MPLAB® XC8 User's Guide for Embedded Engineers

INTRODUCTION

This document presents five code examples for 8-bit devices and the MPLAB XC8 C compiler. Some knowledge of microcontrollers and the C programming language is necessary.

1. TURN LEDS ON OR OFF

This example will light alternate LEDs on the Explorer 8 board with a PIC16F1719 microcontroller (MCU). For more information, see **Section B. "Get Software and Hardware"**.

```
#include <xc.h>          see Section 1.1

// PIC16F1719 Configuration Bit Settings

// For more on Configuration Bits,          see Section 1.2
// consult your device data sheet

// CONFIG1
#pragma config FOSC = ECH     // External Clock, 4-20 MHz
#pragma config WDTE = OFF     // Watchdog Timer (WDT) disabled
#pragma config PWRTE = OFF    // Power-up Timer disabled
#pragma config MCLRE = ON     // MCLR/VPP pin function is MCLR
#pragma config CP = OFF       // Flash Memory Code Protection off
#pragma config BOREN = ON     // Brown-out Reset enabled
#pragma config CLKOUTEN = OFF // Clock Out disabled.
#pragma config IESO = ON      // Internal/External Switchover on
#pragma config FCMEN = ON     // Fail-Safe Clock Monitor enabled

// CONFIG2
#pragma config WRT = OFF      // Flash Memory Self-Write Protect off
#pragma config PPS1WAY = ON   // PPS one-way control enabled
#pragma config ZCDDIS = ON    // Zero-cross detect disabled
#pragma config PLLEN = OFF    // Phase Lock Loop disable
#pragma config STVREN = ON    // Stack Over/Underflow Reset enabled
#pragma config BORV = LO      // Brown-out Reset low trip point
#pragma config LPBOR = OFF    // Low-Power Brown Out Reset disabled
#pragma config LVP = OFF      // Low-Voltage Programming disabled

#define LEDS_ON_OFF 0x55          see Section 1.3

void main(void) {

    // Port D access          see Section 1.4

    ANSELD = 0x0; // set to digital I/O (not analog)
    TRISD = 0x0;  // set all port bits to be output
    LATD = LEDS_ON_OFF; // write to port latch - RD[0:3] = LED[0:3]

    // Port B access
    ANSELB = 0x0; // set to digital I/O (not analog)
    TRISB = 0x0;  // set all port bits to be output
    LATB = LEDS_ON_OFF; // write to port latch - RB[0:3] = LED[4:7]

    return;
}
```

1.1 Header File <xc.h>

This header file allows code in the source file to access compiler- or device-specific features. This and other header files may be found in the MPLAB XC8 installation directory in the `include` subdirectory.

Based on your selected device, the compiler will set macros that allow `xc.h` to vector to the correct device-specific header file. Do not include a device-specific header in your code or your code will not be portable.

1.2 Configuration Bits

Microchip devices have configuration registers with bits that enable and/or set up device features.

> **Note:** If you do not set Configuration bits correctly, your device will not operate at all or at least not as expected.

WHICH CONFIGURATION BITS TO SET

In particular, you need to look at:

- **Oscillator selection** - This must match your hardware's oscillator circuitry. If this is not correct, the *device clock may not run*. Typically, development boards use high-speed crystal oscillators. From the example code:
  `#pragma config FOSC = ECH`
- **Watchdog timer**- It is recommended that you disable this timer until it is required. This prevents *unexpected Resets*. From the example code:
  `#pragma config WDTE = OFF`
- **Code protection** - Turn off code protection until it is required. This ensures that *device memory is fully accessible*. From the example code:
  `#pragma config CP = OFF`

Different configuration bits may need to be set up to use another 8-bit device (rather than the PIC16F1719 MCU used in this example). See your device data sheet for the name and function of corresponding configuration bits. Use the part number to search http://www.microchip.com for the appropriate data sheet.

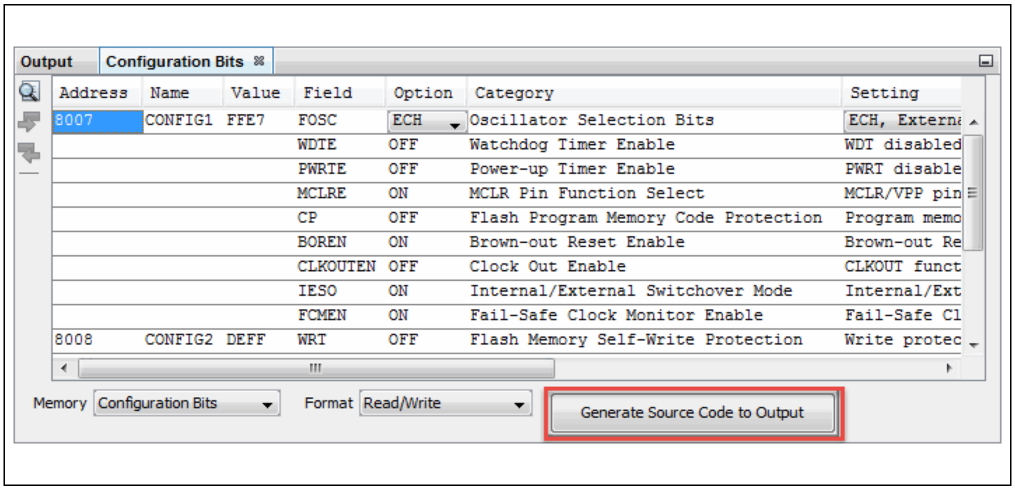
For more about configuration bits that are available for each device, see the following file in the location where MPLAB XC8 was installed:

`MPLAB XC8 Installation Directory/docs/chips`

HOW TO SET CONFIGURATION BITS

In MPLAB X IDE, you can use the Configuration Bits window to view and set these bits. Select *Window>PIC Memory Views>Configuration Bits* to open this window.

FIGURE 1: CONFIGURATION WINDOW



Once you have the settings you want, click **Generate Source Code to Output** and then copy the `pragma` directives from the Output window into your code, as was done in the example code.

1.3 Define Macro for LED Values

The value to be written to the LEDs, as explained in the next section, has been assigned to a descriptive macro (`LEDS_ON_OFF`), i.e., LEDs D1, D3, D5, and D7 will be on and LEDs D2, D4, D6 and D8 will be off. See the *Explorer 8 Development Board User's Guide* (DS40001812) for the board schematic (**Section B.4 "Get and Set Up the Explorer 8 Board"**).

1.4 Port Access

Digital I/O device pins may be multiplexed with peripheral I/O pins. To ensure that you are using digital I/O only, disable the other peripheral(s). Do this by using the pre-defined C variables that represent the peripheral registers and bits. These variables are listed in the device-specific header file in the compiler `include` directory. To determine which peripherals share which pins, refer to your device data sheet.

For the example in this section, Port D and Port B pins are multiplexed with peripherals that are disabled by default. The only issue is that the pins default to analog so you will need to set them to digital I/O. For Port D:

```
ANSELD = 0x0; // set to digital I/O (not analog)
```

A device pin is connected to either a digital I/O port (`PORT`) or latch (`LAT`) register in the device. For the example, `LATD` and `LATB` are used. The macro `LEDS_ON_OFF` is assigned to both latches. For Port D:

```
LATD = LEDS_ON_OFF; // write to port latch - RD[0:3] = LED[0:3]
```

In addition, there is a register for specifying the directionality of the pin - either input or output - called a TRIS register. For the example in this section, `TRISD` and `TRISB` are used. Setting a bit to 0 makes the pin an output, and setting a bit to 1 makes the pin an input. For Port D:

```
TRISD = 0x0; // set all port bits to be output
```

