User's Guide

Interfacing the MikroElektronika Weather Click Board™ with the PIC18F25K42

Preface

Important: Notice to customers:
All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our website (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXXA”, where “XXXXX” is the document number and “A” is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics to open a list of available online help files.

Introduction
This document describes how to use the device as a development tool to emulate and debug firmware on a target board, as well as how to program devices.

The MikroElektronika Weather Click module contains the Bosch BME280 Environmental Sensor that is used to detect humidity, barometric pressure, and temperature. This user's guide explains how to connect the Weather Click to the PIC18F25K42 microcontroller, send and receive commands and raw weather data, and convert the data into a usable format.

Recommended Reading
For the latest information on using the device, read the “`Readme for Device #.htm`” file (an HTML file) in the Readmes subdirectory of the MPLAB® IDE installation directory. The release notes (Readme) contain update information and known issues that may not be included in this user’s guide.

Hardware/Software Requirements

This demonstration uses the following hardware and software components:

Hardware:

- Curiosity High Pin Count (HPC) Development Board (DM164136)
- PIC18F25K42 Microcontroller (PIC18F25K42-I/SP)

- MikroElektronika Weather Click Board™ (MIKROE-1978)
- MCP2200 USB-to-UART Breakout Module (ADM00393)
- USB Micro-B 5-pin cable (Curiosity to PC for programming/USB power)
- USB Mini-B 5-pin cable (MCP2200 to PC for displaying data)
- Jumper wires

Software:

- MPLABX® IDE v4.15 or higher
- XC8 Compiler v1.45 or higher
- Tera Term or equivalent PC terminal program

Other Relevant Documents:

- Bosch *"BME280 Combined Humidity and Pressure Sensor"* Data Sheet
- *"PIC18(L)F24/25K42 28-Pin, Low-Power High-Performance Microcontrollers with XLP Technology"* Data Sheet (DS40001869)
- *TB3192, "Using the SPI module on 8-bit PIC® Microcontrollers"* Technical Brief (90003192)

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1. Application Overview

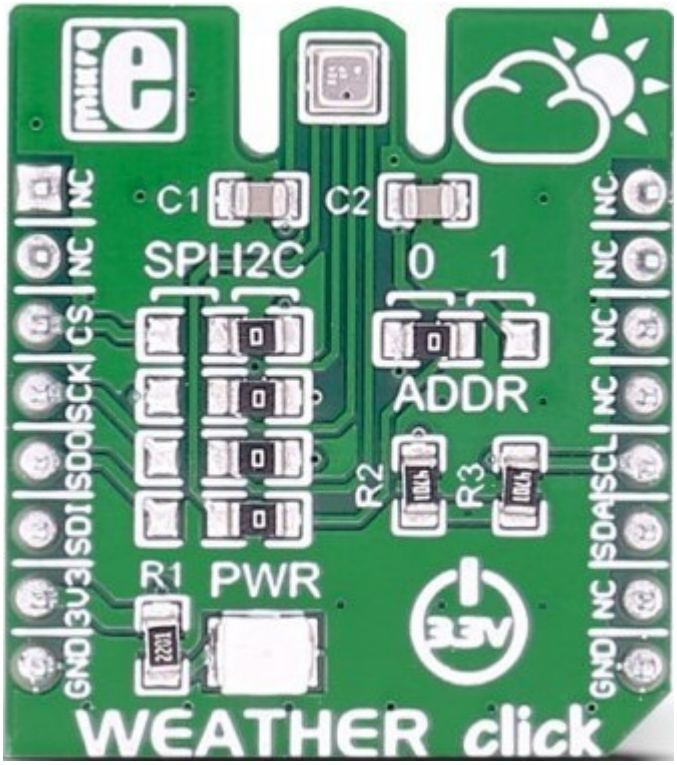
The demo uses a PIC18F25K42 microcontroller to communicate with the MikroElektronika Weather Click Board to read temperature, pressure, and humidity levels of the environment in which the demo is placed. Once the weather data has been acquired and processed, the information is transmitted to a PC terminal program for display.

1.1 BME280 Environmental Sensor

The Weather Click contains the Bosch BME280 Environmental Sensor. Communication with the sensor is handled either over the I^2C or SPI interfaces. For this demo, the SPI interface is used; therefore, the jumper selector resistors must be changed from the default right position to the left position (see Figure 1-1). The Weather Click operates at 3.3V nominal, and routes power to the sensor's V_{DD} and V_{DDIO} pins.

The sensor features three operating modes: Sleep, Forced, and Normal modes. This application uses Forced mode as recommended by Bosch for weather monitoring since the temperature, humidity, and pressure readings will not rapidly change. Forced mode allows user software to decide when to read the sensor. Each time a measurement has completed, the sensor returns to Sleep mode, reducing power consumption.

Figure 1-1. Weather Click Jumper Locations



1.1.1 Register Map

The BME280 contains several important registers, as shown in Figure 1-2.

Data Registers:

The 'hum_lsb' and 'hum_msb' registers are read-only and contain the 16-bit raw humidity measurement output data.

The ‘temp_xlsb’, ‘temp_lsb’, and ‘temp_msb’ registers are read-only and are combined to form the 20-bit raw temperature output data.

The ‘press_xlsb’, ‘press_lsb’, and ‘press_msb’ registers are read-only and are combined to form the 20-bit raw pressure output data.

Control Registers:
The ‘config’ register controls the rate, filter, and interface options of the sensor. The ‘t_sb<2:0>’ bits determine the inactive standby time when operating in normal mode. The ‘filter<2:0>’ bits determine the time constant of the IIR filter. The ‘spi3w_en’ bit determines whether the SPI interface uses the standard four-wire interface or a three-wire interface.

The ‘ctrl_meas’ register controls the oversampling settings for temperature and pressure readings and the sensor’s mode of operation. The ‘osrs_t<2:0>’ bits control oversampling of temperature data. The ‘osrs_p<2:0>’ bits control oversampling of pressure data. The ‘mode<1:0>’ bits determine which mode the sensor operates in: Sleep, Forced, or Normal. It is important to note that the ‘crtl_meas’ register must be written to after changing settings in the ‘ctrl_hum’ register for the changes to become effective.

The ‘status’ register is read-only and is used to indicate the status of the sensor. The ‘measuring’ bit is set whenever a conversion is running and is clear when the conversion results have been transferred to the data registers. The ‘im_update’ bit is set when the Nonvolatile Memory (NVM) data is actively being copied into the calibration registers.

The ‘ctrl_hum’ register contains the ‘osrs_h<2:0>’ bits, which control the oversampling of humidity data. It is important to note that changes to the ‘ctrl_hum’ register only become effective after a write to the ‘ctrl_meas’ register.

The ‘reset’ register is used to perform a Power-on Reset (POR) procedure. Writing the value of 0xB6 will direct the sensor to perform a POR. Writing any other values will have no effect. This register is write-only; reads from this register will always result in 0x00.

The ‘id’ register contains the sensor’s chip identification number, which is always a value of 0x60.

Calibration Registers:
Register ‘calib00’ through ‘calib31’ holds the sensor’s calibration values for humidity, temperature, and pressure readings. These registers have to be used to compensate for variations that occur due to the individual sensing elements of the sensor.

Figure 1-2. BME280 Register Map

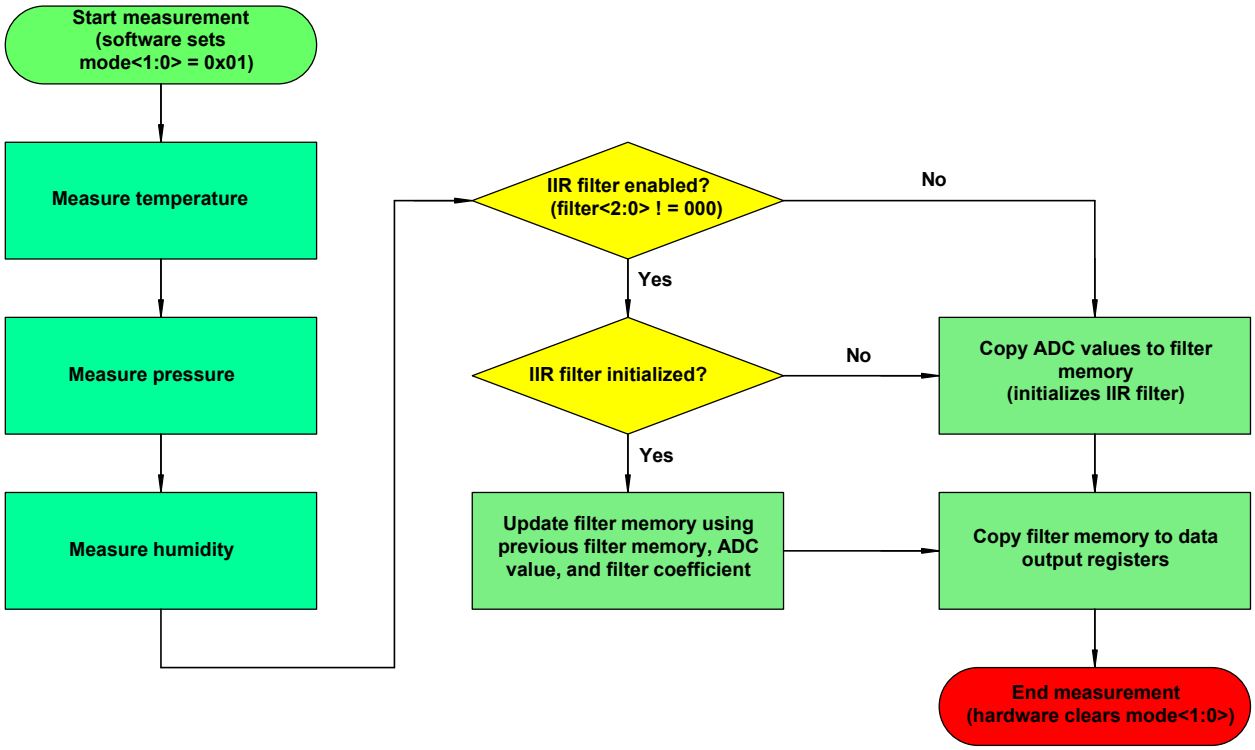
Register	Address	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Reset Value
hum_lsb	0xFE	hum<7:0>								0x00
hum_msb	0xFD	hum<15:8>								0x80
temp_xlsb	0xFC	temp<3:0>				0	0	0	0	0x00
temp_lsb	0xFB	temp<11:4>								0x00
temp_msb	0xFA	temp<19:12>								0x80
press_xlsb	0xF9	press<3:0>				0	0	0	0	0x00
press_lsb	0xF8	press<11:4>								0x00
press_msb	0xF7	press<19:12>								0x80
config	0xF5	t_sb<2:0>			filter<2:0>			reserved	spi3w_en	0x00
ctrl_meas	0xF4	osrs_t<2:0>			osrs_p<2:0>			mode<1:0>		0x00
status	0xF3	reserved				measuring	reserved		im_update	0x00
ctrl_hum	0xF2	reserved					osrs_h<2:0>			0x00
calib31	0xE7	dig_H6								varies part-to-part
calib30	0xE6	dig_H5<15:8>								
calib29	0xE5	dig_H5<7:0>								
calib28	0xE4	dig_H4<15:8>								
calib27	0xE3	dig_H4<7:0>								
calib26	0xE2	dig_H3<15:8>								
calib25	0xE1	dig_H3<7:0>								
reset	0xE0	reset<7:0>								0x00
id	0xD0	chip_id<7:0>								0x60
calib24	0xA1	dig_H1<7:0>								varies part-to-part
calib23	0x9F	dig_P9<15:8>								
calib22	0x9E	dig_P9<7:0>								
calib21	0x9D	dig_P8<15:8>								
calib20	0x9C	dig_P8<7:0>								
calib19	0x9B	dig_P7<15:8>								
calib18	0x9A	dig_P7<7:0>								
calib17	0x99	dig_P6<15:8>								
calib16	0x98	dig_P6<7:0>								
calib15	0x97	dig_P5<15:8>								
calib14	0x96	dig_P5<7:0>								
calib13	0x95	dig_P4<15:8>								
calib12	0x94	dig_P4<7:0>								
calib11	0x93	dig_P3<15:8>								
calib10	0x92	dig_P3<7:0>								
calib09	0x91	dig_P2<15:8>								
calib08	0x90	dig_P2<7:0>								
calib07	0x8F	dig_P1<15:8>								
calib06	0x8E	dig_P1<7:0>								
calib05	0x8D	dig_T3<15:8>								
calib04	0x8C	dig_T3<7:0>								
calib03	0x8B	dig_T2<15:8>								
calib02	0x8A	dig_T2<7:0>								
calib01	0x89	dig_T1<15:8>								
calib00	0x88	dig_T1<7:0>								

1.1.2 Measurement Flow

The measurement cycle depends on the sensor's operating mode. Since this application is operating in Forced mode, the measurement cycle begins with a write to the 'mode<1:0>' bits of the 'ctrl_meas' register. Writing a value of 0x01 or 0x10 places the sensor into Forced mode. Next, the temperature, pressure, and humidity measurements are performed. Once the raw environmental conditions have been measured, each measured value may be passed through an Infinite Impulse Response (IIR) filter, if enabled. Finally, the filtered (if enabled) or unfiltered results are stored in the data registers, and the

sensor returns to Sleep mode (see Figure 1-3). It is important to note that in Forced mode, the ‘mode<1:0>’ bits must be written to each time a new measurement cycle is desired.

Figure 1-3. Measurement Flow in Forced Mode



1.1.2.1 Humidity Measurement

Humidity measurements are controlled by the ‘osrs_h<2:0>’ bits of the ‘ctrl_hum’ register. Humidity measurements can be skipped by clearing the ‘osrs_h<2:0>’ bits; otherwise, the ‘osrs_h<2:0>’ bits control the oversampling setting. Since humidity values do not change rapidly, they do not require the use of the IIR filter; therefore, the output resolution is fixed at 16 bits.

1.1.2.2 Pressure Measurement

Pressure measurements are controlled by the ‘osrs_p<2:0>’ bits of the ‘ctrl_meas’ register. Pressure measurements can be skipped by clearing the ‘osrs_p<2:0>’ bits; otherwise, they control the oversampling rate of the temperature measurement.

The output resolution is determined by the IIR filter and oversampling settings:

- When the IIR filter is enabled, the output pressure resolution is 20 bits.
- When the IIR filter is disabled, the pressure resolution is 16 bits plus the value of the ‘osrs_p<2:0>’ bits minus 1 (osrs_p<2:0> – 1). For example, if the IIR filter is disabled, and a value of ‘`011`’ is written into ‘osrs_p<2:0>’, the pressure resolution is 18 bits (16 + (3-1)). It is important to note that the pressure resolution has a maximum of 20 bits; ‘osrs_p<2:0>’ values at or above ‘`101`’ will result in 20 bits of resolution.

