MPLAB® X IDE User's Guide

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ISBN: 978-1-63277-614-3

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Table of Contents

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NOTES:

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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 "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 chapter contains general information that will be useful to know before using MPLAB® X IDE. Items discussed include:

- Document Layout
- Conventions Used
- Recommended Reading

DOCUMENT LAYOUT

This document describes how to use the MPLAB X IDE. The layout of the manual is as follows:

- **Chapter 1. "What is MPLAB X IDE?"** – an overview of what the MPLAB X IDE is and where to find help.
- **Chapter 2. "Before You Begin"** – describes how to install USB drivers for the hardware tools and language toolsuites for compiling/assembling code.
- **Chapter 3. "Tutorial"** – provides step-by-step descriptions of features for using MPLAB X IDE.
- **Chapter 4. "Basic Tasks"** – describes how to use the basic features of MPLAB X IDE. It is similar to the Tutorial chapter but with more detail.
- **Chapter 5. "Additional Tasks"** – describes how to use additional features of MPLAB X IDE, e.g., importing MPLAB IDE v8 projects or using the stopwatch.
- **Chapter 6. "Advanced Tasks & Concepts"** – describes how to use the advanced features of MPLAB X IDE, e.g., working with multiple projects and project configurations.
- **Chapter 7. "Editor"** – provides an overview of editor features. For more details on the editor, see NetBeans help.

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- **Chapter 8. "Project Files and Folders"** – describes MPLAB X IDE windows that are used to view files and folders, as well as information about, and methods for, working with files.
- **Chapter 9. "Troubleshooting"** – discusses troubleshooting techniques.
- **Chapter 10. "MPLAB X IDE vs. MPLAB IDE v8"** – explains the major features, menus, and tool support differences between MPLAB X IDE and MPLAB IDE v8.
- **Chapter 11. "Desktop Reference"** – provides a reference to MPLAB X IDE desktop items, including menus, toolbars, and the status bar.
- **Chapter 12. "MPLAB X IDE Windows and Dialogs"** – describes the windows and dialogs that are unique to MPLAB X IDE.
- **Chapter 13. "NetBeans Windows and Dialogs"**– references the NetBeans™ windows and dialogs available in MPLAB X IDE.
- **Appendix A. "Configuration Settings Summary"** – shows how to set Configuration bits in code for supported language tools. This is required in MPLAB X IDE as the Configurations Settings window only temporarily sets the bits for debug.
- **Appendix B. "Working Outside the IDE"** – describes how to create files in MPLAB X IDE that may be used outside the IDE. It also describes how to import files that were created outside the IDE into MPLAB X IDE.
- **Appendix C. "Revision History"** – list of changes to the document as it has been updated.

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CONVENTIONS USED

The following conventions may appear in this documentation:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* 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, or an individual menu item	"Save project before build"
Underlined, italic with right angle bracket between text	A path in text	*File>Save*
Right angle bracket between text	A path in a table cell	File>Save
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain	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	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mpasmwin [options]` *`file`* `[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) { ... }`

RECOMMENDED READING

This user's guide describes how to use MPLAB X IDE. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

Readme for MPLAB IDE

For the latest information on using MPLAB X IDE, read the release notes under the "Release Notes and Support Documentation" heading on the Start page. The release notes contain update information and known issues that may not be included in this user's guide.

Readme Files

For the latest information on using other tools, read the tool-specific Readme files in the Readmes subdirectory of the MPLAB X IDE installation directory. The Readme files contain update information and known issues that may not be included in this user's guide.

Online Help Files – MPLAB X IDE

Comprehensive help files are available for MPLAB X IDE, MPLAB Editor, and MPLAB SIM simulator, as well as Microchip compilers and other development tools. Tutorials, functional descriptions and reference material are included.

Online Help Files – NetBeans Platform

Help is available for platform-related topics. For online documentation, see:

NetBeans Developing Applications with NetBeans IDE, Release 8.0, E50452-06

Device Data Sheets and Family Reference Manuals

See the Microchip web site, http://www.microchip.com, for complete and updated versions of PIC® MCU and dsPIC® DSC data sheets and related device family reference manuals.

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Chapter 1. What is MPLAB X IDE?

1.1 INTRODUCTION

MPLAB® X IDE is a software program that is used to develop applications for Microchip microcontrollers and digital signal controllers. (Experienced embedded-systems designers may want to skip to the next chapter.)

This development tool is called an Integrated Development Environment, or IDE, because it provides a single integrated "environment" to develop code for embedded microcontrollers.

This chapter describes the development of an embedded system and briefly explains how MPLAB X IDE from Microchip is used in the process.

Topics discussed here include the following:

- An Overview of Embedded Systems
- The Development Cycle
- Project Manager
- Language Tools
- Target Debugging
- Device Programming
- Components of MPLAB X IDE
- MPLAB X IDE Online Help
- Other MPLAB X IDE Documentation
- Web Site
- MPLAB X Store
- MPLAB X IDE Updates

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1.2 AN OVERVIEW OF EMBEDDED SYSTEMS

An embedded system is typically a design that uses the power of a small microcontroller, like the Microchip PIC® microcontroller (MCU) or dsPIC® digital signal controller (DSC). These microcontrollers combine a microprocessor unit (like the CPU in a personal computer) with some additional circuits called peripherals, plus some additional circuits, on the same chip to make a small control module requiring few other external devices. This single device can then be embedded into other electronic and mechanical devices for low-cost digital control.

1.2.1 Differences Between an Embedded Controller and a Personal Computer

The main difference between an embedded controller and a personal computer is that the embedded controller is dedicated to one specific task or set of tasks. A personal computer is designed to run many different types of programs and to connect to many different external devices. An embedded controller has a single program and, as a result, can be made cheaply to include just enough computing power and hardware to perform that dedicated task.

A personal computer has a relatively expensive generalized central processing unit (CPU) at its heart with many other external devices (memory, disk drives, video controllers, network interface circuits, etc.). An embedded system has a low-cost MCU for its intelligence, has many peripheral circuits on the same chip, and has relatively few external devices.

Often, an embedded system is an invisible part, or sub-module of another product, such as a cordless drill, refrigerator or garage door opener. The controller in these products does a tiny portion of the function of the whole device. The controller adds low-cost intelligence to some of the critical sub-systems in these devices.

An example of an embedded system is a smoke detector. Its function is to evaluate signals from a sensor and sound an alarm if the signals indicate the presence of smoke. A small program in the smoke detector either runs in an infinite loop, sampling the signal from the smoke sensor, or lies dormant in a low-power "Sleep" mode, being awakened by a signal from the sensor. The program then sounds the alarm. The program would possibly have a few other functions, such as a user test function, and a low battery alert.

While a personal computer with a sensor and audio output could be programmed to do the same function, it would not be a cost-effective solution (nor would it run on a nine-volt battery, unattended for years). Embedded designs use inexpensive microcontrollers to put intelligence into the everyday things in our environment, such as smoke detectors, cameras, cell phones, appliances, automobiles, smart cards and security systems.

1.2.2 Components of a Microcontroller

The PIC MCU has on-chip program memory (Figure 1-1) for the firmware, or coded instructions, to run a program (Figure 1-2). A Program Counter (PC) is used to address program memory, including Reset and interrupt addresses. A hardware stack is used with call and return instructions in code, so it works with, but is not part of, program memory. Device data sheets describe the details of program memory operation, vectors and the stack.