2. FLASH LEDs USING _delay() FUNCTION

This example is a modification of the previous code. Instead of just turning on LEDs, this code will flash alternating LEDs.

```
#include <xc.h>

// PIC16F1719 Configuration Bit Settings
// For more on Configuration Bits, consult your device data sheet

// CONFIG1
#pragma config FOSC = ECH      // External Clock, 4-20 MHz
#pragma config WDTE = OFF      // Watchdog Timer (WDT) disabled
#pragma config PWRTE = OFF     // Power-up Timer disabled
#pragma config MCLRE = ON      // MCLR/VPP pin function is MCLR
#pragma config CP = OFF        // Flash Memory Code Protection off
#pragma config BOREN = ON      // Brown-out Reset enabled
#pragma config CLKOUTEN = OFF // Clock Out disabled.
#pragma config IESO = ON       // Internal/External Switchover on
#pragma config FCMEN = ON      // Fail-Safe Clock Monitor enabled

// CONFIG2
#pragma config WRT = OFF       // Flash Memory Self-Write Protect off
#pragma config PPS1WAY = ON    // PPS one-way control enabled
#pragma config ZCDDIS = ON     // Zero-cross detect disabled
#pragma config PLLEN = OFF     // Phase Lock Loop disable
#pragma config STVREN = ON     // Stack Over/Underflow Reset enabled
#pragma config BORV = LO       // Brown-out Reset low trip point
#pragma config LPBOR = OFF     // Low-Power Brown Out Reset disabled
#pragma config LVP = OFF       // Low-Voltage Programming disabled

#define LEDS_ON_OFF 0x05
#define LEDS_OFF_ON 0x0A
#define INSTR_CYCLE_DELAY 25000

void main(void) {

    // Port D access
    ANSELD = 0x0; // set to digital I/O (not analog)
    TRISD = 0x0;  // set all port bits to be output

    // Port B access
    ANSELB = 0x0; // set to digital I/O (not analog)
    TRISB = 0x0;  // set all port bits to be output

    while(1) {      see Section 2.1

        LATD = LEDS_ON_OFF; // RD[0:3] = LED[0:3]
        LATB = LEDS_ON_OFF; // RB[0:3] = LED[4:7]

        // delay value change      see Section 2.2

        _delay(INSTR_CYCLE_DELAY); // delay in instruction cycles

        LATD = LEDS_OFF_ON; // RD[0:3] = LED[0:3]
        LATB = LEDS_OFF_ON; // RB[0:3] = LED[4:7]
        _delay(INSTR_CYCLE_DELAY); // delay in instruction cycles

    }
    return;
}
```

2.1 The while() Loop and Variable Values

To make the LEDs on Port D and Port B change, the macro `LEDS_ON_OFF` is assigned in the first part of the loop and a complementary macro, `LEDS_OFF_ON`, is assigned in the second part of the loop. To perform the loop, `while(1) { }` was used.

2.2 The _delay() Function

Because the speed of execution will, in most cases, cause the LEDs to flash faster than the eye can see, execution needs to be slowed. `_delay()` is a built-in function of the compiler.

For more details on the delay built-in, see the *MPLAB® XC8 C Compiler User's Guide* (DS50002053).

3. COUNT UP ON LEDs USING INTERRUPTS AS DELAY

This example is a modification of the previous code. Although the delay loop in the previous example was useful in slowing down loop execution, it created dead time in the program. To avoid this, a timer interrupt can be used.

```
#include <xc.h>

// PIC16F1719 Configuration Bit Settings
// For more on Configuration Bits, consult your device data sheet

// CONFIG1
#pragma config FOSC = ECH     // External Clock, 4-20 MHz
#pragma config WDTE = OFF     // Watchdog Timer (WDT) disabled
#pragma config PWRTE = OFF    // Power-up Timer disabled
#pragma config MCLRE = ON     // MCLR/VPP pin function is MCLR
#pragma config CP = OFF       // Flash Memory Code Protection off
#pragma config BOREN = ON     // Brown-out Reset enabled
#pragma config CLKOUTEN = OFF // Clock Out disabled.
#pragma config IESO = ON      // Internal/External Switchover on
#pragma config FCMEN = ON     // Fail-Safe Clock Monitor enabled

// CONFIG2
#pragma config WRT = OFF      // Flash Memory Self-Write Protect off
#pragma config PPS1WAY = ON   // PPS one-way control enabled
#pragma config ZCDDIS = ON    // Zero-cross detect disabled
#pragma config PLLEN = OFF    // Phase Lock Loop disable
#pragma config STVREN = ON    // Stack Over/Underflow Reset enabled
#pragma config BORV = LO      // Brown-out Reset low trip point
#pragma config LPBOR = OFF    // Low-Power Brown Out Reset disabled
#pragma config LVP = OFF      // Low-Voltage Programming disabled

// Interrupt function      ◄─────  see Section 3.1

void interrupt isr(void){
   // only process Timer0-triggered interrupts
   if(INTCONbits.TMR0IE && INTCONbits.TMR0IF) {
            // static variable for permanent storage duration
            static unsigned char portValue;
            // write to port latches
            LATD = ++portValue;      // RD[0:3] = LED[0:3]
            LATB = (portValue >> 4); // RB[0:3] = LED[4:7]
            // clear this interrupt condition
            INTCONbits.TMR0IF = 0;
   }
}

void main(void){

    // Port D access
    ANSELD = 0x0; // set to digital I/O (not analog)
    TRISD = 0x0;  // set all port bits to be output

    // Port B access
    ANSELB = 0x0; // set to digital I/O (not analog)
    TRISB = 0x0;  // set all port bits to be output
```

```
    // Timer0 setup        see Section 3.2

    OPTION_REG = 0xD7; // timer 0 internal clock, prescaler 1:256
    INTCONbits.TMR0IE = 1; // enable interrupts for timer 0
    ei(); // enable all interrupts

    while(1);

   return;
}
```

3.1 The Interrupt Function `isr()`

Functions are made into interrupt functions by using the `interrupt` specifier. As this one interrupt function may have to handle multiple interrupt sources, code was added to ensure the counter `portValue` is only incremented if Timer0 generated the interrupt.

3.2 Timer0 Setup

Code also needs to be added to the main routine to enable and set up the timer, enable timer interrupts, and change the latch assignment, now that the variable value changes are performed in the interrupt service routine.

To enable all interrupts, `ei()` is used, defined in `xc.h`.

4 DISPLAY POTENTIOMETER VALUES ON LEDS USING A/D

This example uses the same device and the Port B and Port D LEDs as the previous example. However, in this example, values from a potentiometer on the demo board provide A/D input through Port A that is converted and displayed on the LEDs.

Instead of generating code by hand, the MPLAB Code Configurator (MCC) is used. The MCC is a plug-in available for installation under the MPLAB X IDE menu *Tools>Plugins*, **Available Plugins** tab. See MPLAB X IDE Help for more on how to install plugins.

For information on the MCC, including the *MPLAB® Code Configurator User's Guide* (DS40001725), go to the MPLAB Code Configurator web page at:

http://www.microchip.com/mplab/mplab-code-configurator

For this example, the MCC GUI was set up as shown in the following graphics.

