



MICROCHIP

**MPLAB[®] Code Configurator
User's Guide**

MPLAB[®] CODE CONFIGURATOR USER'S GUIDE

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Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC[®] MCUs and dsPIC[®] DSCs, KEELOQ[®] code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.



Table of Contents

Preface	4
Introduction.....	4
Document Layout	4
Conventions Used in this Guide	5
Recommended Reading.....	6
The Microchip Web Site	7
Development Systems Customer Change Notification Service	7
Customer Support	8
Revision History	8
Chapter 1. Overview	
1.1 Introduction	9
Chapter 2. Getting Familiar with the User Interface	
2.1 Operating Areas	10
2.1.1 Resource Area	10
2.1.1.1 Device Resources Area	10
2.1.1.2 Project Resources Area	12
2.1.2 Pin Manager Area	13
2.1.2.1 Package View	13
2.1.2.2 Table View	14
2.1.3 Composer Area	14
2.1.3.1 Initializers	15
2.1.3.2 MCC File Handling	16
2.1.3.3 MCC Dialogs	16
Chapter 3. Operating the MPLAB[®] Code Configurator	
3.1 Procedure for Peripheral Drivers Generation	17
3.1.1 GPIO Module	19
3.2 Generated Peripheral Drivers	21
3.2.1 Code Modification Tracking	22
Appendix A. Support	
A.1 Abbreviations Used	23
A.2 Support	23
Worldwide Sales and Service	24



MPLAB[®] CODE CONFIGURATOR USER'S GUIDE

Preface

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 web site (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 "DSXXXXA", where "XXXX" 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 chapter contains general information that will be useful to know before using the MPLAB[®] Code Configurator. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Revision History

DOCUMENT LAYOUT

This document describes how to use the MPLAB[®] Code Configurator to generate peripheral driver code. The document is organized as follows:

- **Chapter 1. "Overview"**
- **Chapter 2. "Installation"**
- **Chapter 2. "Getting Familiar with the User Interface"**
- **Chapter 3. "Operating the MPLAB[®] Code Configurator"**
- **Appendix A. "Support "**

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	<i>MPLAB[®] IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	<u><i>File>Save</i></u>
Bold characters	A dialog button	Click OK
	A tab	Click the Power tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	#define START
	Filenames	autoexec.bat
	File paths	c:\mcc18\h
	Keywords	_asm, _endasm, static
	Command-line options	-Opa+, -Opa-
	Bit values	0, 1
	Constants	0xFF, 'A'
Italic Courier New	A variable argument	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets []	Optional arguments	mcc18 [options] <i>file</i> [options]
Curly brackets and pipe character: { }	Choice of mutually exclusive arguments; an OR selection	errorlevel {0 1}
Ellipses...	Replaces repeated text	var_name [, var_name...]
	Represents code supplied by user	void main (void) { ... }

MPLAB[®] Code Configurator User's Guide

RECOMMENDED READING

This user's guide describes how to use MPLAB[®] Code Configurator. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

<http://www.microchip.com/mcc>

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

DEVELOPMENT SYSTEMS CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at www.microchip.com, click on Customer Change Notification and follow the registration instructions.

The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers, assemblers, linkers and other language tools. These include all MPLAB C compilers; all MPLAB assemblers (including MPASM™ assembler); all MPLAB linkers (including MPLINK™ object linker); and all MPLAB librarians (including MPLIB™ object librarian).
- **Emulators** – The latest information on Microchip in-circuit emulators. This includes the MPLAB REAL ICE™ and MPLAB ICE 2000 in-circuit emulators.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debuggers. This includes MPLAB ICD 3 in-circuit debuggers and PICKit™ 3 debug express.
- **MPLAB® IDE** – The latest information on Microchip MPLAB IDE, the Windows® Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB IDE Project Manager, MPLAB Editor and MPLAB SIM simulator, as well as general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include production programmers such as MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger and MPLAB PM3 device programmers. Also included are nonproduction development programmers such as PICSTART® Plus and PICKit 2 and 3.

MPLAB[®] Code Configurator User's Guide

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at:

<http://www.microchip.com/support>.

REVISION HISTORY

Revision A (October 2013)

This is the initial release of this document.

Revision B (May 2014)

Updated Figures 3-7, 3-8, 4-3, 4-6, 4-7; Other minor corrections.

Chapter 1. Overview

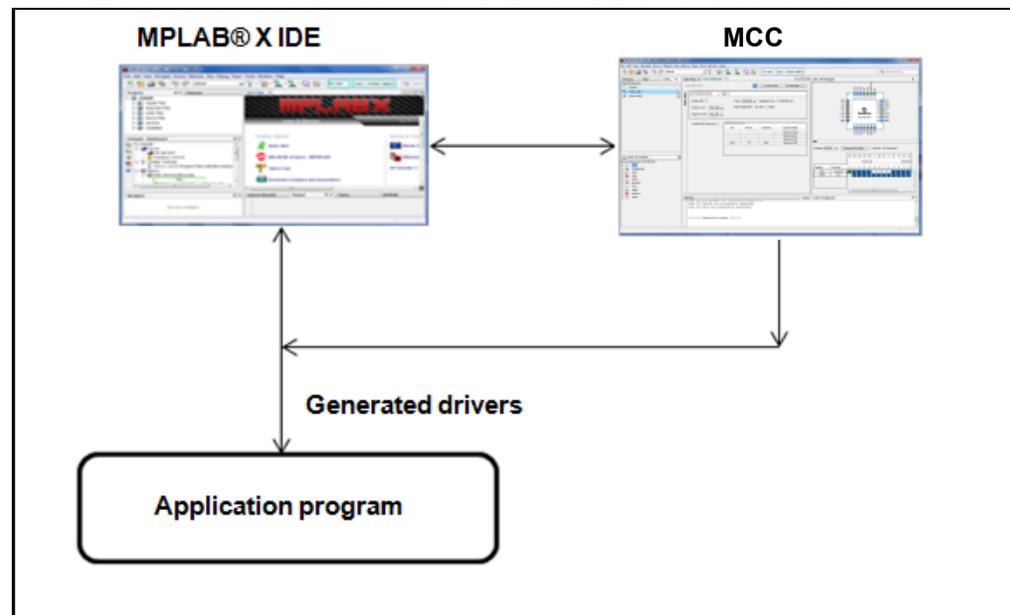
1.1 INTRODUCTION

The MPLAB® Code Configurator (MCC) is a user friendly plug-in tool for MPLAB® X IDE which generates drivers for controlling and driving peripherals of PIC® microcontrollers, based on the settings and selections made in the Graphical User Interface (GUI). The generated drivers can be used in any application program.