1.1.2.3 Temperature Measurement

Temperature measurements are controlled by the ‘osrs_t<2:0>’ bits of the ‘ctrl_meas’ register. Pressure measurements can be skipped by clearing the ‘osrs_t<2:0>’ bits; otherwise, they control the temperature measurement’s oversampling rate. The output resolution is determined by the IIR filter and oversampling settings:

- When the IIR filter is enabled, the output temperature resolution is 20 bits.
- When the IIR filter is disabled, the temperature resolution is 16 bits plus the value of the ‘osrs_t<2:0>’ bits minus 1 (osrs_t<2:0> – 1). For example, if the IIR filter is disabled, and a value of ‘101’ is written into ‘osrs_t<2:0>’, the pressure resolution is 20 bits (16 + (5-1)). It is important to note that the pressure resolution has a maximum 20 bits; ‘osrs_p<2:0>’ values at or above ‘101’ will result in 20 bits of resolution.

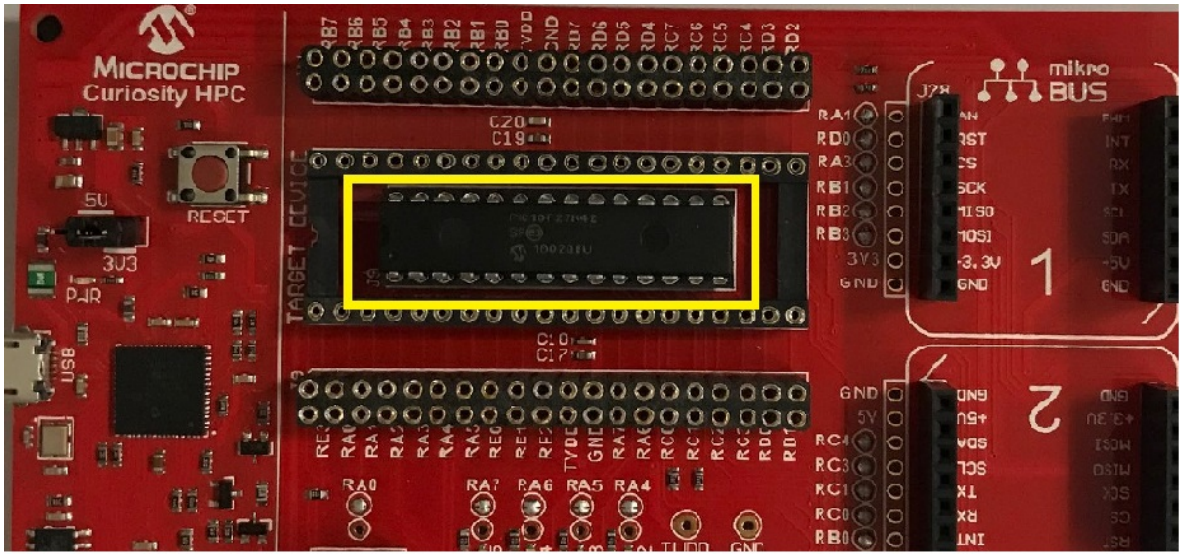
2. Application Configuration

The following pages describe the configuration of the hardware and software components necessary for data acquisition.

2.1 Hardware Configuration

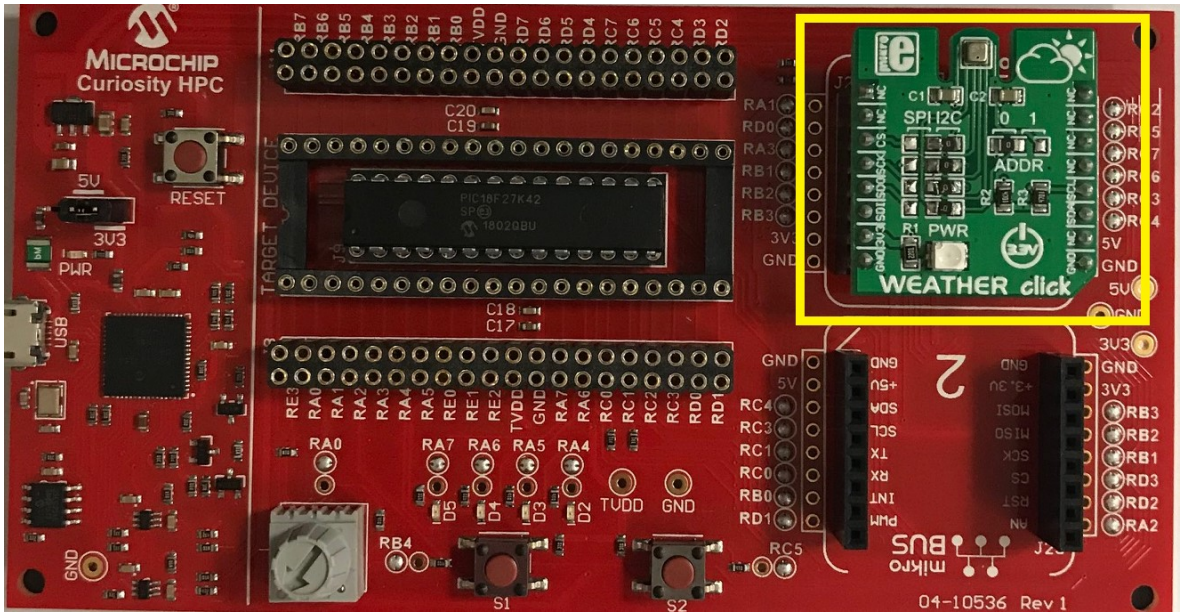
1. Place the PIC18F25K42 microcontroller into the 28-lead socket (J9) of the Curiosity HPC board (see Figure 2-1).

Figure 2-1. PIC18F25K42 Inserted into 28-Lead Socket (J9)



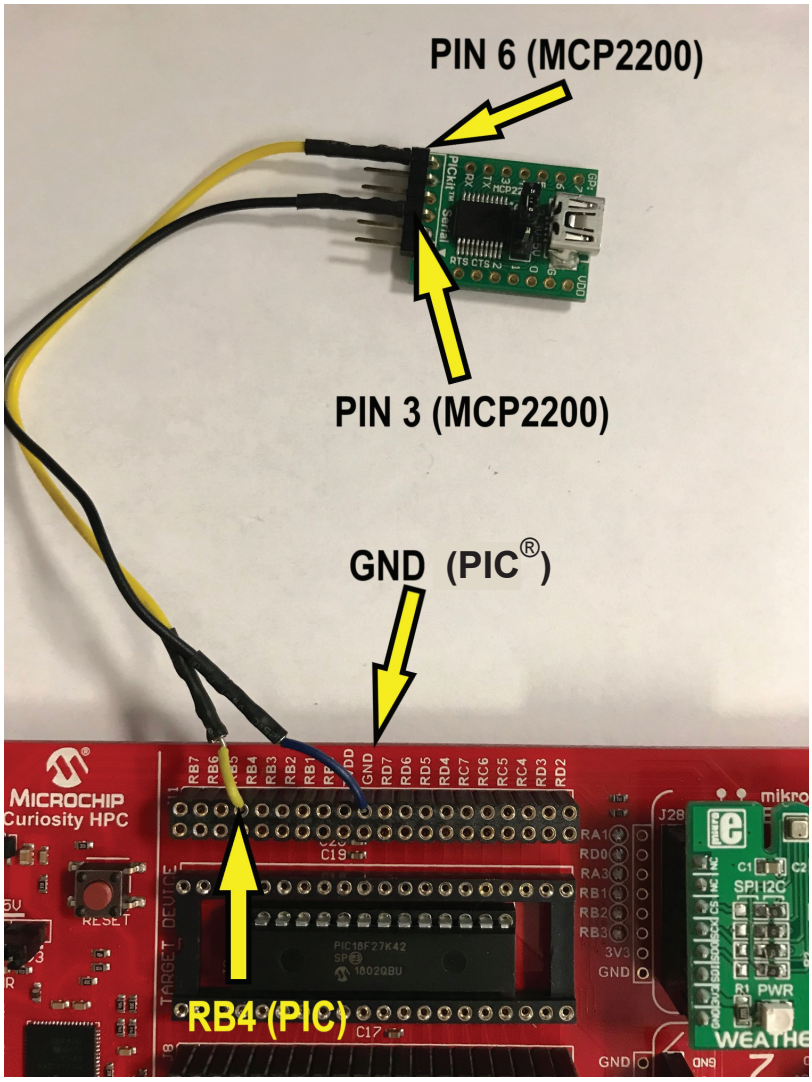
2. Place the MikroElektronika Weather Click into mikroBUS™ Socket 1 of the Curiosity HPC board (see Figure 2-2).

Figure 2-2. Weather Click Inserted in mikroBUS™ Socket 1



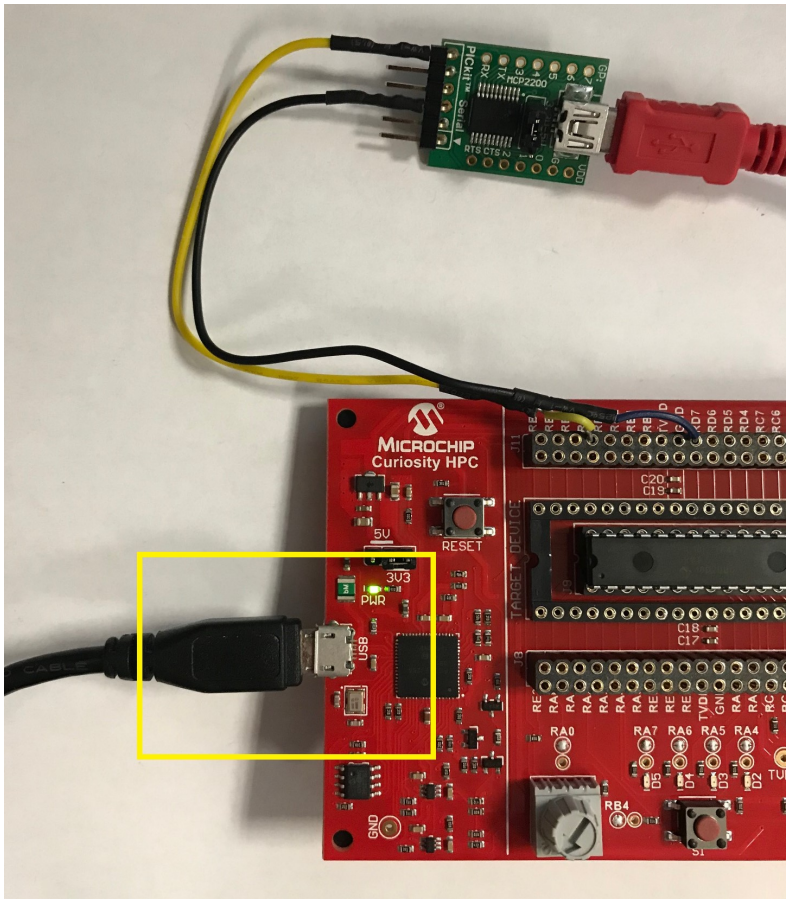
3. Connect the MCP2200 to the Curiosity board using jumper wires. Connect one end of a jumper wire to pin RB4 of header J11, and the other end to pin 6 of the MCP2200. Next, connect one end of a jumper wire to the GND pin of header J11, and the other end to pin 3 of the MCP2200. See Figure 2-3 for the connection points. Finally, connect the MCP2200 to a PC using the USB Mini-B 5-pin cable. Note that the PIC device's UART receive line is not used, so no additional wiring is needed.

Figure 2-3. MCP2200 USB-to-UART Connections



4. Connect the Curiosity HPC to the PC using the USB Micro-B 5-pin cable, as shown in Figure 2-4. This is the final step in the hardware configuration.

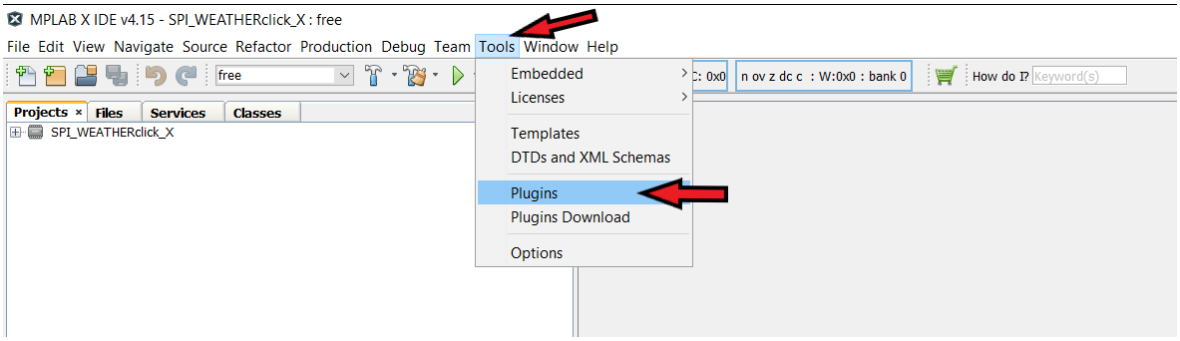
Figure 2-4. Curiosity HPC Connection to the PC



2.2 Software Configuration

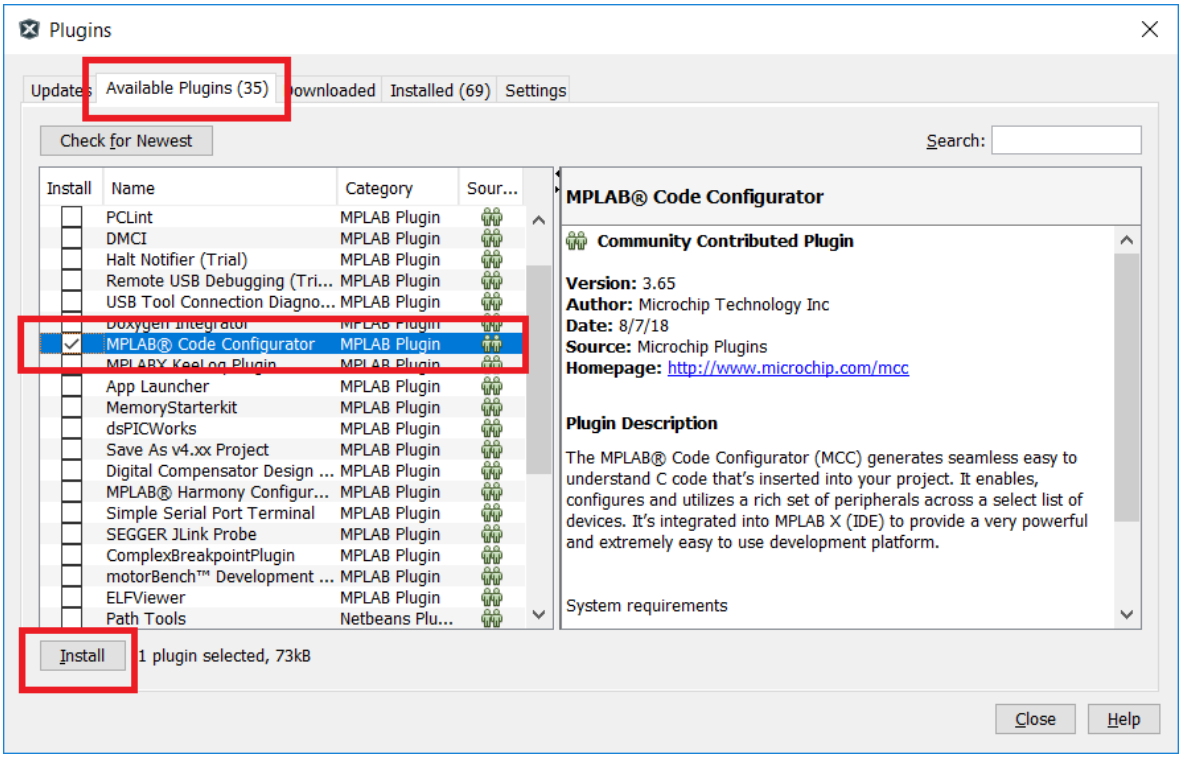
1. Download and install the latest MPLAB X IDE. The latest MPLAB X version can be found at http://www.microchip.com/mplab/mplab-x-ide.
2. Download and install the latest MPLAB XC8 compiler. The latest MPLAB XC8 compiler can be found at http://www.microchip.com/mplab/compilers.
3. Open the MPLAB X IDE. On the main toolbar, select **Tools**, and then select the **Plugin** tab in the drop-down menu, as shown in Figure 2-5.

