheral under the **Peripherals** tab in the Device Configurator and select **I2C** as the mode of operation. Note that the SCB0 peripheral is enabled by default and configured in the BSP with the alias `CYBSP_I2C_CONTROLLER`
2. Configure the SCB2 block to be used as I2C with the following set of configurations in the **Parameters** pane. Configurations include the I2C mode, data rate, Clock , SCL and SDA connections

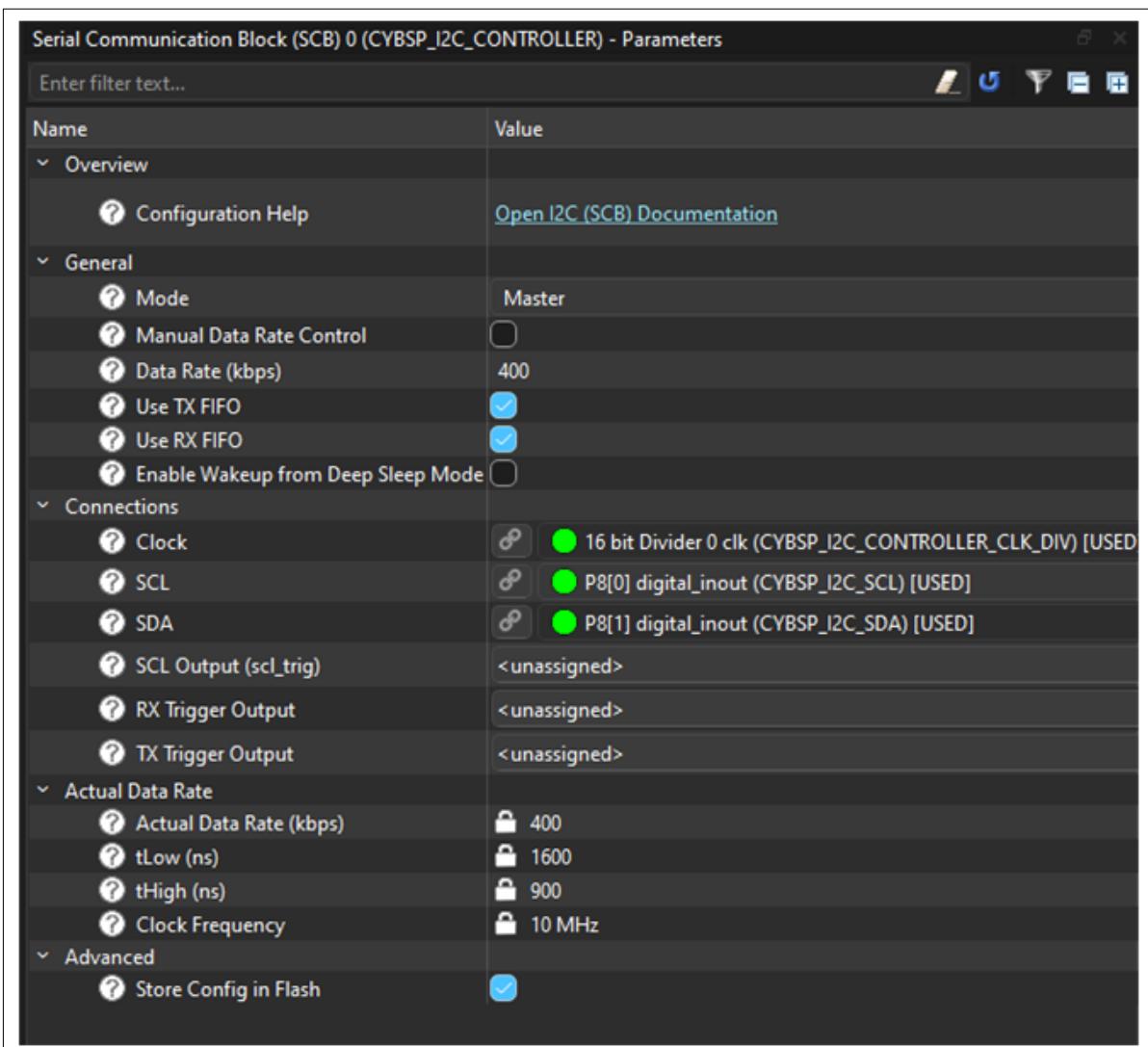


Figure 10 I2C configuration parameters

3. Import the `sensor-motion-bmi270` middleware library using ModusToolbox™ Library Manager. See [1] on steps to add libraries to projects
4. Once imported, Add `#include "mtb_bmi270.h"` inclusion in the application source file
5. Create and use the `CYBSP_I2C_CONTROLLER_hal_obj` HAL object to set up the I2C HAL and pass the same object to initialize the `sensor-motion-bmi270` middleware
6. Follow the steps as highlighted in the section "Initialization sequence" to initialize and set up SCB I2C
 - a. Initialize SCB I2C

```

initStatus = Cy_SCB_I2C_Init(CYBSP_I2C_CONTROLLER_HW,
                             &CYBSP_I2C_CONTROLLER_config,
                             &CYBSP_I2C_CONTROLLER_context);
/* Check result */

