TB3259

Creating a Hello World Application on PIC32 Microcontrollers Using the MPLAB Harmony v3's MPLAB Harmony Configurator (MHC)

Introduction

MPLAB® Harmony v3 is a software framework consisting of compatible and interoperable modules that include peripheral libraries (PLIBs), drivers, system services, middleware 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 modules. The MHC is a plug-in for the MPLAB X Integrated Development Environment (IDE).

This document describes how to create an application on a 32-bit PIC32 microcontroller (MCU) using MHC with MPLAB Harmony v3 modules. This application sends a "Hello World!" string to a console running on a computer. For this demonstration, the following MPLAB Harmony v3 modules are used and configured using the MHC:

- Clock PLIB using the Clock manager to configure the microcontroller clock
- GPIO PLIB using the Pin manager to configure the microcontroller I/Os
- UART PLIB to configure UART peripheral as serial port

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1. Creating a "Hello World" Application

This document describes how to create a "Hello World" application on PIC32 devices using the MPLAB Harmony v3 MHC tool. It also covers the process which is shown in the following sections. The following software and hardware tools are used for this demonstration:

- MPLABX IDE v5.30
- MHC 3 MPLAB Plug-in v3.4.0
- XC32 v2.30
- MPLAB Harmony v3 repositories:
  - csp v3.5.2
  - mhc v3.3.3
  - dev_packs v3.5.0
- Curiosity PIC32MZ EF 2.0 Development Board

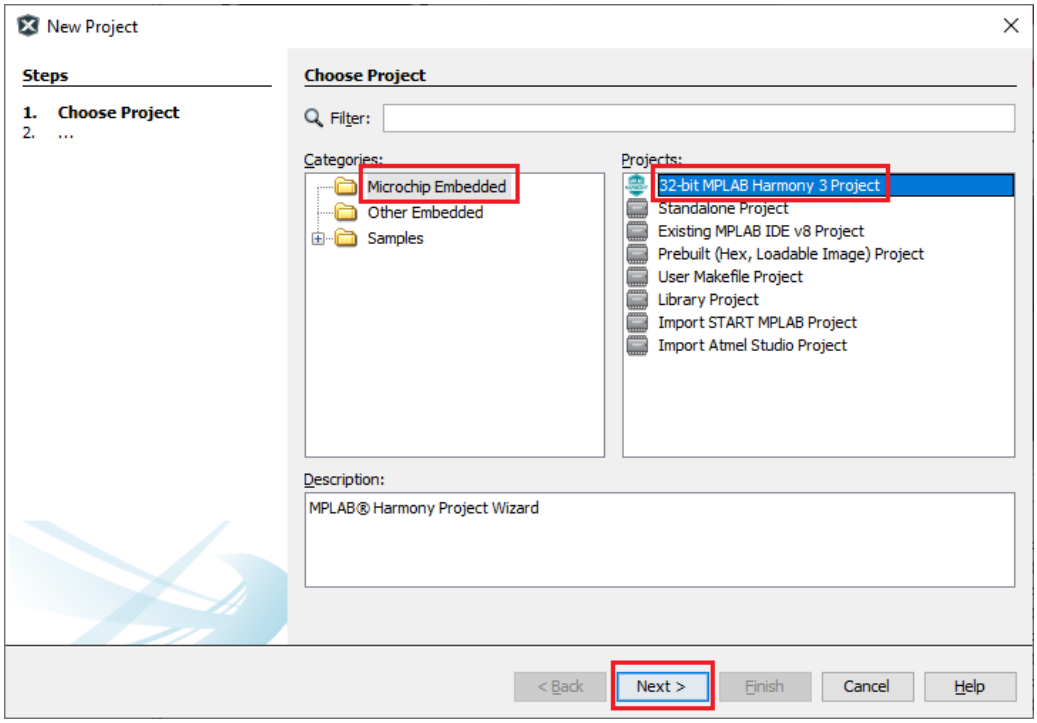
Note: Updated versions of the above listed tools can also be used to create the applications, and users are not restricted to use the older versions.

1.1 Creating an MPLAB Harmony v3-based Project

To create an MPLAB Harmony v3-based project, follow these steps:

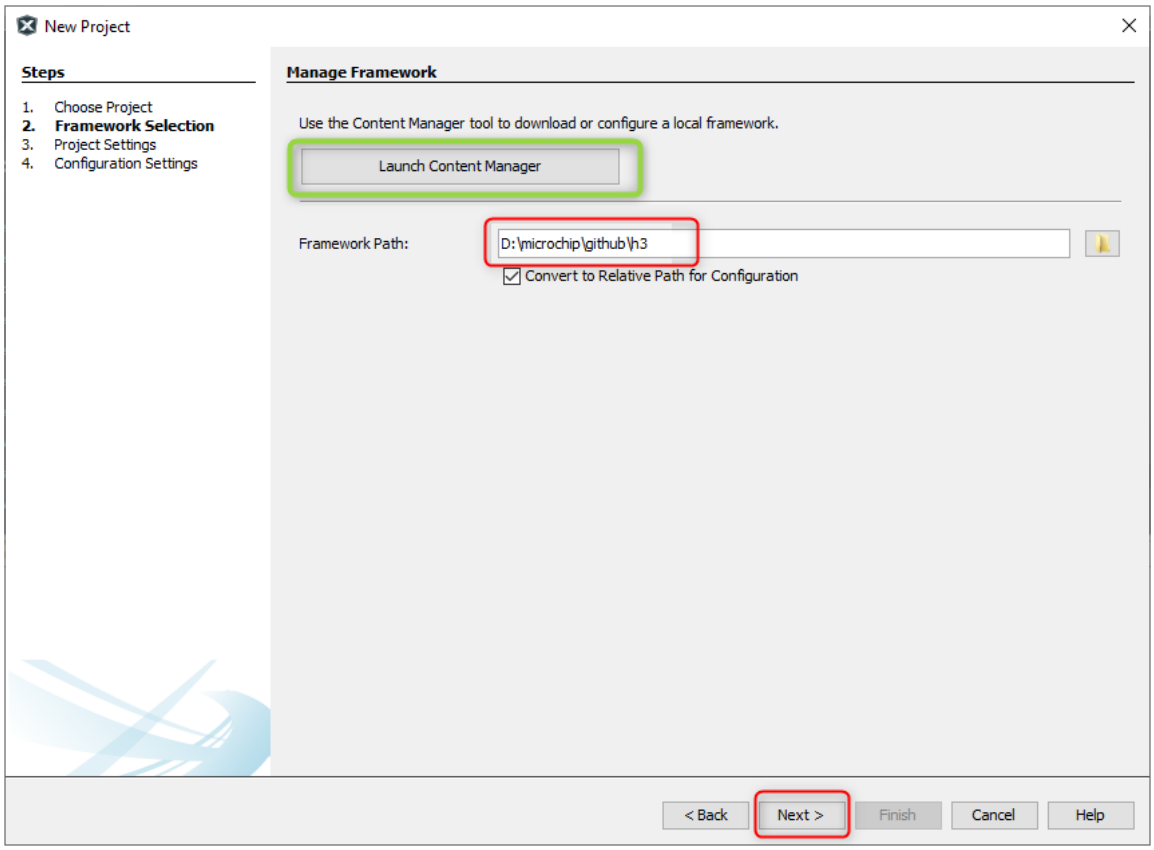
1. Launch MPLAB X IDE.
2. In MPLAB X IDE, select *File* > *New Project* (or click the New Project icon).
3. In the **New Project** dialog window, select **Microchip Embedded** in the **Categories** pane, and select **32-bit MPLAB Harmony 3 Project** in the **Projects** pane.
   - **Note**: If the option 32-bit MPLAB Harmony v3 project is not available, install the MPLAB Harmony v3 Configurator plug-in from *Tools* > *Plugins* > *Available Plugins* before continuing with this demonstration.
     Note: For more information, visit MPLAB® Harmony v3 Configurator Overview.

