TB3177

Creating a "Hello World" Application Using the MPLAB Harmony Configurator (MHC)

Introduction

MPLAB® Harmony is a software framework consisting of compatible and interoperable libraries that include peripheral drivers, middleware, system services, and third-party libraries. The MPLAB Harmony Configurator (MHC) is a GUI-based tool that provides an easy way to enable and configure various MPLAB Harmony library components. The MHC is a plug-in to the MPLAB X IDE and is included as part of the MPLAB Harmony Software Framework installation. The MHC provides a GUI to:

- Enable and configure MPLAB Harmony libraries
- Configure the system clock
- Assign pins to peripherals and configure various options available on the I/O pins
- Design a UI for displays using the Graphics Composer Suite
- Configure a new display using the Display Manager, and many more functionalities

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1. Creating a Hello World Application Using the MHC

This section describes how to create a simple MPLAB Harmony application using the MHC. The application sends a “Hello World!” string to a console running on a computer.

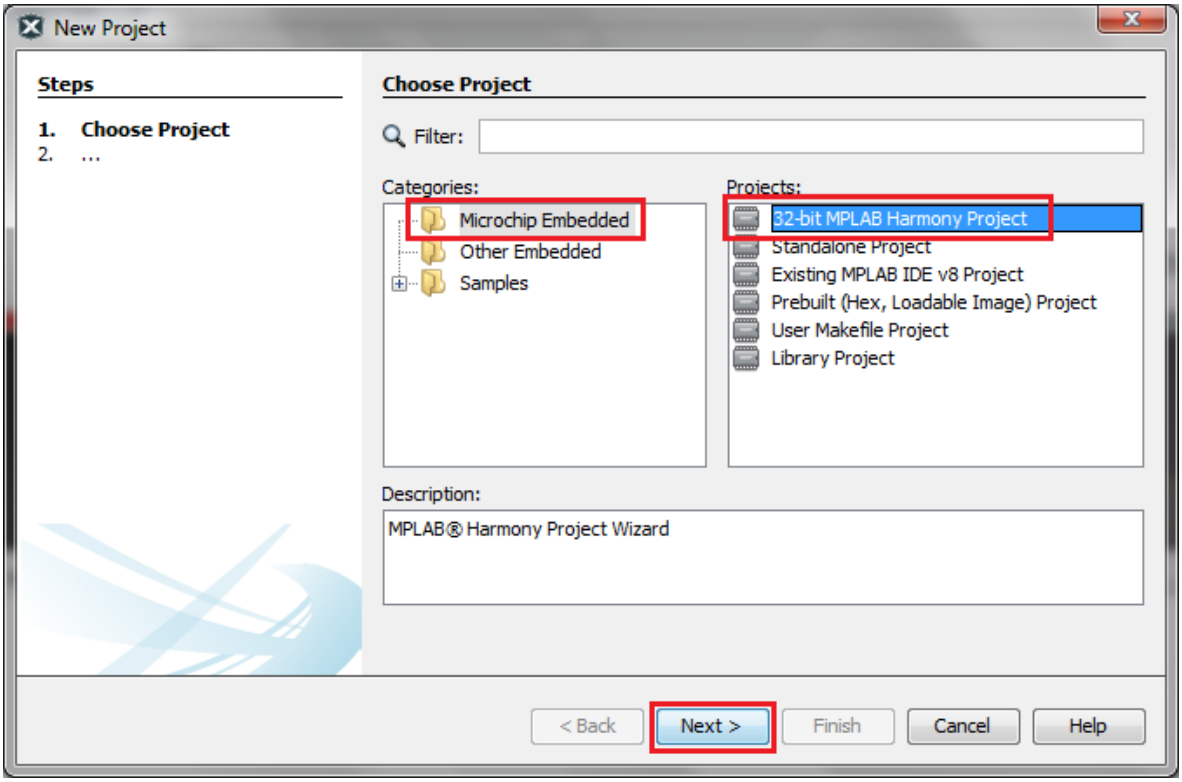
Before beginning, it is assumed that you have already installed MPLAB Harmony and the MHC plug-in. Please refer to *Volume I: Getting Started With MPLAB Harmony Libraries and Applications* > *Prerequisites* to understand the requirements. If the MHC plug-in is not installed, refer to the steps provided at http://microchipdeveloper.com/harmony:mhc-installation.

The demonstration board used in this example is the PIC32MZ Embedded Connectivity with Floating Point Unit (EF) Starter Kit. MPLAB X IDE version 3.61 and the MHC plug-in version 2.04 are used in this example.