```

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- b. Enable the I2C peripheral

```
Cy_SCB_I2C_Enable(CYBSP_I2C_CONTROLLER_HW);
```

- c. Set up the HAL I2C object

```
result = mtb_hal_i2c_setup(&CYBSP_I2C_CONTROLLER_hal_obj,  
                           &CYBSP_I2C_CONTROLLER_hal_config,  
                           &CYBSP_I2C_CONTROLLER_context,  
                           NULL);  
/* Check result */
```

7. Initialize the middleware using the HAL object

```
result = mtb_bmi270_init_i2c(&bmi270,  
                           &CYBSP_I2C_CONTROLLER_hal_obj,  
                           MTB_BMI270_ADDRESS_DEFAULT);  
/* Check result */
```

8. Configure the sensor and use it in the application code

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See the following code snippets for implementation details.

```
/* HAL objects for sensor-motion-bmi270 library. */
static mtb_hal_i2c_t CYBSP_I2C_CONTROLLER_hal_obj;
cy_stc_scb_i2c_context_t CYBSP_I2C_CONTROLLER_context;
```

```
{
    initStatus = Cy_SCB_I2C_Init(CYBSP_I2C_CONTROLLER_HW,
                                &CYBSP_I2C_CONTROLLER_config,
                                &CYBSP_I2C_CONTROLLER_context);
    /* I2C initialization failed. Stop program execution. */
    if (CY_SCB_I2C_SUCCESS != initStatus)
    {
        handle_app_error();
    }
    Cy_SCB_I2C_Enable(CYBSP_I2C_CONTROLLER_HW);
    result = mtb_hal_i2c_setup(&CYBSP_I2C_CONTROLLER_hal_obj,
                                &CYBSP_I2C_CONTROLLER_hal_config,
                                &CYBSP_I2C_CONTROLLER_context,
                                NULL);
    /* HAL I2C setup failed. Stop program execution. */
    if (CY_RSLT_SUCCESS != result)
    {
        handle_app_error();
    }
    /* Initialize can configure platform-dependent function pointers. */
    result = mtb_bmi270_init_i2c(&bmi270,
                                &CYBSP_I2C_CONTROLLER_hal_obj,
                                MTB_BMI270_ADDRESS_DEFAULT);

    /* BMI270 sensor initialization failed. Stop program execution. */
    if (CY_RSLT_SUCCESS != result)
    {
        handle_app_error();
    }
}
```

3.1.3 LPTimer setup for use with abstraction RTOS library

The RTOS abstraction layer provides a simple RTOS-agnostic implementation of common RTOS services such as threads, semaphores, mutexes, queues, and timers. See this library on GitHub: <https://github.com/Infineon/abstraction-rtos>.

For PSOC™ Edge code examples based on FreeRTOS, the tickless idle mode must be implemented for power saving in Deep Sleep by setting up the LPTimer instance in the application. The RTOS interface will be treated as a middleware. An HAL object will be passed to the abstraction RTOS library. In this example, the LPTimer instance is set up for the CM33 CPU. A similar setup must be done on the CM55 side using another instance of LPTimer.

You may refer to the [PSOC Edge MCU: Empty application](#) code example for a demonstration of using the LPTimer with the BMI 270 motion sensor library.

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1. As the first step, enable the Multi-Counter Watchdog Timer (MCWDT) 0 peripheral under the **Peripherals** tab in the Device Configurator. Note that the MCWDT0 peripheral is enabled by default and configured in the BSP Device Configurator with the alias CYBSP_CM33_LPTIMER_0. MCWDT0 instance is meant to be used with CM33 CPU while the MCWDT1 instance should be used with CM55 CPU as also indicated by the alias
2. Configure the MCWDT0 block with the following set of configurations in the **Parameters** pane:

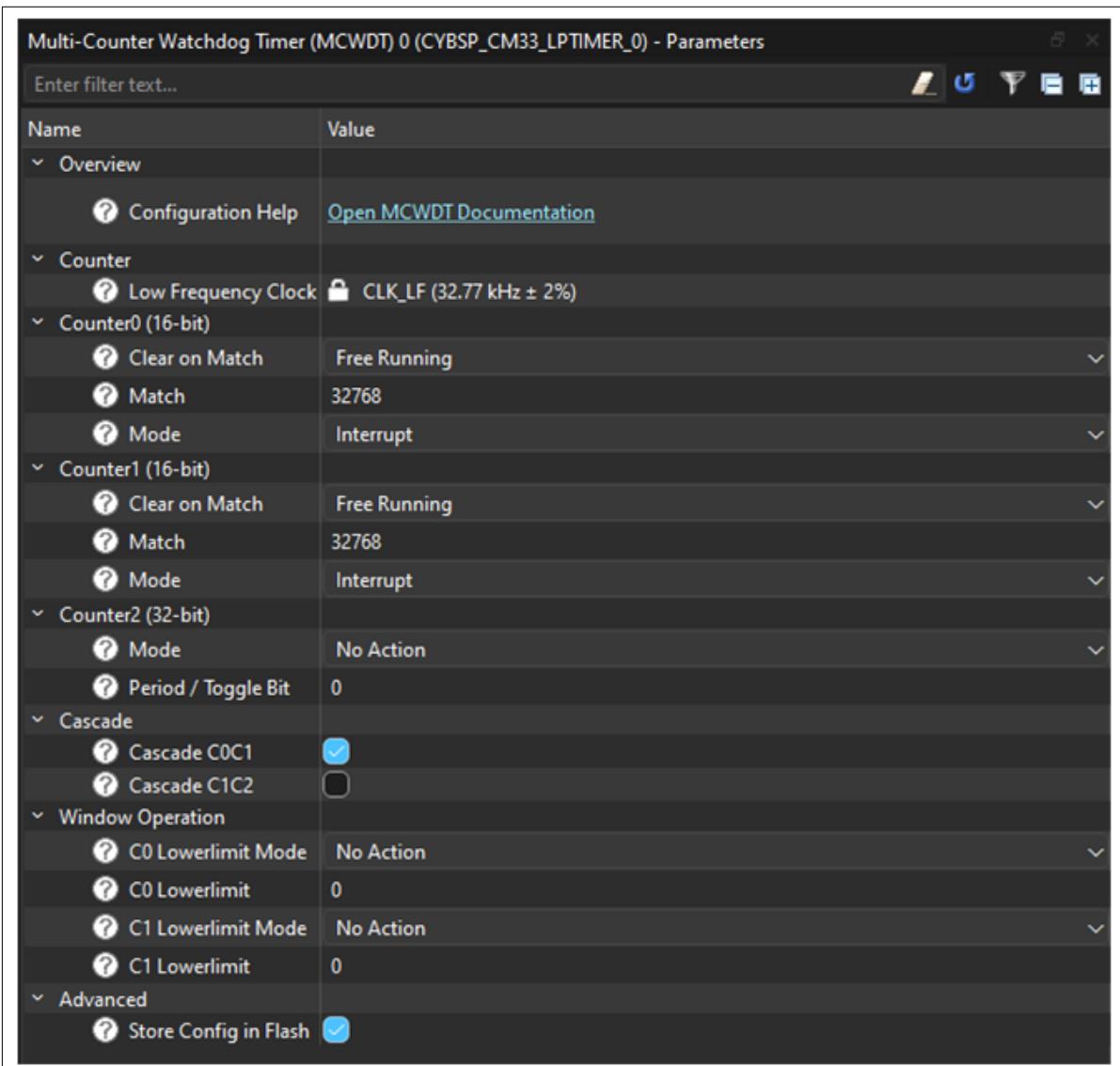


Figure 11 LPTimer configuration parameters

3. The abstraction-rtos middleware library is a dependent library for the FreeRTOS middleware library. It is therefore automatically fetched when FreeRTOS is added to the code example. See [1] on steps to add libraries to projects
4. Include the header files for the abstraction-rtos library in the application source file: - #include "cyabs_rtos.h"
5. Create and use the HAL object lptimer_obj to set up the LPTimer HAL and pass the same object to initialize the abstraction-rtos middleware

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6. Follow the steps as highlighted in the "Initialization sequence" section to initialize and set up the LPTimer0 instance
 - a. Initialize the LPTimer interrupt and interrupt handler as necessary

```
/* Interrupt configuration structure for LPTimer */
cy_stc_sysint_t lptimer_intr_cfg =
{
    .intrSrc = CYBSP_CM33_LPTIMER_0_IRQ,
    .intrPriority = APP_LPTIMER_INTERRUPT_PRIORITY
};

/* Initialize the LPTimer interrupt and specify the interrupt handler. */
cy_en_sysint_status_t interrupt_init_status =
    Cy_SysInt_Init(&lptimer_intr_cfg,
                    lptimer_interrupt_handler);

/* LPTimer interrupt initialization failed. Stop program execution. */
if(CY_SYSINT_SUCCESS != interrupt_init_status)
{
    handle_app_error();
}
```