Figure 1-1. Creating an MPLAB Harmony v3-Based Project - Choose Project



4. Click **Next**.
5. Under **Framework Selection**, in the **Manage Framework** section, enter the **Framework Path** (Path to the folder in which the MPLAB Harmony v3 packages are downloaded). For this demonstration, the MPLAB Harmony v3 packages are downloaded in the following location: *D:\microchip\github\h3*.

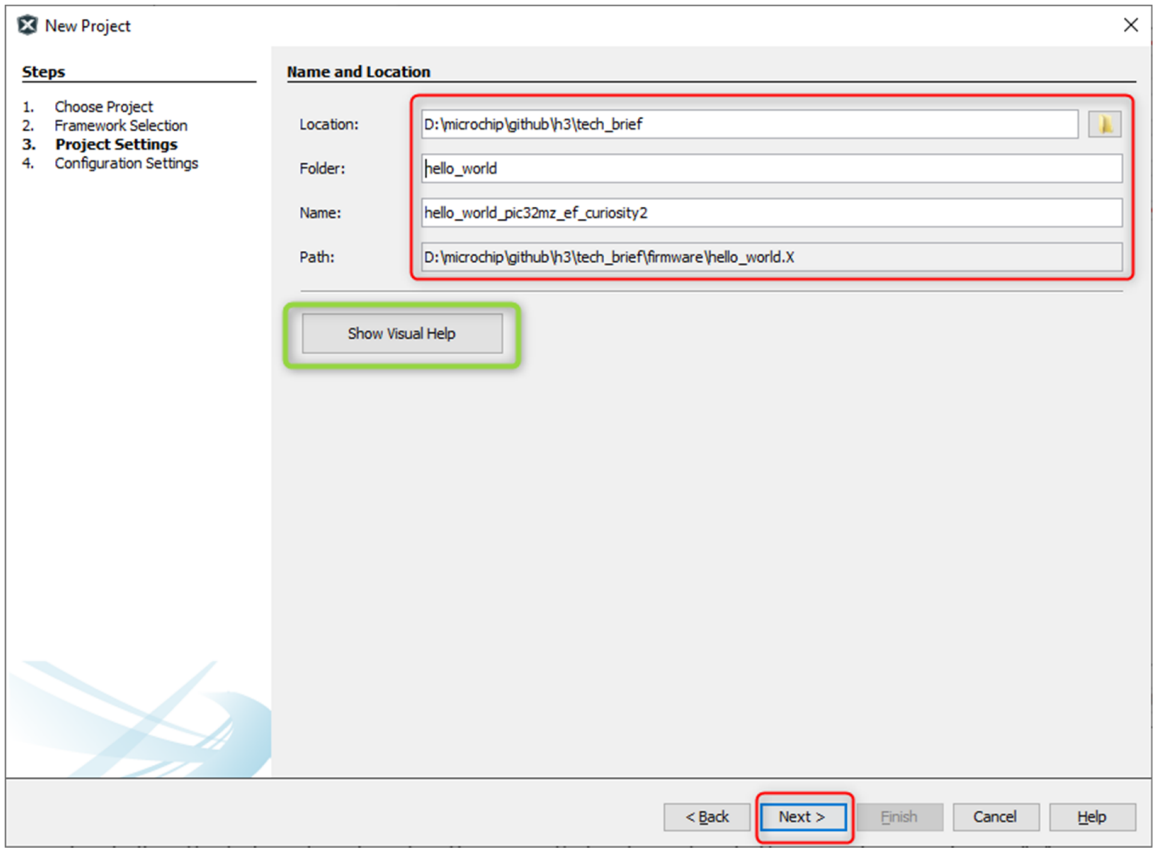
Figure 1-2. Creating MPLAB Harmony v3-Based Project - Framework Selection



Note: For this demonstration application, the following MPLAB Harmony v3 packages are required: mhc, dev_packs, and csp.
The MPLAB Harmony 3 Content Manager tool simplifies the downloading of the MPLAB Harmony v3 packages. If these packages are not downloaded, then the user can use the MPLAB Harmony v3 Content Manager tool to download them onto a computer.

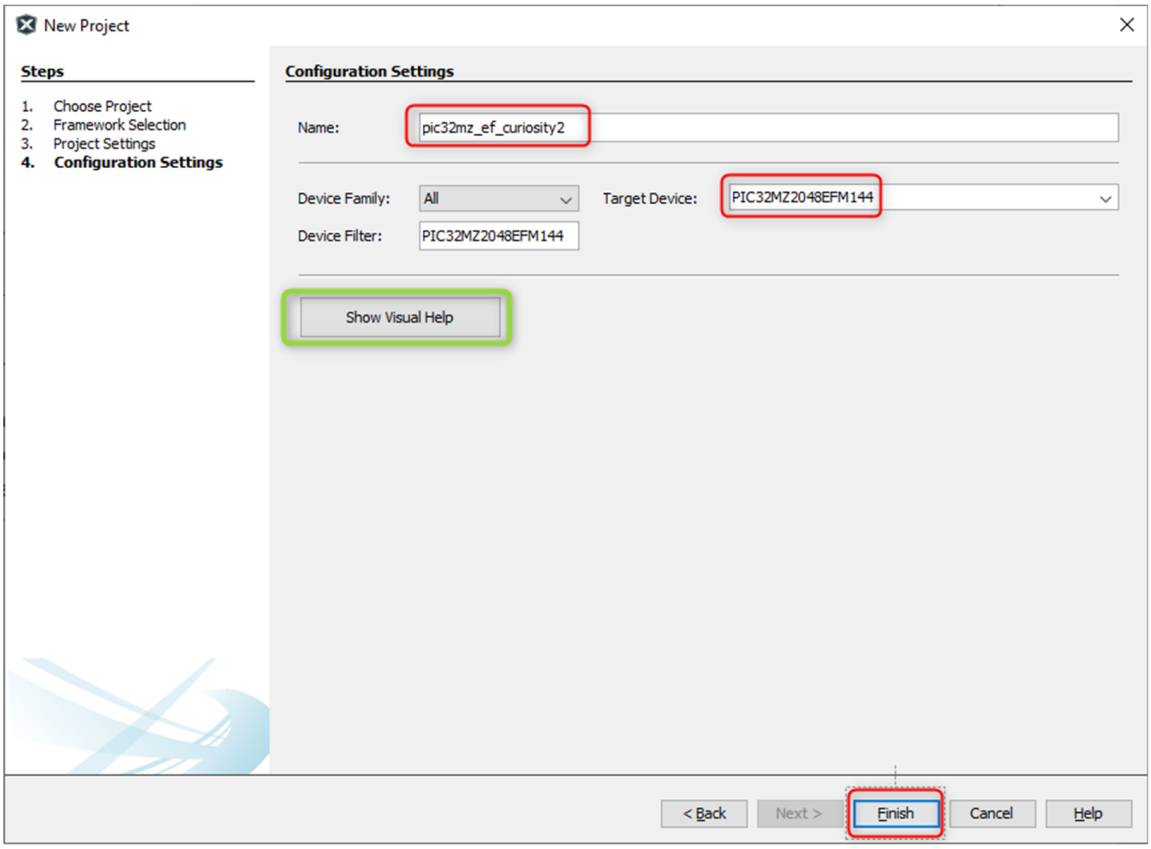
6. Click **Next**.
7. Under **Project Settings**, in the **Name and Location** section, enter these details:
   - Location: Indicates the path to the root folder of the new project. All project files will be placed inside this folder. The project location can be any valid path, for example: *D:\microchip\github\h3\tech_brief.*
   - Folder: Indicates the name of the MPLAB X IDE folder. Enter *hello_world* to create a `hello_world.X` folder.
   - Name: Enter name of the project as `hello_world_pic32mz_ef_curiosity2`. This name will be displayed in the MPLAB X IDE.
   - Path: The path information will be updated when users make changes to other fields