Figure 2-5. Tools Drop-Down Menu



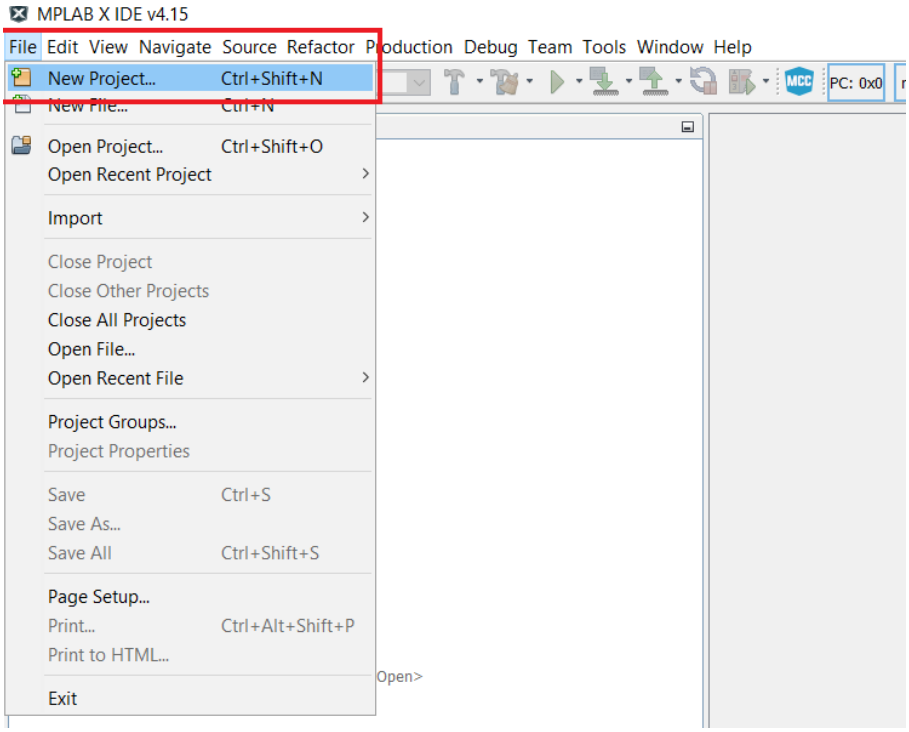
4. A new window, Plugins, will open. Under the **Available Plugins** tab, find the MPLAB Code Configurator selection and add a checkmark to the check box. Press the **Install** button (see Figure 2-6). This installs the MCC tool used to configure the necessary peripherals contained in this project. Once the install is complete, MPLAB will require a restart to enable the MCC tool.

Figure 2-6. Installing the MCC Plug-in Tool



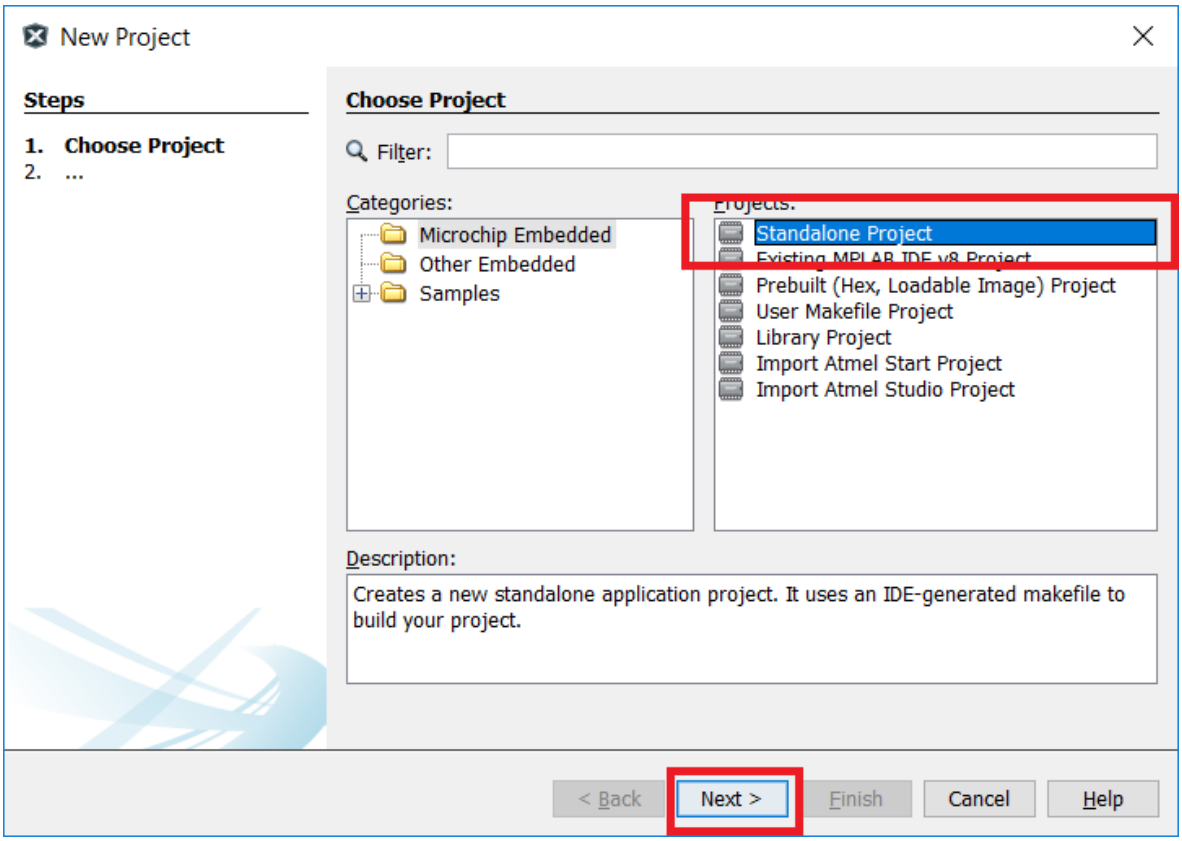
5. Create a new project in MPLAB X. Click on **File**, then “New Project” from the drop-down menu, as shown in Figure 2-7.

Figure 2-7. Create a New Project



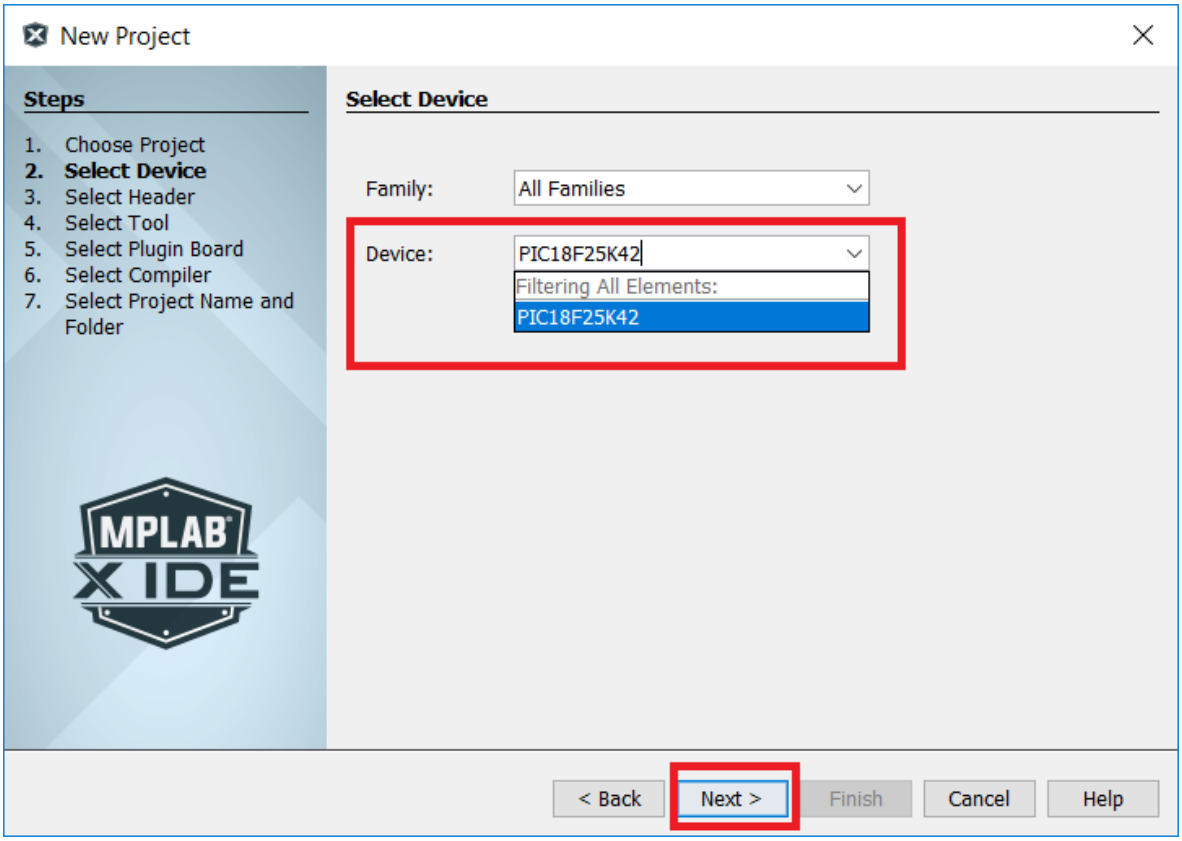
6. The New Project window will open. Select “Standalone Project” in the Projects window and click **Next >** (see Figure 2-8).

Figure 2-8. Choose Type of Project



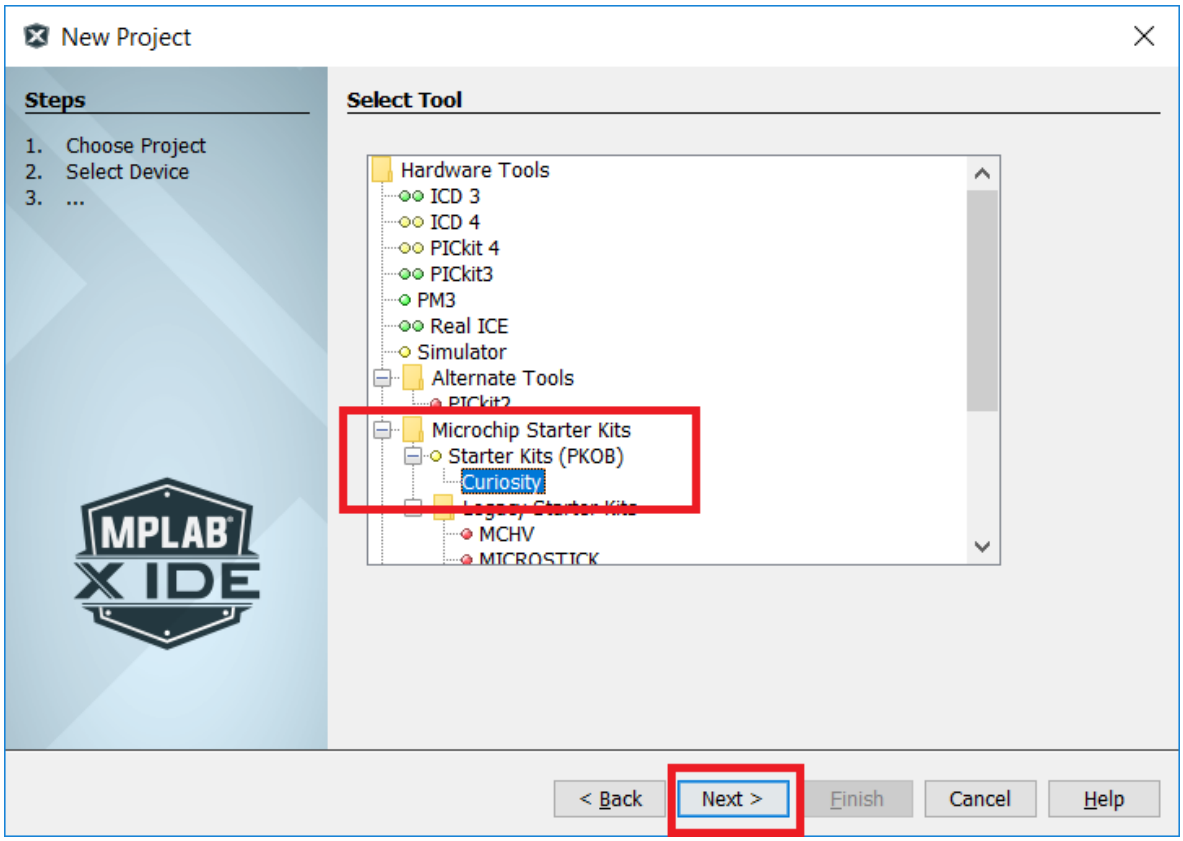
7. In the Select Device window, select **PIC18F25K42** from the “Device:” drop-down menu, as shown in Figure 2-9. Click **Next >**.