Before starting MCC, a new MPLAB X IDE project needs to be created or an existing project needs to be opened. This is necessary as MCC needs to know the device used in the application, to have access to device-specific information like registers, bits and configurations and also to setup its GUI. MCC generates source and header files based on selections made in the GUI. It adds the generated files into the active project of MPLAB X IDE.

Figure 1-1 shows an overview of working of the MCC for generating peripheral drivers.

FIGURE 1-1: WORKING OF MPLAB® CODE CONFIGURATOR



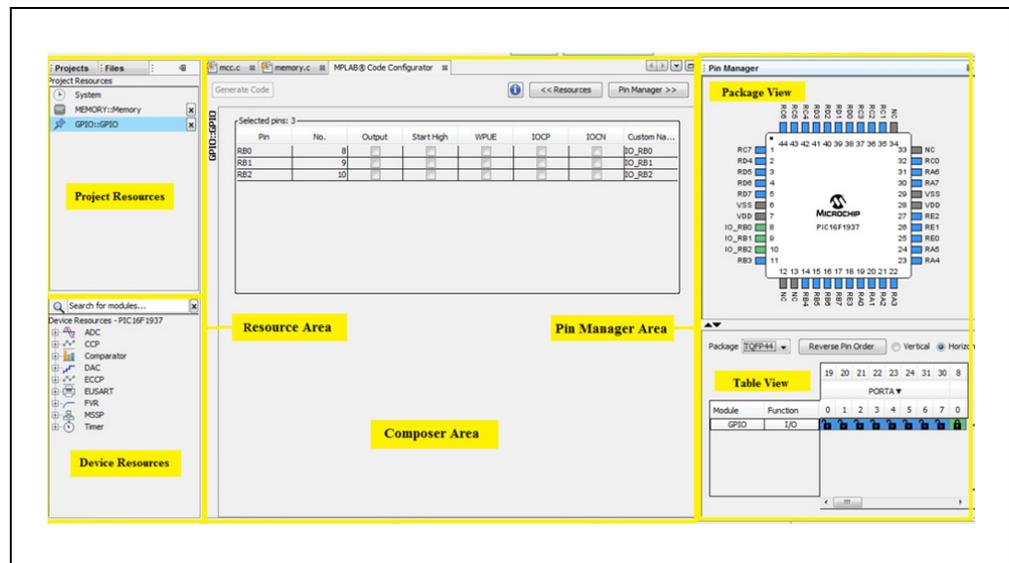
Chapter 2. Getting Familiar with the User Interface

2.1 OPERATING AREAS

MCC user interface consists of the following three main operating areas, see Figure 2-1.

- **Resource Area:** It displays the MCC supported peripherals that are available in the selected device. Includes both selected Project Resources and a list of possible Device Resources.
- **Composer Area:** It is the main area in which a peripheral can be configured. It displays the possible configurations of the peripheral.
- **Pin Manager Area:** The I/O pins of the device can be configured in pin manager in Table view. It also displays the pinout of the device and their functions as a Package view.

FIGURE 2-1: MCC GUI WITH DIFFERENT OPERATING AREAS



2.1.1 Resource Area

It is further divided into two sub-windows:

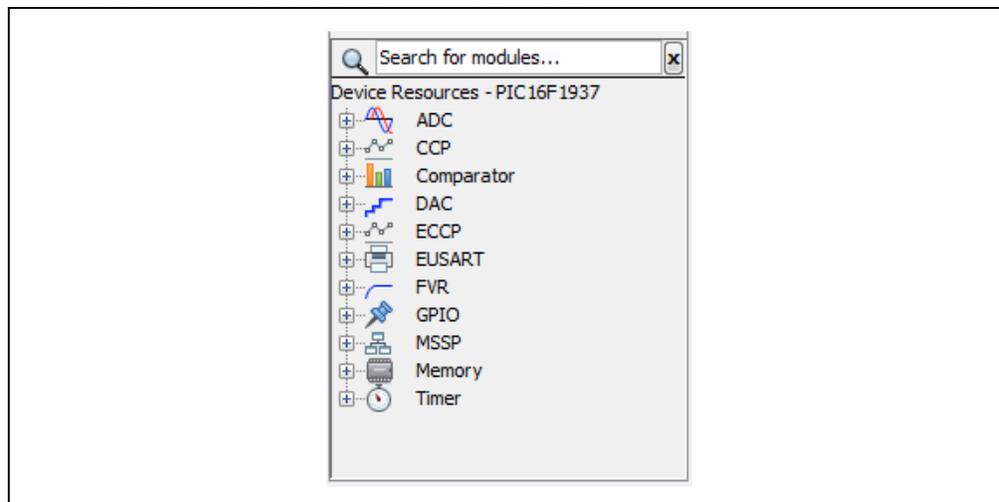
- Device Resources area, and
- Project Resources area

2.1.1.1 DEVICE RESOURCES AREA

The Device Resources area lists all supported peripherals of the selected device from where they can be included into the project resources. Once a peripheral is selected, it is moved to the Project Resource area, simultaneously invoking the pin manager with associated I/O pins of that peripheral.

Getting Familiar with the User Interface

FIGURE 2-2: DEVICE RESOURCES AREA



The device resources tree can also be navigated and handled by using the following keys:

- Up and down arrow keys: For moving up and down in the tree, respectively.
- Right arrow key: For expanding a node.
- Left arrow key: For collapsing a node.
- Space key: For enabling a module if it is not a node or expanding or collapsing a node.

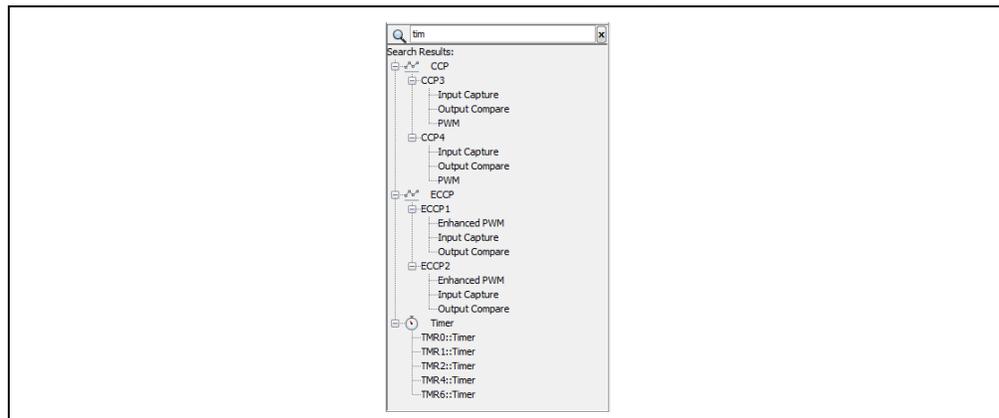
2.1.1.1.1 Peripheral Search Feature

MCC supports peripheral search in the Device Resources area. There's a search bar and any available peripherals can be based on their name or application use.