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FIGURE 1-1: PIC® MCU DATA SHEET – PROGRAM MEMORY AND STACK

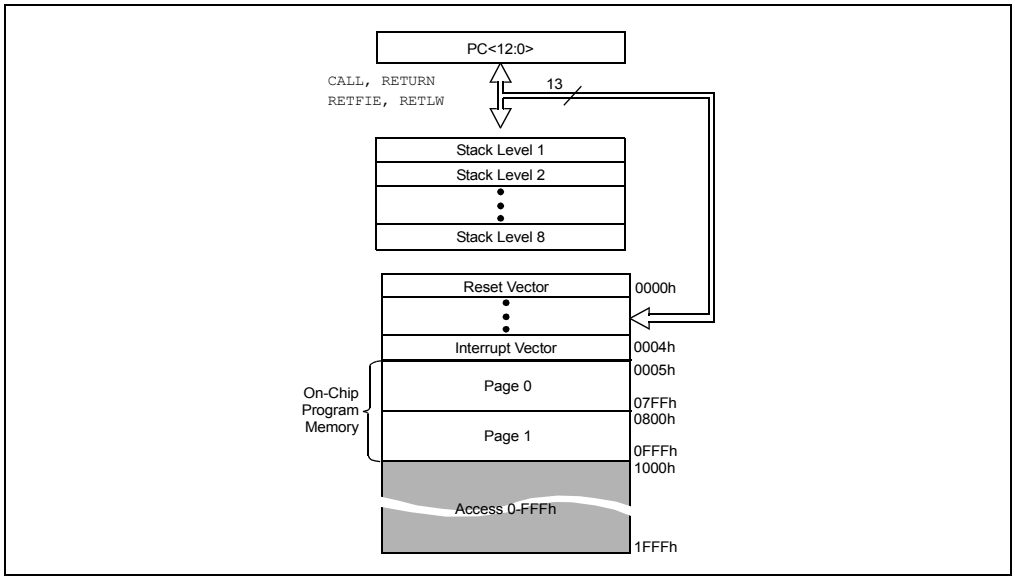
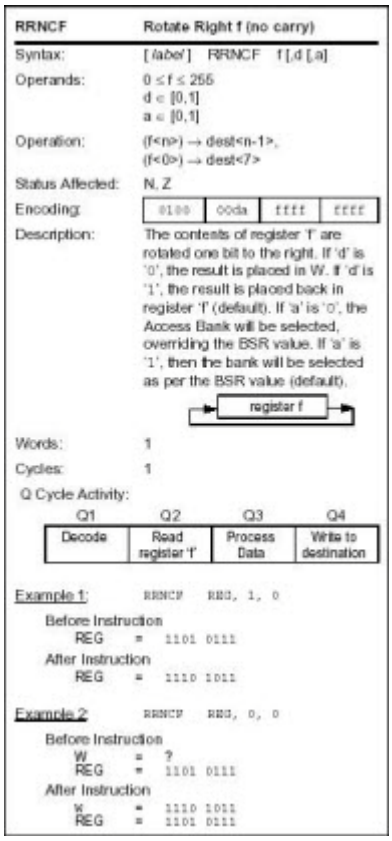


FIGURE 1-2: PIC® MCU DATA SHEET – INSTRUCTIONS (EXCERPT)



The microcontroller also has data or “file register” memory. This memory consists of Special Function Registers (SFRs) and General Purpose Registers (GPRs) as shown in Figure 1-4. SFRs are registers used by the CPU and peripheral functions for controlling the desired operation of the device. GPRs are for storage of variables that the program will need for computation or temporary storage. Some microcontrollers have additional data EEPROM memory. As with program memory, device data sheets describe the details of data memory use and operation.

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FIGURE 1-3: PIC® MCU DATA SHEET – FILE REGISTERS

	File Address		File Address		File Address		File Address
Indirect addr. (1)	00h	Indirect addr. (1)	80h	Indirect addr. (1)	100h	Indirect addr. (1)	180h
TMR0	01h	OPTION_REG	81h	TMR0	101h	OPTION_REG	181h
PCL	02h	PCL	82h	PCL	102h	PCL	182h
STATUS	03h	STATUS	83h	STATUS	103h	STATUS	183h
FSR	04h	FSR	84h	FSR	104h	FSR	184h
PORTA	05h	TRISA	85h	PORTA	105h	TRISA	185h
PORTB	06h	TRISB	86h	PORTB	106h	TRISB	186h
PORTC	07h	TRISC	87h	PORTC	107h	TRISC	187h
	08h		88h		108h		188h
	09h		89h		109h		189h
PCLATH	0Ah	PCLATH	8Ah	PCLATH	10Ah	PCLATH	18Ah
INTCON	0Bh	INTCON	8Bh	INTCON	10Bh	INTCON	18Bh
PIR1	0Ch	PIE1	8Ch	EEDAT	10Ch	EECON1	18Ch
PIR2	0Dh	PIE2	8Dh	EEADR	10Dh	EECON2(1)	18Dh
TMR1L	0Eh	PCON	8Eh	EEDATH	10Eh		18Eh
TMR1H	0Fh	OSCCON	8Fh	EEADRH	10Fh		18Fh
T1CON	10h	OSCTUNE	90h		110h		190h
TMR2	11h		91h		111h		191h
T2CON	12h	PR2	92h		112h		192h
SSPBUF	13h	SSPADD(2)	93h		113h		193h
SSPCON	14h	SSPSTAT	94h		114h		194h
CCPR1L	15h	WPUA	95h	WPUB	115h		195h
CCPR1H	16h	IOCA	96h	IOCB	116h		196h
CCP1CON	17h	WDTCON	97h		117h		197h
RCSTA	18h	TXSTA	98h	VRCON	118h		198h
TXREG	19h	SPBRG	99h	CM1CON0	119h		199h
RCREG	1Ah	SPBRGH	9Ah	CM2CON0	11Ah		19Ah
	1Bh	BAUDCTL	9Bh	CM2CON1	11Bh		19Bh
PWM1CON	1Ch		9Ch		11Ch		19Ch
ECCPAS	1Dh		9Dh		11Dh	PSTRCON	19Dh
ADRESH	1Eh	ADRESL	9Eh	ANSEL	11Eh	SRCON	19Eh
ADCON0	1Fh	ADCON1	9Fh	ANSELH	11Fh		19Fh
General Purpose Register 96 Bytes	20h – 7Fh	General Purpose Register 80 Bytes	A0h – EFh	General Purpose Register 80 Bytes	120h – 16Fh		1A0h
		accesses 70h-7Fh	F0h – FFh	accesses 70h-7Fh	170h – 17Fh	accesses 70h-7Fh	1F0h – 1FFh
Bank 0		Bank 1		Bank 2		Bank 3	

Unimplemented data memory locations, read as '0'.

Note 1: Not a physical register.

2: Address 93h also accesses the SSP Mask (SSPMSK) register under certain conditions.

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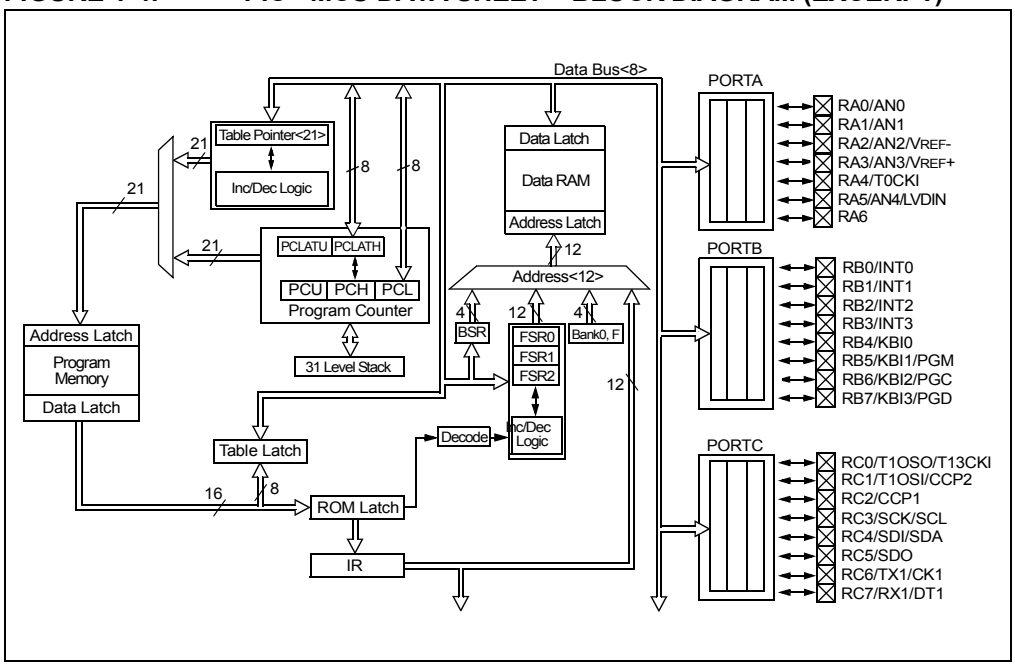
In addition to memory, the microcontroller has a number of peripheral device circuits on the same chip (Figure 1-4). Some peripheral devices are called input/output (I/O) ports. I/O ports are pins on the microcontroller that can be used as outputs and driven high or low to send signals, blink lights, drive speakers – just about anything that can be sent through a wire. Often these pins are bidirectional and can also be configured as inputs, allowing the program to respond to an external switch, a sensor, or to communicate with some external device.