Figure 2-9. Select Device



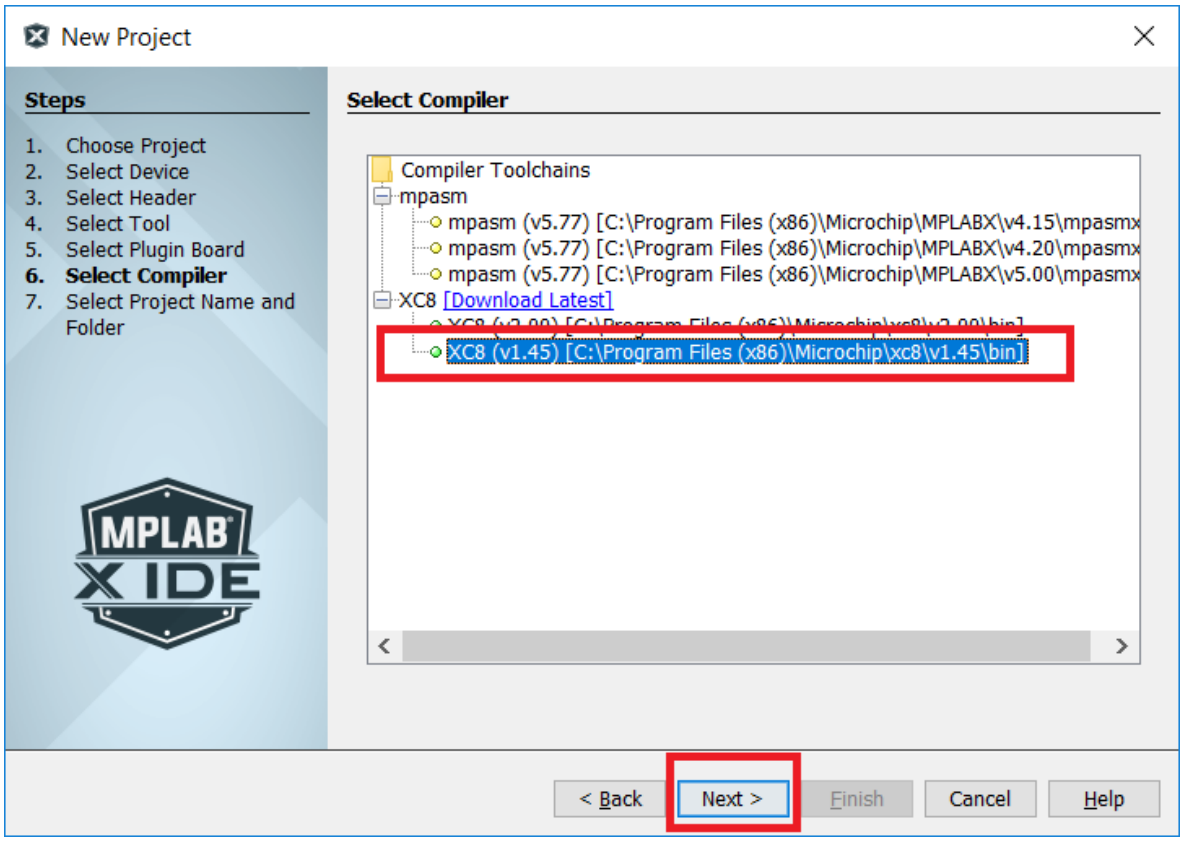
8. In the Select Tool window, under the *Microchip Starter Kits > Starter Kits (PKOB)* menu selection, click **Curiosity** (see Figure 2-10). Click **Next >**. It is important to note that the Curiosity HPC board must be connected to the PC for MPLAB X to recognize it as a tool. The Curiosity selection will not be visible if the board is not connected to the PC.

Figure 2-10. Select Tool



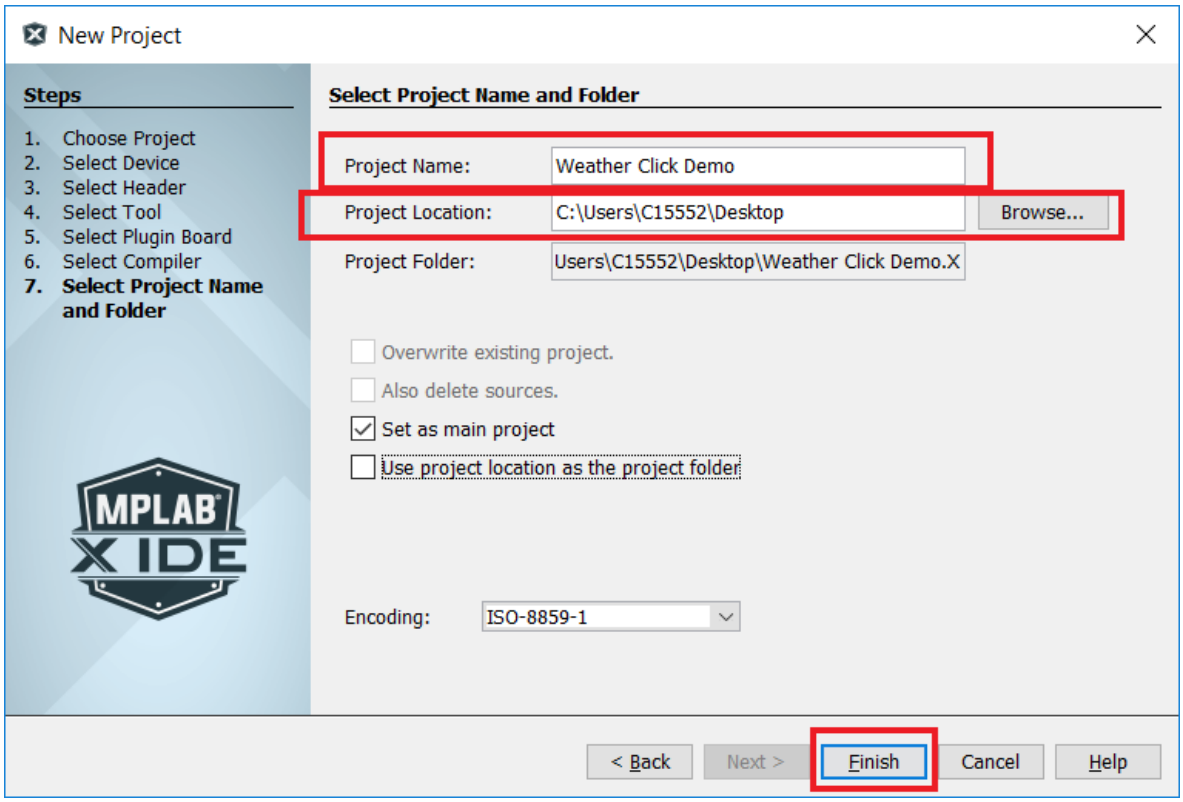
9. In the Select Compiler window, select the desired XC compiler under the XC8 menu list (see Figure 2-11). Click **Next >**. Note that Figure 2-11 shows two XC8 compiler choices. XC8 (v2.00) must be used with MPLAB X v.5.00, while XC8 (v1.45) is compatible with the MPLAB X v.4.15 utilized in this application.

Figure 2-11. Select Compiler



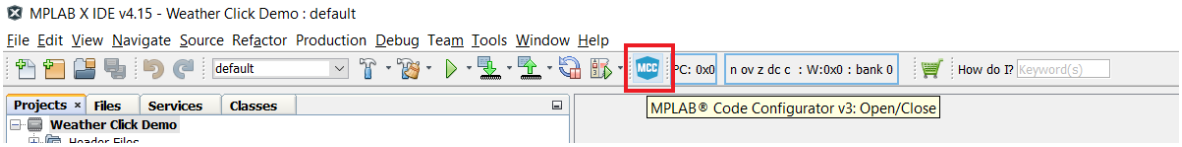
10. In the Select Project Name and Folder window, type the name of the project into the “Project Name:” text box. Next, choose the location to store the project. For this application, the Desktop file location was chosen (see Figure 2-12). After the project name and location have been determined, click **Finish**.

Figure 2-12. Select Project Name and Folder



11. At this point, the PIC microcontroller is ready for configuration. The MCC tool is used to configure the peripherals needed for the application and generate the necessary driver files. Click on the **MCC** icon in the MPLAB X toolbar, as shown in Figure 2-13. This opens the MCC tool.

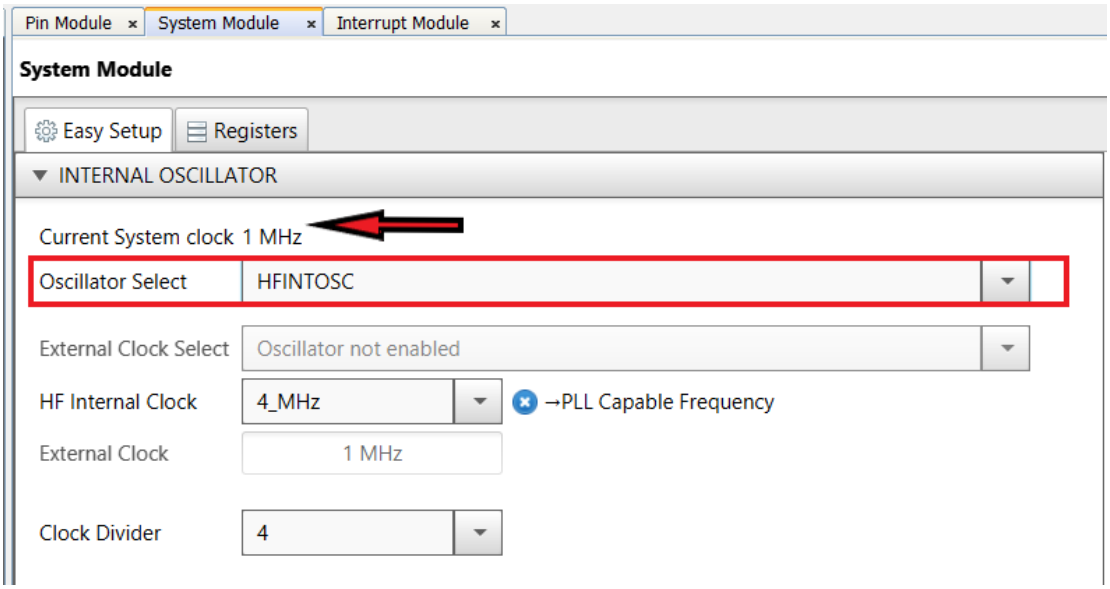
Figure 2-13. MCC Icon



12. MCC will default to the System Module window when it opens. There are two tabs within this window: **Easy Setup** and **Registers**. The **Easy Setup** tab allows for simple changes to the system oscillator, configures the Windowed Watchdog Timer, and enables Low-Voltage Programming (LVP). The **Registers** tab allows for changes to be made to the Configuration Words, oscillator registers, Peripheral Module Disable (PMD) registers, and the Windowed Watchdog Timer registers. The **Registers** tab has to be used when the default settings of the above registers cannot be utilized by the application. For this application, the system can be configured using the **Easy Setup** tab. The settings are as follows:

- In the INTERNAL OSCILLATOR window, under the “Oscillator Select” drop-down menu, select **HFINTOSC**. When HFINTOSC is selected, MCC automatically configures the “HF Internal Clock” and “Clock Divider” selections to achieve a 1 MHz system clock, as shown in Figure 2-14.

Figure 2-14. Oscillator Selection



- The WWDT and Programming windows can be left in their default states.

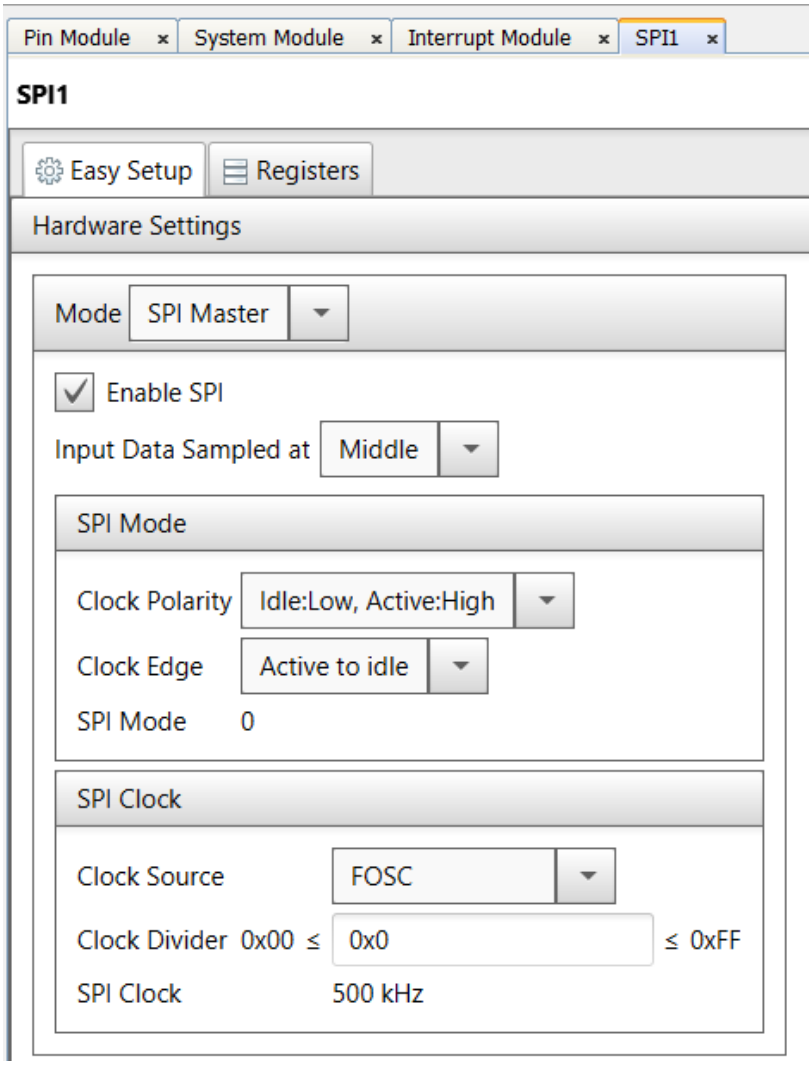
13. Next, in the Device Resources window, scroll down to the SPI selection, click on the arrow next to the **SPI** selection, click the arrow next to **SPI1**, and double click on the **SPI1 [PIC10/PIC12/PIC16/PIC18 MCUs by Microchip Technology, Inc.]** selection. A new tab will appear named **SPI1**. The SPI1 window contains the **Easy Setup** and **Registers** tabs. For this application, the **Easy Setup** tab is used.