- **Based on peripheral name:**

Entering a few characters of the peripheral name in the search tab and pressing enter key lists all peripherals having those characters in their name. For example, see Figure 2-3 where the search has been done using a few characters of the peripheral name ("tim" for timers).

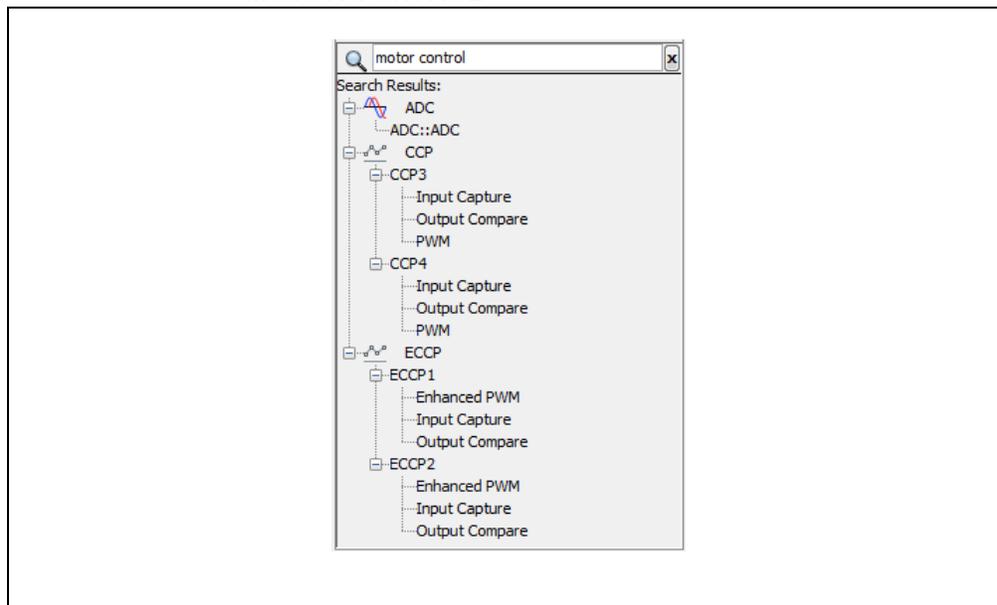
FIGURE 2-3: PERIPHERAL SEARCH BASED ON ITS NAME



- **Based on peripheral application:**

Entering the application name in the **Search** tab and pressing enter key lists all peripherals related to that particular application. For example, see Figure 2-4 where the search has been done using “motor control” keyword. This lists all the peripherals related to motor control applications.

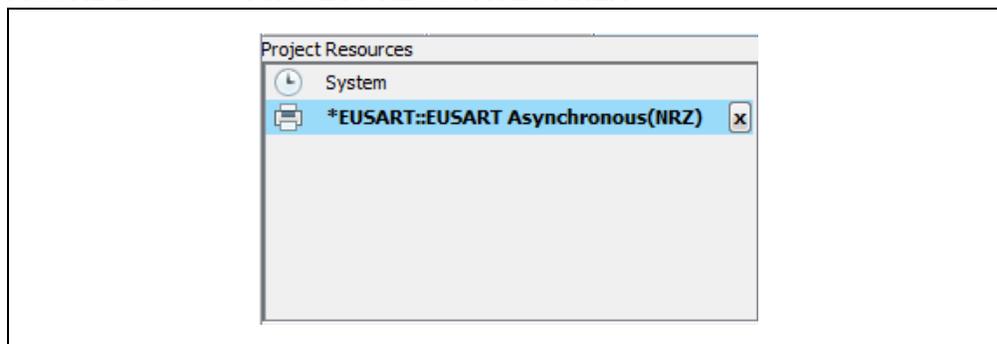
FIGURE 2-4: PERIPHERAL SEARCH BASED ON ITS APPLICATION: MOTOR CONTROL



2.1.1.2 PROJECT RESOURCES AREA

The Project Resources area consists of a list of enabled peripherals selected from the Device Resource area. For configuring, click the peripheral name. The corresponding peripheral GUI gets displayed in the Composer area from where the selected peripheral can be configured.

FIGURE 2-5: PROJECT RESOURCES AREA



A module in the Project Resources window can be disabled by right clicking it and selecting the “Disable Module” option or by clicking the “x” button against it. Disabling a module will remove it from the generated files and the respective module configurations will be lost.

Getting Familiar with the User Interface

2.1.2 Pin Manager Area

The pin manager area consists of the following two sub areas:

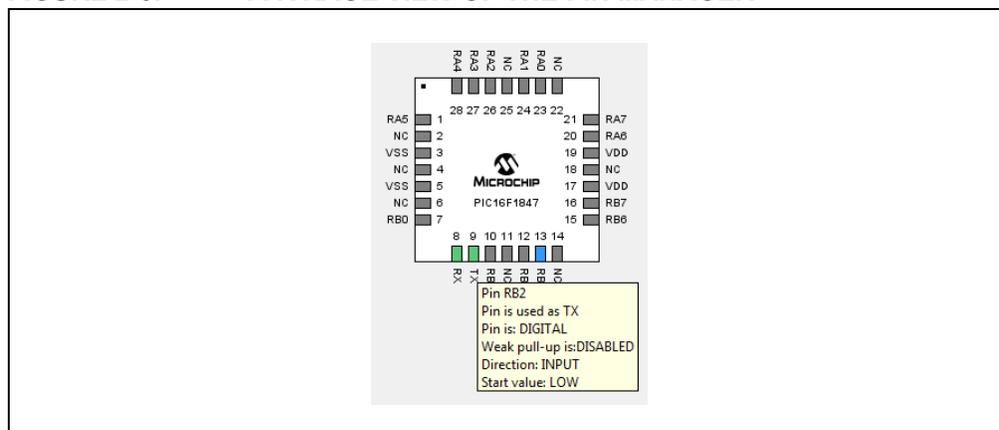
- **Package or graphical view** which shows the graphical package of the device, see Figure 2-6 and,
- **Table view** which shows the tabular form of pin manager, see Figure 2-7.

I/O pins of the selected device can be configured from these windows.

2.1.2.1 PACKAGE VIEW

The graphical pin manager can be zoomed in and out in order to adjust its visibility. This can be done by holding down the CTRL key and scrolling the mouse wheel. Also, hovering over a selected pin shows the real-time configuration of that pin. The functionality of a pin can be selected by right clicking it in the package and selecting the desired functionality among the listed ones.