FIGURE 1-4: PIC® MCU DATA SHEET – BLOCK DIAGRAM (EXCERPT)



To design such a system, choose which peripherals are necessary for the application.

The following is a list of common peripherals:

- Analog-to-Digital Converters (ADCs) allow microcontrollers to connect to sensors and receive changing voltage levels.
- Serial communication peripherals that allow streaming communications over a few wires to another microcontroller, to a local network, or to the Internet.
- Peripherals on the PIC MCU called “timers” accurately measure signal events and generate and capture communications signals, produce precise waveforms, even automatically reset the microcontroller if it gets “hung” or lost due to a power glitch or hardware malfunction.
- Other peripherals detect when the external power is dipping to dangerous levels, so that the microcontroller can store critical information and safely shut down before power is completely lost.

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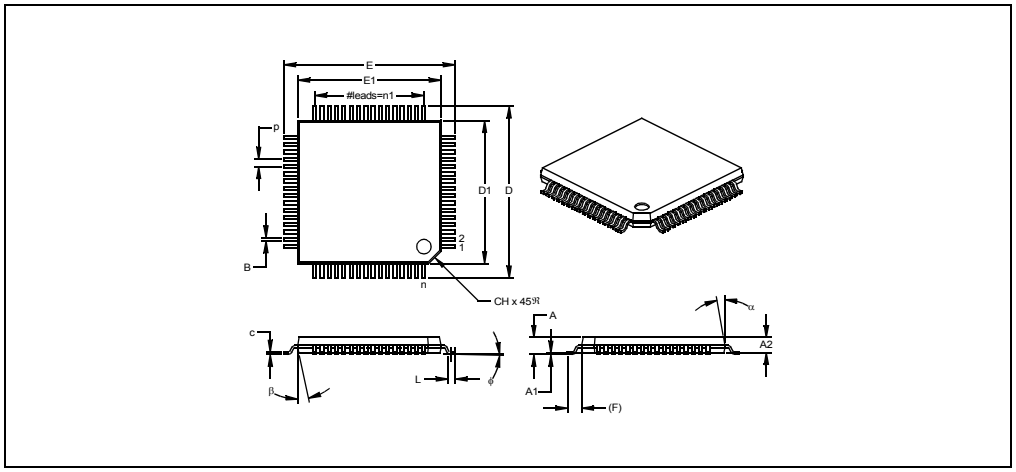
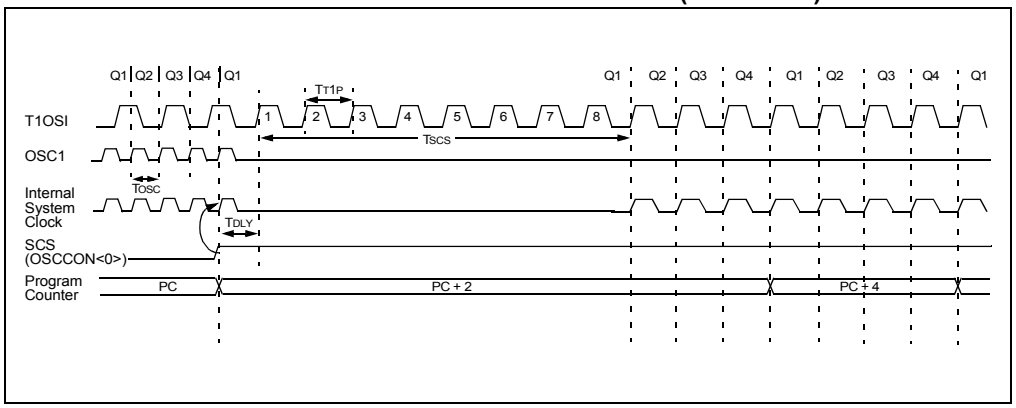
The peripherals, and the amount of memory an application needs to run a program, largely determine which PIC MCU to use. Other factors could include the power consumed by the microcontroller and its "form factor," i.e., the size and characteristics of the physical package that must reside on the target design (Figure 1-5).

FIGURE 1-5: EXAMPLE PIC® MCU DEVICE PACKAGE



A microcontroller becomes active when power is applied and an oscillator begins generating a clocking signal (Figure 1-6). Depending on the microcontroller, there may be several internal and external oscillator operational modes.

FIGURE 1-6: PIC® MCU DATA SHEET – TIMING (EXCERPT)



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1.2.3 Implementing an Embedded System Design with MPLAB X IDE

A development system for embedded controllers is a system of programs running on a computer that help to write, edit, debug and program code – which is the intelligence of embedded systems applications – into a microcontroller. MPLAB X IDE is such a system, it contains all the components needed to design and deploy embedded systems applications.

The typical tasks for developing an embedded controller application are:

1. Create the high level design. From the features and performance desired, decide which PIC MCU or dsPIC DSC device is best suited to the application, then design the associated hardware circuitry. After determining which peripherals and pins control the hardware, write the firmware – the software that will control the hardware aspects of the embedded application. A language tool such as an assembler, which is directly translatable into machine code, or a compiler that allows a more natural language for creating programs, should be used to write and edit code. Assemblers and compilers help make the code understandable, allowing function labels to identify code routines with variables that have names associated with their use, and with constructs that help organize the code in a maintainable structure.
2. Compile, assemble and link the software using the assembler and/or compiler and linker to convert your code into “ones and zeros” – machine code for the PIC MCUs. This machine code will eventually become the firmware (the code programmed into the microcontroller).
3. Test your code. Usually a complex program does not work exactly the way imagined, and “bugs” need to be removed from the design to get proper results. The debugger allows you to see the “ones and zeros” execute, related to the source code you wrote, with the symbols and function names from your program. Debugging allows you to experiment with your code to see the value of variables at various points in the program, and to do “what if” checks, changing variable values and stepping through routines.
4. “Burn” the code into a microcontroller and verify that it executes correctly in the finished application.

Of course, each of these steps can be quite complex. The important thing is to concentrate on the details of your own design, while relying upon MPLAB X IDE and its components to get through each step without continuously encountering new learning curves.

Step 1 is driven by the designer, although MPLAB X IDE can help in modeling circuits and code so that crucial design decisions can be made.

MPLAB X IDE really helps with steps 2 through 4. Its Programmer's Editor helps write correct code with the language tools of choice. The editor is aware of the assembler and compiler programming constructs and automatically "color-keys" the source code to help ensure it is syntactically correct. The Project Manager enables you to organize the various files used in your application: source files, processor description header files and library files. When the code is built, you can control how rigorously code will be optimized for size or speed by the compiler and where individual variables and program data will be programmed into the device. You can also specify a "memory model" in order to make the best use of the microcontroller's memory for your application. If the language tools run into errors when building the application, the offending line is shown and can be double clicked to go to the corresponding source file for immediate editing. After editing, you will rebuild and try your application again. Often this write-compile-fix loop is done many times for complex code as the sub-sections are written and tested. MPLAB X IDE goes through this loop with maximum speed, allowing you to get on to the next step.

When the code builds with no errors, it needs to be tested. MPLAB X IDE has components called "debuggers" and free software simulators for all PIC MCU and dsPIC DSC devices to help test the code. Even if the hardware is not yet finished, you can begin testing the code with the simulator, a software program that simulates the execution of the microcontroller. The simulator can accept a simulated input (stimulus), in order to model how the firmware responds to external signals. The simulator can measure code execution time, single step through code to watch variables and peripherals, and trace the code to generate a detailed record of how the program ran.