Step 1: Create a MPLAB Harmony-based Project

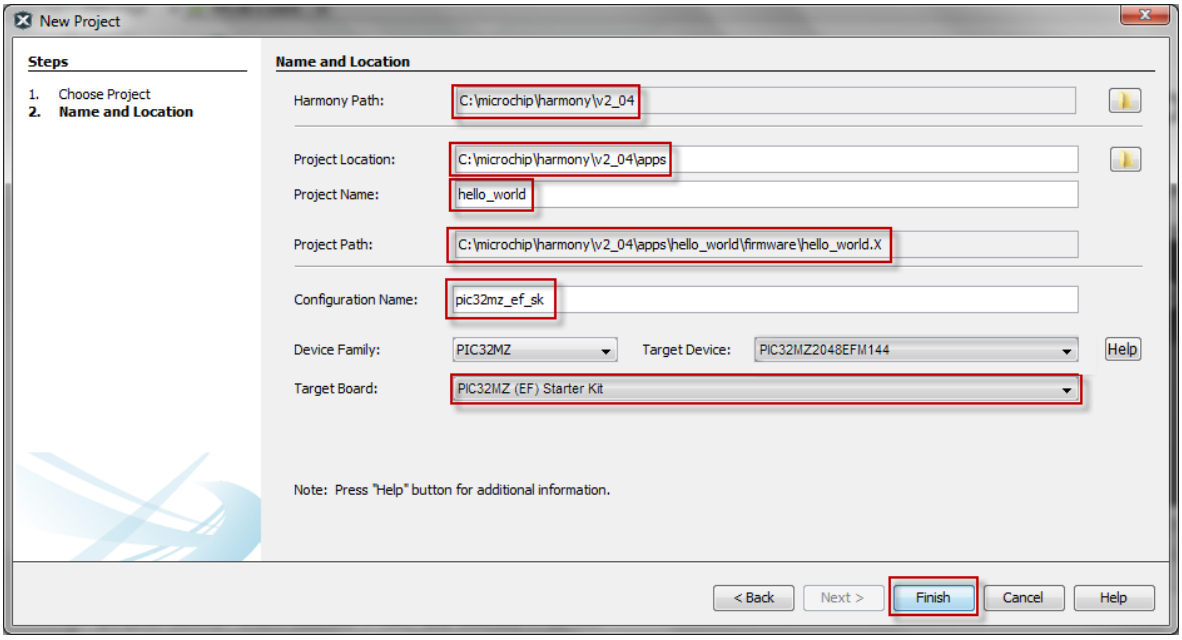
1. In MPLAB X IDE, select *File* > *New Project* (or click the New Project icon).
2. In Categories, select **Microchip Embedded** and in Projects select **32-bit MPLAB Harmony Project**, and then click **Next**, see Figure 1-1.
   Note: If the option *32-Bit MPLAB Harmony Project* is not visible, please download and install MPLAB Harmony before continuing with this tutorial.

Figure 1-1. Creating a MPLAB Harmony-based Project



3. Specify the project details in the New Project dialog, as shown in Figure 1-2.

Figure 1-2. Creating a MPLAB Harmony-based Project (Continued)



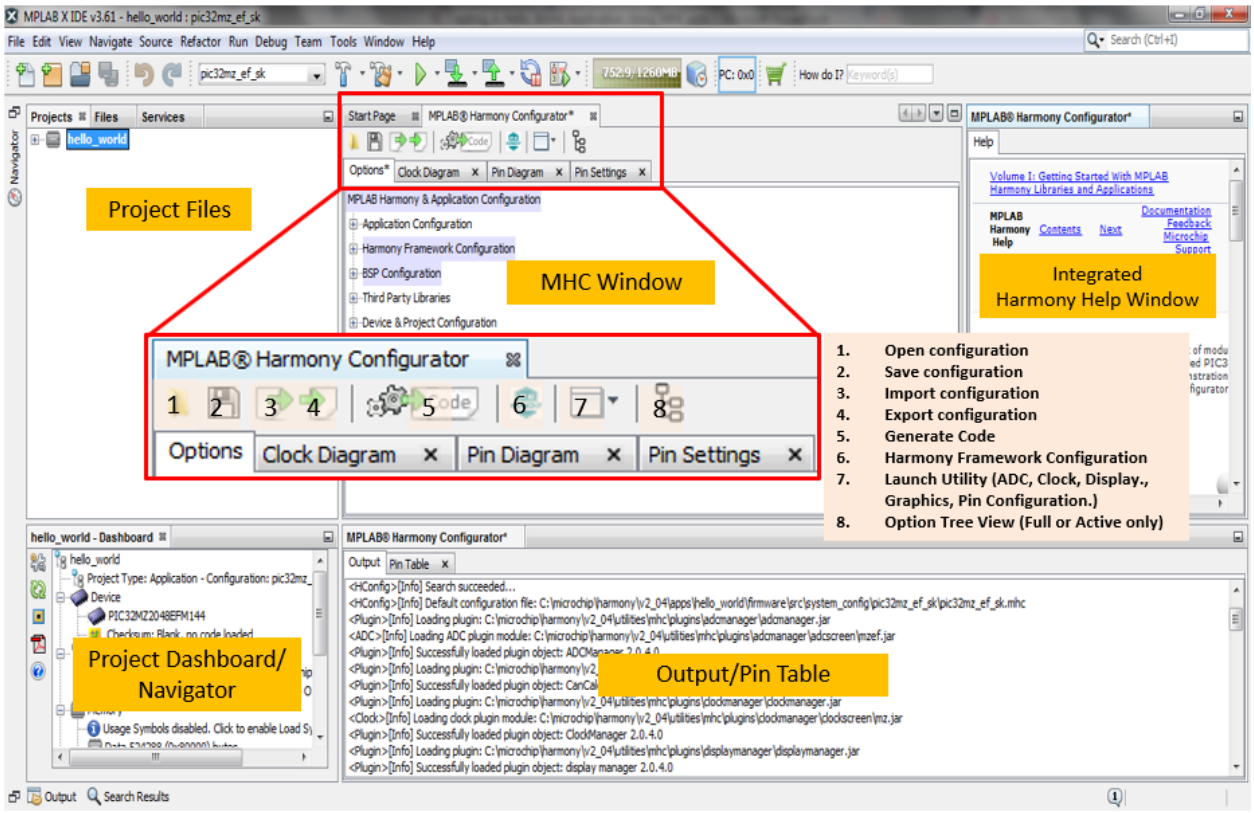
4. Click Finish.