FIGURE 2: ADC PROJECT SYSTEM RESOURCE CONFIGURATION

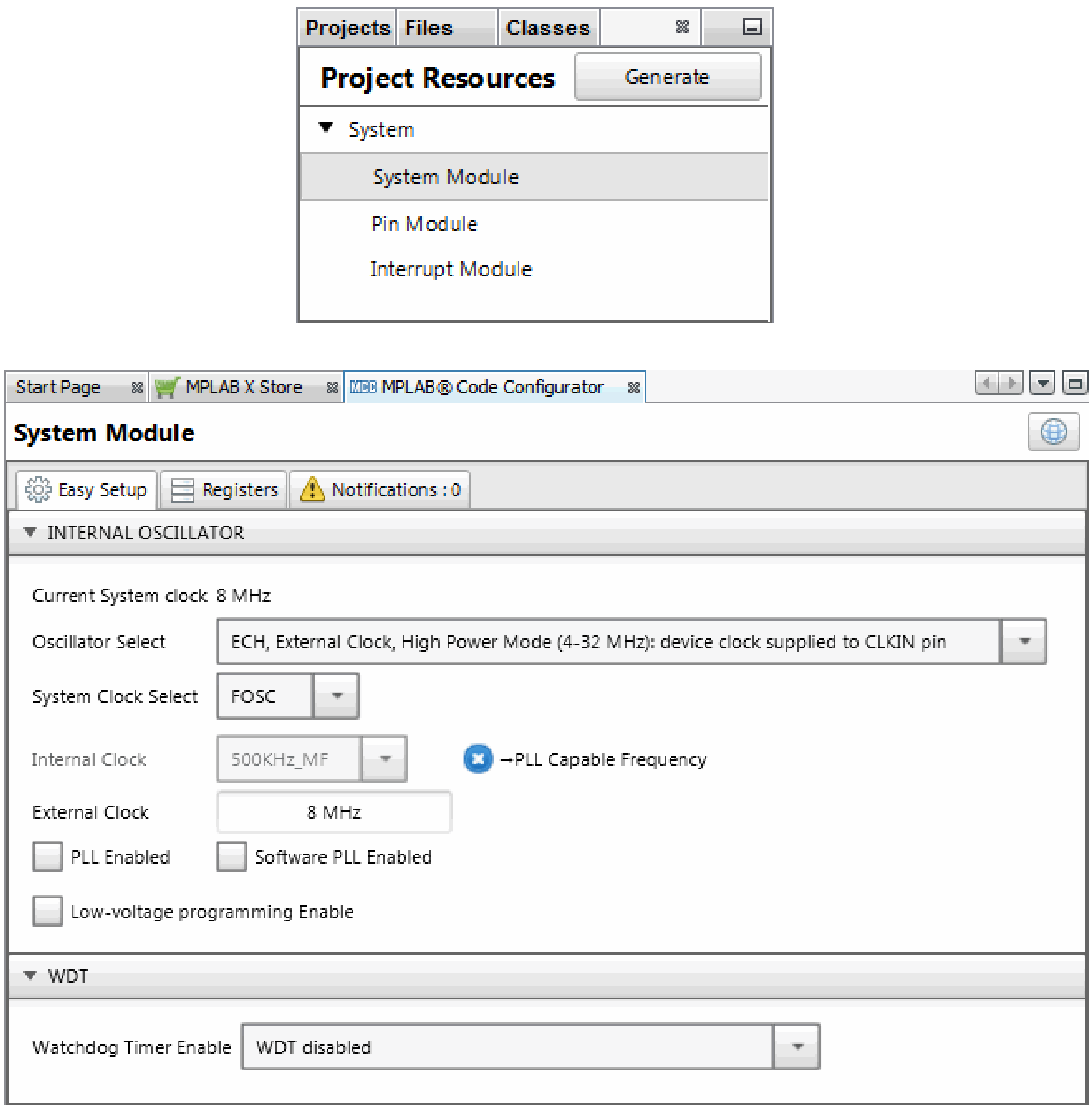


FIGURE 3: ADC PROJECT ADC RESOURCE CONFIGURATION

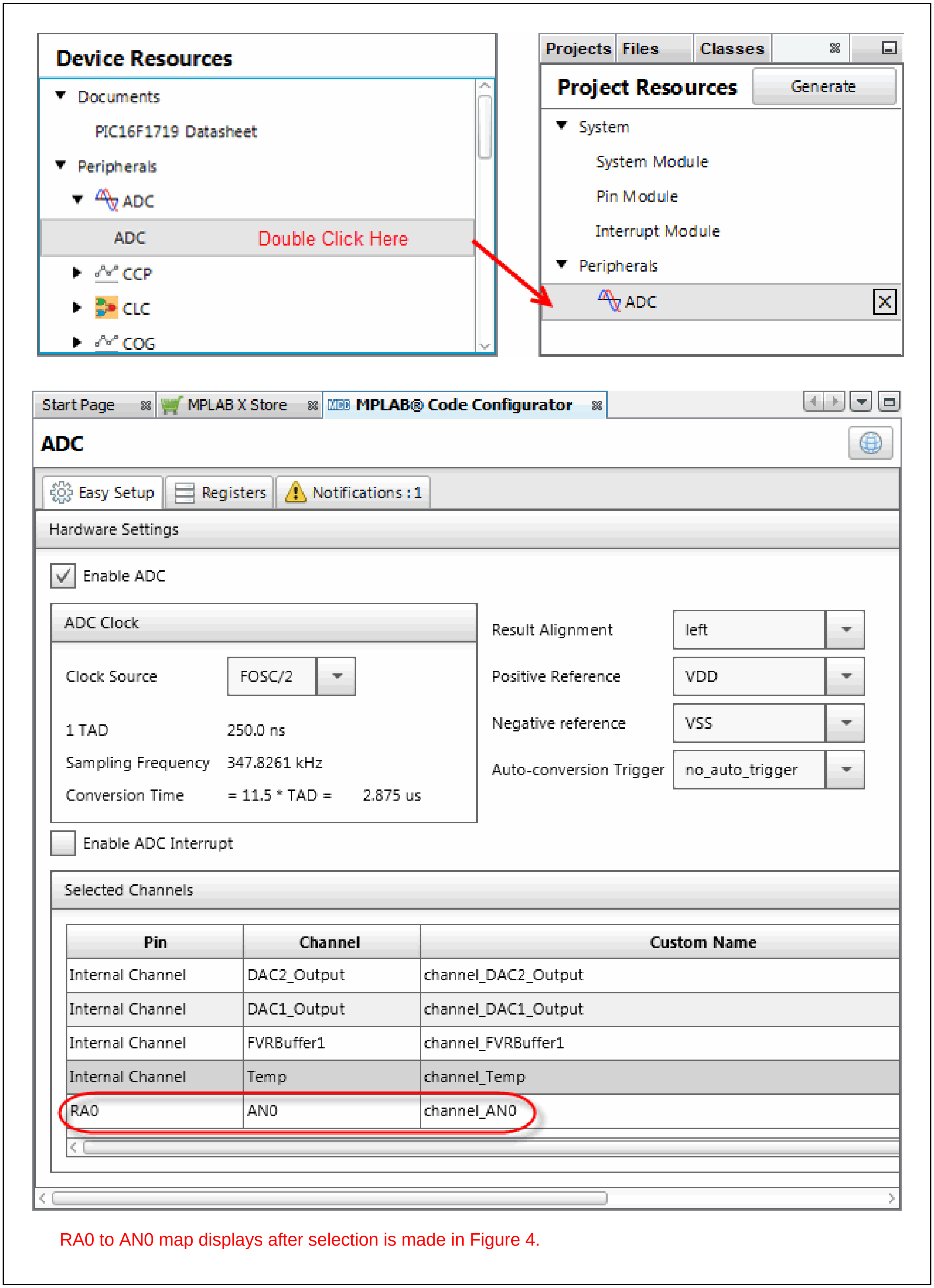


FIGURE 4: ADC PROJECT ADC PIN RESOURCE- GRID

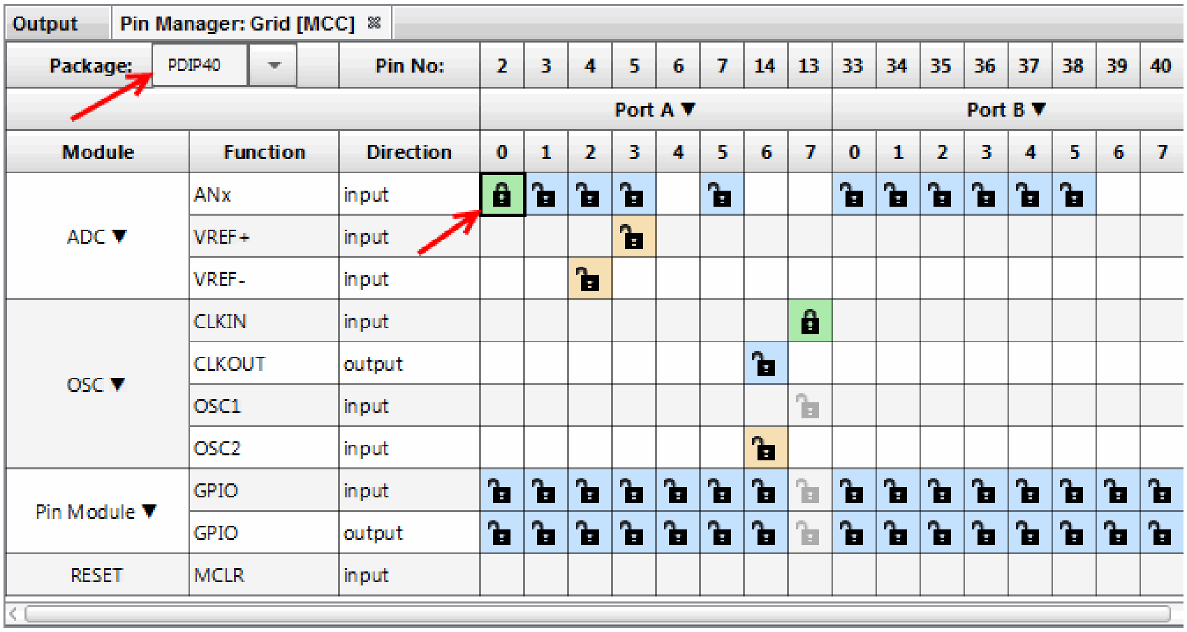
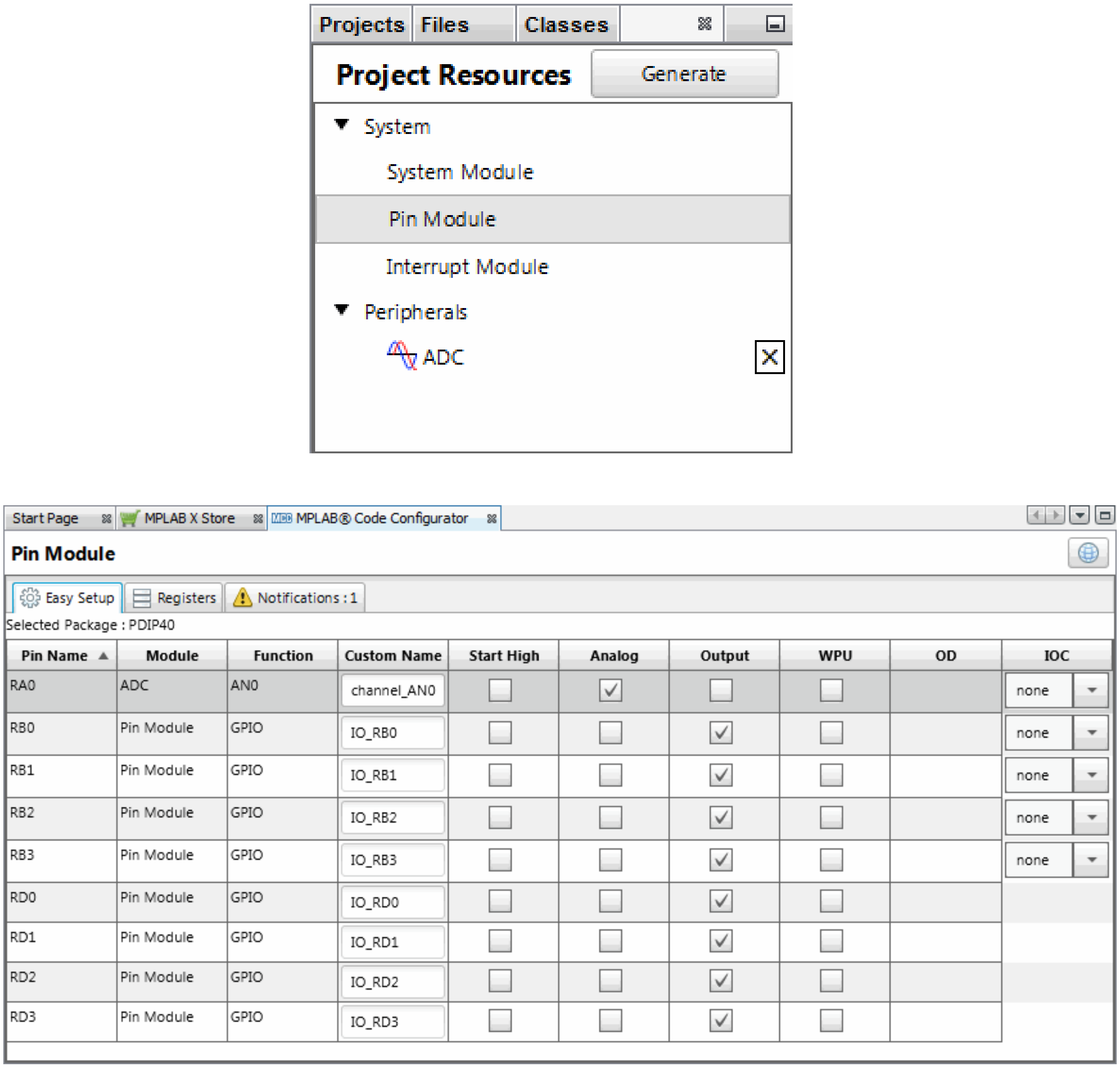