When the hardware is in a prototype stage, a hardware debugger, such as an in-circuit emulator or an in-circuit debugger, can be used. These debug tools run the code in real time on your actual application by using special circuitry built into many devices with Flash program memory. They can "see into" the target microcontroller's program and data memory, and stop and start program execution, allowing you to test the code with the microcontroller in place on the application.

After the application is running correctly, you can program a microcontroller with one of Microchip's devices or development programmers. These programmers verify that the finished code will run as designed. MPLAB X IDE supports most PIC MCUs and all dsPIC DSCs.

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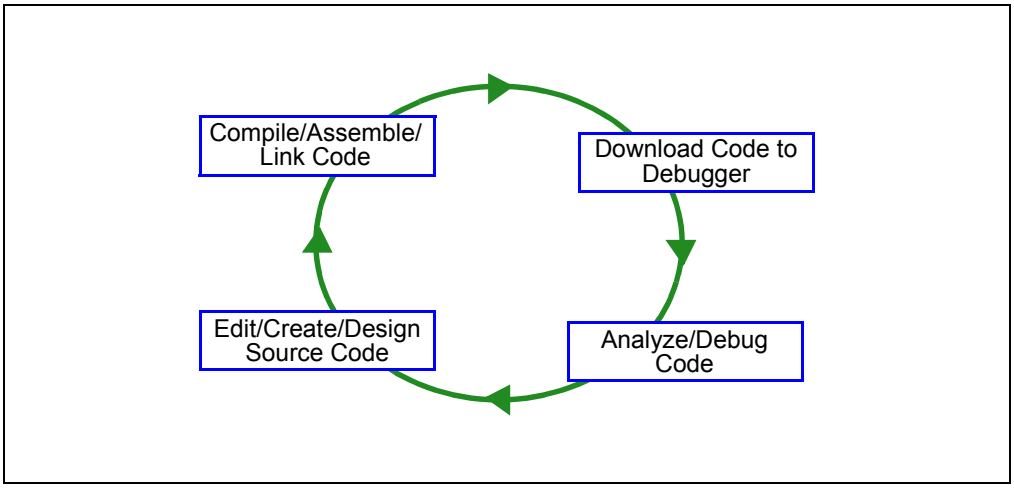
1.3 THE DEVELOPMENT CYCLE

The process for writing an application is often described as a development cycle, since it is rare that all the steps from design to implementation can be done flawlessly the first time. More often code is written, tested and then modified to produce an application that performs correctly.

The Integrated Development Environment allows the embedded systems design engineer to progress through this cycle without the distraction of switching among an array of tools. By using MPLAB X IDE, all the functions are integrated, allowing the engineer to concentrate on completing the application without the interruption of separate tools and different modes of operation.

FIGURE 1-7: THE DESIGN CYCLE



MPLAB X IDE is a “wrapper” that coordinates all the tools from a single graphical user interface, usually automatically. For instance, once code is written, it can be converted to executable instructions and downloaded into a microcontroller to see how it works. In this process multiple tools are needed: an editor to write the code, a project manager to organize files and settings, a compiler or assembler to convert the source code to machine code and some sort of hardware or software that either connects to a target microcontroller or simulates the operation of a microcontroller.

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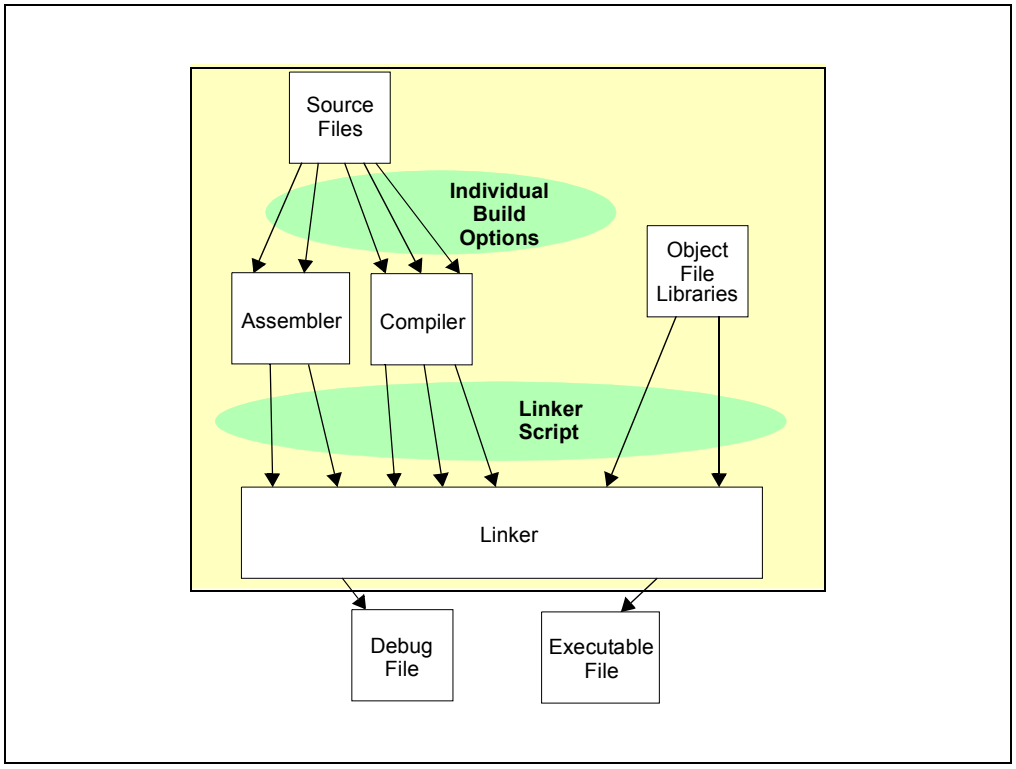
1.4 PROJECT MANAGER

The project manager organizes the files to be edited and other associated files so they can be sent to the language tools for assembly or compilation, and ultimately to a linker.

The linker has the task of placing the object code fragments from the assembler, compiler and libraries into the proper memory areas of the embedded controller, and ensure that the modules function with each other (or are "linked").

This entire operation from assembly and compilation through the link process is called a project "build". Properties specified for the language tools can be invoked differently for each file, if desired, and a build process integrates all of the language tools' operations.

FIGURE 1-8: MPLAB® X IDE PROJECT MANAGER



The source files are text files that are written conforming to the rules of the assembler or compiler. The assembler and compiler convert them into intermediate modules of machine code and placeholders for references to functions and data storage.

The linker resolves these placeholders and combines all the modules into a file of executable machine code. The linker also produces a debug file which allows MPLAB X IDE to relate the executing machine codes back to the source files.

A text editor is used to write the code. It recognizes the constructs in the text and uses color coding to identify various elements, such as instruction mnemonics, C language constructs and comments. The editor supports operations commonly used in writing source code. After the code is written, the editor works with the other tools to display code execution in the debugger. Breakpoints (which stop or "break" the execution of code) can be set in the editor, and the values of variables can be inspected by hovering the mouse pointer over the variable name. Names of variables can be dragged from source text windows and then dropped into a Watches window where their changing values can be watched after each breakpoint or during code execution.

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1.5 LANGUAGE TOOLS

Language tools are programs such as cross-assemblers and cross-compilers. Most people are familiar with some of the language tools that run on a computer, e.g., Visual Basic or C compilers.