FIGURE 2-6: PACKAGE VIEW OF THE PIN MANAGER

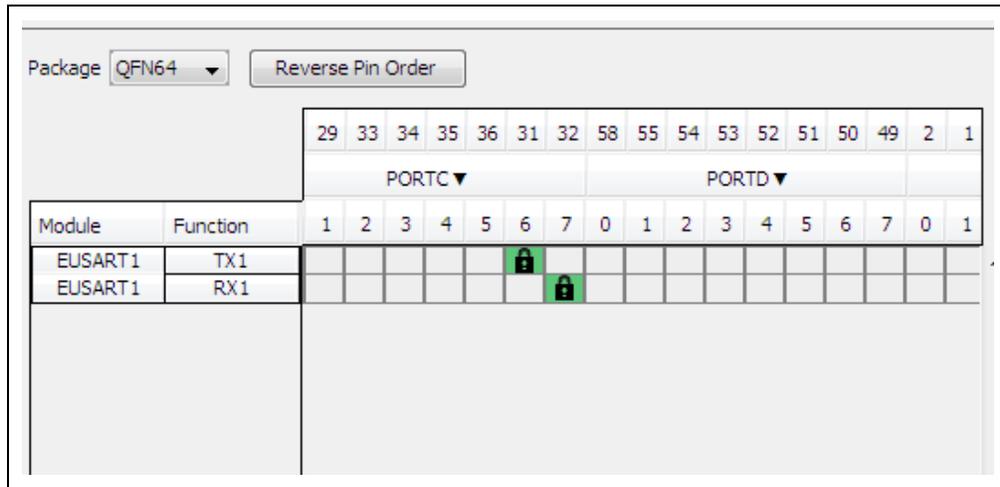


The following color combinations are associated with the pins in graphical view:

- **Grey colored pin:** It indicates that the pin is not usable in the selected configuration and that there is no enabled module which has any functionality on that pin.
- **Blue colored pins:** It indicates pins which can be allocated to a module for configuration.
- **Green colored pin:** This combination indicates that the pin has been allocated and selected for a module. The name displayed against the pin is either the name of the pin in the module's context or a custom name entered.
- **Yellow colored pin:** It indicates the pin currently being configured.

2.1.2.2 TABLE VIEW

FIGURE 2-7: TABLE VIEW OF THE PIN MANAGER



The **Package** button allows the user to select between various supported packages, the selection made at which gets reflected in the graphical view of the pin manager.

The **Reverse Pin Order** button changes the port order of the I/O's. Clicking this button will switch between port pin ordering 0-7 or 7-0.

The three columns in the table view which indicate module name, functionality name and the port pin numbers, respectively, are movable and can be switched in between them for easier access.

Hovering over a cell with a lock shows the pins functionality in that module while it is not selected. However, when a pin is selected, it shows the name in that module or the custom name entered. Clicking on the “**PORTx**” title cell expands/collapses all the pins in that port. Also, right clicking anywhere in the “**PORTx**” row shows a menu to collapse/expand all the ports.

More features of the pin manager:

Right clicking in the pin manager area pops up a menu with the following options:

- **Invert split panes:** It is used to invert the split panes between the graphical and table views of the pin manager.
- **Divider:** It is used to change the divider between the graphical and table views of the pin manager to either horizontal or vertical types.
- **Print:** It is used to print the graphical or table view of the pin manager. If the table view is selected for printing, the currently selected table gets printed. Thus, for printing both the horizontal and vertical tables, the user should switch and print each view individually.
- **Export:** It is used to save the package or the table view to an image file. The supported image formats are **.jpg**, **.png**, **.gif** and **.bmp** which along with the user defined name can be provided in the dialog which appears when this option is selected.

2.1.3 Composer Area

Once a peripheral is selected from the Project Resources area, its corresponding **Configuration** GUI is displayed in the Composer area. The Composer area is where a peripheral is configured based on application's requirements.

Getting Familiar with the User Interface

2.1.3.1 INITIALIZERS

Initializers are the functions which are generated based on the module configuration set by user inputs and settings done in the GUI. The GUI supports multiple initializers, so any number of initializers can be generated for a module based on the application's requirements. In the case of multiple initializers, each initializer GUI needs to be configured separately.

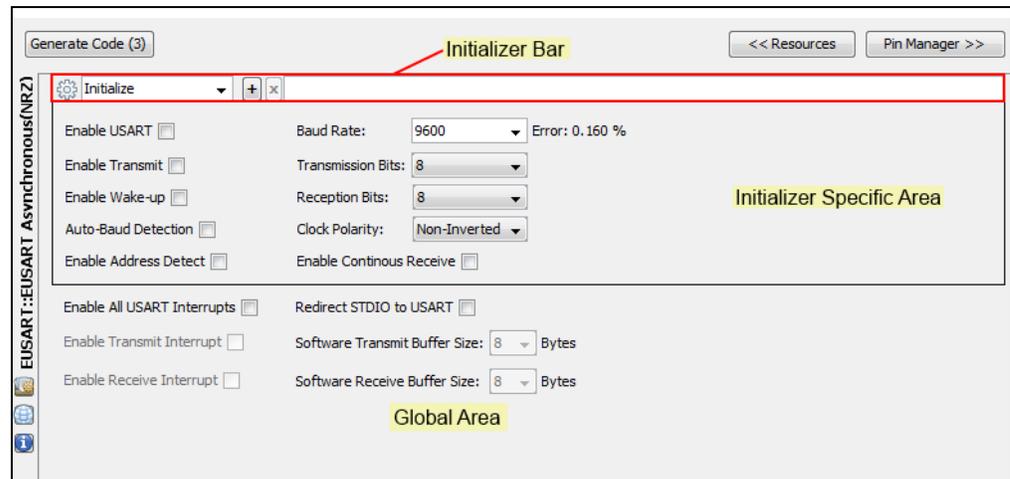
The Composer area has two main regions:

- **Initializer specific area:** It is the region which includes settings particular to the initializer. Any changes in the settings will be reflected in the generated configuration function. Visually, it is the area bounded by the black rectangle in the composer, see Figure 2-8.

The initializer specific area consists of an initializer bar from where an initializer can be added, removed, renamed or given comments. Clicking the “+” button adds a new initializer, whereas clicking “x” button removes the selected initializer. Also, the comment entered for an initializer is included in the generated code for the initializer.

- **Global area:** The region of the composer excluding the initializer specific area is treated as global area. It consists of settings which globally affect the module and thus all, initializers share these settings.