FIGURE 5: ADC PROJECT PIN RESOURCE CONFIGURATION



Pins RB0:3 and RD0:3 will appear in the window above when they are selected in Figure 6.

RA0 was previously selected in Figure 4.

Once visible in the window, pin configurations may be selected for each pin.

FIGURE 6: ADC PROJECT GPIO PIN RESOURCE- GRID

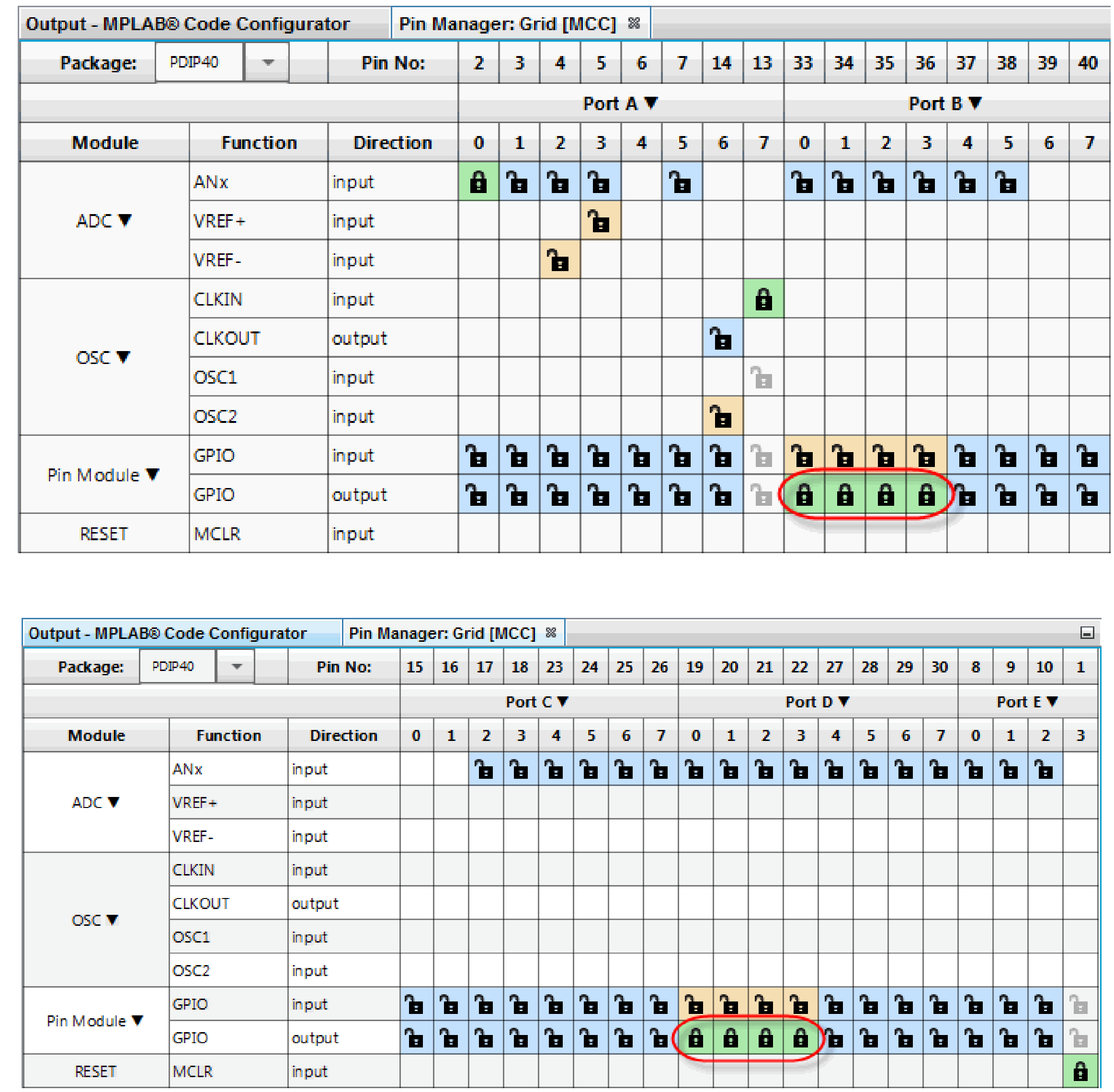
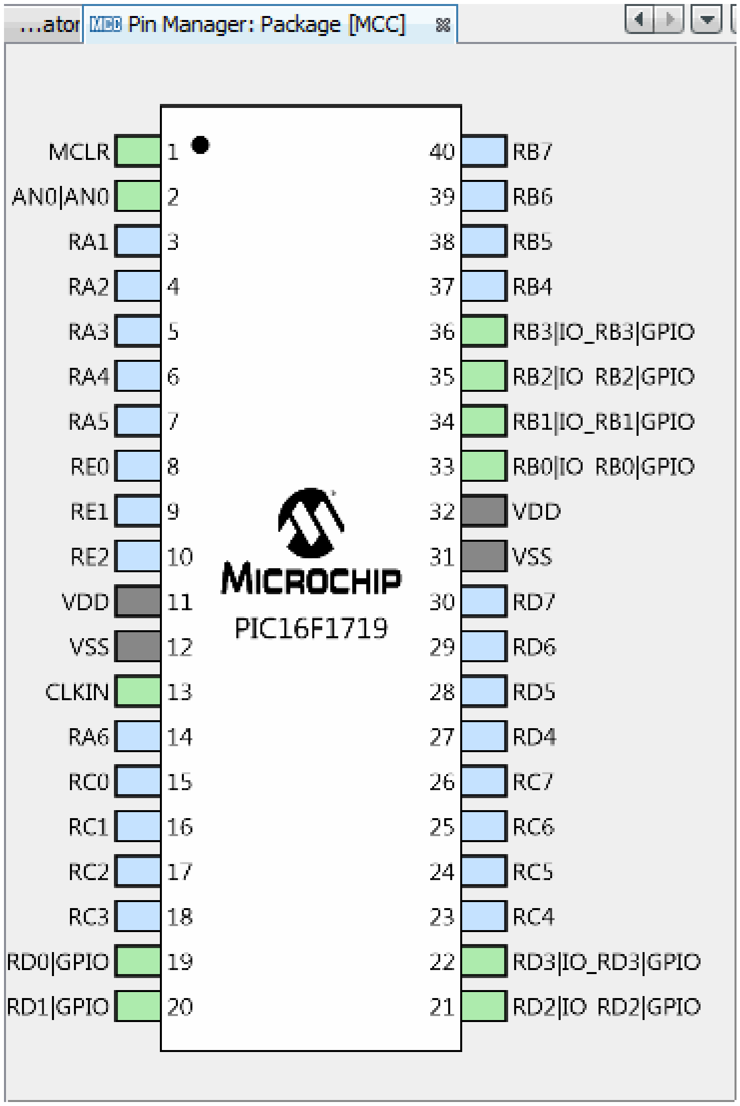