Figure 1-3. Creating an MPLAB Harmony v3-Based Project - Project Settings



8. Click **Next**.
9. Under the **Configuration Settings** section, enter the details as follows:
   - **Name**: Enter the configuration name as **pic32mz_ef_curiosity2**
   - **Target Device**: Choose **PIC32MZ2048EFM144**

Figure 1-4. Creating an MPLAB Harmony v3-Based Project - Configuration Settings



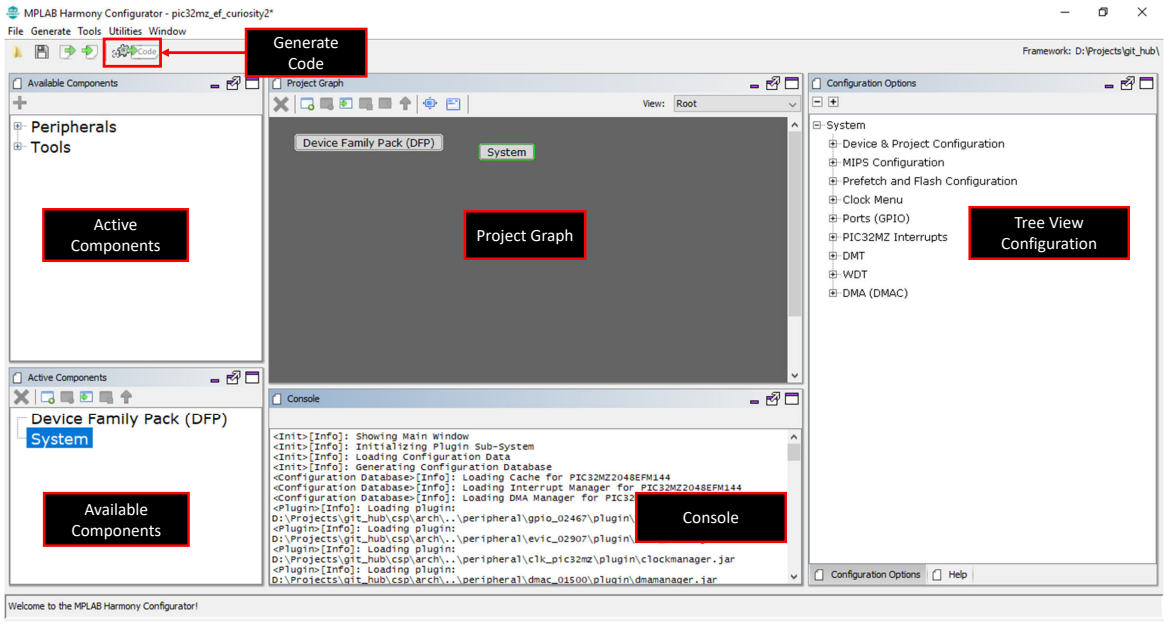
Note: : Clicking the **Show Visual Help** button will open a contextual help window for a detailed description of various fields in the Project Settings.

10. Click **Finish** to launch the MHC.
    Note: After clicking the **Finish** button, if the MHC does not launch, users can launch it by selecting *Tools >Embedded > MPLAB® Harmony 3 Configurator* from the MPLAB X IDE.
11. Before launching the MHC, the **Configuration Database Setup** dialogue will be displayed, where the Device Family Pack (DFP) path can be changed, if required. For this demonstration, the default settings are used.

Figure 1-5. Configuration Database Setup

12. Click **Launch**.
13. The MHC plug-in will open in a new window. The following figure highlights the different sections available in the MHC.

Figure 1-6. MPLAB Harmony v3 Configurator Window



Note: For this demonstration, Standalone mode is used for the MHC Window Manager by changing the settings in the MPLAB X IDE, by selecting *Tools* > *Options* > *Plugins* > *MPLAB Harmony Configurator3* >*Window Manager*. If the Native Netbeans mode of the MHC is required, users can set it as default mode by configuring it.

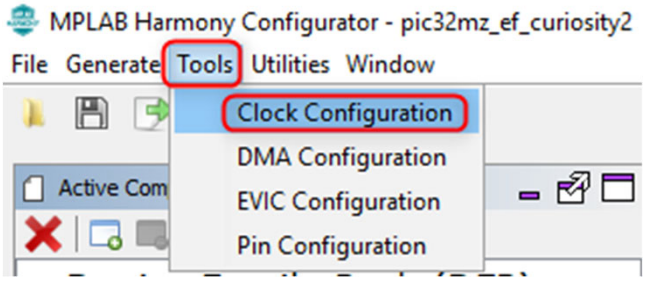
14. For additional information on the MHC and how to create MPLAB Harmony v3 project, visit: MPLAB® Harmony v3 Configurator Overview.

1.2 Adding and configuring the MPLAB Harmony components

To add and configure the MPLAB Harmony components using the MHC, follow these steps:

1. From **Tools**, select **Clock Configuration** to launch the Clock Easy View.

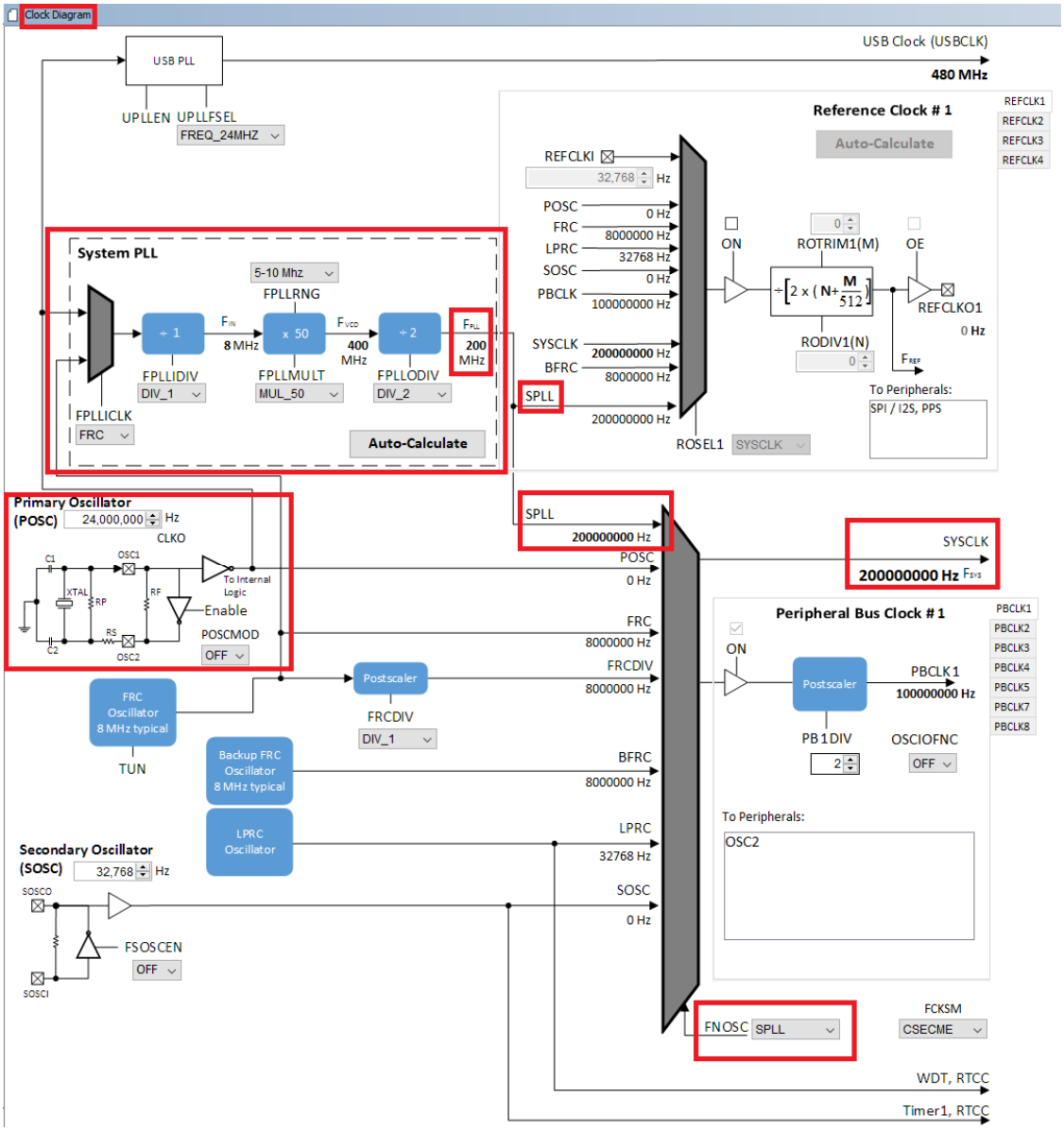
Figure 1-7. MPLAB Harmony Configurator Tools