FIGURE 2-8: COMPOSER AREA FOR EUSART MODULE



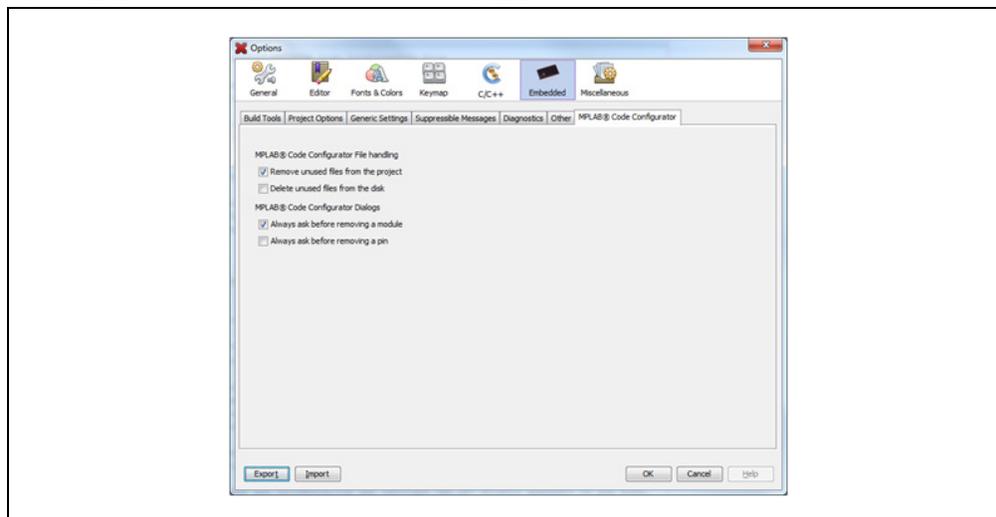
For example, if the EUSART peripheral is selected from the Project Resources area, the EUSART Composer area gets invoked, see Figure 2-8. The EUSART Composer area allows configuring different EUSART parameters related to transmission and reception operations. It also has fields to use peripheral interrupts as well as standard input-output (stdio) functions, which can be used depending upon the application needs. Once setting up of required peripheral configurations is done, clicking **Generate Code** will generate drivers for that particular peripheral. The **Generate Code** button gets activated only when there is something that needs to be generated (e.g., a new module) or when some changes have been done in an already generated module.

Hovering over the **Generate Code** button provides the list of modules which need to be generated or regenerated.

“**Resources**” and “**Pin manager**” buttons provide a link to those particular areas. Thus, if any of these areas are not in focus, they can be brought in focus by clicking these respective buttons.

Configuration of the operation of MCC can be managed by using the “Options” panel which can be invoked by clicking **Tools -> Options -> Embedded -> MPLAB Code Configurator** in the menu bar of MPLAB® X IDE.

FIGURE 2-9: MCC OPTIONS PANEL



The MCC Options panel offers the following controls:

2.1.3.2 MCC FILE HANDLING

- **Remove unused files from the project:** Enabling this option tells the MCC to remove .c and .h files for modules which were removed from the MCC configuration between the subsequent generation procedures. This option ensures that the files which are included in the project (and thus in the compilation) are only those which are strictly necessary. However, this will not delete files from the disk.
- **Delete unused files from the disk:** This option gets enabled only when “Remove unused files from the project” is selected. This performs the additional task of deleting unused files from the disk and thus, files cannot be recovered anymore.

2.1.3.3 MCC DIALOGS

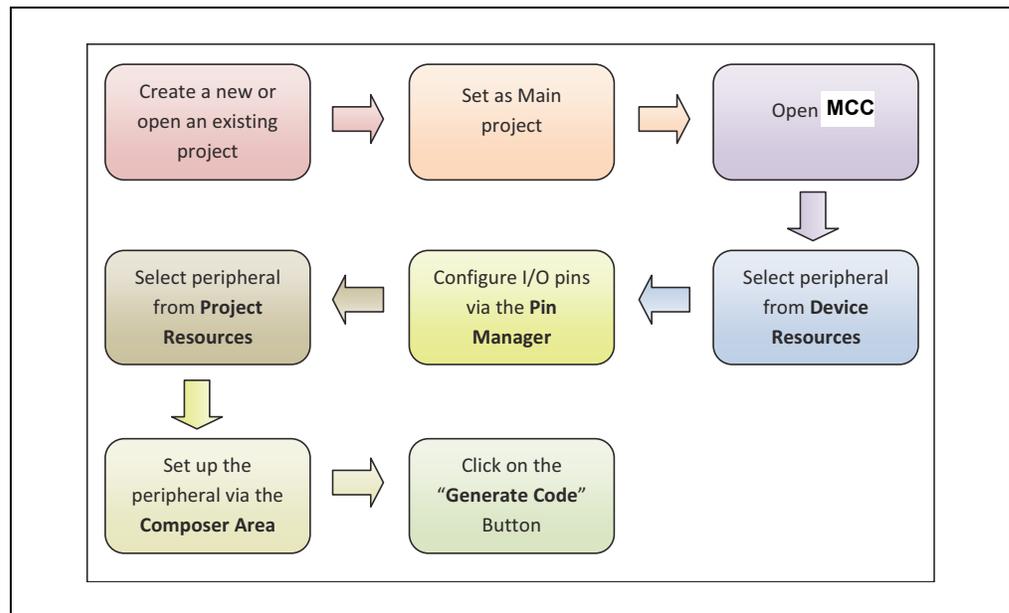
- **Always ask before removing a module:** Enabling this control enables the “are you sure?” dialog which appears while disabling or removing an enabled module.
- **Always ask before removing a pin:** Enabling this control enables the “are you sure?” dialog which appears while deallocating or removing a pin from a peripheral.

Chapter 3. Operating the MPLAB[®] Code Configurator

3.1 PROCEDURE FOR PERIPHERAL DRIVERS GENERATION

Figure 3-1 shows an overview of steps involved in generating peripheral drivers using MCC.

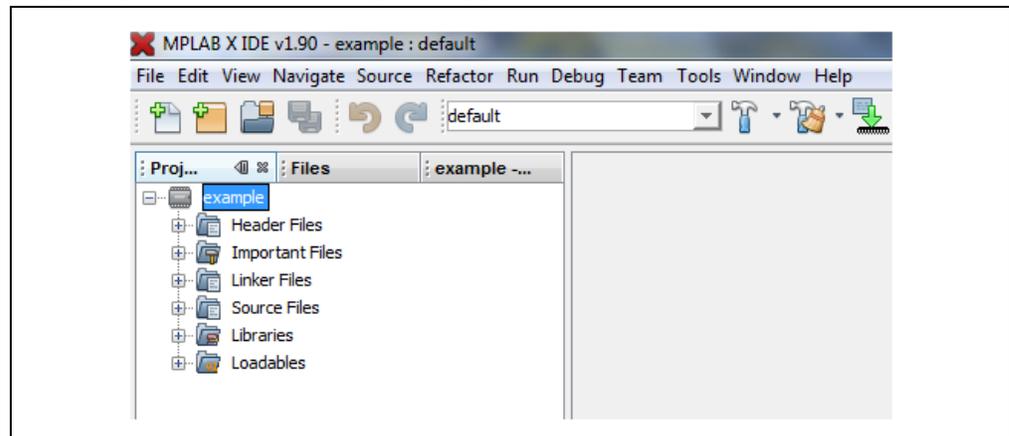
FIGURE 3-1: PROCESS OF CODE GENERATION USING MCC



Follow the steps to generate peripheral drivers using MCC in MPLAB[®] X IDE:

1. Create a new MPLAB X IDE project or open an existing project. As an example, a project for the PIC16F1937 device with the name **example** is created here, see Figure 3-2.