Configure the SPI as follows (see Figure 2-15):

- In the “Mode” drop-down menu, select **SPI Master**.
- Leave the “Enable SPI” check box checked (default).

- In the “Input Data Sampled at” drop-down menu, select **Middle** (default).
- In the “Clock Polarity” drop-down menu, select **Idle:Low, Active:High**.
- In the “Clock Edge” drop-down menu, select **Active to idle**.
- In the “Clock Source” drop-down menu, select **FOSC** (default).
- In the “Clock Divider” box, enter **0x0** (no divider).

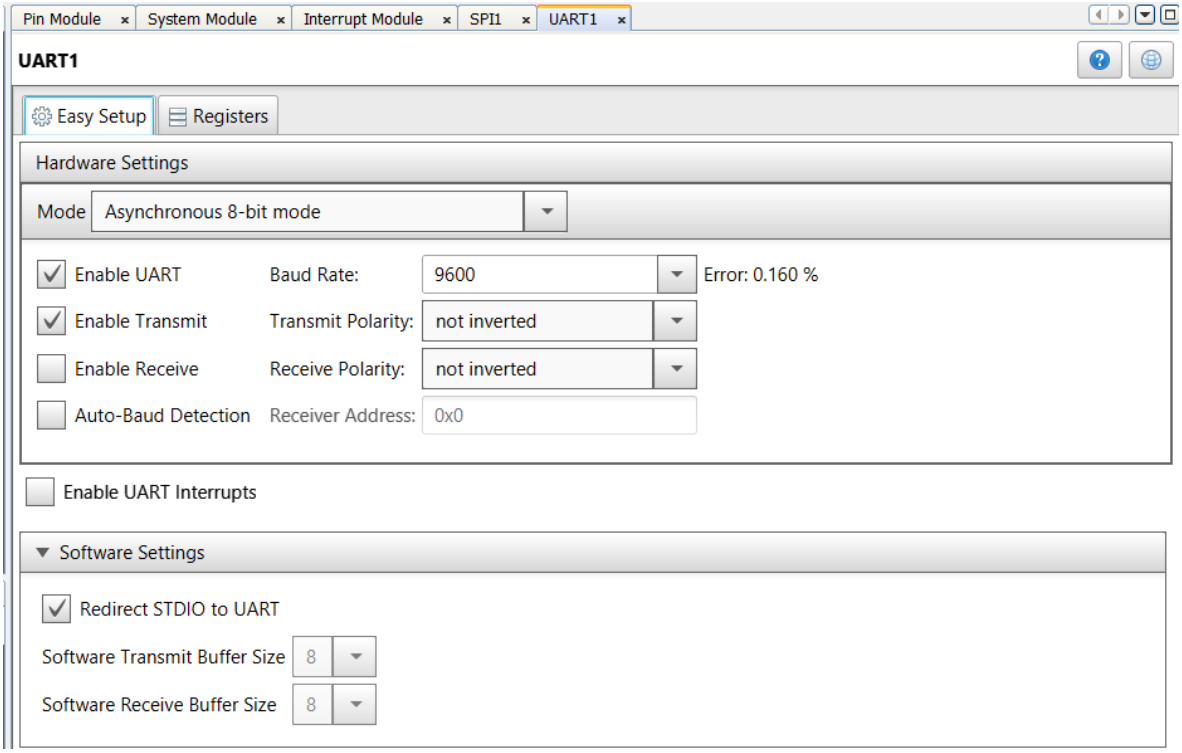
Figure 2-15. SPI Configuration



14. Under the Device Resources window, scroll down to “UART”, click on the arrow next to “UART”, then click on the arrow next to “UART1”, and double click on the **UART1 [PIC10/PIC12/PIC16/ PIC18 MCUs by Microchip Technology, Inc.]** selection. A new tab will appear named **UART1**. Configure the SPI in the **Easy Setup** tab as follows (see Figure 2-16):
    - In the “Mode” drop-down menu, select **Asynchronous 8-bit mode** (default).
    - Leave the “Baud Rate:” setting at 9600 (default).
    - Leave the “Enable UART” check box checked (default).
    - Add a checkmark in the “Enable Transmit” check box.
    - Leave the “Transmit Polarity” and “Receive Polarity” drop-down menu selections as ‘not inverted’ (default).

- Add a checkmark to the “Redirect STDIO to UART” check box.
- Leave the “Transmit Polarity” and “Receive Polarity” drop-down menu selections as ‘not inverted’ (default).
- Add a checkmark to the “Redirect STDIO to UART” check box.

Figure 2-16. UART Configuration



15. In the Project Resources window, click on **Pin Module**. This opens the **Pin Module** tab, allowing for the configuration of the I/Os used for the application. The user will need to change the SPI pins from the default settings, and add the UART TX pin.
    Under the **Registers** tab, change the following:
    - Register RB1PPS – enter **0x1E** (SCK1 output).
    - Register RB3PPS – enter **0x1F** (SDO output).
    - Register RB4PPS – enter **0x13** (TX output).
    - Register RC3PPS – change the value to 0x0 (unused).
    - Register SPI1SCKPPS – change the value to 0x0 (SCK input not used).
    - Register SPI1SDIPPS – change the value to 0x0A (SDI input on RB1).
    - Register SPI1SSPPS – change the value to 0x0 (SS input not used).

    In the Pin Manager: Grid View window, click on the Port A number 3 box in the “*Pin Module > GPIO > output*” selection row (see Figure 2-17).

    Switch from the **Registers** tab to the **Easy Setup** tab in the Pin Module window, then make the following changes (see Figure 2-18):
    - Pin RA3 – In the “Custom Name” column, change the name to **CS**, add a checkmark to the “Start High” check box, and remove the checkmark from the “Analog” check box.
    - Pin RB3 – Remove the checkmark from the “Analog” check box.
    - Pin RB4 – Remove the checkmark from the “Analog” check box.

Figure 2-17. Pin Manager: Grid View Window

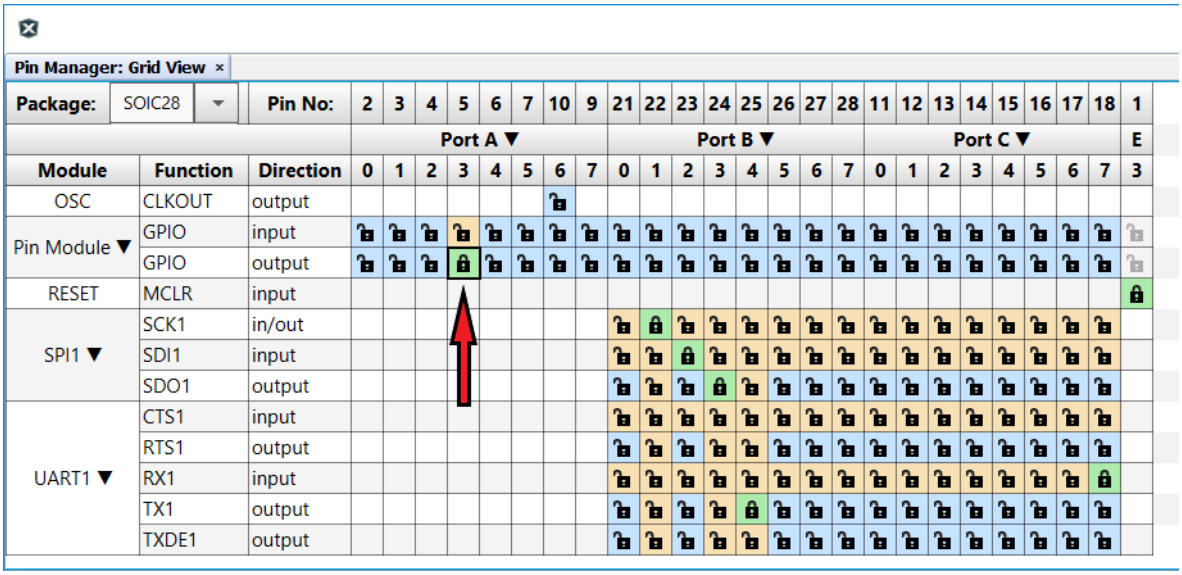
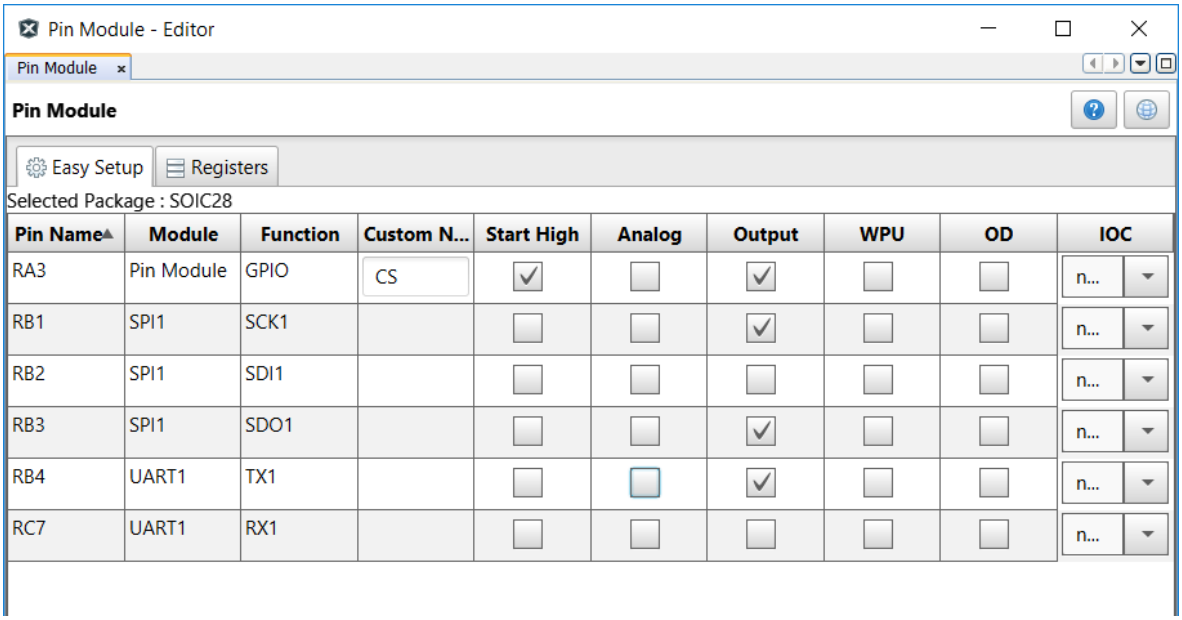
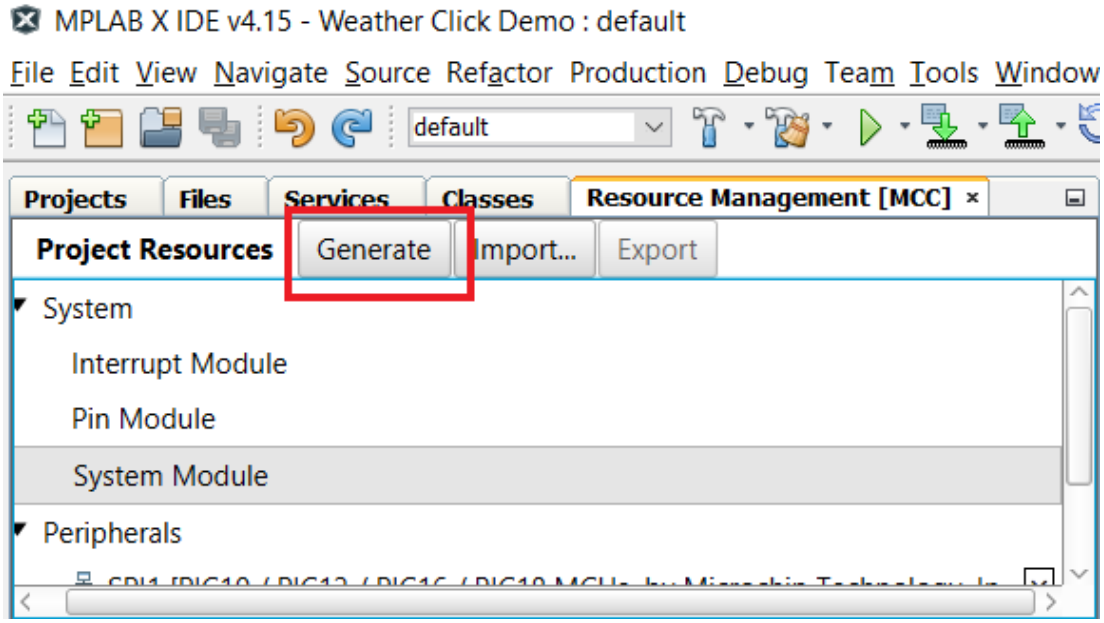


Figure 2-18. Pin Module Easy Setup Window



16. In the Project Resources window, click the **Generate** button (see Figure 2-19). MCC creates a project that contains the driver files for the peripherals that had been configured.

Figure 2-19. MCC Generate Button



17. At this point, the user has all the necessary files to run the application, except for the drivers for the Weather Click. Additionally, the `main.c` file needs to have some routines added.
To add the Weather Click drivers and `main.c` code, follow these steps in MPLAB X:

a. In the **Projects** tab, right-click on **Source Files**, then drag the mouse over **New**, and click on **C Source File** (see Figure 2-20).

b. The New C Source File window will open. In the “File Name” text box, enter `Weather_click` as the C file name (see Figure 2-21). The remaining text boxes do not need modification unless a separate file location is desired. Once the file name has been entered, click the **Finish** button. The new file will appear under the Source Files file menu, as shown in Figure 2-22.

c. Next, the user will essentially perform steps ‘a’ and ‘b’ again for the header file. In the **Projects** tab, right-click on **Header Files**, then drag the mouse over “New”, and click on **`xc8_header.h`** (see Figure 2-23).

d. The `New xc8_header.h` window will open. In the “File Name” text box, enter `Weather_click` as the header file name (see Figure 2-24). Click the **Finish** button, and the new file will appear under the “Header Files” file menu, as shown in Figure 2-25.

e. The BME280 sensor’s data sheet provides the necessary compensation routines and recommends these routines be used for calculations. For simplicity, these routines have been extracted from the data sheet and modified for this application. Copy the entire code example in Example 2-1 and paste into the newly created `Weather_click.c` file.

f. Copy the entire code example in Example 2-2 and paste into the newly created `Weather_click.h` file.

g. Copy the entire code example in Example 2-8 and paste into the project’s `main.c` file.

h. Click on the **Clean and Build Main Project** button (see Figure 2-26). If all the steps have been followed, there will be no errors. If there are any errors, confirm that the code examples were copied properly.

i. Click on the **Make and Program Device Main Project** button to program the PIC device (see Figure 2-27).