The Clock Easy View window will be displayed inside the MHC Window.

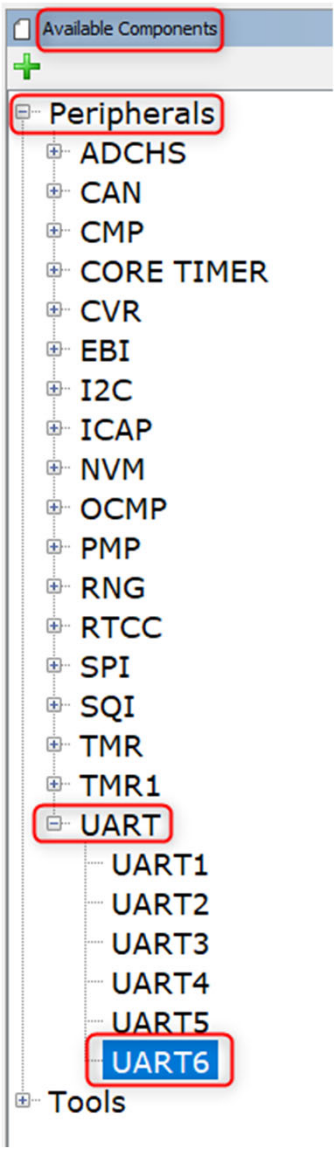
2. In the Clock Easy View window, scroll to the right and verify that the SYSCLK is set to 200 MHz.

Figure 1-8. MPLAB Harmony 3 Clock Configurator - Clock Easy View



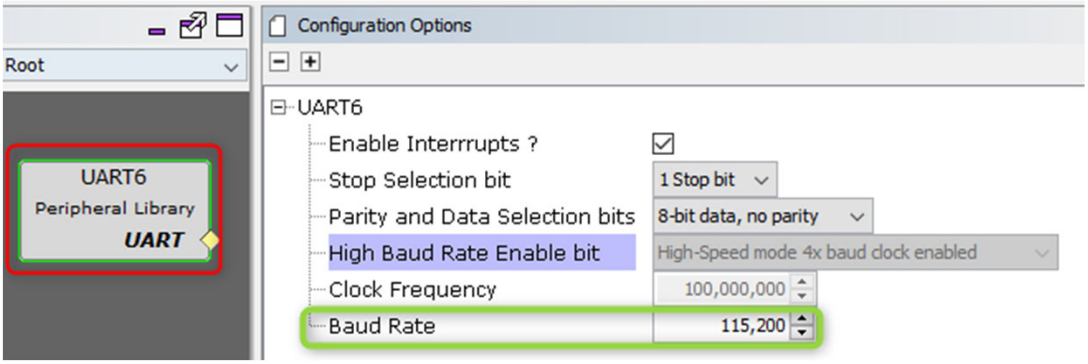
3. To add and configure the UART Peripheral Library follow these steps:
   - Under **Available Components**, expand **Peripherals** and then expand the options available for the **UART**.
   - Double-click on **UART6** to add it to the project graph.

Figure 1-9. MHC Available Components



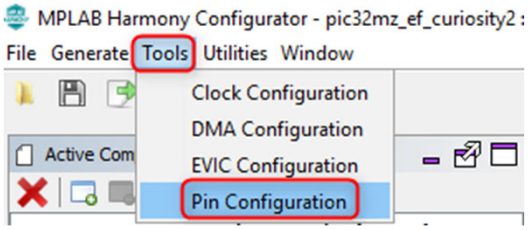
4. Select the **UART6** Peripheral Library in the **Project Graph**, and in the **Configuration Options window**. Configure it as follows:
   – Verify that the default baud rate is set to **115,200**

Figure 1-10. MHC UART Configuration



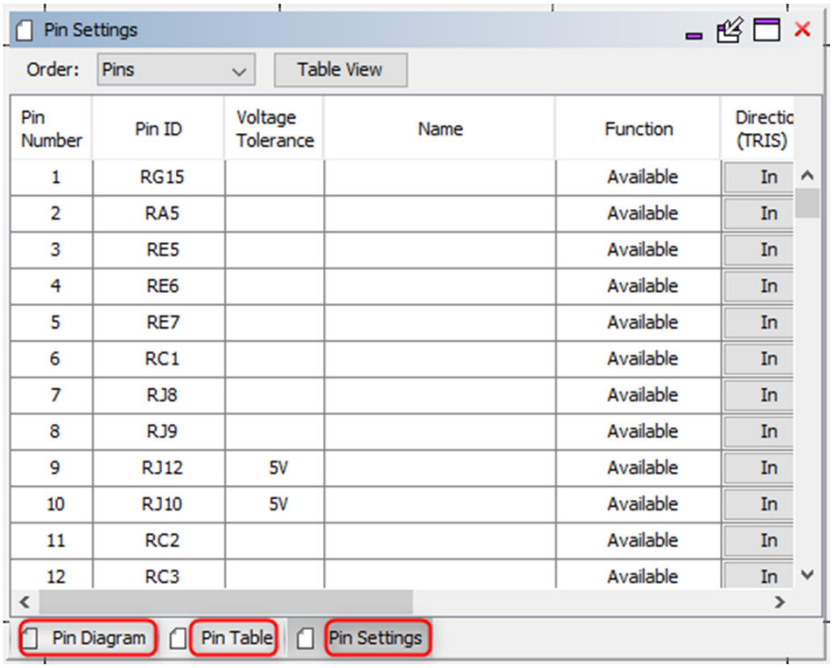
5. Configure the UART pins in the Pin Settings window. In the MHC, select *Tools* > *Pin Configuration* to open the **Pin Settings** window.