This will create a MPLAB Harmony-based project and launch the MHC, as shown in Figure 1-3. MHC can be launched anytime in MPLAB X IDE by navigating to *Tools* > *Embedded*.

Note:

1. The path to MPLAB Harmony will be different if a different version of MPLAB Harmony is used or if MPLAB Harmony is not installed at its default location.
2. Based on the selected Target Board, the corresponding Board Support Package (BSP) will be selected. The BSP assigns device pins to various board functions and sets up the device's clock tree based on the board's clock source.

Figure 1-3. MHC User Interface

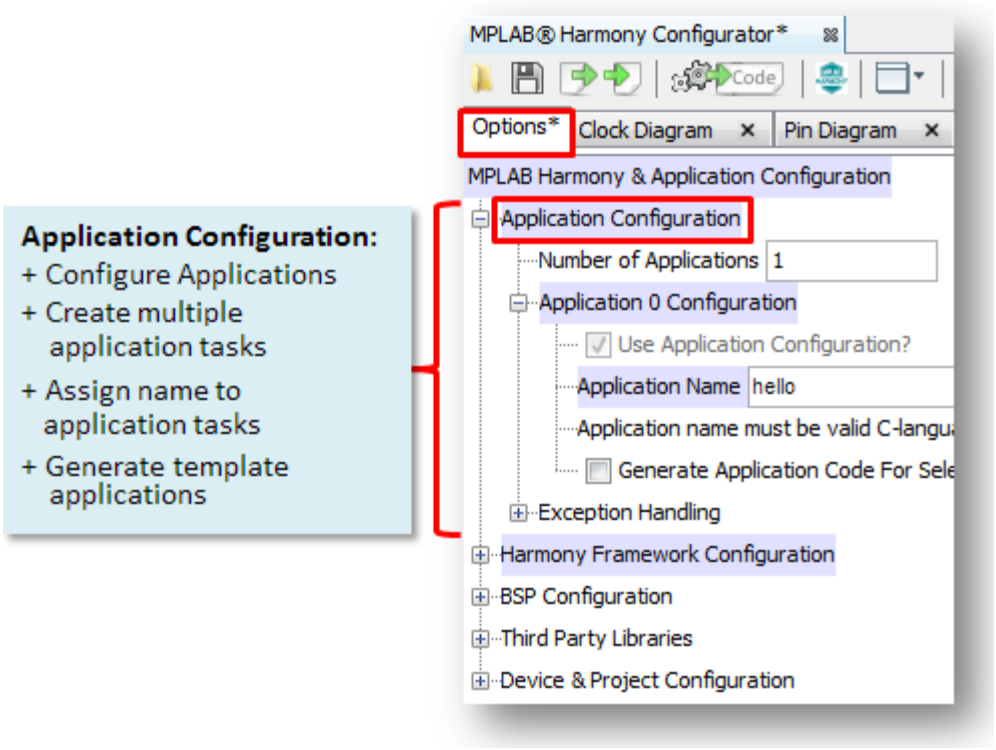


Note: For detailed information on the MHC, please refer to *Volume III: MPLAB Harmony Configurator (MHC) > MPLAB Harmony Configurator User's Guide* in the MPLAB Harmony help.

Step 2: Add and Configure MPLAB Harmony Libraries Using MHC

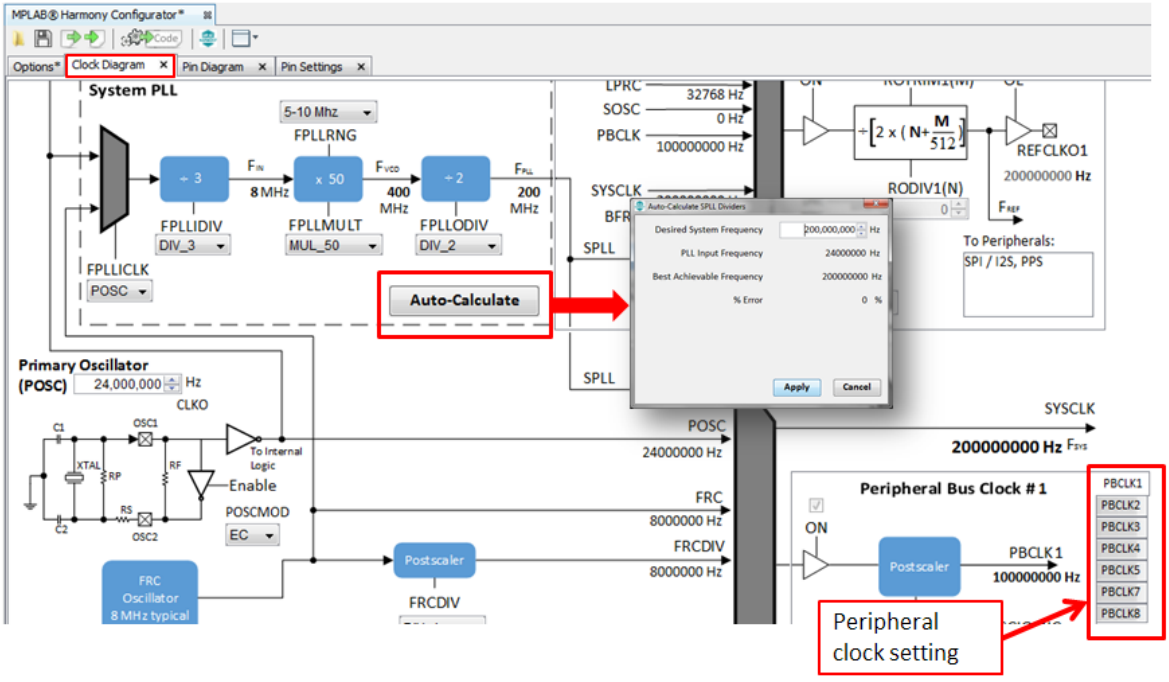
1. In MHC, expand *Options* > *Application Configuration* > *Application 0 Configuration*, and set the Application Name to `hello`, as shown in Figure 1-4. This will create an `HELLO_Initialize()` routine and a template state machine by the name `HELLO_Tasks()`.