Figure 2-20. Creating the `Weather_click.c` File

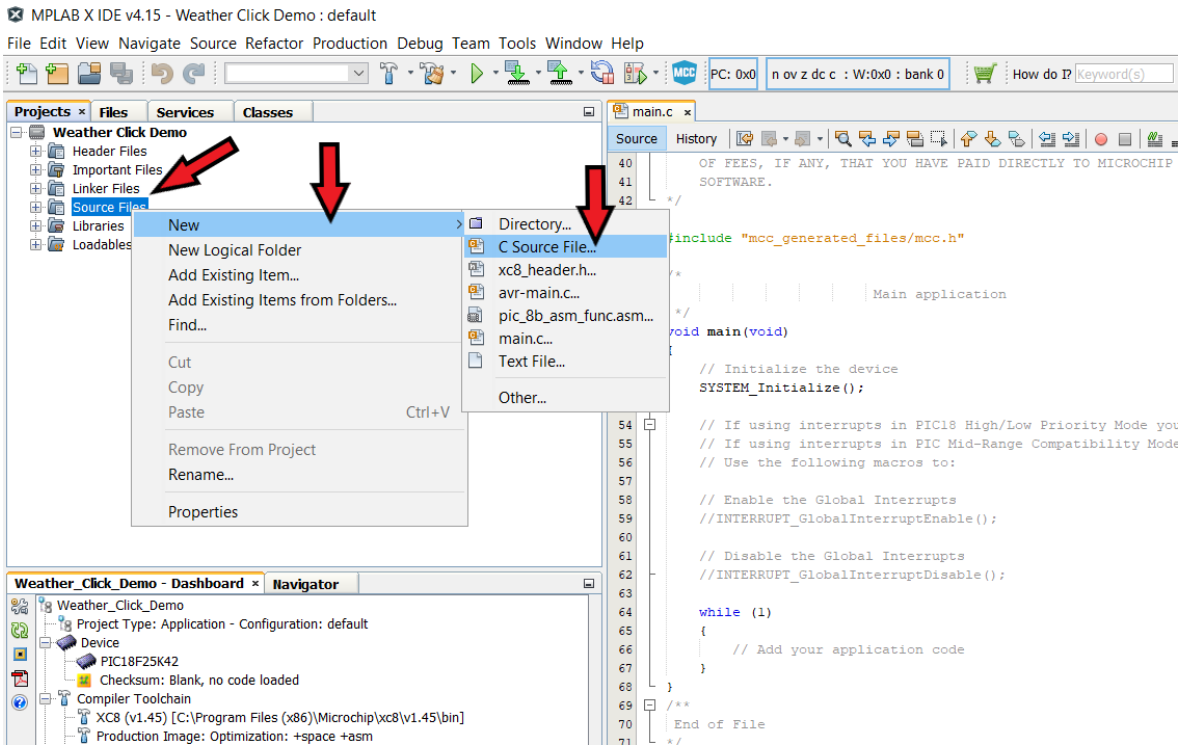


Figure 2-21. New C Source File Window

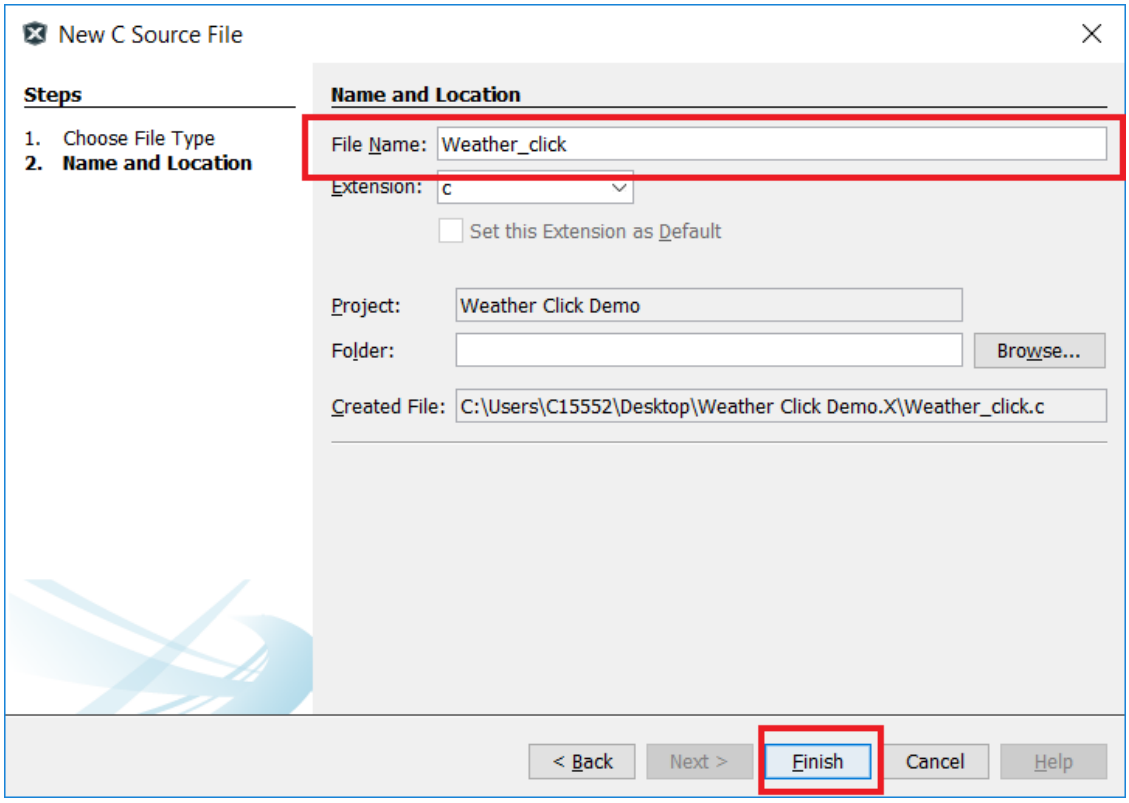


Figure 2-22. Generated `Weather_click.c` File in Projects Window

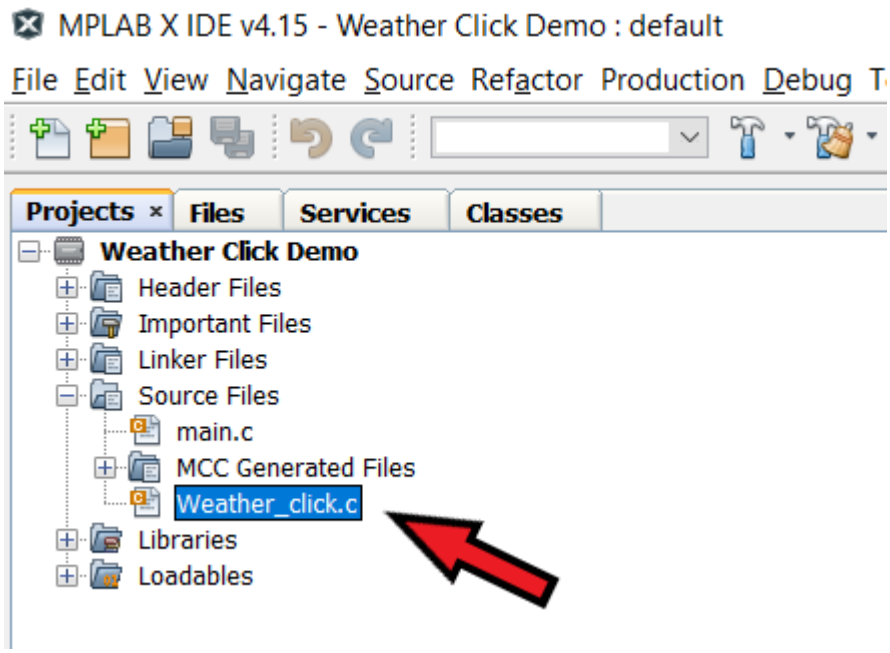


Figure 2-23. Creating the `Weather_click.h` File

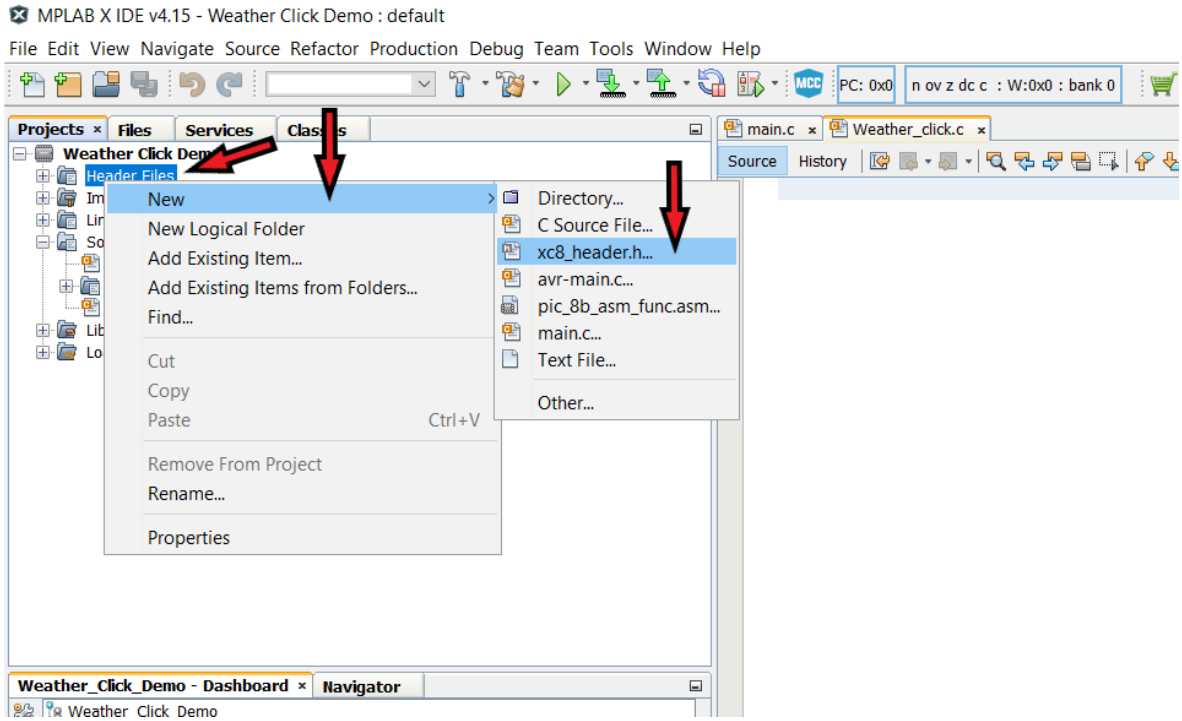


Figure 2-24. New `xc8_header.h` File Window

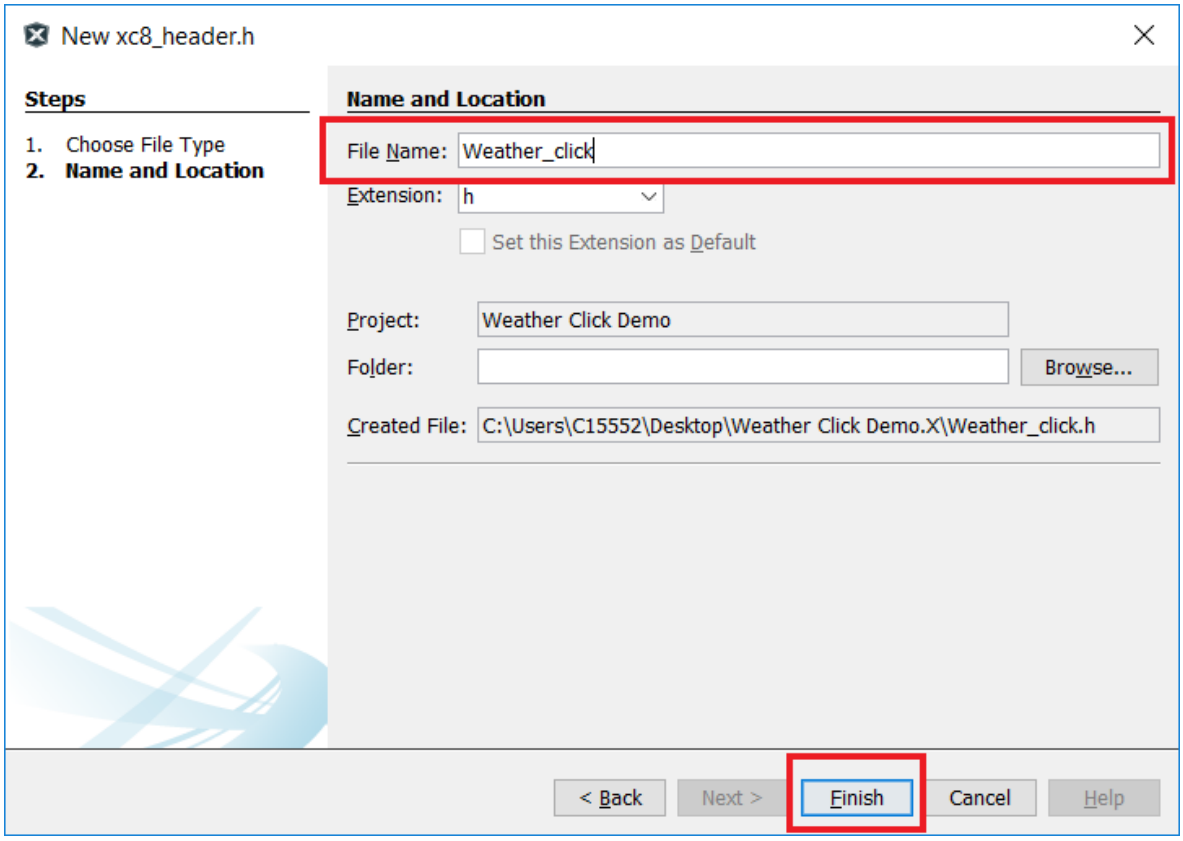


Figure 2-25. Generated `Weather_click.h` File in Projects Window

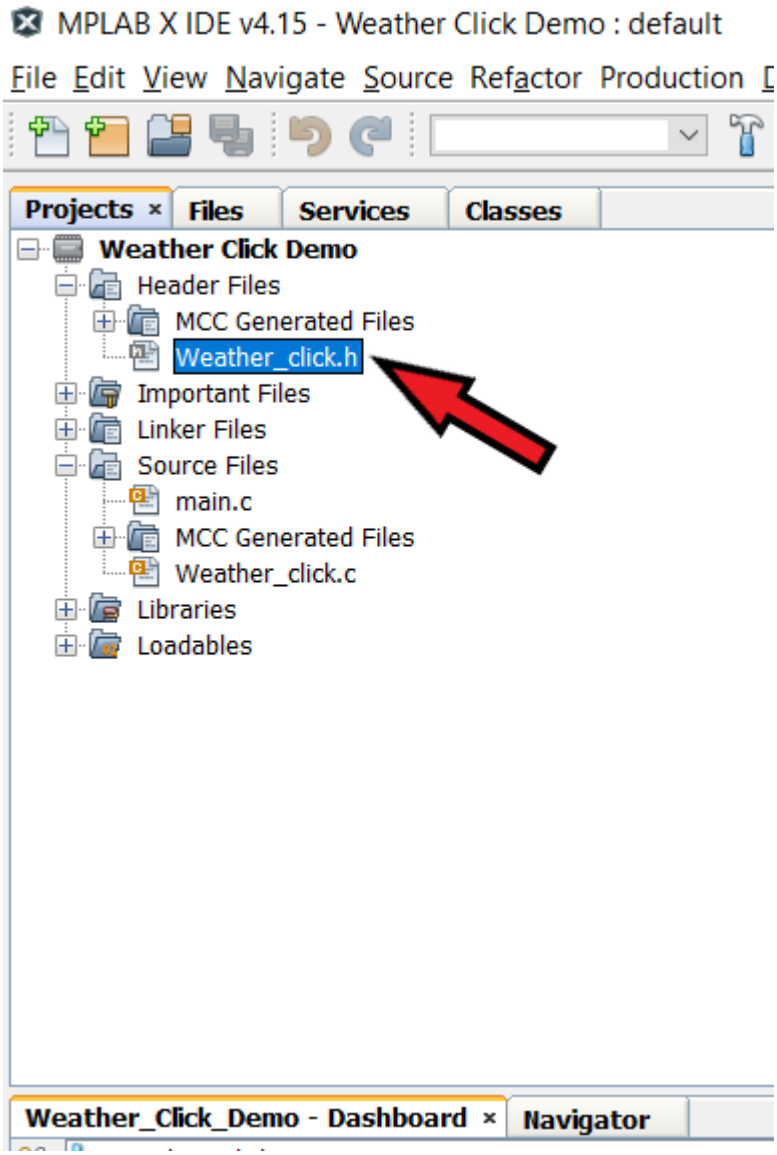


Figure 2-26. Clean and Build Main Project Button

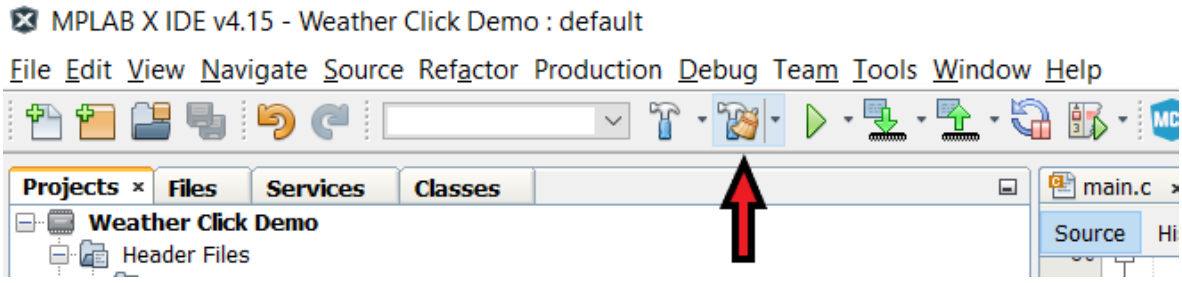
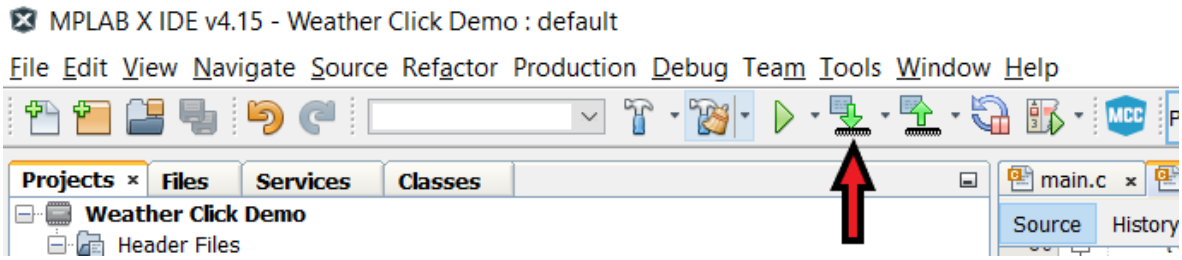
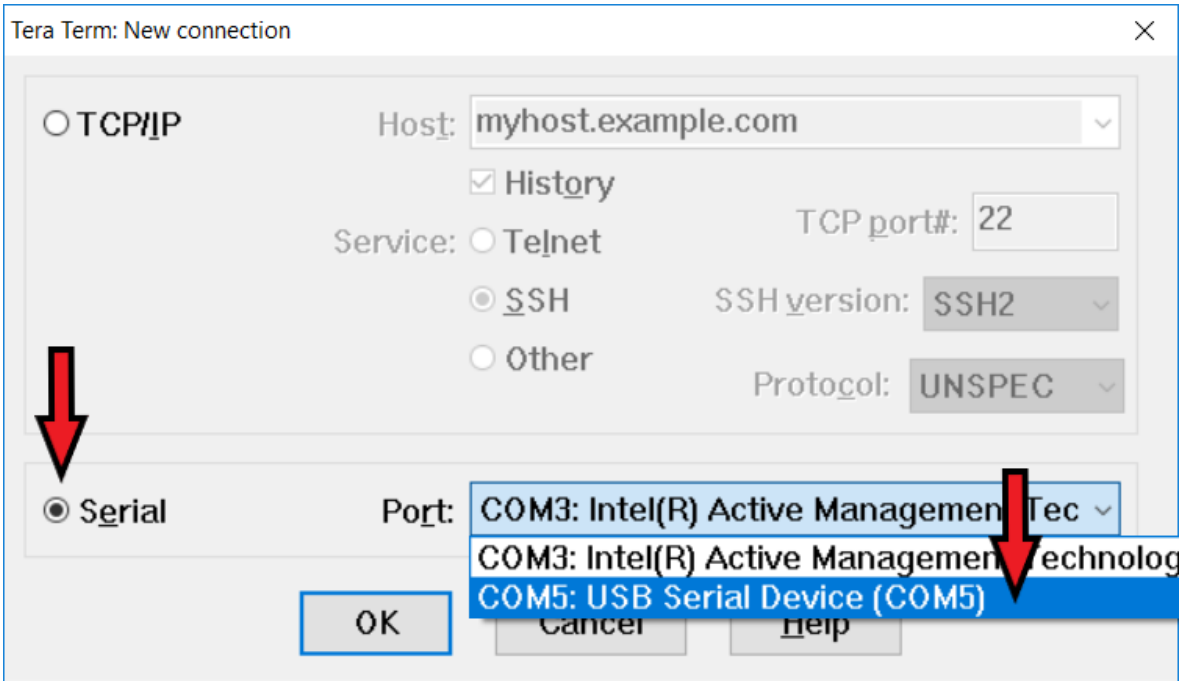


Figure 2-27. Make and Program Device Main Project Button



18. Download and install a free PC terminal program. The free “Tera Term” open-source software terminal emulator was chosen for this project. The Tera Term program can be downloaded here: https://osdn.net/projects/ttssh2/releases/.