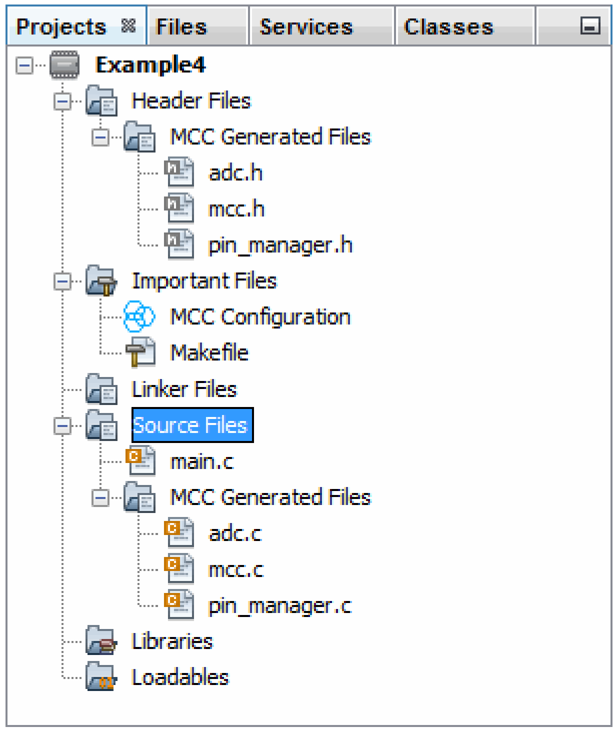
FIGURE 7: ADC PROJECT GPIO PIN RESOURCE - PACKAGE



When the code is configured as shown in the previous figures, click the **Generate** button on the "Project Resources" window. Code generated by the MCC is modular. Therefore main, system, and peripheral code are all in individual files. Also, each peripheral has its own header file.

Editing of `main.c` is always required to add functionality to your program. Review the generated files to find any functions or macros you may need in your code.

FIGURE 8: ADC PROJECT TREE FOR CODE GENERATED BY MCC



4.1 main.c Modified Code

The `main.c` template file has been edited as shown below. Some comments have been removed as described in < >. Code added to `main()` is in red.

```
/**
  Generated Main Source File

<See generated main.c file for file information.>
 */

/*
  (c) 2016 Microchip Technology Inc. and its subsidiaries. You may use
  this software and any derivatives exclusively with Microchip
  products.

<See generated main.c file for additional copyright information.>
 */

#include "mcc_generated_files/mcc.h"

/*
                         Main application
 */
void main(void) {
    // initialize the device
    SYSTEM_Initialize();

    // <No interrupts used - see generated main.c file for code.>

    while (1) {

        // Start A/D conversion            see Section 4.2

        ADC_StartConversion(channel_AN0);

        // Wait for ADC to complete            see Section 4.3

        while(!ADC_IsConversionDone());

        // Write to Port Latches            see Section 4.4

        LATD = ADRESH; // RD[0:3] = LED[0:3]
        LATB = (ADRESH >> 4); // RB[0:3] = LED[4:7]

    }
}
/**
 End of File
 */
```

4.2 Start A/D Conversion

From the `adc.c` module, use the function:

```
void ADC_StartConversion(adc_channel_t channel)
```

The variable `channel` is of typedef `adc_channel_t` defined in `adc.h`. For this example, pot input is on RA0, so select `channel_AN0`.

4.3 Wait for ADC to compete

From the `adc.c` module, use the function:

```
bool ADC_IsConversionDone()
```

This function returns the negated value of the `ADCON0bits.GO_nDONE` bit (defined in the device header file). However, the actual value of this bit is desired in the `main while` loop, so the return value is negated again.

4.4 Write to Port Latches

As only 8 LEDs are available, just the value from ADRESH is displayed. The lower bits are displayed via `LATD` on LEDs 0 through 3, and the upper bits are shifted so they can be displayed via `LATB` on LEDs 4 through 7.

5. DISPLAY EEPROM DATA VALUES ON LEDS

This example uses another Microchip device, the PIC16F1939 MCU, to demonstrate how to write to and read from EEPROM Data (EEData). Read values are displayed on Port D and Port B LEDs.

Again, MPLAB Code Configurator (MCC) is used to generate most of the code. To find out how to install and get the user's guide for MCC, see:
Section 4 "Display Potentiometer Values on LEDs Using A/D".

For this example, the MCC GUI was set up as shown in the following graphics.