Figure 1-4. Application Configuration



2. In MHC, select the Clock Diagram Tab and verify that the clock is configured correctly for the selected target board. The Clock Diagram tab allows for easy setup of the system clocks (see Figure 1-5).

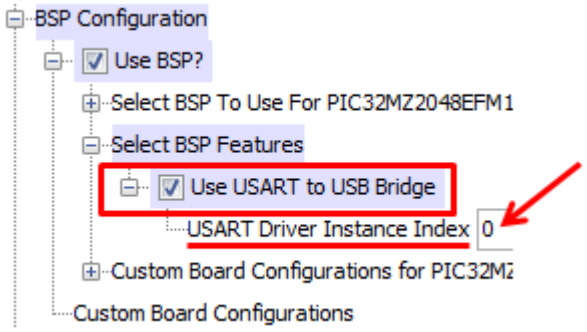
Figure 1-5. Clock Configuration



3. In MHC, go back to the Options tab and expand *BSP Configuration* > *Select BSP Features* and check the Use USART to USB Bridge option, as shown in Figure 1-6. This will map the USART

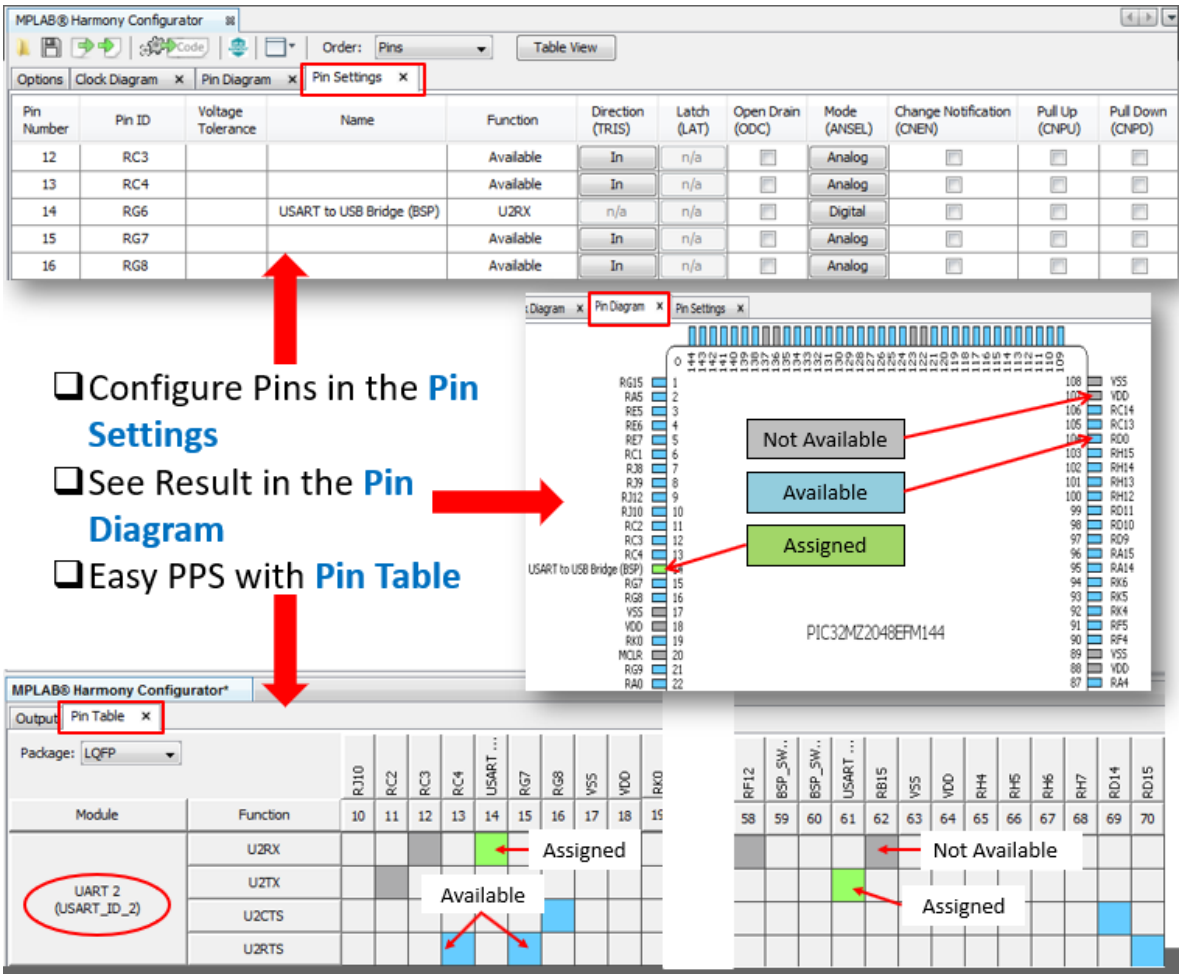
lines - U2RX pin-to-pin 14 and the U2TX pin-to-pin 61. This will also map the USART driver instance 0 to USART2.