- b. Initialize the MCWDT0 peripheral block

```
/* Initialize the MCWDT block */
cy_en_mcwdt_status_t mcwdt_init_status =
    Cy_MCWDT_Init(CYBSP_CM33_LPTIMER_0_HW,
                    &CYBSP_CM33_LPTIMER_0_config);

/* MCWDT initialization failed. Stop program execution. */
if(CY_MCWDT_SUCCESS != mcwdt_init_status)
{
    handle_app_error();
}
```

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- c. Enable the MCWDT0 instance

```
/* Enable MCWDT instance */
Cy_MCWDT_Enable(CYBSP_CM33_LPTIMER_0_HW,
                  CY_MCWDT_CTR_Msk,
                  LPTIMER_0_WAIT_TIME_USEC);
```

- d. Set up the LPTimer HAL object

```
* Setup LPTimer using the HAL object and desired configuration as defined
* in the device configurator. */
cy_rslt_t result = mtb_hal_lptimer_setup(&lptimer_obj,
                                          &CYBSP_CM33_LPTIMER_0_hal_config);

/* LPTimer setup failed. Stop program execution. */
if(CY_RSLT_SUCCESS != result)
{
    handle_app_error();
}
```

7. Initialize the middleware using the HAL object

```
/* Pass the LPTimer object to abstraction RTOS library that implements
 * tickless idle mode */
cyabs_rtos_set_lptimer(&lptimer_obj);
```

8. LPTimer is now set up to enable tickless idle mode

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See the following code snippet for implementation details.

```
/* LPTimer HAL object */
static mtb_hal_lptimer_t lptimer_obj;
```

```
static void lptimer_interrupt_handler(void)
{
    mtb_hal_lptimer_process_interrupt(&lptimer_obj);
}
```

```
static void setup_tickless_idle_timer(void)
{
    /* Interrupt configuration structure for LPTimer */
    cy_stc_sysint_t lptimer_intr_cfg =
    {
        .intrSrc = CYBSP_CM33_LPTIMER_0_IRQ,
        .intrPriority = APP_LPTIMER_INTERRUPT_PRIORITY
    };

    /* Initialize the LPTimer interrupt and specify the interrupt handler. */
    cy_en_sysint_status_t interrupt_init_status =
        Cy_SysInt_Init(&lptimer_intr_cfg,
                       lptimer_interrupt_handler);

    /* LPTimer interrupt initialization failed. Stop program execution. */
    if(CY_SYSINT_SUCCESS != interrupt_init_status)
    {
        handle_app_error();
    }

    /* Enable NVIC interrupt. */
    NVIC_EnableIRQ(lptimer_intr_cfg.intrSrc);

    /* Initialize the MCWDT block */
    cy_en_mcwdt_status_t mcwdt_init_status =
        Cy_MCWDT_Init(CYBSP_CM33_LPTIMER_0_HW,
                      &CYBSP_CM33_LPTIMER_0_config);

    /* MCWDT initialization failed. Stop program execution. */
    if(CY_MCWDT_SUCCESS != mcwdt_init_status)
    {
        handle_app_error();
    }

    /* Enable MCWDT instance */
    Cy_MCWDT_Enable(CYBSP_CM33_LPTIMER_0_HW,
                    CY_MCWDT_CTR_Msk,
                    LPTIMER_0_WAIT_TIME_USEC);

    /* Setup LPTimer using the HAL object and desired configuration as defined
```

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```
* in the device configurator. */
cy_rslt_t result = mtb_hal_lptimer_setup(&lptimer_obj,
                                         &CYBSP_CM33_LPTIMER_0_hal_config);

/* LPTimer setup failed. Stop program execution. */
if(CY_RSLT_SUCCESS != result)
{
    handle_app_error();
}

/* Pass the LPTimer object to abstraction RTOS library that implements
 * tickless idle mode */
cyabs_rtos_set_lptimer(&lptimer_obj);
}
```

4 Summary

This guide introduces Infineon's redesigned Hardware Abstraction Layer (HAL) for PSOC™ Edge and how to use it effectively. The new HAL is streamlined and middleware-focused; therefore, you should not use it directly in an application. Device setup, resource management, pins, clocks, and higher-level configuration are handled explicitly by the Peripheral Driver Library (PDL) and the Device Configurator, with device-specific details centralized in a device support library. The redesign clarifies layering, separates configuration from initialization, moves device-dependent behavior down to PDL, thereby improving transparency, predictability, and debuggability. HAL's role is to support portability and a consistent API for middleware once the hardware is already configured.

[1] Infineon Technologies AG: *AN235935 - Getting started with PSOC™ Edge E8 MCU on ModusToolbox™ software*; [Available online](#)

Revision history

Revision history

Document revision	Date	Description of changes
**	2025-10-14	Initial release

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Edition 2025-10-14

Published by

Infineon Technologies AG
81726 Munich, Germany

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Document reference
IFX-vmt1758564423034

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