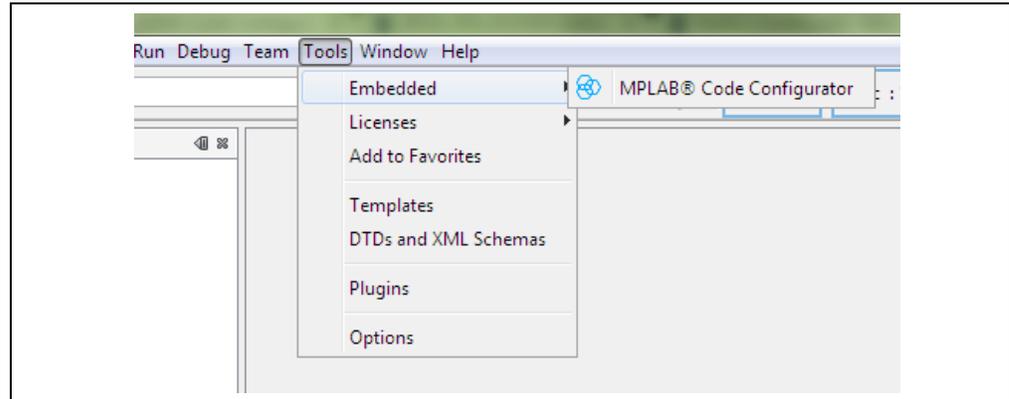
FIGURE 3-2: CREATING A PROJECT IN MPLAB X IDE



Operating the MPLAB® Code Configurator

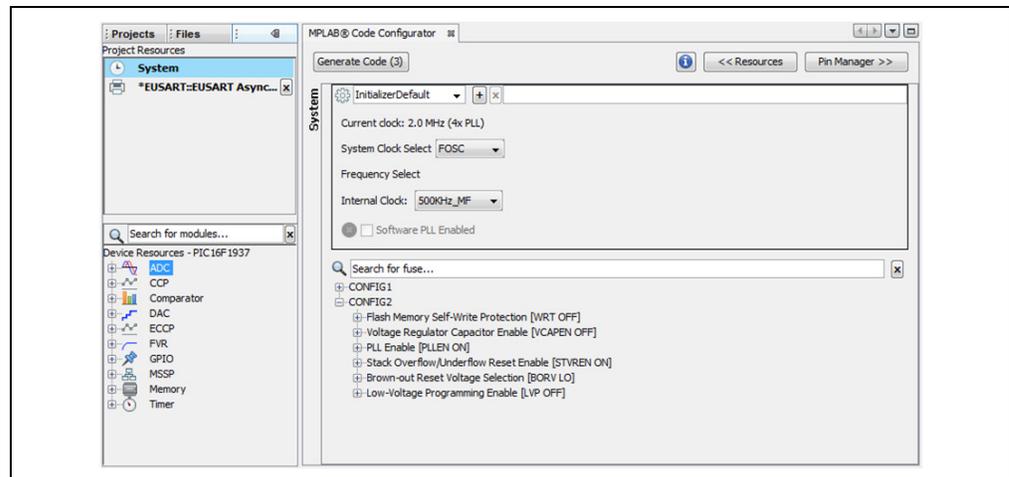
2. If multiple projects are open in MPLAB X IDE, set one as the main (active) project by selecting “Set as Main Project” in the MPLAB X IDE. For the active project, MCC automatically includes the generated driver files.
3. Open the MCC plug-in tool. For this, in the menu bar of MPLAB X IDE, go to **Tools** -> **Embedded** and click **MPLAB® Code Configurator**. Note that for MAC users the “Embedded” selection will be under the “Preferences” menu. This launches the MCC GUI.

FIGURE 3-3: OPENING MCC IN MPLAB X IDE



4. Clicking the **system** module in the Project Resources area invokes the Configuration bits setting GUI in the Composer area where device Configuration bits can be set, see Figure 3-4. The Configuration bit settings will be included in the generated code.

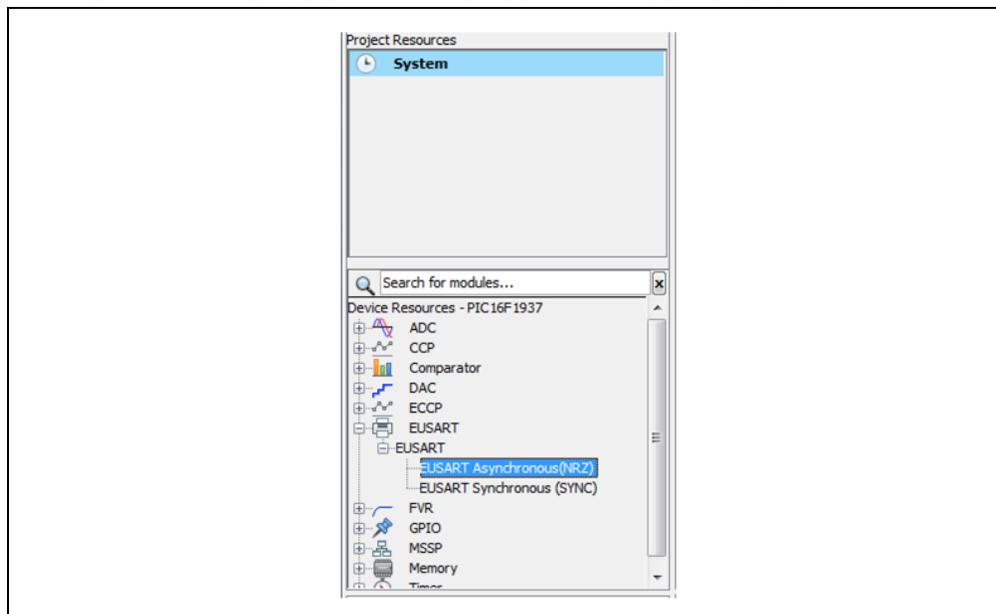
FIGURE 3-4: SETTING CONFIGURATION BITS IN MCC



The Configuration bits tree can be navigated and handled by using following keys:

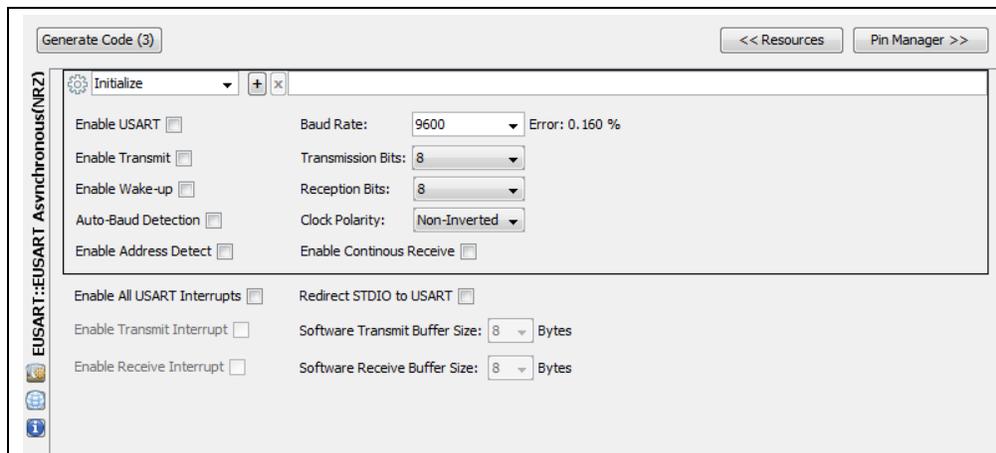
- Up and down arrow keys: For moving up and down in the tree, respectively.
 - Right arrow key: For expanding a node.
 - Left arrow key: For collapsing a node.
 - Space key: For setting a bit if it is not a node or expanding or collapsing a node.
5. From the Device Resources area, select a peripheral to be enabled for code generation. For example, EUSART asynchronous (NRZ) module has been enabled here, see Figure 3-5. Once a peripheral is enabled, observe that the peripheral now appears on the Project Resources area, see Figure 2-6. Also, pins in the Pin Manager area get invoked based on the enabled peripherals.

FIGURE 3-5: ENABLING A MODULE FOR CODE GENERATION IN MCC



6. In the Project Resource area, select the peripheral which needs to be configured by clicking the peripheral name. Once a peripheral is selected for configuration, the configuration GUI for that peripheral comes up in the Composer area. For example, EUSART asynchronous (NRZ) module is selected for configuration and hence, the respective module configuration GUI is displayed on the Composer area, see Figure 3-6.

FIGURE 3-6: SELECTING A MODULE FOR CONFIGURATION IN MCC



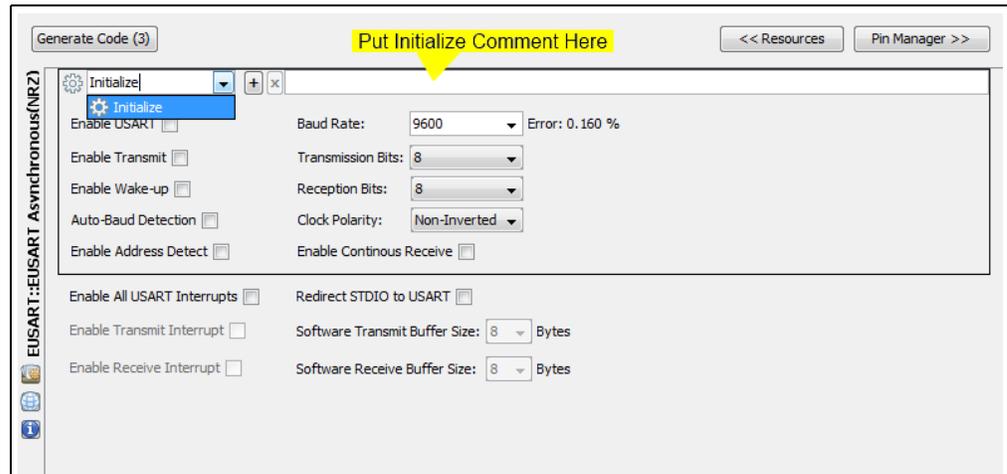
3.1.1 GPIO Module

The order of the pins in the GPIO module GUI can be moved up and down by merely dragging and dropping them to the desired location. Also, for pins supporting Interrupt on Change (IOC), the corresponding parameters (e.g., enable/disable, IOCP, IOCN etc.) can be configured using the GPIO module GUI.

Operating the MPLAB® Code Configurator

- Configure the peripheral in the Composer area. As an example, assume that an application requires two EUSART initialization functions: one with a 1200 baud rate and the other with a 9600 baud rate. Multiple initializers can be generated for each baud rate required. Each initializer can be called as required by application. Multiple initializers can be added by clicking the “+” button present next to the initializer name in the Composer area.

FIGURE 3-7: CONFIGURING MULTIPLE INITIALIZERS OF A PERIPHERAL IN MCC

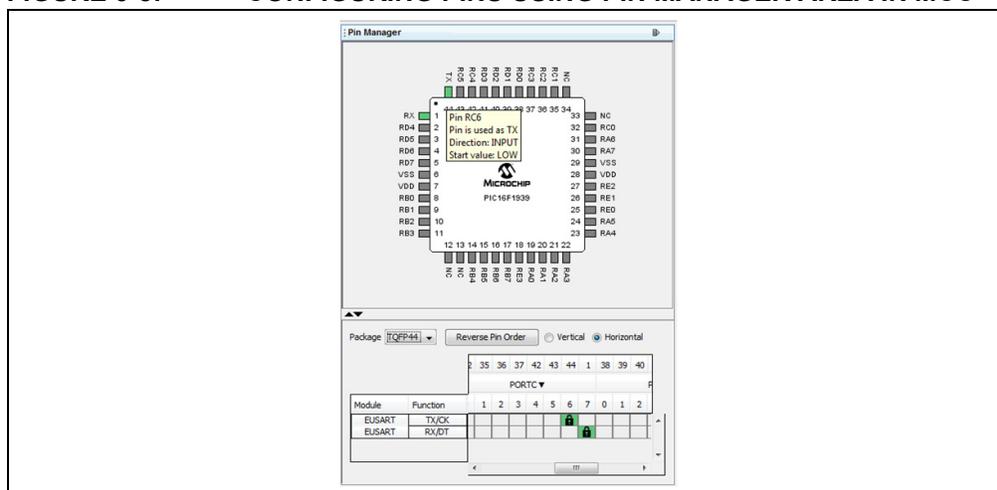


Note that when multiple initializers are used only the default initializer, denoted by the small sprocket icon, will be automatically included in the global initializer function. Additional initializers must be called by the application when they are required.