Figure 1-11. MHC Pin Configuration



6. The MHC Pin Settings window will open and display these options: Pin Diagram, Pin Table, and Pin Settings.

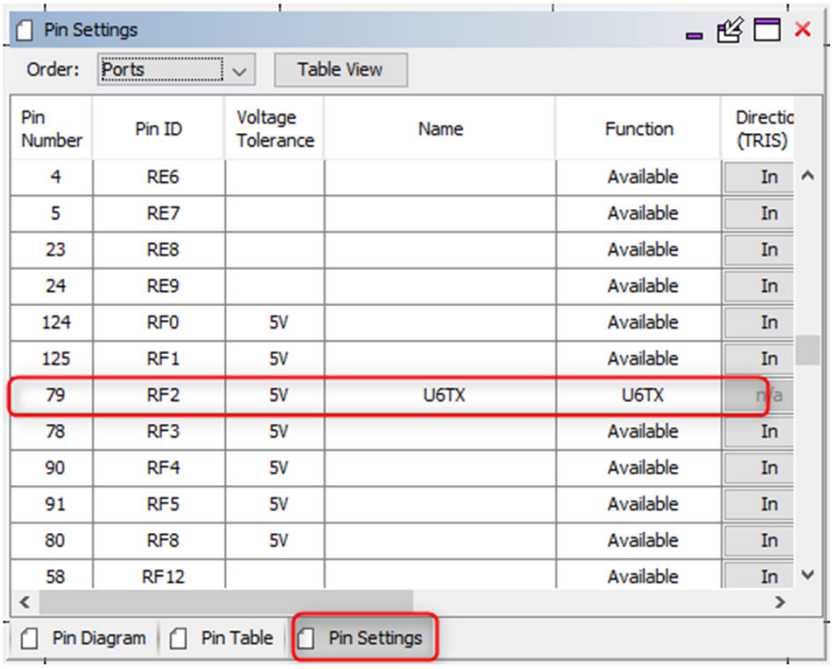
Figure 1-12. MHC Pin Settings



Note: According to schematic of the Curiosity PIC32MZ EF 2.0 Development Board, the PICkit™ On Board 4 (PKOB4) can be used as Virtual Com Port to have serial communication between PIC32MZ EF device and connected computer console. For that, RF2 (Pin #79) of the PIC32MZ EF must be configured as U6TX.

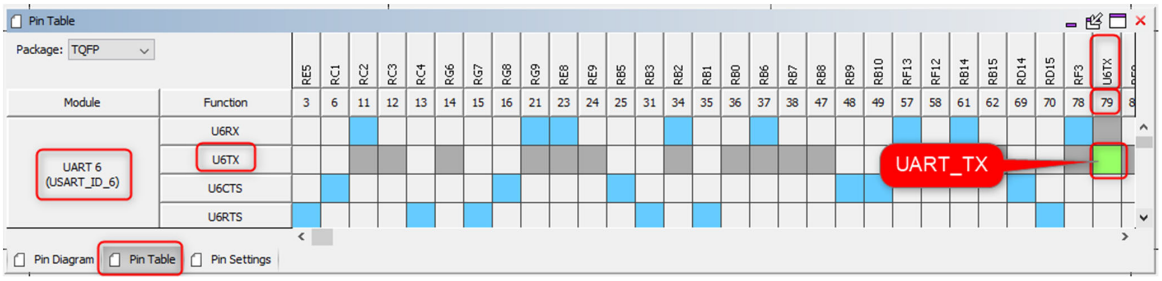
7. Click the **Pin Settings** tab and configure the RF2 pin as U6TX.

Figure 1-13. UART Pin Settings



8. The same pin (RF2) can be configured by clicking the **Pin Table** tab.

Figure 1-14. UART Pin Table



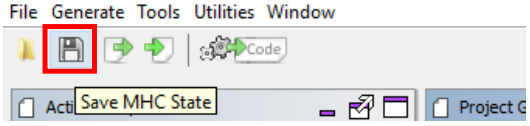
Note: The demonstration will use the UART PLIB for printing messages on the serial terminal. Therefore, in the UART6 configuration, only the transmit pin is configured and the receive pin is not configured.

1.3 Generating the Code

To generate the code, use the following steps:

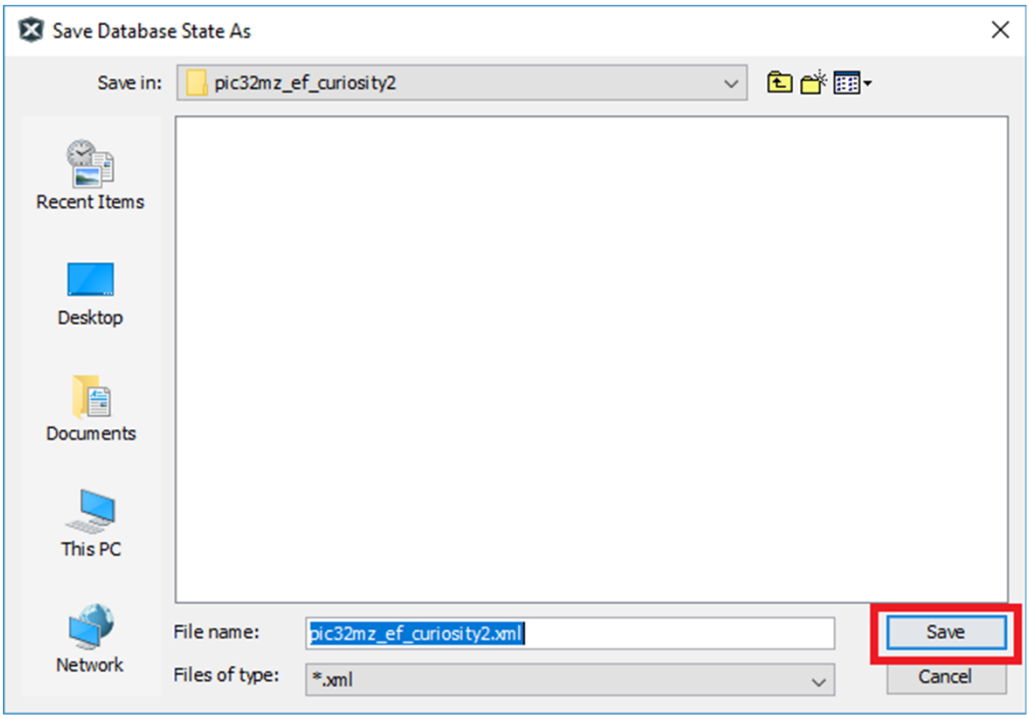
1. In the MHC, click on the **Save MHC State** icon to save the MHC state before generating the code.

Figure 1-15. Save MHC State



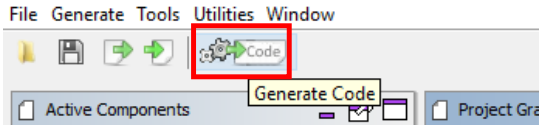
2. Save the configuration in its default location, when prompted.

Figure 1-16. Save Configuration at Default Path



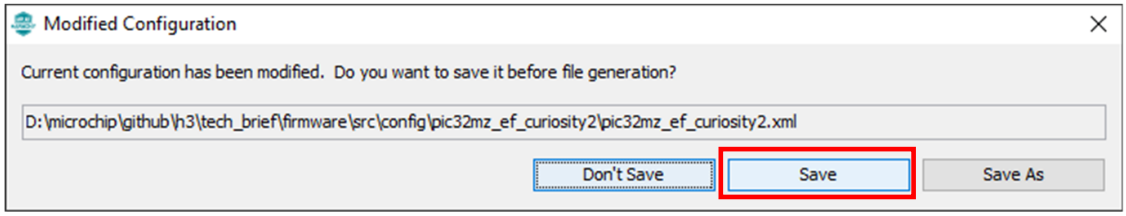
3. Click on the **Generate Code** icon to generate the code.