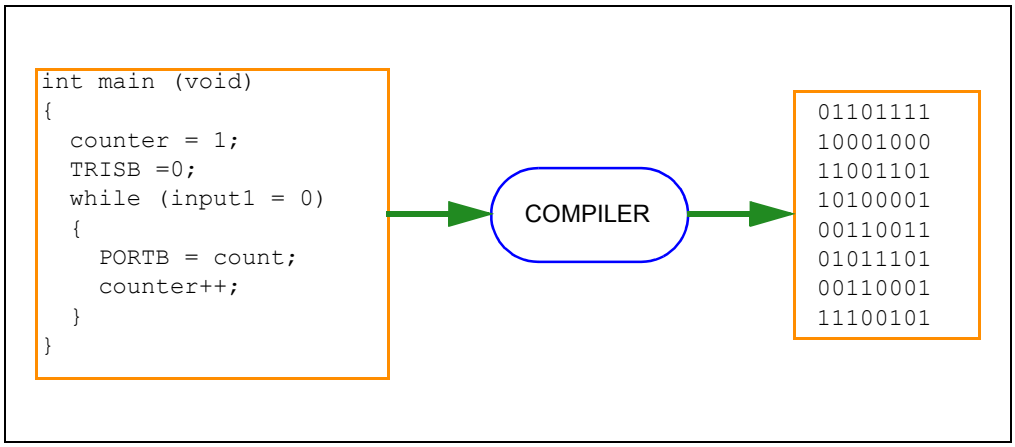
When using language tools for embedded systems, a “cross-assembler” or “cross-compiler” is used. These tools differ from typical compilers in that they run on a computer, but they produce code to run on another microprocessor (or microcontroller).

Language tools also produce a debug file that MPLAB X IDE uses to correlate the machine instructions and memory locations with the source code. This bit of integration allows the MPLAB X IDE editor to set breakpoints, allows Watches windows to view variable contents, and lets you single step through the source code, while watching the application execute.

Embedded system language tools also differ somewhat from compilers that run and execute on a computer because they must be very space conscious. The smaller the code produced, the better, because that provides the smallest possible memory usage for the target, which reduces cost. This means that techniques to optimize and enhance the code, using machine-specific knowledge, are desirable.

The size of programs for computers typically extends into the megabytes for moderately complex programs. The size of simple embedded systems programs may be as small as a thousand bytes or less. A medium size embedded system might need 32K or 64K of code for relatively complex functions. Some embedded systems use megabytes of storage for large tables, user text messages or data logging.

FIGURE 1-9: A COMPILER CONVERTS SOURCE CODE INTO MACHINE INSTRUCTIONS



1.6 TARGET DEBUGGING

In a development environment, the execution of the code is tested on a debugger. The debugger can be a software program that simulates the operation of the microcontroller for testing, or it can be a hardware instrument to analyze the program as it executes in the application.

1.6.1 Software Debuggers

Simulators are built into MPLAB X IDE so a program can be tested without any additional hardware. A simulator is a software debugger, and the debugger functions for the simulator are almost identical to the hardware debuggers, allowing a new tool to be learned with ease. Usually, a simulator runs somewhat slower than an actual microcontroller, since the CPU in the computer is being used to simulate the operations of the microcontroller.

1.6.2 Hardware Debuggers

There are two types of hardware that can be used with MPLAB X IDE: programmers and hardware debuggers. A programmer simply burns the machine code from the PC into the internal memory of the target microcontroller. The microcontroller can then be plugged into the application and, hopefully, it will run as designed.

Usually, however, the code does not function exactly as anticipated, and the engineer is tasked with reviewing the code and its operation in the application to determine how to modify the original source code to make it execute as desired. This process is called debugging. As noted previously, the simulator can be used to test how the code will operate, but once a microcontroller is programmed with the firmware, many things outside the scope of the simulator come into play. Using just a programmer, the code could be changed, reprogrammed into the microcontroller and plugged into the target for retest, but this could be a long, laborious cycle if the code is complex, and it is difficult to understand exactly what is going wrong in the hardware.

This is where a hardware debugger is useful. Hardware debuggers can be in-circuit emulators or in-circuit debuggers, which use microcontrollers that have special built-in debugging features. A hardware debugger, like a simulator, allows the engineer to inspect variables at various points in the code, and single step to follow instructions as the hardware interacts with its specialized circuitry.

1.6.3 Integrated Development Environment

Debugging usually becomes urgent near the end of the project design cycle. As deadlines loom, getting the application to function as originally designed is the last step before going into deployment of the product, and often has the most influence on producing delays in getting a product out. That's where an integrated development environment is most important. Doing fine "tweaks" to the code, recompiling, downloading and testing all require time. Using all tools within a single environment will reduce the time around the "cycle." These last steps, where critical bugs are worked out, are a test for the embedded systems designer. The right tool can save time. With MPLAB X IDE, many tools can be selected, but they all will have a similar interface, and the learning curve from simulator to low-cost in-circuit debugger to powerful in-circuit emulator is small.

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1.7 DEVICE PROGRAMMING

After the application has been debugged and is running in the development environment, it needs to be tested on its own. A device can be programmed with an in-circuit emulator, an in-circuit debugger, a development programmer, or a device programmer. MPLAB X IDE can be set to the programmer function, and the part can be “burned”. The target application can now be observed in its nearly final state. Engineering prototype programmers allow quick prototypes to be made and evaluated. Some applications can be programmed after the device is soldered on the target PC board. Using In-Circuit Serial Programming™ (ICSP™) programming capability, the firmware can be programmed into the application at the time of manufacture, allowing updated revisions to be programmed into an embedded application later in its life cycle. Devices that support in-circuit debugging can even be plugged back into an in-circuit debugger after manufacturing for quality tests and development of next generation firmware.

Production programming can be accomplished using a production programmer and the MPLAB IPE, which is installed with MPLAB X IDE.

1.8 COMPONENTS OF MPLAB X IDE

MPLAB X IDE includes:

- a full-featured programmer's text editor that also serves as a window into the debugger.
- a project manager (visible as the Projects window) that provides integration and communication between the IDE and the language tools.
- a number of assembler/linker suites for the development of firmware for your project's device.
- a debugger engine that provides breakpoints, single stepping, Watches windows and all the features of a modern debugger. The debugger works in conjunction with debug tools, both software and hardware.
- a software simulator for all PIC MCU and dsPIC DSC devices. The simulator is actually composed of several device-specific simulator executables. MPLAB X IDE decides which one to use based on your project's device.

Optional components can be acquired or purchased to work with the MPLAB X IDE:

- **Compiler Language Tools**

MPLAB XC C compilers from Microchip provide fully integrated, optimized code for PIC MCUs and dsPIC DSCs. Along with compilers from microEngineering Labs, CCS and SDCC, they are invoked by the MPLAB X IDE project manager to compile code that is automatically loaded into the target debugger for instant testing and verification.

- **Programmers**

MPLAB ICD 3 in-circuit debugger, MPLAB REAL ICE™ in-circuit emulator, and MPLAB PM3 programmer are capable of the production programming of code into target devices. PICkit™ 3 in-circuit debugger is capable of the development programming of code into target devices.

All of these tools may be used with MPLAB X IDE to control programming of both code and data, as well as the Configuration bits to set the various operating modes of the target microcontrollers or digital signal controllers.

In addition, all of these tools may be used with MPLAB IPE to program code, data and configuration bits. MPLAB IPE is designed more for production programming, and its interface is simplified to do just that.

- **In-Circuit Debuggers and Emulators**

PICkit 3 and MPLAB ICD 3 in-circuit debuggers, and MPLAB REAL ICE in-circuit emulator can be used to debug application code on target devices. By using some of the on-chip resources, these can download code into a target microcontroller inserted in the application, set breakpoints, single step and monitor registers and variables. The emulator includes additional debug features, such as trace.

- **Plug-In Tools**

Several plug-ins are available to add to the capabilities for MPLAB X IDE. For example, the Data Monitor and Control Interface (DMCI) provides a mechanism to view and control variables in code and change their values real-time. It also allows you to view output data in a graphical format.

For more on the plug-in tools supported, see **Section 5.22 "Add Plug-In Tools"**.

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1.9 MPLAB X IDE ONLINE HELP

MPLAB X IDE is built upon the NetBeans platform. Therefore, many of the NetBeans functions are now MPLAB X IDE functions.

For NetBeans information, see the online help files under “NetBeans Help” in the table of contents. For all MPLAB X IDE development tool information, see the online help files under “MPLAB X IDE Help” in the table of contents.