Figure 1-6. Enable BSP Features



Verify the mapping of the UART lines by opening the Pin Table tab and scrolling down to the UART2 module, as shown in Figure 1-7. The Pin Manager consists of the Pin Settings, Pin Diagram and the Pin Table tabs and allows users to configure (assign peripheral function, set pin direction, configure pull-up/pull-down etc.,) and map the I/O pins, as shown in Figure 1-7.

Figure 1-7. Pin Manager - Pin Settings, Pin Diagram, and Pin Table Tabs

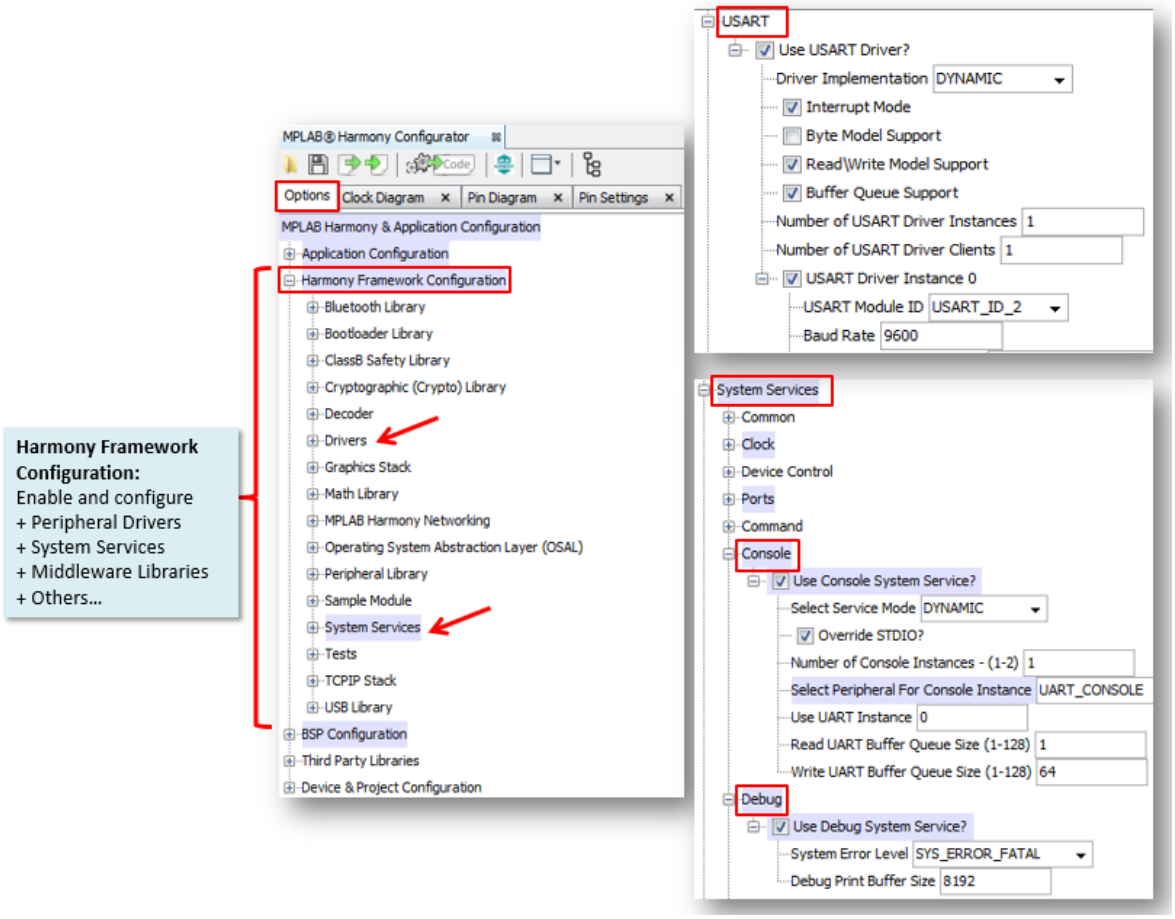


4. In MHC, expand *Options* > *Harmony Framework Configurator*. Peripheral drivers, system services and middleware libraries can be configured under this tree. Expand *System Services* > *Console*

and select the **Use Console System Service?** option. Expand the Use Console System Service? option and set the Select Peripheral For Console Instance to **UART_CONSOLE**, as shown in Figure 1-8. The Console System Service will use the UART instance 0.

5. In MHC, expand *Options* > *Harmony Framework Configurator* > *System Services* > *Debug* and select the **Use Debug System Service?** option, as shown in Figure 1-8. The Debug System Service is used to send formatted messages to the console.