Figure 1-17. MHC Generate Code



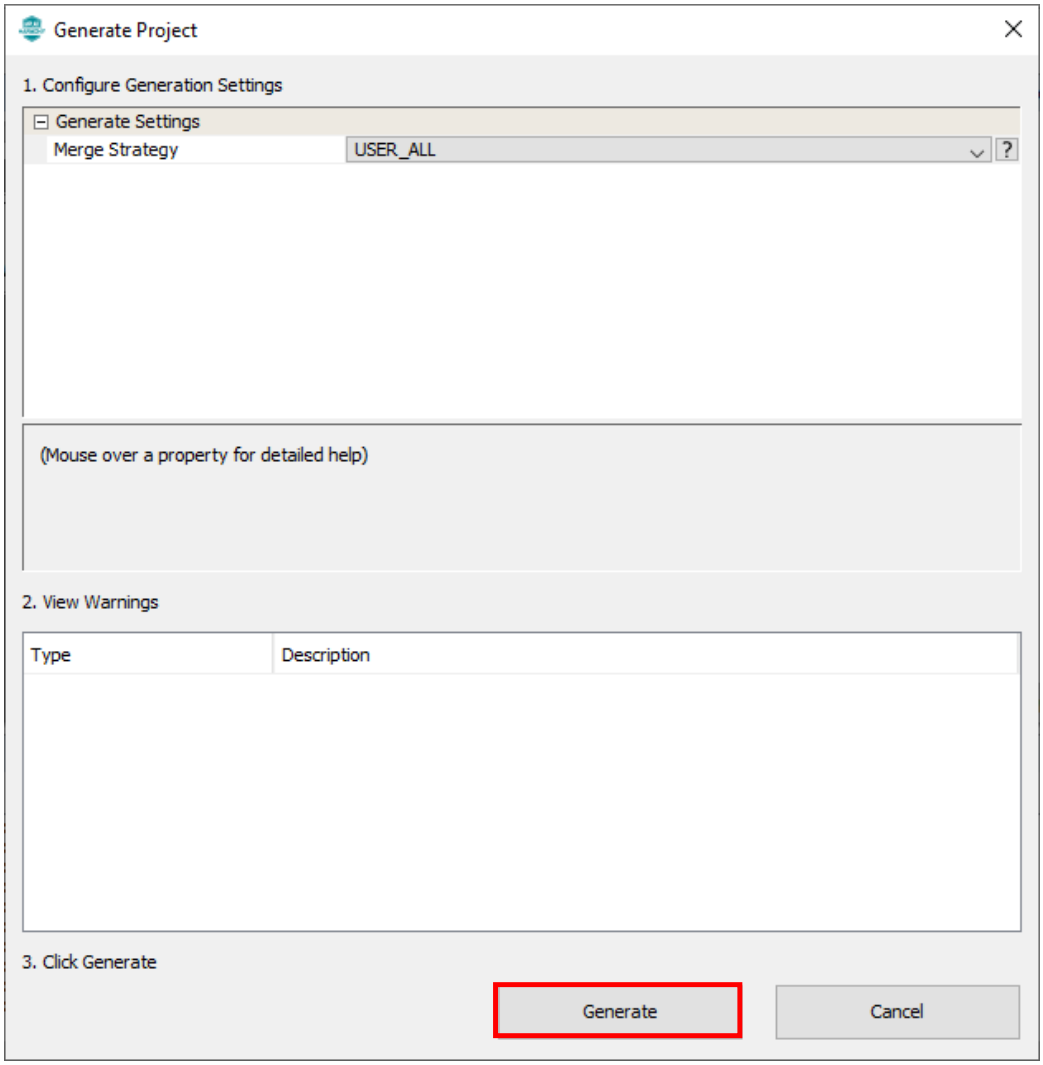
4. The Modified Configuration dialogue is prompted, click **Save** to save the configuration.

Figure 1-18. Saving Configuration



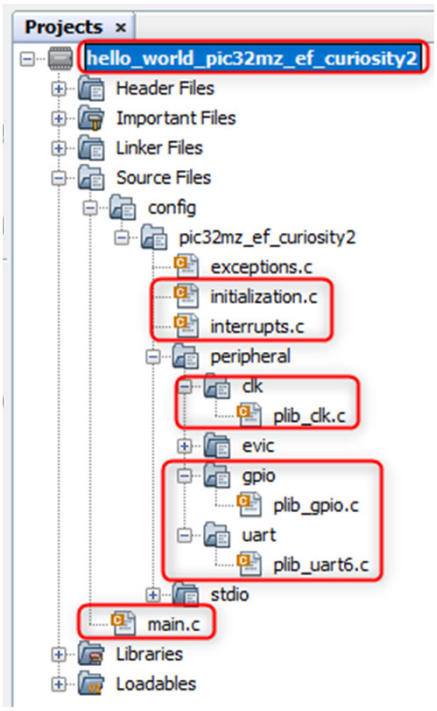
5. In the Generate Project window, click **Generate** to generate the code.

Figure 1-19. Generating the Code



6. The previous step triggers these actions in the MHC:
   - Generates the code per the user configurations
   - Place the generated code and required Harmony framework files in the MPLAB Harmony project directory, in this case: *D:\microchip\github\h3\tech_brief\firmware\src*
   - Add all generated codes and MPLAB Harmony framework files into the MPLAB Harmony project, as shown in the following figure.

Figure 1-20. MHC Generated Code

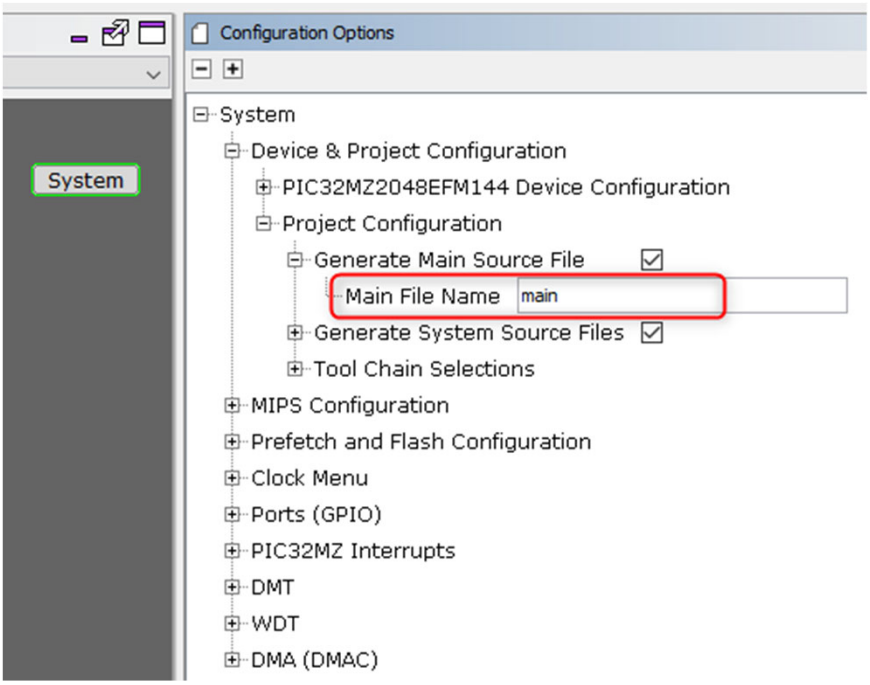


Note: The MPLAB Harmony project will be shown in another window as this project is in Standalone mode.