FIGURE 9: EEDATA PROJECT SYSTEM RESOURCE CONFIGURATION

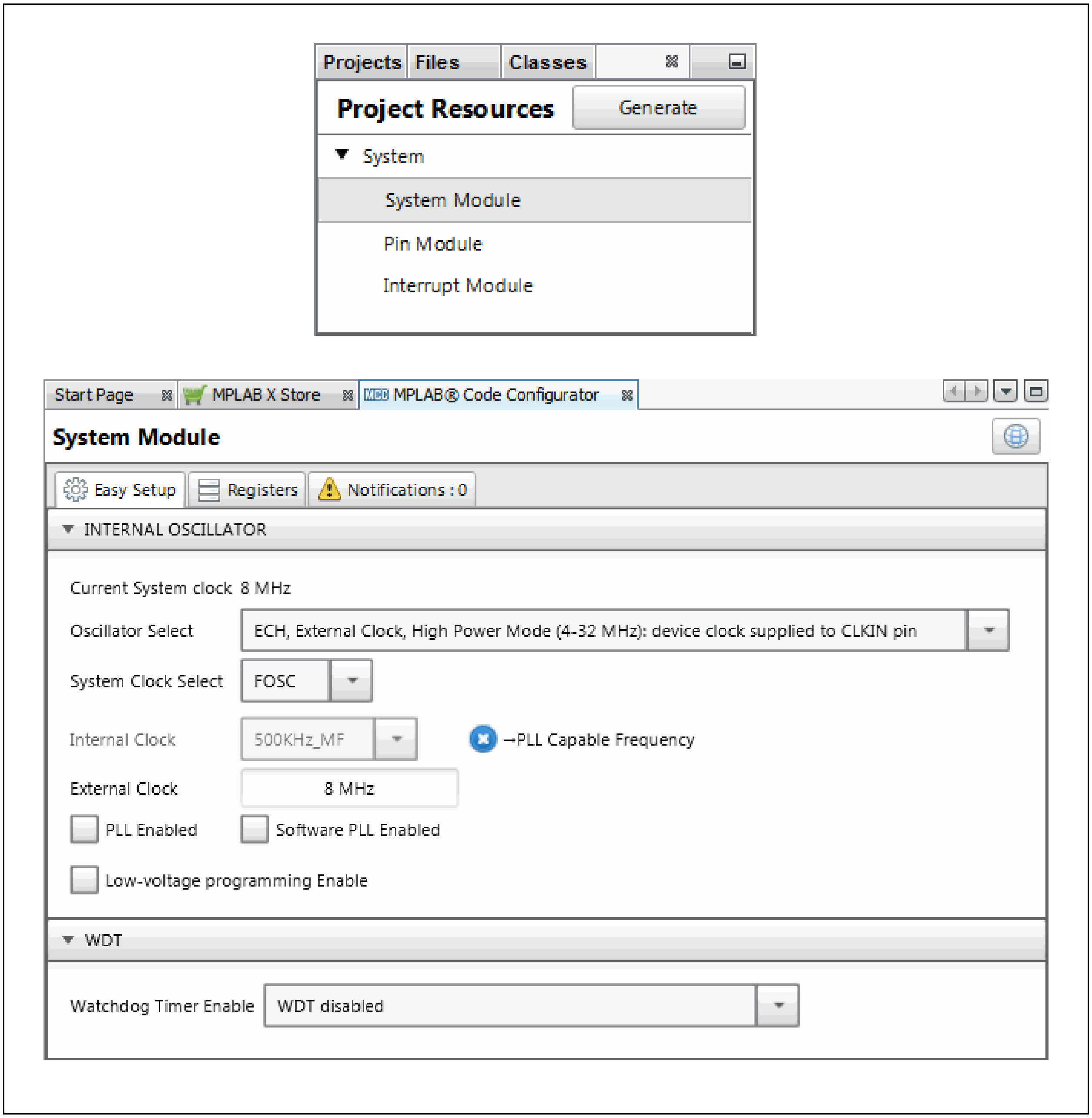


FIGURE 10: EEDATA PROJECT MEMORY RESOURCE CONFIGURATION

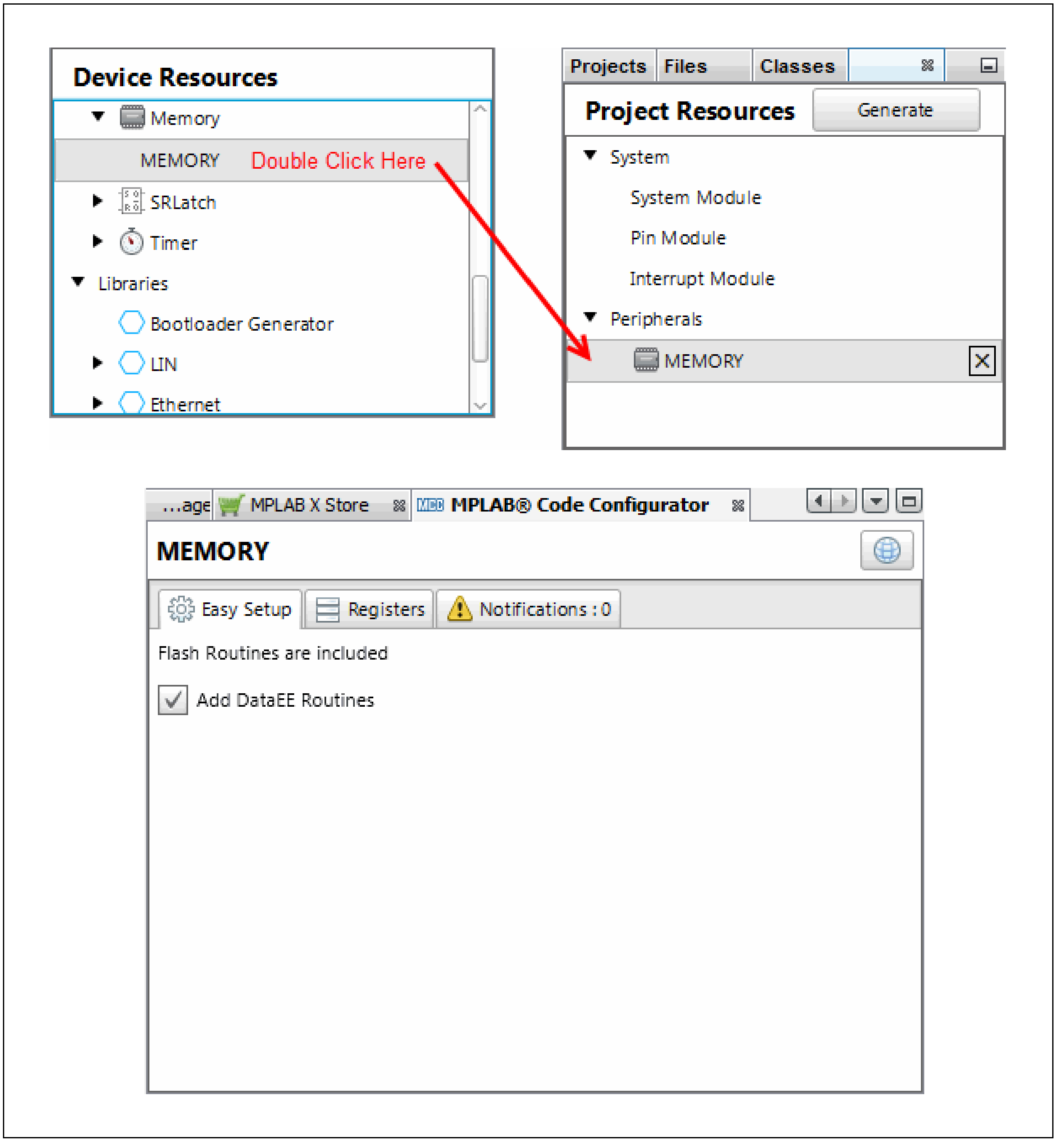
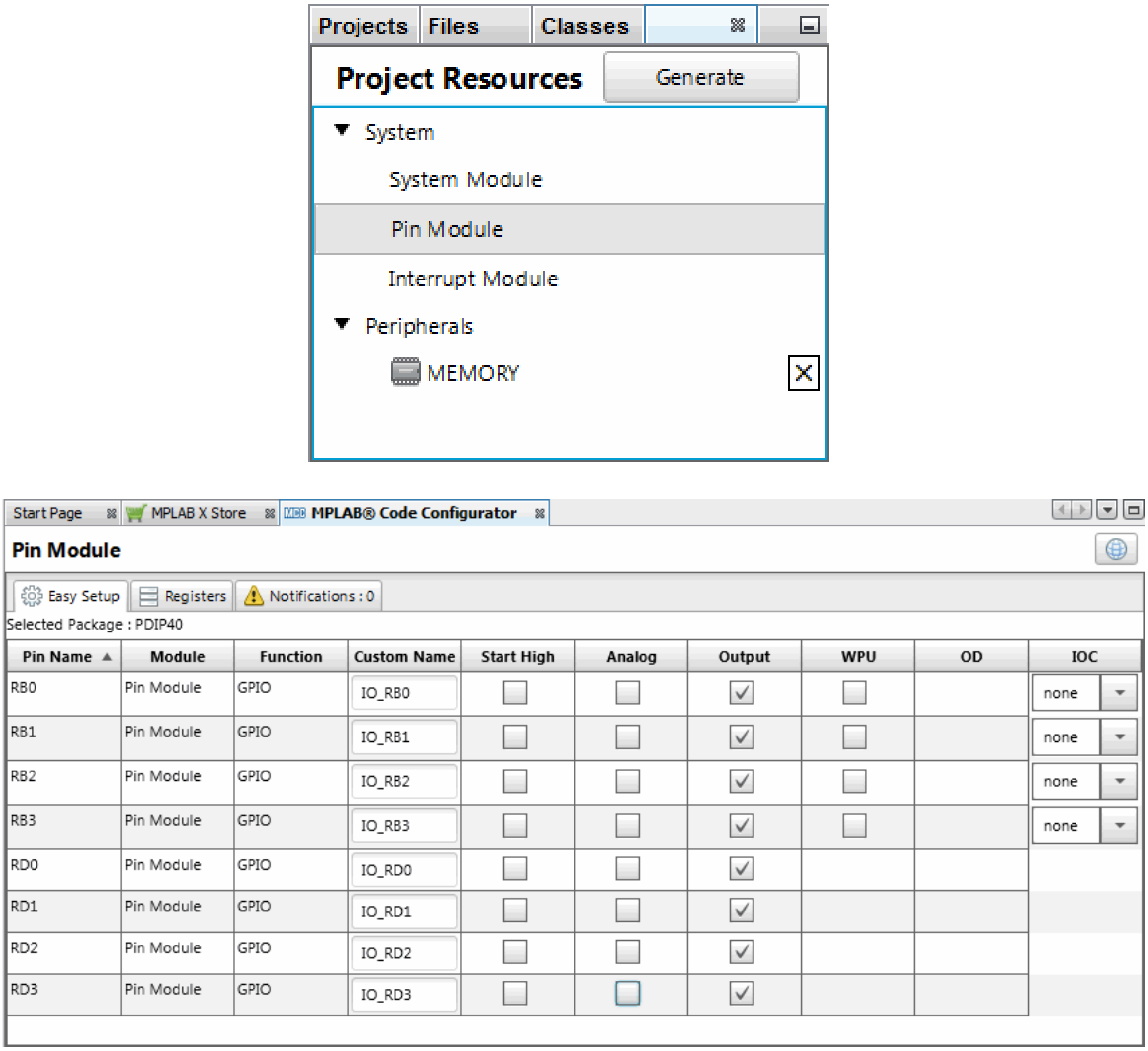


FIGURE 11: EEDATA PROJECT PIN RESOURCE CONFIGURATION



Pins RB0:3 and RD0:3 will appear in the window above when they are selected in Figure 12.
Once visible in the window, pin configurations may be selected for each pin.