For a comparison of MPLAB X IDE and MPLAB IDE v8, see **Chapter 10. “MPLAB X IDE vs. MPLAB IDE v8”**.

1.9.1 Help Contents

Please refer to all help files for a complete understanding of MPLAB X IDE behavior. To launch help, select *Help>Help Contents*. This merges all help files into one, so it may take a little more time to open.

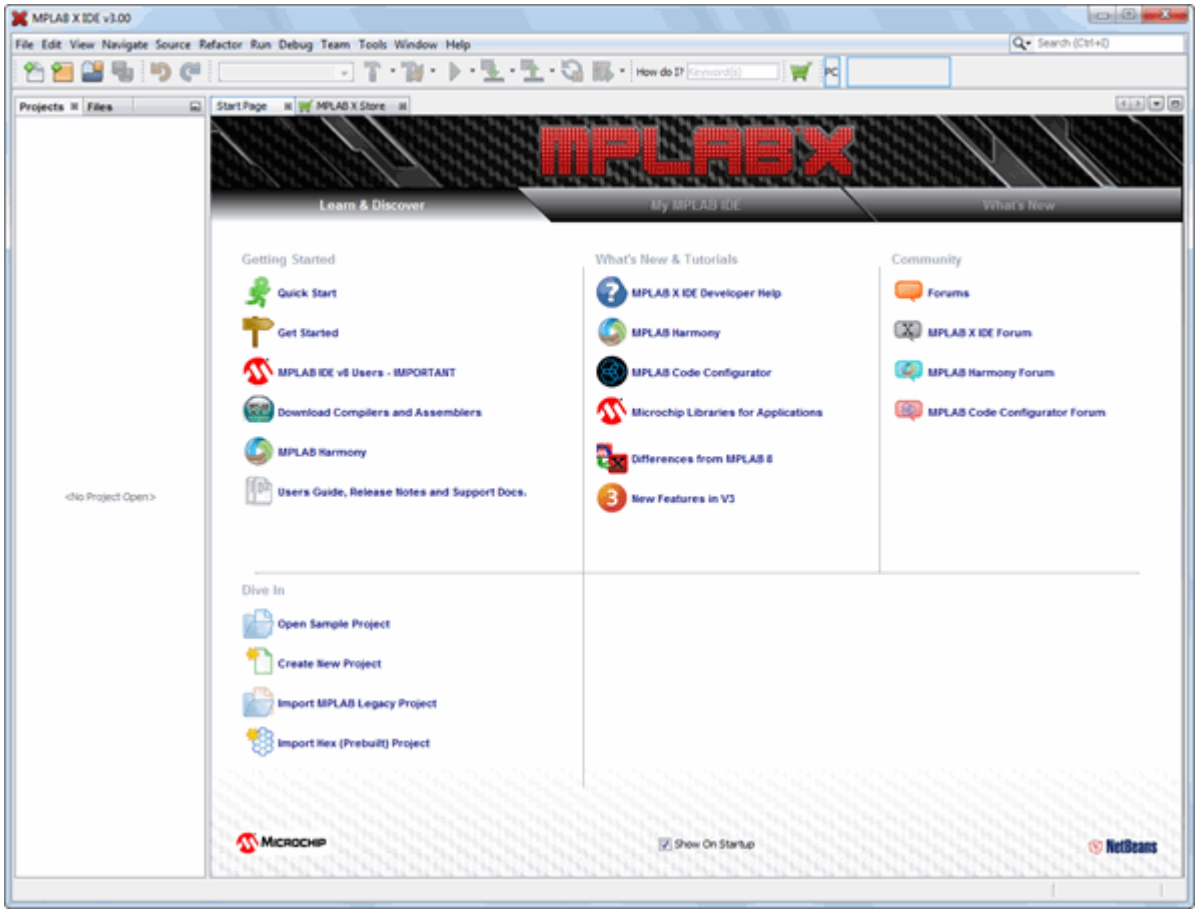
1.9.2 Tool Help Contents

You can also view individual help files for selected tools under *Help>Tool Help Contents*. Launching an individual help file will be faster and provide a smaller search of topics.

1.10 OTHER MPLAB X IDE DOCUMENTATION

In addition to help, links to other documentation, videos, forums, and wikis are featured on the Start Page (Figure 1-10).

FIGURE 1-10: MPLAB X IDE START PAGE



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The Microchip Wiki is a good place to look for tips on advanced features (Figure 1-11).

Click this link to go to the Wiki: https://microchip.wikidot.com

FIGURE 1-11: MICROCHIP WIKI

1.11 WEB SITE

Microchip provides online support via our web site at:

http://www.microchip.com/devtools

This web site make files and information easily available to customers. For more details, see Support.

1.12 MPLAB X STORE

For MPLAB X IDE v3.xx, you may access the Microchip store for development tools software and hardware products via the IDE.

 Store Icon

- MPLAB X Store tab – next to the Start tab is this tab, which provides links to products.
- *Help>MPLAB X Store* – under the Help menu is a link to open the MPLAB X Store tab.
- MPLAB X Store Toolbar Icon – an icon on the MPLAB X Store toolbar opens the MPLAB X Store tab.

See also **Section 2.8 "Shop the MPLAB X Store"**.

1.13 MPLAB X IDE UPDATES

MPLAB X IDE is an evolving program with thousands of users. Microchip Technology is continually designing new microcontrollers with new features. Many new MPLAB X IDE features come from customer requests and from internal usage. Continued new designs and the release of new microcontrollers ensure that MPLAB X IDE will continue to evolve.

MPLAB X IDE is scheduled for a version update approximately every few months to add new device support and new features.

For projects that are midway through development when a new version of MPLAB X IDE is released, it is considered "best practice" to not update to the new release unless there is a compelling reason to do so, such as a bug fix on a bug that inhibits the current efforts. The start of a new project is the best time to update to a new release.

Each new release of the MPLAB X IDE software has new features implemented, so the printed documentation will inevitably "lag" behind the online help. The online help is the best source for any questions about MPLAB X IDE.

To be notified of updates to MPLAB X IDE and its components, subscribe to the Development Tools section of myMICROCHIP Personalized Notification Service on:

http://www.microchip.com/pcn

For more details, see Support.

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Chapter 2. Before You Begin

2.1 INTRODUCTION

As you prepare to use MPLAB X IDE, do the following:

- Install JRE and MPLAB X IDE
- Install the USB Device Drivers (For Hardware Tools)
- Connect to a Target (For Hardware Tools)
- Install the Language Tools
- Launch the IDE and View the Desktop
- Access Information from the Start Page
- Shop the MPLAB X Store
- Launch Multiple Instances of the IDE
- Launch Multiple Versions of the IDE

2.2 INSTALL JRE AND MPLAB X IDE

When you install MPLAB X IDE (based on the NetBeans platform), the correct Java Runtime Environment (JRE) for your Windows® or Linux® operating system will be installed. If you have Mac OS® and the correct JRE is already installed, the MPLAB X IDE installation will proceed. If not, you will be prompted by a dialog to acquire the correct version. Follow the instructions, install the JRE, and then install MPLAB X IDE.

2.3 INSTALL THE USB DEVICE DRIVERS (FOR HARDWARE TOOLS)

For correct tool operation, you might need to install USB drivers.

2.3.1 USB Driver Installation for Mac or Linux Operating Systems

When you install MPLAB X IDE on a Mac or Linux computer, the installer will place the USB drivers for you. You do not need to do anything.

2.3.2 USB Driver Installation for Windows® XP/7/8 Operating Systems

If you install MPLAB X IDE on a personal computer that uses the Windows operating system, follow the instructions below to correctly install the USB drivers. (**Note:** The USB hardware tool drivers for MPLAB IDE v8.xx are not the same as those for MPLAB X IDE.)

These instructions apply to the following tools:

- MPLAB REAL ICE in-circuit emulator
- MPLAB ICD 3 in-circuit debugger
- MPLAB PM3 device programmer
- PIC32 Starter Kit

You do not need to do anything for PICkit 2, PICkit 3 or other MPLAB Starter Kits.

Follow the instructions below to determine your installation method.