19. Open the terminal program. Select the COM Port that is connected to the MCP2200. Figure 2-28 shows the COM Port selections using the Tera Term program. Click **OK**.

Figure 2-28. COM Port Selection Window



20. Ensure that the terminal program is configured to match the PIC device’s UART settings. If using the Tera Term program, click on the **Setup** tab, and click on **Serial port...**, as shown in Figure 2-29. The Tera Term: Serial Port Setup window will appear (see Figure 2-30). The serial port settings are as follows (regardless of the terminal program used):
    - Baud rate: 9600
    - Data: 8 bit
    - Parity: none
    - Stop: 1 bit
    - Flow control: none

Figure 2-29. Serial Port Setup Tab

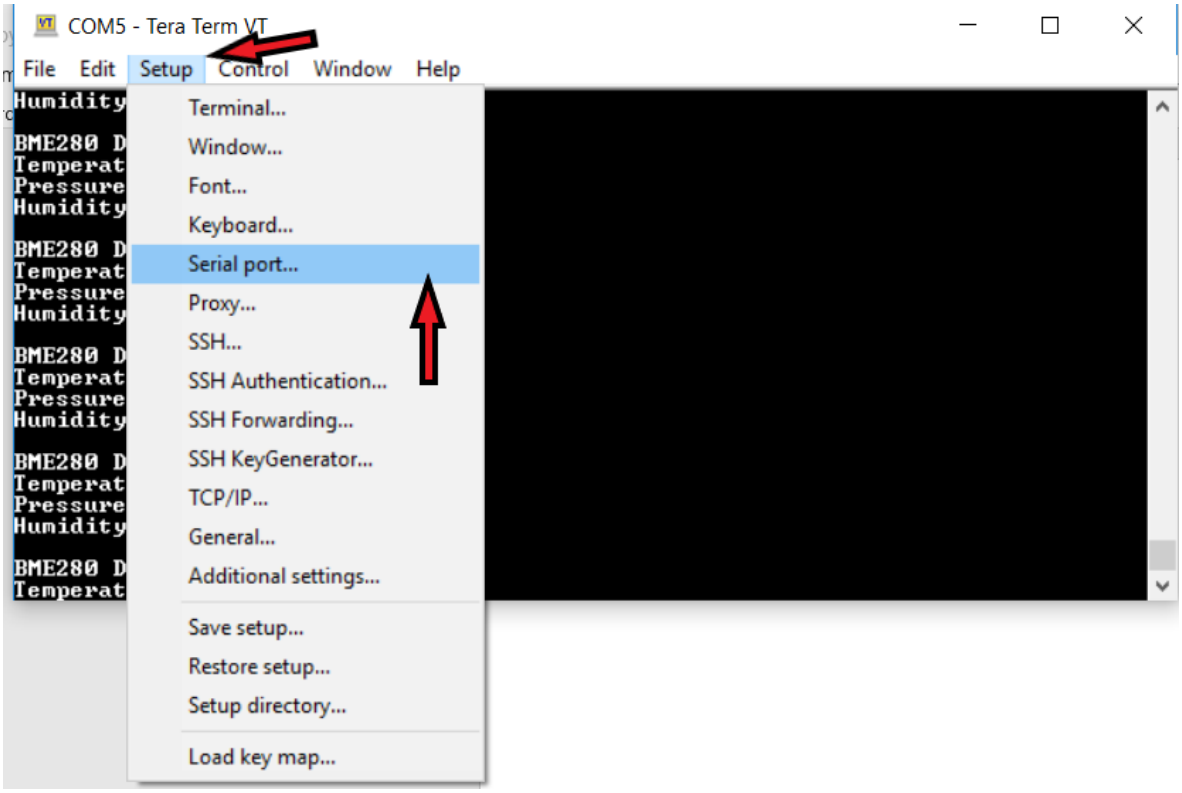
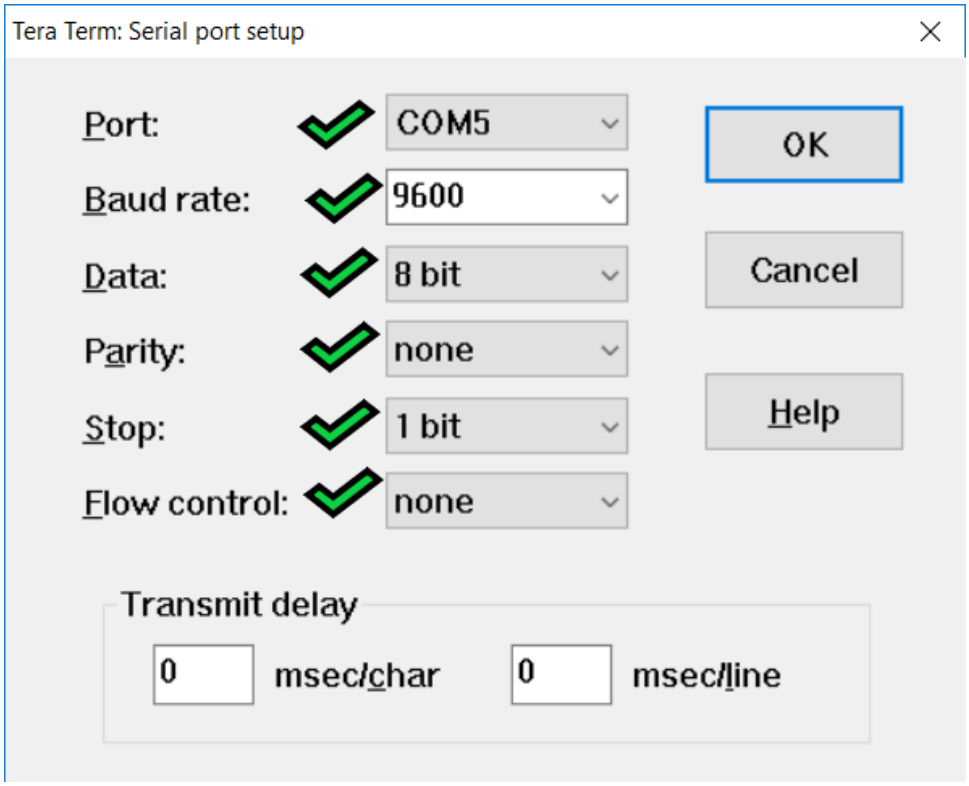
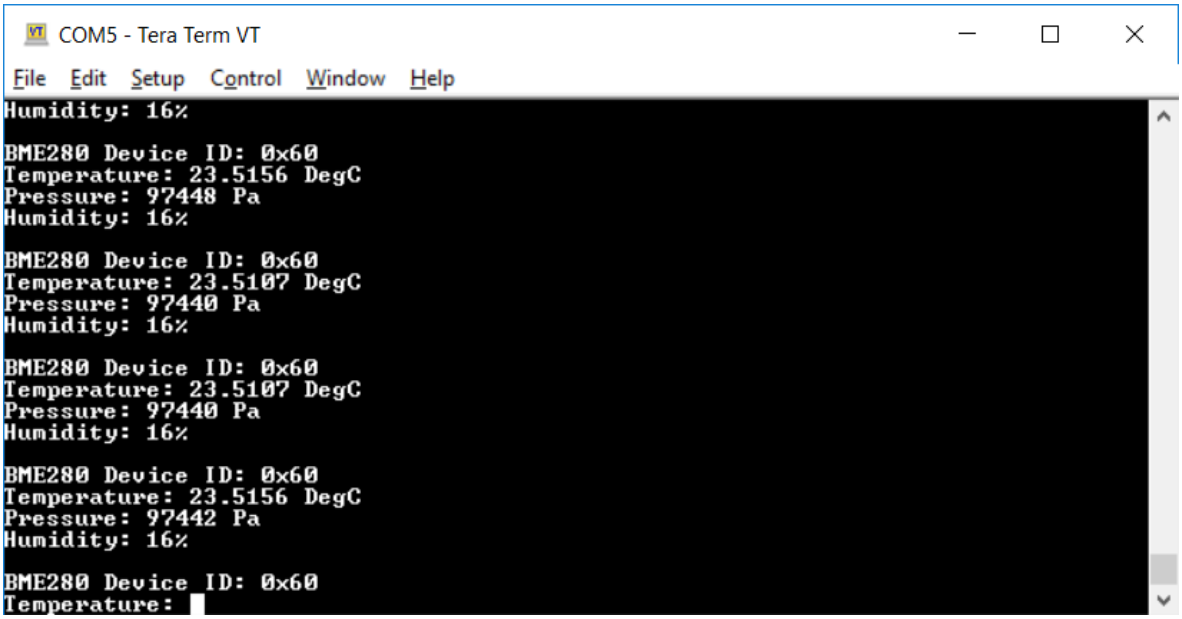


Figure 2-30. Tera Term Serial Port Setup Window with Correct Settings



21. At this point, the PIC device will be transmitting the environmental data to the terminal window for viewing, as shown in Figure 2-31.