Figure 1-8. Harmony Framework Configuration

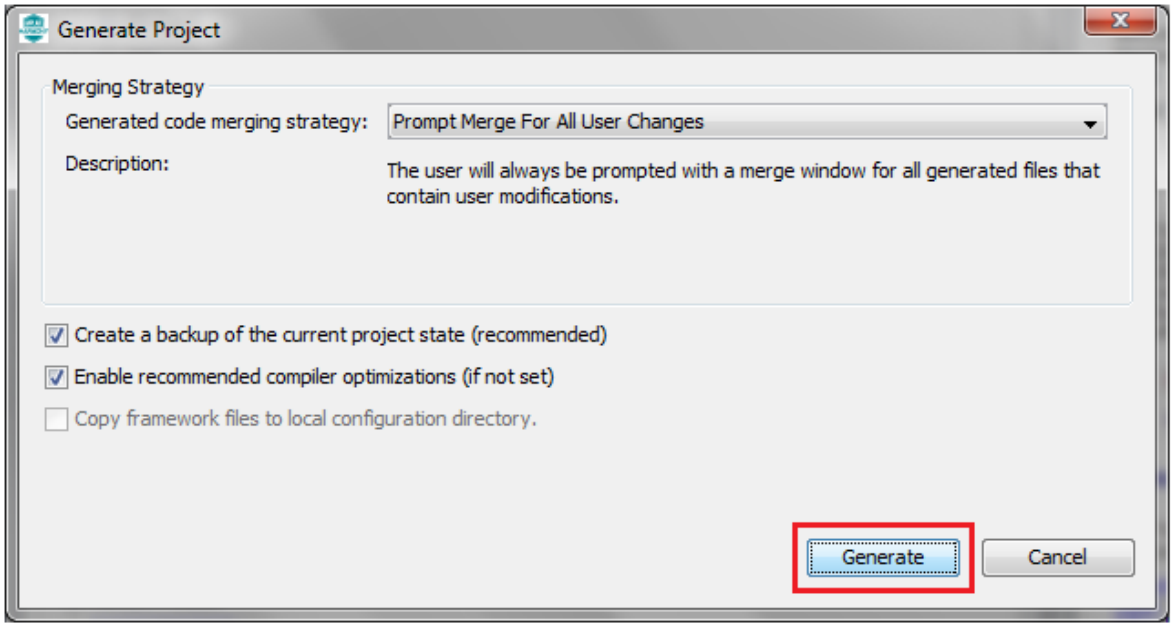


6. Expand *Options* > *Harmony Framework Configurator* > *Drivers* > *USART* and verify that the USART driver is automatically enabled by MHC because the Console System Service is configured to use USART, as shown in Figure 1-8. The USART Module ID for USART Driver Instance 0 is automatically set to USART_ID_2 because the BSP is configured to use the USART-to-USB Bridge. Also, notice that the USART driver is configured for 9600 baud, 8 data bits, no parity and 1 stop bit.

   Note: Support for third-party libraries, such as RTOS, Graphics, Cryptography, etc., is integrated in MHC under *Options* > *Third Party Libraries*. The Project configurations and fuse settings can be configured under *Options* > *Device & Project Configuration*.

7. Save the MHC configuration (), click Generate Code (), and then click **Generate**, as shown in Figure 1-9.

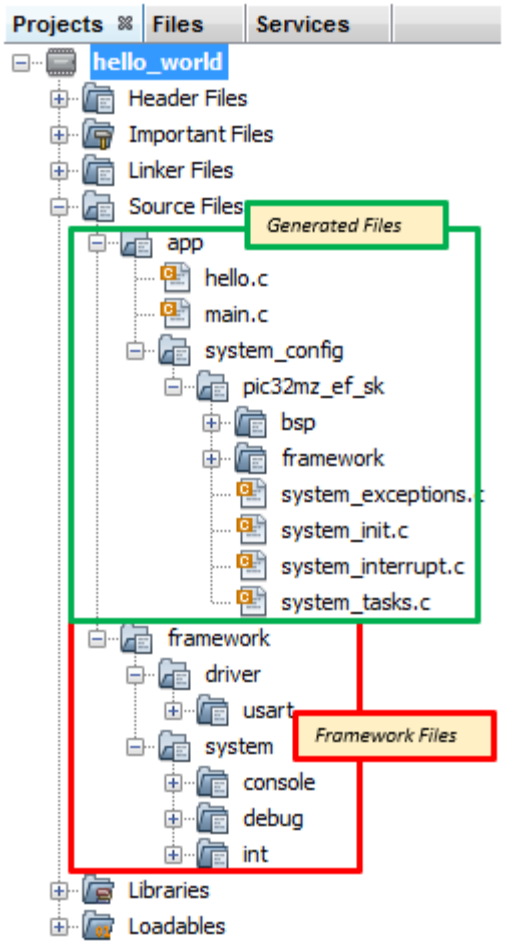
Figure 1-9. Generate Project



Step 3: Add Application Code and Test the Demonstration

Upon clicking **Generate**, MHC will include MPLAB Harmony library files for the modules enabled in MHC to your project, as shown in Figure 1-10.