2.3.2.1 BEFORE YOU INSTALL THE DRIVERS

Whether you use the Switcher utility or activate the preinstaller to install your drivers (both are discussed in following sections), be aware that your system's version of WinUSB drivers will be replaced if they are older than the Switcher or preinstaller version. If you want to keep your version of WinUSB drivers, rename these files before installing any Microchip device driver.

The WinUSB driver files are located at the following locations:

32-bit OS

`C:\Windows\system32\WinUSB.dll` (32-bit)

`C:\Windows\system32\drivers\WinUSB.sys` (64-bit)

64-bit OS

`C:\Windows\SysWOW64\WinUSB.dll` (32-bit)

`C:\Windows\system32\WinUSB.dll` (64-bit)

`C:\Windows\system32\drivers\WinUSB.sys` (64-bit)

2.3.2.2 IF YOU HAVE WINDOWS XP 64, MANUALLY SWITCH

If using the Windows XP 64-bit OS, you will have to switch the device drivers manually. See **Section 2.3.2.6 "If You Need to Manually Install the Drivers"**.

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2.3.2.3 IF YOU HAVE WINDOWS 7 OR 8, USE ADMINISTRATOR MODE

If you will use the Switcher executable to install your device drivers, you must be in Administrator mode to run this program on Windows 7 or 8.

To run the Device Driver Switcher GUI application as administrator, right click on the executable – `MPDDSwitch.exe` or `MPDDSwitch64.exe` – and select 'Run as Administrator'.

It is recommended that you use the GUI application first to switch the drivers. If this is problematic, you may switch the drivers using command-line applications.

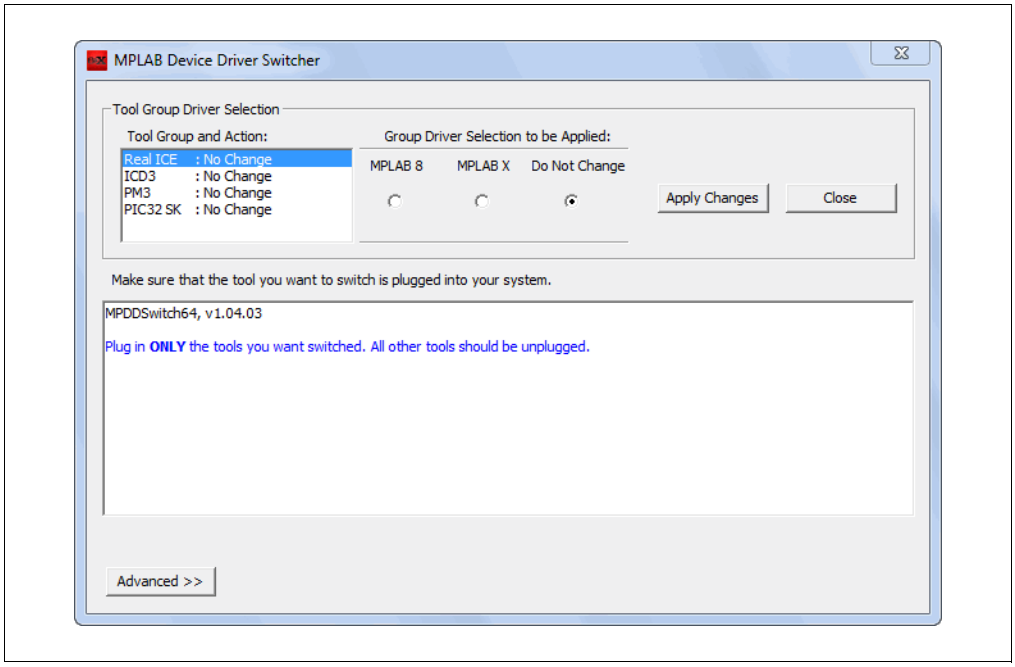
To run the command-line application – `mchpdds32.exe` or `mchpdds64.exe` – as administrator, first open the command prompt as administrator: *Start>All Programs>Accessories>Command Prompt*, right click and select 'Run as Administrator'. This will open up the Administrator: Command Prompt. After this, the instructions provided in the `ReadMe32.txt` or `ReadMe64.txt` file may be followed to complete the driver switching.

2.3.2.4 IF MPLAB IDE V8.XX IS ALREADY INSTALLED ON YOUR SYSTEM

If MPLAB IDE v8.xx or earlier is already installed on your computer, you will run the Switcher program to switch from MPLAB IDE v8 drivers to MPLAB X IDE drivers, which are installed the first time your switch.

The Switcher program is a GUI application called MPDDSwitch (32-bit OS) or MPDDSwitch64 (64-bit OS). This should be available as the desktop icon MPLAB Driver Switcher.

FIGURE 2-1: SWITCHER UTILITY



1. Plug your desired tool into the USB connector on your personal computer.
2. Open the computer's Device Manager window. For example, on a personal computer running Windows XP, right click on the My Computer icon and select "Properties". In the System Properties dialog, click the **Hardware** tab and then click the **Device Manager** button.
3. Expand the "Microchip Tools" section to view the current driver for your tool. The name should be in the following format: Microchip *Tool Name*.
4. Go to the MPLAB X IDE install folder and find the Switcher folder, which is located, by default, in the following location:

   32-bit OS: `C:\Program Files\Microchip\MPLABX\vx.xx\Switcher`

   64-bit OS: `C:\Program Files (x86)\Microchip\MPLABX\vx.xx\Switcher`

   where `vx.xx` is the MPLAB X IDE version.
5. Under the `Switcher` folder, go to the folder for your operating system – `32Bit` or `64Bit`.
6. Launch `MPDDSwitch.exe` (32-bit OS) or `MPDDSwitch64.exe` (64-bit OS).
7. If your MPLAB IDE v8 or MPLAB X IDE installation is not in the default directory, click **Advanced** to specify the location of the driver files.
8. To install or switch USB drivers:
   a) Click to select the *connected* tool for which you wish to switch drivers under "Tool Group and Action".
   b) Click the radio button for either "MPLAB 8" or "MPLAB X".
   c) Click **Apply All**. Switcher progress will be shown in the large text window. This may take some time.

   Note: If the tool(s) are not connected when Switcher is run, the driver(s) will not be installed or switched for those particular tools.
9. If the GUI fails to install the drivers, check the paths to the driver files by clicking **Advanced**. Run the Switcher again.
10. If the GUI still fails to install the drivers, you will need to install the drivers manually. For instructions and driver locations, see **Section 2.3.2.6 "If You Need to Manually Install the Drivers"**.
11. Once the program/batch completes, view the name of the drivers in the Device Manager window. It should read, "Microchip WinUSB Device".

Once your MPLAB X IDE drivers are installed, you can switch your drivers back and forth between MPLAB IDE v8.xx and MPLAB X IDE.

2.3.2.5 IF MPLAB IDE V8.XX IS NOT INSTALLED ON YOUR SYSTEM

You do not need to do anything; the USB drivers will be preinstalled when MPLAB X IDE is installed. Once you plug your tool into a computer USB port, a "New Hardware Found" notification should appear. Then, either the install will proceed automatically or your will have to follow a wizard and choose to "Automatically select driver". However, if either procedure fails to install the drivers, you will need to install the drivers manually. For instructions and driver locations, see **Section 2.3.2.6 "If You Need to Manually Install the Drivers"**.

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2.3.2.6 IF YOU NEED TO MANUALLY INSTALL THE DRIVERS

If you need to install the drivers manually:

1. Open the Device Manager (under Control Panel). Look under “Microchip Tools” for your tool or, if you cannot find it there, under “Other Devices” for “Unknown Device”.
2. Right-click on your tool name or “Unknown Device” and select “Update Driver Software”.
3. In the Update Driver Software dialog, select “Browse my computer for driver software”.

   Note: DO NOT select “Search automatically for updated driver software”. This will install the wrong device driver. If you accidentally select this, back out or exit and repeat these steps to install the correct driver.