Figure 2-31. Terminal Window with Environmental Data



Example 2-1. `Weather_click.c` Code

```
#include <xc.h>
#include "Weather_click.h"
#include "mcc_generated_files/mcc.h"
#include "mcc_generated_files/uart1.h"

uint8_t   cmd_deviceID[2] = {0xD0, DUMMY_DATA};
uint8_t   deviceID[2];
uint8_t   cmd_initialize[7] = {0x72, 0x01, 0x74, 0x25, 0x75, 0x80, DUMMY_DATA};
uint8_t   cmd_temp[4] = {0xFA, 0xFB, 0xFC, DUMMY_DATA};
uint8_t   temp[4];
uint8_t   cmd_press[4] = {0xF7, 0xF8, 0xF9, DUMMY_DATA};
uint8_t   press[4];
uint8_t   cmd_hum[3] = {0xFD, 0xFE, DUMMY_DATA};
uint8_t   hum[3];
uint8_t   cmd_uDigT[3] = {0x88, 0x89, DUMMY_DATA};
int8_t    cmd_sDigT[5] = {0x8A, 0x8B, 0x8C, 0x8D, DUMMY_DATA}
uint8_t   uDigT[3];
int8_t    sDigT[5];
uint8_t   cmd_uDigP[3] = {0x8E, 0x8F, DUMMY_DATA};
uint8_t   cmd_sDigP[17] = {0x90, 0x91, 0x92, 0x93, 0x94, 0x95, 0x96, 0x97,
                           0x98, 0x99, 0x9A, 0x9B, 0x9C, 0x9D, 0x9E, 0x9F,
                           DUMMY_DATA};
uint8_t   uDigP[3];
uint8_t   sDigP[17];
uint8_t   cmd_uDigH[3] = {0xA1, 0xE3, DUMMY_DATA};
int8_t    cmd_sDigH[7] = {0xE1, 0xE2, 0xE4, 0xE5, 0xE6, 0xE7, DUMMY_DATA};
uint8_t   uDigH[3];
int8_t    sDigH[7];
int32_t   t_fine;
double    T,P;
uint32_t  H;
typedef union {
    int32_t  raw;
    struct {
        signed byte0 : 8;
        signed byte1 : 8;
        signed byte2 : 8;
        signed byte3 : 8;
```

```
    };
} raw_data_t;
raw_data_t    temp_raw, press_raw, hum_raw;
```

Example 2-2. `Weather_click.c` Code

```
// Section: MikroElektronika WEATHER click APIs

void WEATHERclick_Config(void)
{
    uint8_t   i;
    CS_SetLow();
    for (i = 0; i < 7; i++)
    {
        SPI1_Exchange8bit(cmd_initialize[i]);
    }
    CS_SetHigh();
}

void WEATHERclick_ReadID(void)
{
    uint8_t i;
    CS_SetLow();
    for (i = 0; i < 2; i++)
    {
        deviceID[i] = SPI1_Exchange8bit(cmd_deviceID[i]);
    }
    CS_SetHigh();
}

void WEATHERclick_ReadTempParameters(void)
{
    uint8_t   i;
    uint8_t   j;

    CS_SetLow();
    for (i = 0; i < 3; i++)
    {
        uDigT[i] = SPI1_Exchange8bit(cmd_uDigT[i]);
    }
    CS_SetHigh();

    CS_SetLow();
    for (j = 0; j < 5; j++)
    {
        sDigT[j] = SPI1_Exchange8bit(cmd_sDigT[j]);
    }
    CS_SetHigh();
}
```

Example 2-3. `Weather_click.c` Code

```
void WEATHERclick_ReadPressParameters(void)
{
    uint8_t   i;
    uint8_t   j;

    CS_SetLow();
    for (i = 0; i < 3; i++)
    {
        uDigP[i] = SPI1_Exchange8bit(cmd_uDigP[i]);
    }
    CS_SetHigh();

    CS_SetLow();
    for (j = 0; j < 17; j++)
    {
        sDigP[j] = SPI1_Exchange8bit(cmd_sDigP[j]);
    }
    CS_SetHigh();
```

```
}

void WEATHERclick_ReadHumParameters(void)
{
    uint8_t   i;
    uint8_t   j;

    CS_SetLow();
    for (i = 0; i < 3; i++)
    {
        uDigH[i] = SPI1_Exchange8bit(cmd_uDigH[i]);
    }
    CS_SetHigh();

    CS_SetLow();
    for (j = 0; j < 7; j++)
    {
        sDigH[j] = SPI1_Exchange8bit(cmd_sDigH[j]);
    }
    CS_SetHigh();
}
```

Example 2-4. `Weather_click.c` Code

```
void WEATHERclick_ReadTemp(void)
{
    uint8_t   i;
    CS_SetLow();
    for (i = 0; i < 4; i++)
    {
        temp[i] = SPI1_Exchange8bit(cmd_temp[i]);
    }
    CS_SetHigh();
}

void WEATHERclick_ReadPress(void)
{
    uint8_t   i;
    CS_SetLow();
    for (i = 0; i < 4; i++)
    {
        press[i] = SPI1_Exchange8bit(cmd_press[i]);
    }
    CS_SetHigh();
}

void WEATHERclick_ReadHum(void)
{
    uint8_t   i;
    CS_SetLow();
    for (i = 0; i < 3; i++)
    {
        hum[i] = SPI1_Exchange8bit(cmd_hum[i]);
    }
    CS_SetHigh();
}

void WEATHERclick_PrintResults(void)
{
    printf("\r\nBME280 Device ID:0x%x\r\n", deviceID[1]);
    printf("Temperature:%g",T);
    printf("DegC\r\n");
    printf("Pressure:%g",P);
    printf("Pa\r\n");
    printf("Humidity:%d",H);
    printf("%%\r\n");
}
```

Example 2-5. `Weather_click.c` Code

```
void WEATHERclick_TempCalc(void)
{
    double var1, var2;
    temp_raw.byte2 = temp[1];
    temp_raw.byte1 = temp[2];
    temp_raw.byte0 = temp[3];
    temp_raw.raw   = temp_raw.raw >> 4;

    uint16_t digT1 = (uDigT[2] << 8) + (uDigT[1]);
    int16_t digT2  = (sDigT[2] << 8) + (sDigT[1]);
    int16_t digT3  = (sDigT[4] << 8) + (sDigT[3]);

    var1 = (((double)temp_raw.raw) / 16384.0 - ((double)digT1) / 1024.0) *
           ((double)digT2);
    var2 = ((((double)temp_raw.raw) / 131072.0 - ((double)digT1) / 8192.0) *
           (((double)temp_raw.raw) / 131072.0 - ((double)digT1) / 8192.0)) *
           ((double)digT3);
    t_fine = (int32_t)(var1 + var2);
    T = (var1 + var2) / 5120.0;
}

void WEATHERclick_HumCalc(void)
{
    int32_t   var1;
    hum_raw.byte1 = hum[1];
    hum_raw.byte0 = hum[2];
    uint8_t   digH1 = uDigH[1];
    int16_t   digH2 = (sDigH[2] << 8) + (sDigH[1]);
    uint8_t   digH3 = uDigH[2];
    int16_t   digH4 = (sDigH[3] << 4) + (sDigH[4] & 0x0F);
    int16_t   digH5 = (sDigH[5] << 4) + ((sDigH[4] >> 4) & 0x0F);
    int8_t    digH6 = sDigH[6];

    var1 = (t_fine - ((int32_t) 76000));
    var1 = (((((temp_raw.raw << 14) - (((int32_t) digH4) << 20) -
           (((int32_t) digH5) * var1)) + ((int32_t) 16384)) >> 15) *
           (((((var1 * ((int32_t) digH6)) >> 10) *
           (((var1 * ((int32_t) digH3)) >> 11) + ((int32_t)32768))) >> 10) +
           ((int32_t) 2097152)) * ((int32_t)digH2) + 8192) >> 14));
    var1 = (var1 - (((((var1 >> 15) * (var1 >> 15)) >> 7) *
           ((int32_t) digH1))>> 4));
    var1 = (var1 < 0 ? 0 :var1);
    var1 = (var1 > 419430400 ? 419430400 : var1);
    H = (uint32_t) (var1 >> 12);
    H = H / 1024.0;
}
```

Example 2-6. `Weather_click.c` Code

```
void WEATHERclick_PressCalc(void)
{
    double var1, var2;
    press_raw.byte2 = press[1];
    press_raw.byte1 = press[2];
    press_raw.byte0 = press[3];
    press_raw.raw = press_raw.raw >> 4;

    uint16_t digP1 = (uDigP[2] << 8) + (uDigP[1]);
    int16_t digP2 = (sDigP[2] << 8) + (sDigP[1]);
    int16_t digP3 = (sDigP[4] << 8) + (sDigP[3]);
    int16_t digP4 = (sDigP[6] << 8) + (sDigP[5]);
    int16_t digP5 = (sDigP[8] << 8) + (sDigP[7]);
    int16_t digP6 = (sDigP[10] << 8) + (sDigP[9]);
    int16_t digP7 = (sDigP[12] << 8) + (sDigP[11]);
    int16_t digP8 = (sDigP[14] << 8) + (sDigP[13]);
    int16_t digP9 = (sDigP[16] << 8) + (sDigP[15]);
```

```
    var1 = ((double)t_fine / 2.0) -64000.0;
    var2 = var1 * var1 * ((double)digP6) /32768.0;
    var2 = var2 + var1 * ((double)digP5) *2.0;
    var2 = (var2 / 4.0) + (((double)digP4) *65536.0);
    var1 = (((double)digP3) * var1 * var1 / 524288.0 + ((double)digP2) *
           var1) / 524288.0;
    var1 = (1.0 + var1 / 32768.0) * ((double)digP1);
    if (var1 == 0.0)
    {
        P = 0;
    }
    P = 1048576.0 - (double)press_raw.raw;
    P = (P - (var2 / 4096.0)) * 6250.0 / var1;
    var1 = ((double)digP9) * P * P/ 2147483648.0;
    var2 = P * ((double)digP8) /32768.0;
    P = P + (var1 + var2 +((double)digP7)) / 16.0;
}
```

Example 2-7. `Weather_click.h` Code

```
#ifndef   XC_HEADER_TEMPLATE_H
#define   XC_HEADER_TEMPLATE_H


#include <xc.h>
#include <stdbool.h>
#include <stddef.h>
#include <stdint.h>

#ifdef __cplusplus
extern "C" {
#endif

    // Section: Macro Declarations
    void WEATHERclick_Config(void);
    void WEATHERclick_ReadID(void);
    void WEATHERclick_ReadTempParameters(void);
    void WEATHERclick_ReadPressParameters(void);
    void WEATHERclick_ReadHumParameters(void);
    void WEATHERclick_ReadTemp(void);
    void WEATHERclick_ReadPress(void);
    void WEATHERclick_ReadHum(void);
    void WEATHERclick_TempCalc(void);
    void WEATHERclick_PressCalc(void);
    void WEATHERclick_HumCalc(void);
    void WEATHERclick_PrintResults(void);

#ifdef __cplusplus
}
#endif
#endif
// End of File
```

Example 2-8. `main.c` Code

```
#include "mcc_generated_files/mcc.h"
#include "Weather_click.h"

void main(void)
{
    SYSTEM_Initialize();

    WEATHERclick_ReadTempParameters();
    WEATHERclick_ReadPressParameters();
    WEATHERclick_ReadHumParameters();
    printf("\r\n\r\nPIC18F25K42 Weather Station\r\n");
    printf("Curiosity HPC with MikroeElektronika WEATHERclick\r\n");
    printf("BME280 Environmental Sensor BOSCH SensorTec\r\n\r\n");
```

```
    WEATHERclick_ReadID();

    while (1)
    {
        WEATHERclick_Config();
        WEATHERclick_ReadTemp();
        WEATHERclick_ReadPress();
        WEATHERclick_ReadHum();
        WEATHERclick_TempCalc();
        WEATHERclick_PressCalc();
        WEATHERclick_HumCalc();
        WEATHERclick_PrintResults();
        __delay_ms(500);
    }
}
// End of File
```

3. Conclusion

This user guide details the steps needed to create a project that interfaces the MikroElektronika Weather Click with the PIC18F25K42 microcontroller. The Weather Click detects temperature, pressure, and humidity values which are read and calibrated by the PIC18F25K42. The environmental data are then transmitted to a PC terminal program for viewing. Although this document provides the procedures to create the user's own project, it can also be found as an example project on the MPLAB Xpress website at: https://mplabxpress.microchip.com/mplabcloud/example/details/415.

For more information on the PIC18F25K42, or on any other Microchip device, visit www.microchip.com.

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- Technical Support

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