Figure 1-10. Project Files

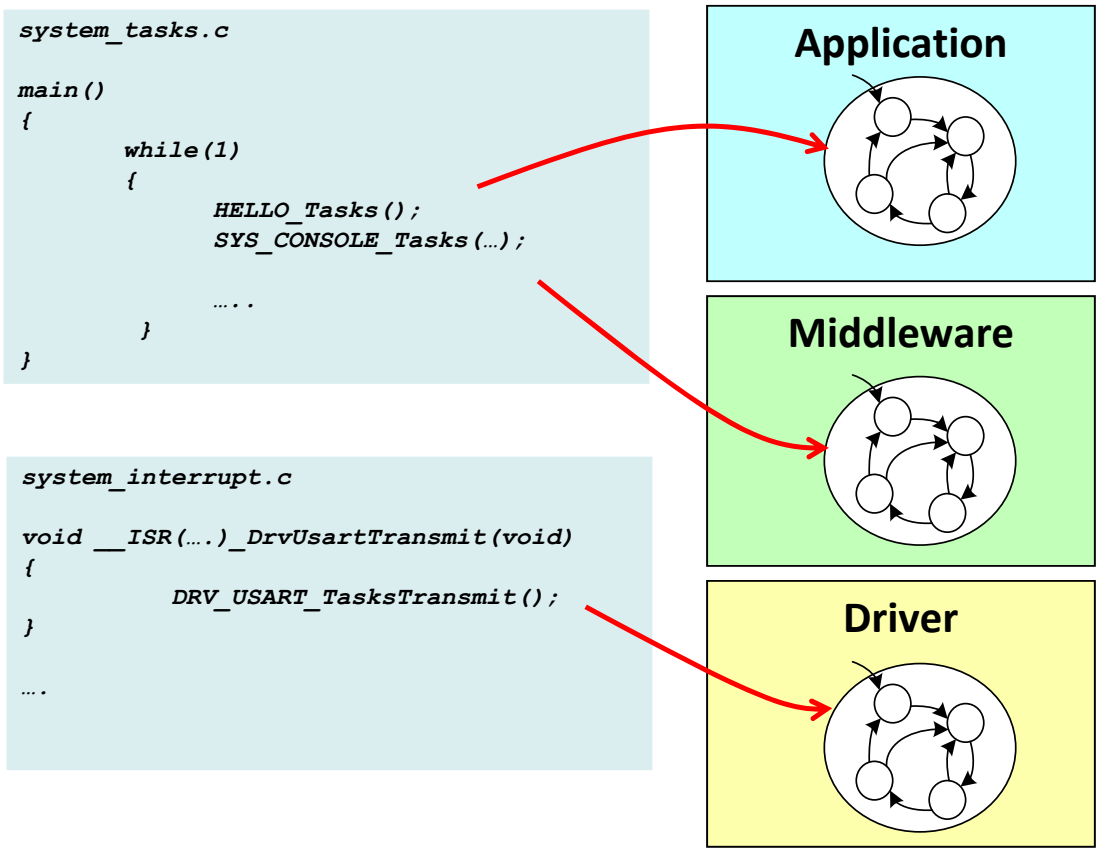


The files generated by MHC are located in the `firmware/src/system_config/pic32mz_ef_sk` folder and mainly consists of the following files:

- `system_config.h` – contains the configuration definitions based on MHC selection
- `system_init.c` – initializes the Harmony modules and calls the application initialization routine
- `system_tasks.c` – runs the Harmony library tasks and the application task routines in a *while (1)* loop
- `system_interrupts.c` – contains the interrupt service routines for the peripherals configured for interrupt mode of operation in MHC

In addition to this, it also includes the template application files `hello.h` and `hello.c`. The `hello.c` file contains an application initialization routine, which is called by the system to allow initialization of the user application and an application task routine that maintains the application state. The application task routine is called by the system in a `while(1)` loop (see Figure 1-11).

Figure 1-11. MPLAB Harmony Libraries and Application Tasks Execution



Users can extend this template state machine to add their application specific code.

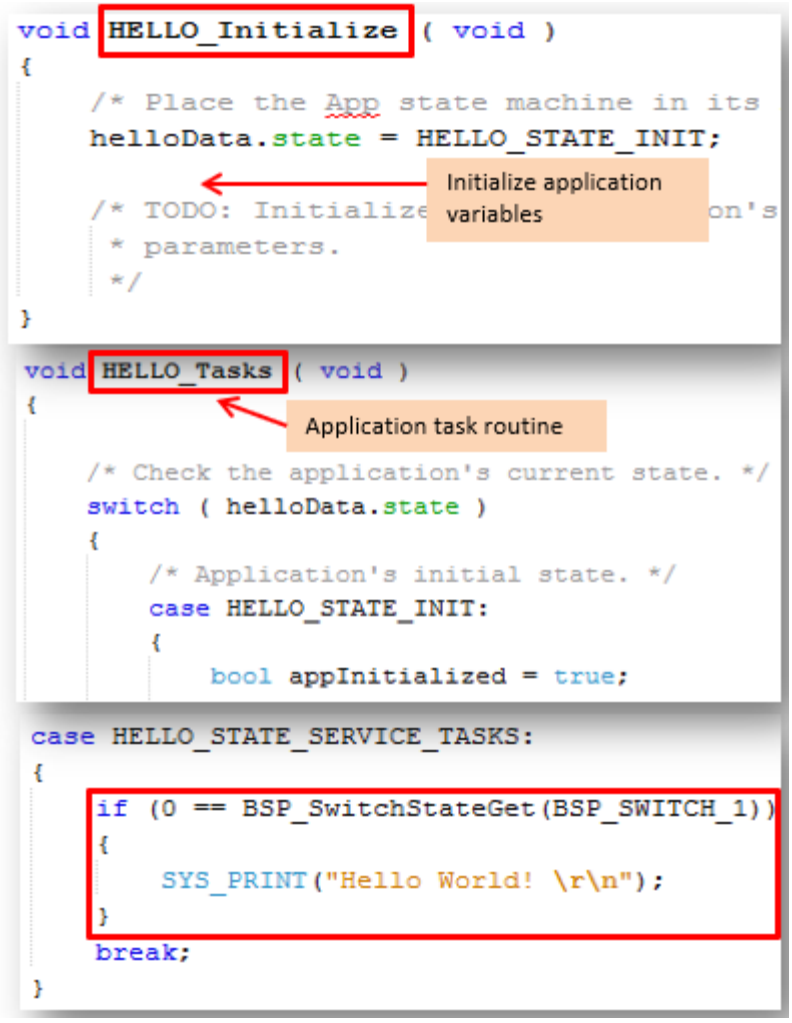
1. For this simple application, add the lines of code in the `HELLO_Tasks()` routine in the `hello.c` file, as highlighted in Figure 1-12. This will send the “Hello World!” string to the console running on the PC whenever the switch, SW1, is pressed.
2. Build and program the PIC32MZ EF Starter Kit by connecting a mini USB cable between port J3 on the board and the PC, as shown in Figure 1-13.
3. Connect a mini USB cable between port J11 on the board and the PC, as shown in Figure 1-13.
4. Open a terminal application (e.g., Tera Term) on the PC (configure: 9600, 8, N, 1) and observe the “Hello World!” string on the console whenever the switch SWI is pressed, as shown in Figure 1-14.