If interrupts are enabled for a peripheral in its Composer area, an interrupt symbol gets prefixed to that peripheral's name in the Project Resources showing the fact that interrupts have been used in its configuration. Also, an extra module called “interrupt manager” gets added in the project resources list which can be used to assign the interrupt execution priority for multiple peripherals.

- Configure the pins in the Pin Manager area depending upon the application requirements. The table view can be displayed in either a vertical or horizontal. The package view displays the respective pin configurations graphically. For example, Figure 3-8 shows the 44-pin TQFP configurations for the EUSART asynchronous (NRZ) module which was enabled for configuration.

FIGURE 3-8: CONFIGURING PINS USING PIN MANAGER AREA IN MCC

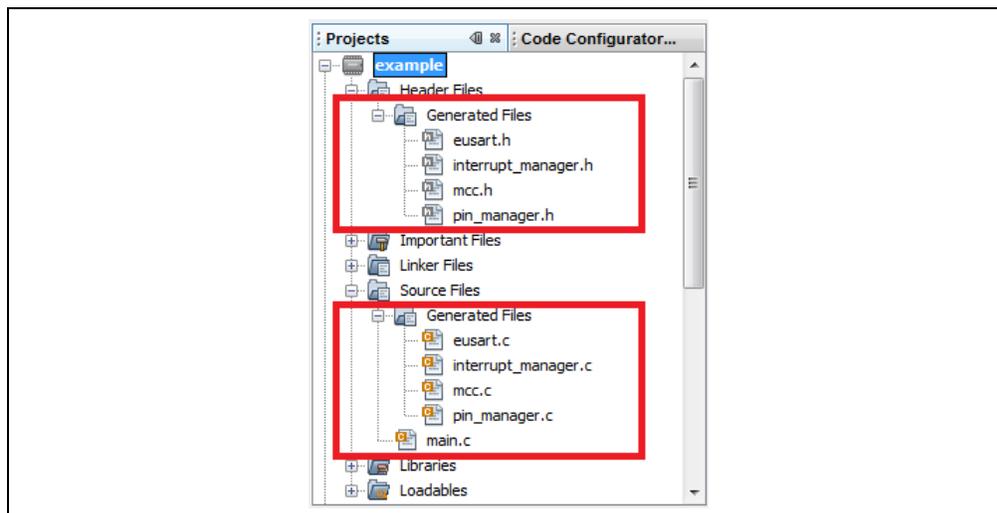


9. When all of the enabled modules have been configured, clicking the **Generate Code** button at the top of the Composer area will generate the drivers and initializers.

3.2 GENERATED PERIPHERAL DRIVERS

The generated drivers will be included in the active MPLAB X IDE project, see Figure 3-9.

FIGURE 3-9: GENERATED PERIPHERAL DRIVERS



These generated drivers consist of module configurations, pin configurations, interrupt configurations and system configurations.

Operating the MPLAB® Code Configurator

- The `mcc.h` and `mcc.c` files include the definitions of Configuration bits and the `oscillator_initializer` function. These definitions are based on the settings which were made for the System module in the Composer. Also included is the `system_initializer` function which can be called in the application program to call all the other default initializers (the ones marked in the GUI by sprocket symbol ).
- The `pin_manager.h` and `pin_manager.c` files include the pin manager initializer functions based on the configurations which were made in the pin manager GUI.
- The `interrupt_manager.h` and `interrupt_manager.c` files are optional files which are generated only when peripheral interrupts are enabled and they include interrupt initializer functions.

Note: The user must enable the peripheral and global interrupts in the application code using the respective macros defined in `interrupt_manager.h` file.

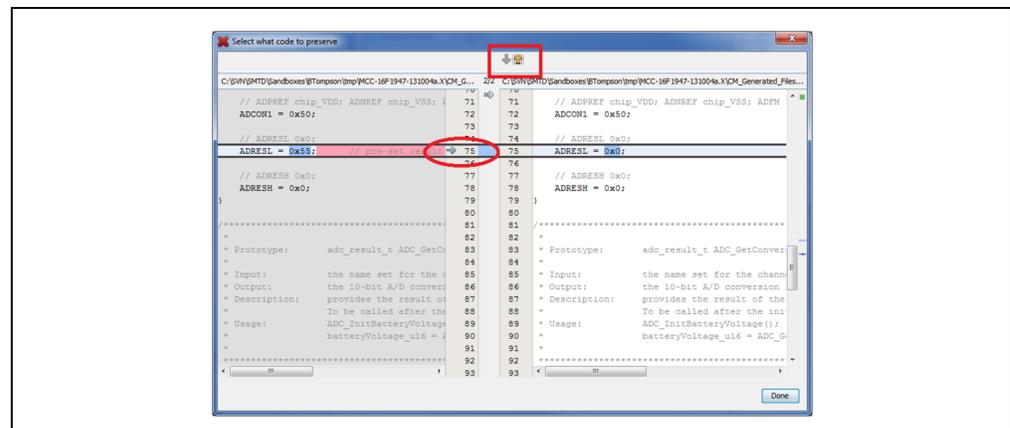
- The `<peripheral_name>.h` and `<peripheral_name>.c` files are module specific files and include each module's peripheral configuration functions.
- The `main.c` file is generated only when the MCC detects that there is no `main.c` file present in the project. If there is any previous `main.c` in the project regardless of its creator (the user or MCC), it will not generate or overwrite the existing one. When using a `main.c` not generated by MCC the lines: `#include "mcc_generated_files/mcc.h"`, and `SYSTEM_Initializer()` need to be added to the `main.c` file.

Functions present in these generated files can be called in the application program based on requirements.

3.2.1 Code Modification Tracking

One of the MPLAB X features which MCC utilizes is the “Diff Checking Tool”. The Diff Checking Tool prevents the MCC code generator from overwriting any modifications the user has made to an MCC generated file. When MCC detects a user modification to a file during generation, the Diff Checking Tool appears (Figure 3-10). The modified code is shown on the left, and the newly generated code is shown on the right. Navigation buttons at the top let the user to quickly move between each of the detected modifications. An arrow along the center margin is used to choose which of the changes are copied into the newly generated code. Clicking on the arrow copies the user modifications into the newly generated code. Not clicking on the arrow causes MCC to replace the user modification with generated code.

FIGURE 3-10: DIFF CHECKING DISPLAY WINDOW



Appendix A. Support

A.1 ABBREVIATIONS USED

- MCC: MPLAB[®] Code Configurator
- IDE: Integrated Development Environment
- GUI: Graphical User Interface

A.2 SUPPORT

- For more information about MPLAB X IDE, please refer to the following link:
<http://www.microchip.com/mplabx>
- For more information about MPLAB XC compilers, please refer to the following link:
<http://www.microchip.com/mplabxc>



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