FIGURE 12: EEDATA PROJECT GPIO PIN RESOURCE- GRID

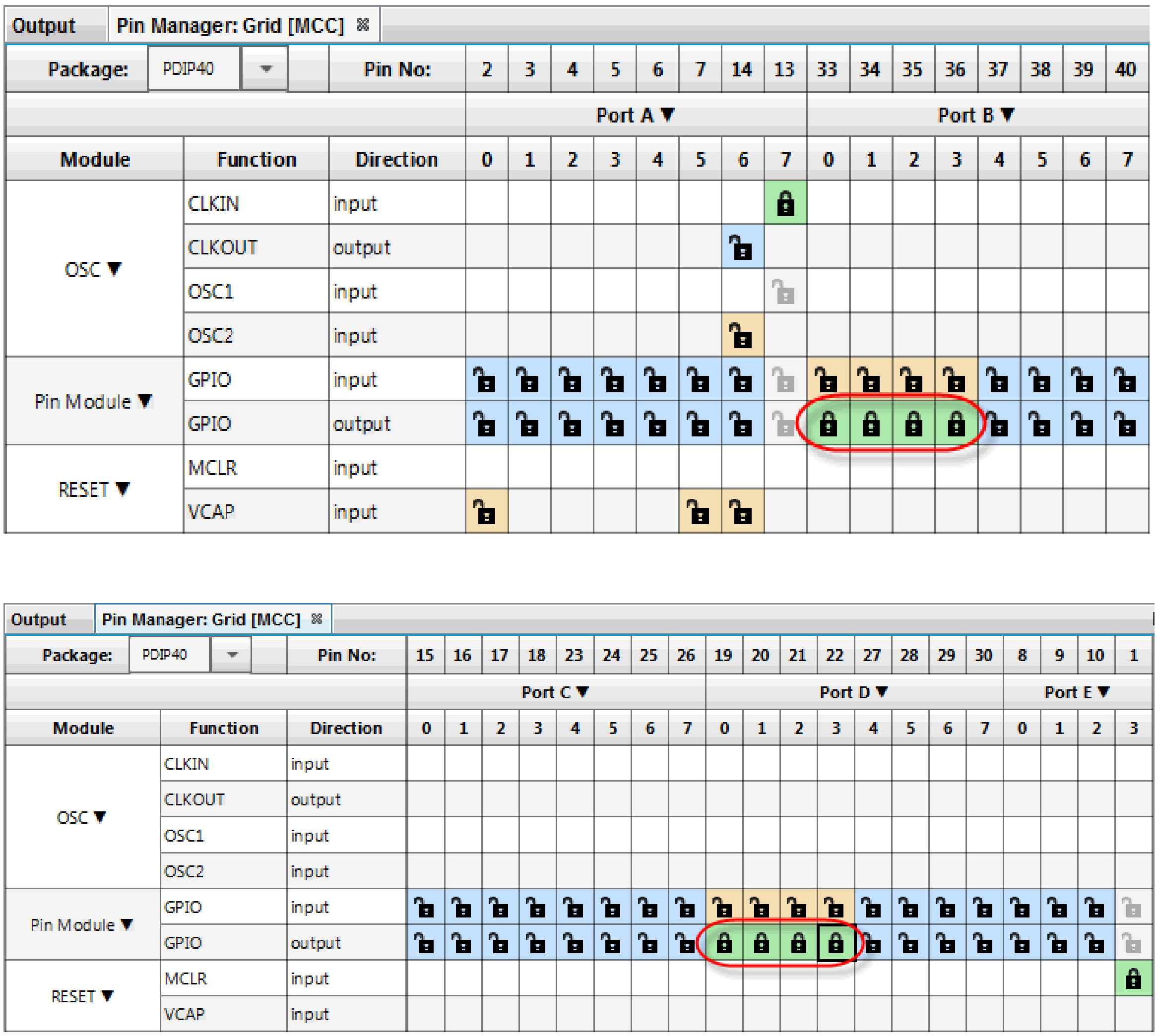
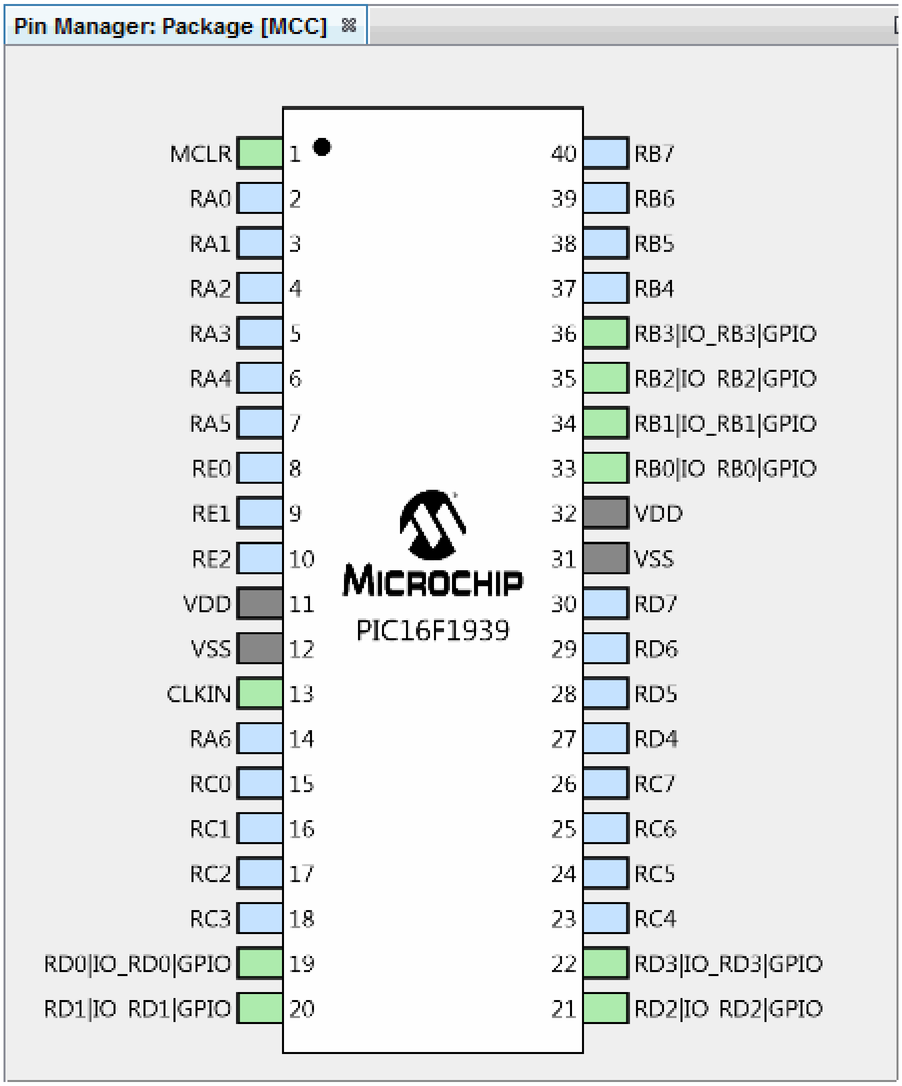


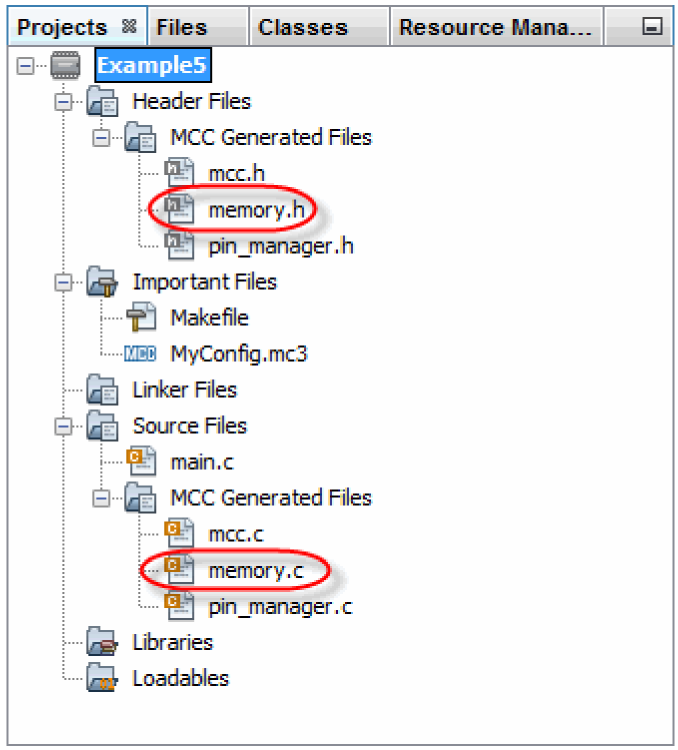
FIGURE 13: EEDATA PROJECT GPIO PIN RESOURCE - PACKAGE



When the code is configured as shown in the previous figures, click the **Generate** button on the “Project Resources” window. Code generated by the MCC is modular. Therefore main, system, and peripheral code are all in individual files. Also, each peripheral has its own header file.