Getting the terminal application to identify the COM port belonging to the MCP2221A (either on-board or in a Breakout Module) can be a difficult and frustrating process. For example, there may be times when you cannot find the COM port. In these instances on a Windows PC, you can try the following:

1. In the Control Panel, select *System* > *Device Manager*.
2. Within Ports (COM & LPT), identify the COM port belonging to the MCP2221A. Double click this port to open its Properties window.
3. Select the Driver tab and disable, and then enable the driver.
4. Close the window. This should allow your HyperTerminal to see the port.

Note: In a worst case situation, use an oscilloscope to ensure that the USART TX signal is getting to the MCP2221A and that the USB data lines are working.

Figure 1-12. Application Initialization and State Machine




```
void HELLO_Initialize ( void )
{
    /* Place the App state machine in its
    helloData.state = HELLO_STATE_INIT;

    /* TODO: Initialize                on's
     * parameters.
     */
}

void HELLO_Tasks ( void )
{
    /* Check the application's current state. */
    switch ( helloData.state )
    {
        /* Application's initial state. */
        case HELLO_STATE_INIT:
        {
            bool appInitialized = true;

case HELLO_STATE_SERVICE_TASKS:
{
    if (0 == BSP_SwitchStateGet(BSP_SWITCH_1))
    {
        SYS_PRINT("Hello World! \r\n");
    }
    break;
}
```

Figure 1-13. Hardware Setup

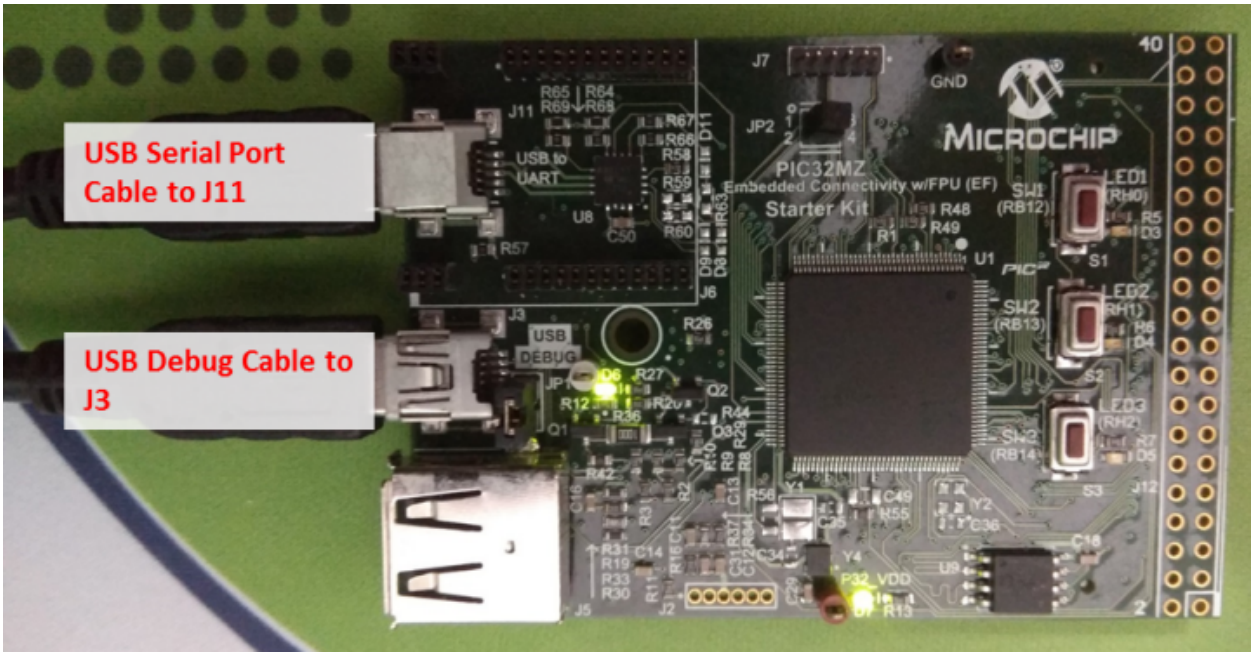


Figure 1-14. "Hello World!" String Output

Tip: MHC provides an option to generate a stand-alone project (*Options* > *Device & Project Configuration* > *Project Configuration* > *Generate Standalone Project?*), whereby all of the MPLAB Harmony library files referred by your project will be copied to the project folder. This project can then be compiled from any path in your system.

2. References

For additional information on MHC and MPLAB Harmony, download the MPLAB Harmony Integrated Software Framework from the Microchip web site: http://www.microchip.com/mplab/mplab-harmony.

Detailed documentation on various MHC options and windows is included in your installation of MPLAB Harmony within the `<harmony-install-path>/doc/` folder. PDF, Compiled HTML (.CHM), and HTML Help formats are available.

Additional resources include:

- Microchip Developer Help http://microchipdeveloper.com/harmony:mhc-overview
- Video Tutorials on MHC http://microchipdeveloper.com/harmony:mhc-videos
- PIC32MZ EF Starter Kit www.microchip.com/PIC32MZEFStarterKit4233990
- *PIC32MZ Embedded Connectivity with Floating Point Unit (EF) Starter Kit User's Guide* (DS70005230)

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