7. The generated code descriptions are as follows:
   - `definitions.h`: Includes all the header file definitions needed for the project
   - `initialization.c`: Initializes all the Harmony modules which are used in the application
   - `interrupts.c`: Contains the mapping of all the interrupt vectors on the selected device
   - `main.c`: A function call to initialize the system is present in this file. The user needs to develop their application in this file.
   - `peripheral`: All peripheral source codes are added in this folder

Note: The MHC provides an option to change the generated file name, and if this option is not used, by default, the file name `main.c` is generated.

Figure 1-21. MHC System Configuration



1.4 Developing and Running an Application

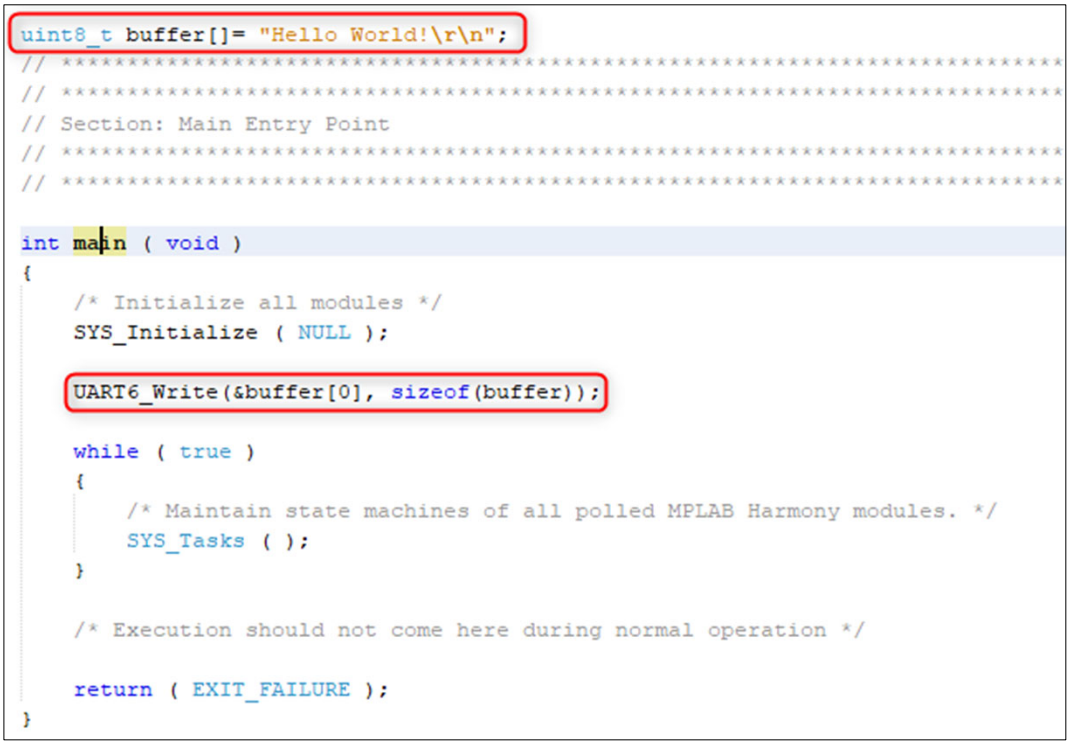
To develop and run an application, follow these steps:

1. Developing an Application: For this demonstration application, add the highlighted codes (as shown below) in the *main.c* file. This will send the “Hello World!” string to the console running on the PC.
   The following code is provided for convenience:

```
uint8_t buffer[]= "Hello World!\r\n";
```

```
UART6_Write(&buffer[0], sizeof(buffer));
```

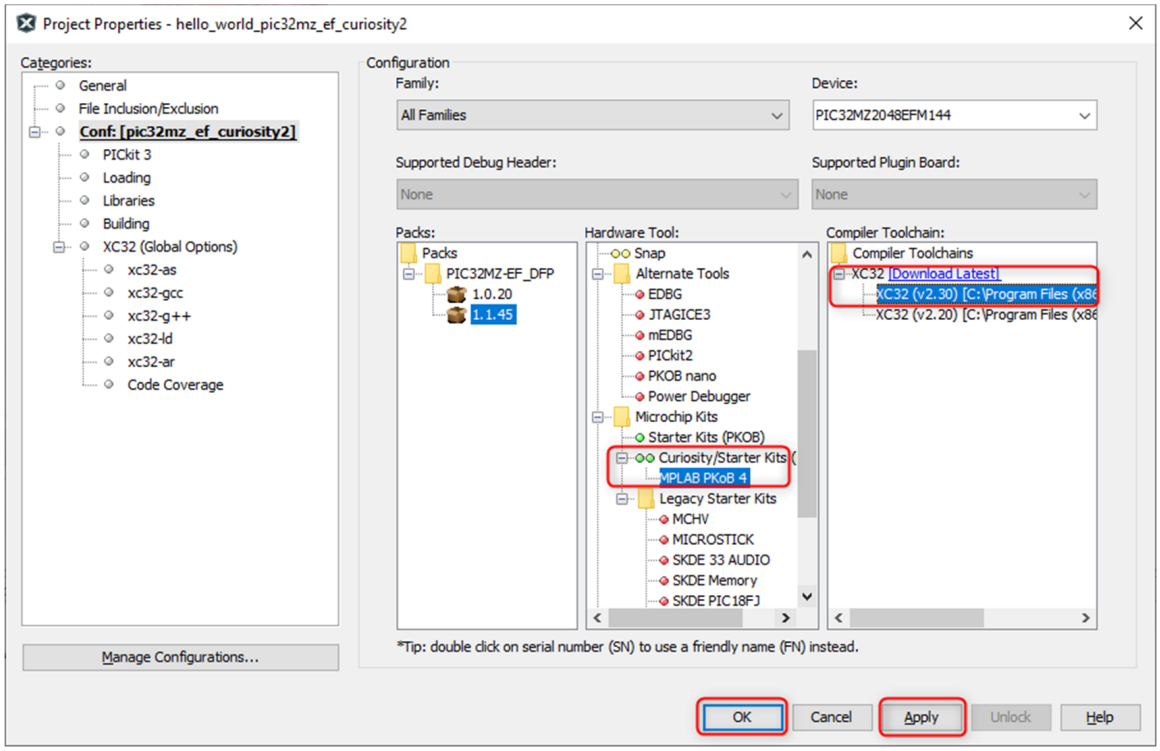
Figure 1-22. Developing Application



```
uint8_t buffer[]= "Hello World!\r\n";
// *****************************************************************************
// *****************************************************************************
// Section: Main Entry Point
// *****************************************************************************
// *****************************************************************************

int main ( void )
{
    /* Initialize all modules */
    SYS_Initialize ( NULL );

    UART6_Write(&buffer[0], sizeof(buffer));

    while ( true )
    {
        /* Maintain state machines of all polled MPLAB Harmony modules. */
        SYS_Tasks ( );
    }

    /* Execution should not come here during normal operation */

    return ( EXIT_FAILURE );
}
```