Editing of `main.c` is always required to add functionality to your program. Review the generated files to find any functions or macros you may need in your code.

FIGURE 14: EEDATA PROJECT TREE FOR CODE GENERATED BY MCC



5.1 `main.c` Modified Code

The `main.c` template file has been edited as shown below. Some comments have been removed as described in < >. Code added is in red.

```
/**
  Generated Main Source File

<See generated main.c file for file information.>
 */

/*
  (c) 2016 Microchip Technology Inc. and its subsidiaries. You may use
  this software and any derivatives exclusively with Microchip
  products.

<See generated main.c file for additional copyright information.>
 */

#include "mcc_generated_files/mcc.h"

#define NUM_EE_VALUES 64
#define INSTR_CYCLE_DELAY 25000

/*
                         Main application
 */
void main(void) {
    // initialize the device
    SYSTEM_Initialize();

    // <No interrupts used - see generated main.c file for code.>

    // Declare RAM array, loop variable          see Section 5.2

    volatile unsigned char RAMArray[NUM_EE_VALUES];
    unsigned char i;

    // Write initial values to EEPROM Data          see Section 5.3
    PIR2bits.EEIF = 0x0; // clear write flag

    for(i=0; i<NUM_EE_VALUES; i++){
        DATAEE_WriteByte(_EEADRL_EEADRL_POSN + i, i);
        while(!PIR2bits.EEIF);  // check for write finished
        PIR2bits.EEIF = 0x0;
    }

    while(1){
        // Read from EEPROM and display          see Section 5.4
        for(i=0; i<NUM_EE_VALUES; i++){
            RAMArray[i] = DATAEE_ReadByte(_EEADRL_EEADRL_POSN + i);
            LATD = RAMArray[i]; // RD[0:3] = LED[0:3]
            LATB = (RAMArray[i] >> 4); // RB[0:3] = LED[4:7]
            _delay(INSTR_CYCLE_DELAY); // delay value change
        }
```



```
        // Write to EEPROM in reverse order
        for(i=0; i<NUM_EE_VALUES; i++){
            DATAEE_WriteByte(_EEADRL_EEADRL_POSN +
              (NUM_EE_VALUES - 1) - i, RAMArray[i]);
            while(!PIR2bits.EEIF);  // check for write finished
            PIR2bits.EEIF = 0x0;
        }

    };

}
/**
 End of File
 */
```

5.2 EEData Associated Variables

Variables used to store data from an EEData read or write must match the types specified in the read/write function prototype, referenced from `mcc.h`, and found in `memory.h`:

```
void DATAEE_WriteByte(uint8_t bAdd, uint8_t bData);
uint8_t DATAEE_ReadByte(uint8_t bAdd);
```

From `stdint.h` (also referenced), `uint8_t` is the same as `unsigned char`.

5.3 Write to EEData

EEData is written twice in this example: first to initialize values in EEData memory and second to change the data for dynamic display.

Writing to EEData takes more than one cycle, so a write-complete flag is used to determine when the write is done (`PIR2bits.EEIF`). The flag is cleared initially, and again, after each time the write completes. (This flag must be cleared in software.)

5.4 Read from EEData

After EEData is written, memory values are read into a RAM array and then displayed on Port D and Port B LEDs. The values in the RAM array are used in this write loop to change the values in EEData memory.

Because the speed of execution will, in most cases, cause the LEDs to flash faster than the eye can see, the `_delay()` function is used again (as in Example 2) to slow execution.

A. RUN CODE IN MPLAB X IDE

Create a project as follows:

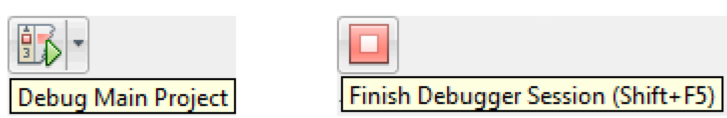
1. Launch MPLAB X IDE.
2. From the IDE, launch the New Project Wizard (*File>New Project*).
3. Follow the screens to create a new project:
   a) **Choose Project:** Select "Microchip Embedded", and then select "Standalone Project".
   b) **Select Device:** Select the example device.
   c) **Select Header:** None.
   d) **Select Tool:** Select your hardware debug tool, SNxxxxxx. If you do not see a serial number (SN) under your debug tool name, ensure that your debug tool is correctly installed. See your debug tool documentation for details.
   e) **Select Plugin Board:** None.
   f) **Select Compiler:** Select XC8 (*latest version number*) [`bin` *location*]. If you do not see a compiler under XC8, ensure the compiler is correctly installed and that MPLAB X IDE is aware of it (*Tools>Options*, **Embedded** button, **Build Tools** tab). See MPLAB XC8 and MPLAB X IDE documentation for details
   g) **Select Project Name and Folder:** Name the project.

After your project is created, do one of the following, based on the example you are using:

1. For examples 1, 2 and 3, create a file to hold the example code:
   a) Right click on the project name in the Projects window. Select *New>Empty FIle*. The New Empty File dialog will open.
   b) Under "File name", enter a name.
   c) Click **Finish**.
   d) Cut and paste the example code from this user's guide into the empty editor window and select *File>Save*.
2. For examples 4 and 5, follow the instructions in each section to generate code using MCC and then edit the `main.c` file with the code shown.

Finally, build, download to a device, and execute the code by selecting Debug Run. You will see every other LED lit on the demo board. Click Halt to end execution.

FIGURE 15: TOOLBAR ICONS



DEBUG RUN **HALT**

B. GET SOFTWARE AND HARDWARE

For the MPLAB XC8 projects in this document, the Explorer 8 board (with either a PIC16F1719 or PIC16F1939 MCU) is powered from a 9V external power supply, and uses standard (ICSP™) communications. MPLAB X IDE was used for development.

B.1 Get MPLAB X IDE and MPLAB XC8 C Compiler

MPLAB X IDE v3.35 and later can be found at:

http://www.microchip.com/mplab/mplab-x-ide

The MPLAB XC8 C compiler v1.38 and later can be found at:

http://www.microchip.com/mplab/compilers

B.2 Get the MPLAB Code Configurator (MCC)

The MCC v3.15 and later can be found at:

http://www.microchip.com/mplab/mplab-code-configurator

B.3 Get PIC® MCUs

The PIC MCUs used in the examples are available at:

http://www.microchip.com/PIC16F1719

http://www.microchip.com/PIC16F1939

B.4 Get and Set Up the Explorer 8 Board

The Explorer 8 development kit (DM160228) is available at:

http://www.microchip.com/DM160228

Jumpers were set up as shown in the following tables.

TABLE 1-1: JUMPER SELECTS FOR PROJECTS

Jumper	Selection	Description
J2	BRD+5V	Power board from power supply (not USB)
J14	+5V	Device Power level
J24	Open	+5V used (not 3.3V)
J7	Closed	Enable LEDs on Port D <RD0:3>
J21	Closed	Enable LEDs on Port B <RB0:3>
J36	OSC1 to RA7	OSC1 CLKIN (8MHz External Oscillator)
J37	OSC2 to RA6	OSC2 CLKOUT (8MHz External Oscillator)
J51	PGD to RB7	ICSPDAT
J52	PGC to RB6	ISCPCLK

TABLE 1-2: JUMPER SELECTS NOT USED

Jumper	Selection	Description
JP2	Closed	LCD not used
J22, J23, J53, J54	Open	LCD not used
J15, J16	Open	Digilent Pmod™ Connectors not used
J43, J44, J45, J46, J47	Open	mikroBUS not used
J41, J42, J48, J49, J50	Open	mikroBUS not used
J4, J31	VCAP	RA5, RA4 not used

B.5 Get Microchip Debug Tools

Emulators and Debuggers may be found on the Development Tools web page:

http://www.microchip.com/development-tools

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