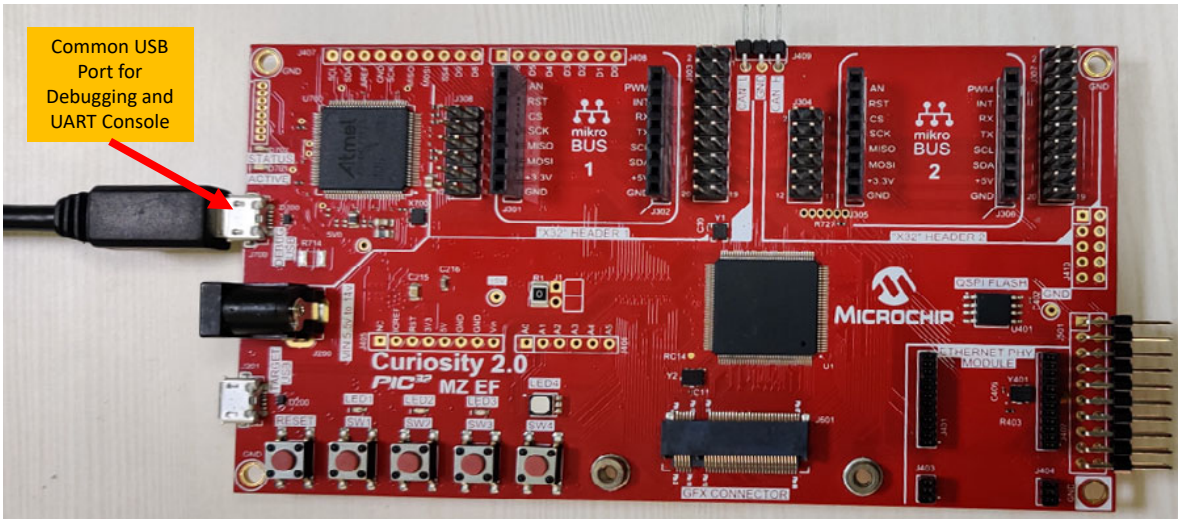
2. Selecting Hardware Tool and Compiler:
   - In the MPLAB X IDE **Project Properties** window perform these actions.
   - Under **Categories** section, select the configuration, **pic32mz_ef_curiosity2**), and in the Configuration section, select the hardware tool and compiler toolchain.

Figure 1-23. MPLAB IDE Project Properties



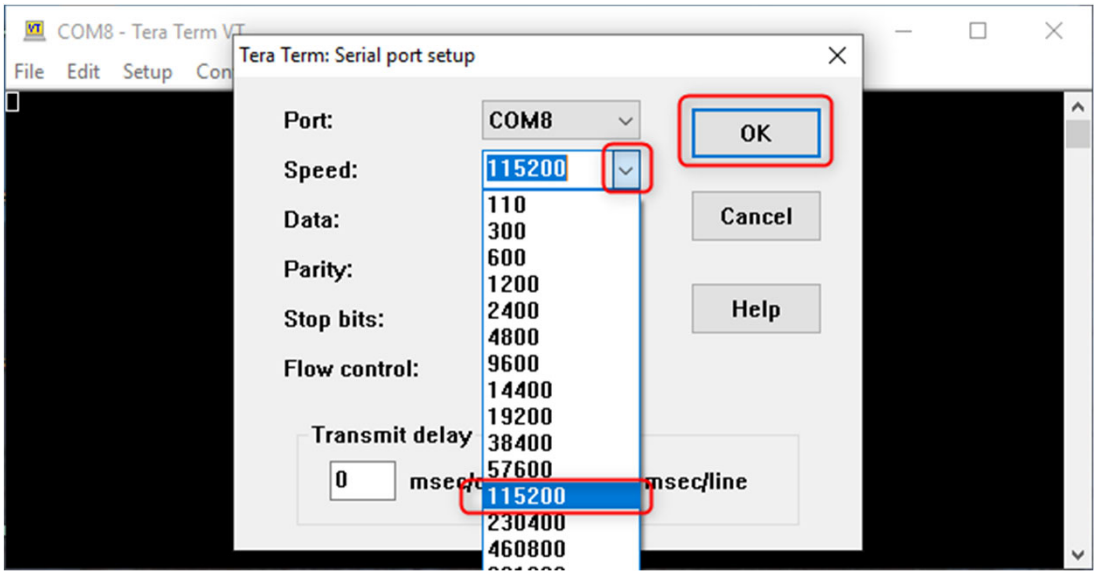
3. Click **Apply**, and then click **OK**.
4. Connecting Hardware: Connect a micro-USB cable between the DEBUG USB on the board and the PC. This enables the programming of the microcontroller and provides a serial connection with the console device (computer).

Figure 1-24. Hardware Connection



5. Setting up the Serial Console: Open a terminal application, such as Tera Term on the PC and perform the serial port setup. The following figure shows the setup details for Tera Term.

Figure 1-25. Serial Port Setup

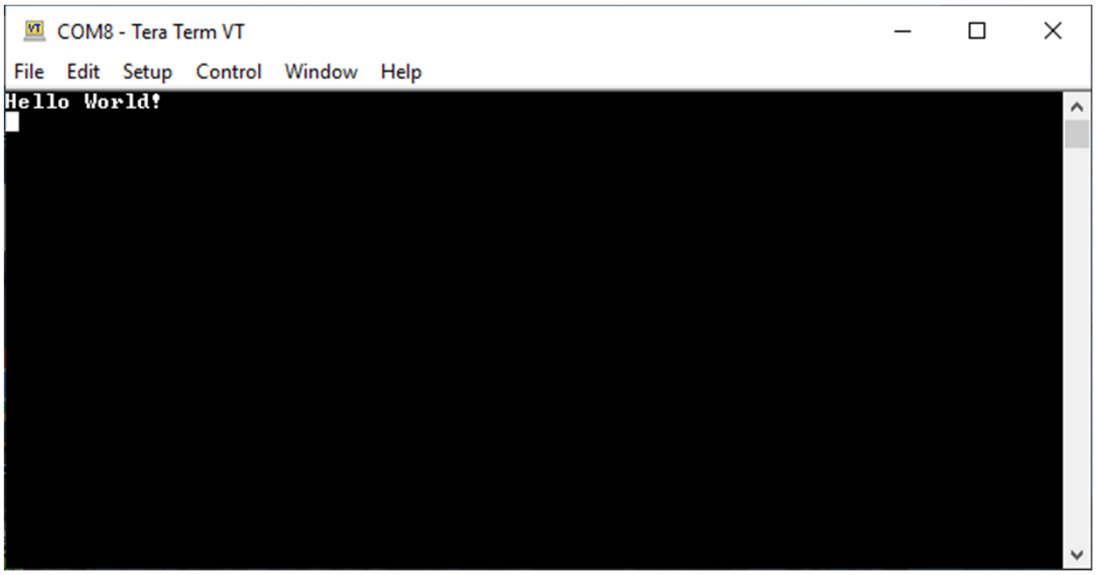


6. Programing and Running the Application: Build and program the Curiosity PIC32MZ EF 2.0 Development Board by using the MPLAB X IDE (Click on **Make and Program** in the MPLAX IDE Tool bar).

Figure 1-26. Make and Program

7. Observing the Output: Observe the “Hello World!” string on the console. If the desired output is not found on the console, press the **Reset** button on the Curiosity Development board to reset the device, and ensure that the UART message is communicated.

Figure 1-27. Observing Output



2. References

- For additional information on MPLAB Harmony v3, go to the Microchip web site: https://www.microchip.com/mplab/mplab-harmony
  And

  https://microchipdeveloper.com/harmony3:start
- Detailed documentation on various MPLAB Harmony v3 components can be found in the “doc” folder of the corresponding repository
- Curiosity PIC32MZ EF 2.0 Development Board details can be found here: https://www.microchip.com/DevelopmentTools/ProductDetails/DM320209

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