4. Locate the correct device driver for your system. The default locations for the device drivers are:

   ```
   C:\Program Files\Microchip\MPLABX\vx.xx\Switcher\32Bit\
      winusb\x86\MCHPWinUSBDevice.inf
   ```

   or

   ```
   C:\Program Files\Microchip\MPLABX\vx.xx\Switcher\64Bit\
      winusb\amd64\MCHPWinUSBDevice.inf
   ```

   where `vx.xx` is the version number of MPLAB X IDE.

   For Windows 8, the drivers are in either the `x86_Windows8` subfolder or in the `amd64_Windows8` subfolder.

5. If a Windows Security dialog pops up, select “Install this driver software anyway” to proceed to install the drivers.

2.3.2.7 TOOL COMMUNICATION ISSUES

1. If you are using a docking station or hub and have issues after plugging in the tool, you may need to plug the tool directly into a USB port on your computer. This is a known issue with the WinUSB driver.
2. If you need to reinstall a driver manually, you will need to point to the INF file in the `32Bit` or `64Bit` folder. See **Section 2.3.2.6 “If You Need to Manually Install the Drivers”** for details.

2.4 CONNECT TO A TARGET (FOR HARDWARE TOOLS)

For in-circuit debuggers and emulators, refer to the following to determine how to connect your hardware tool to a target:

- the Development Tools Design Advisory
- the Header Specification (if you are using a header)
- your tool documentation

For dedicated programmers, refer to your tool documentation for connection information.

If you are using a Microchip demonstration board, evaluation kit or reference design as your target, please refer to the accompanying documentation for set up information.

2.5 INSTALL THE LANGUAGE TOOLS

When you install MPLAB X IDE, the following language tools are installed as well: MPASM toolchain (ASM30 toolchain is no longer included).

Currently there are several C compiler toolsuites (compiler, assembler, linker, etc.) that can be used with MPLAB X IDE. Go to the Microchip web site:

http://www.microchip.com/xc

where you can find compilers to install. Later you can license them as free (Free, Evaluation) or full-featured, code-optimized compilers (Standard, Pro).

To select a compiler toolsuite, consider which device you wish to use and then choose a toolsuite that supports that device.

To install and license the compiler you want, view the document *Installing and Licensing MPLAB XC C Compilers* (DS50002059). MPLAB X IDE includes the option to license your installed compiler and roam in and out network licenses. See the "Licenses" option under **Section 11.2.10 "Tools Menu"**.

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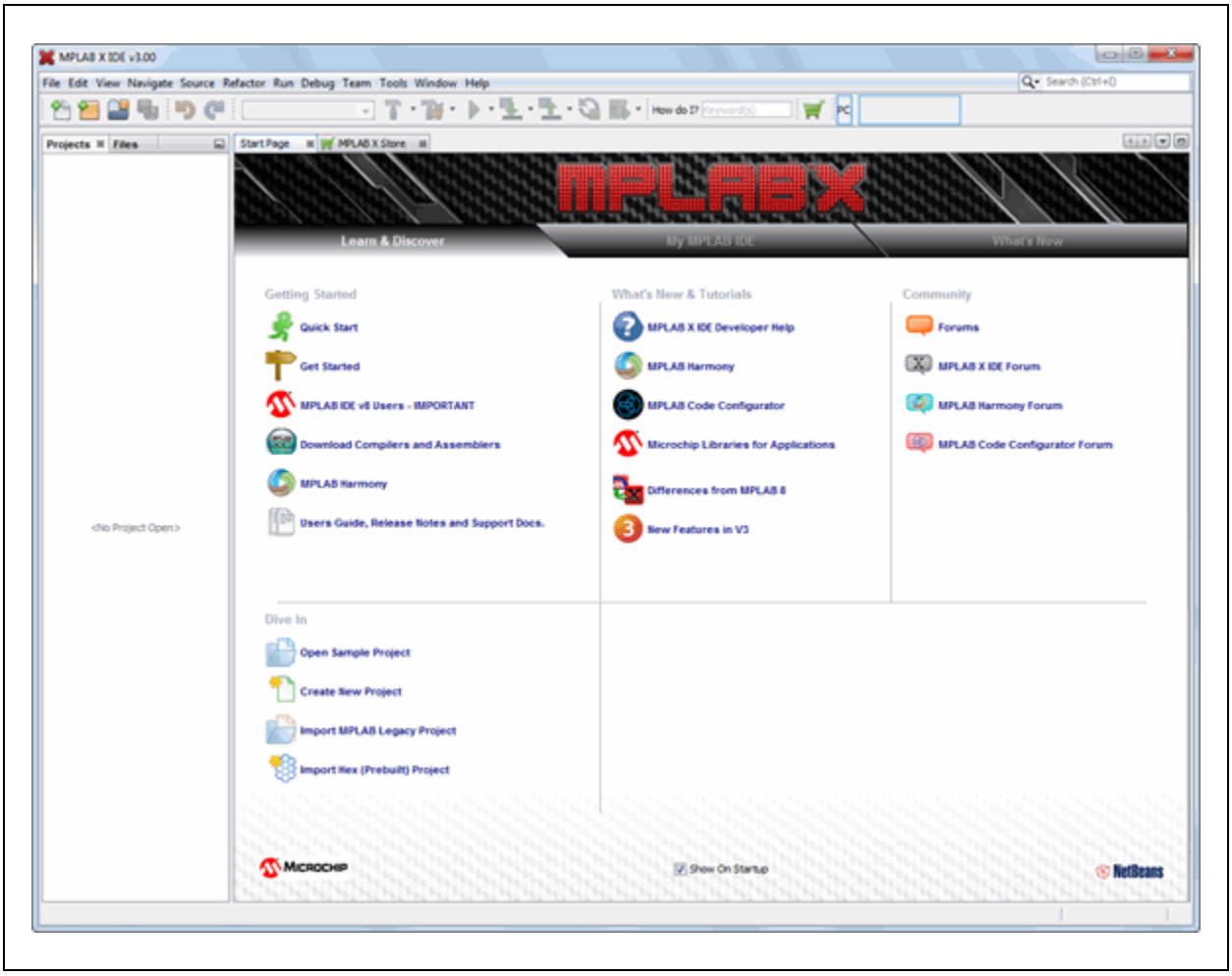
2.6 LAUNCH THE IDE AND VIEW THE DESKTOP

Double click on the MPLAB X IDE icon to launch the program.

MPLAB X IDE is built upon the NetBeans platform. If you are familiar with the NetBeans IDE, then the MPLAB X IDE desktop will look familiar. However, the tabs listed below and shown in the Figure 2-2 are specific to MPLAB X IDE.

- Start Page
- MPLAB X Store

FIGURE 2-2: MPLAB X IDE DESKTOP



2.7 ACCESS INFORMATION FROM THE START PAGE

On the **Start Page**, there are 3 tabs with links. The items on each tab are defined below.

If you don't want the Start Page displayed on start-up, uncheck "Show on Startup" beneath any tab.

TABLE 2-1: LEARN AND DISCOVER TAB

Getting Started	
Quick Start	Get started quickly by creating and setting up a project.
Get Started	Get started using MPLAB X IDE from information on the Microchip Wiki.
MPLAB® IDE v8 Users – IMPORTANT	Install WinUSB device drivers for your hardware tools.
Download Compilers and Assemblers	Learn about, download and install MPLAB XC C compilers and other language tools.
MPLAB® Harmony	Learn how MPLAB Harmony can help you create applications for PIC32 MCUs.
User's Guide, Release Notes and Support Docs	Link to documentation included in the MPLAB X IDE installation, including user's guides, tool release notes, device reserved resources listed by tool and device support documents
Dive In	
Open Sample Project	Open a functional project as an example.
Create New Project	Create a new MPLAB X IDE project. It is recommended that you view the "Quick Start" before creating your first project.
Import Legacy Project	Import your existing MPLAB IDE v8 project. It is recommended that you view the "Quick Start" before working with an imported project.
Import Hex (Prebuilt) Project	Import the hex file from a prebuilt project that was built with another tool.
What's New & Tutorials	
MPLAB X IDE Developer Help	Go to the Microchip Wiki page for information on MPLAB X IDE application development.
MPLAB Harmony	Learn about, download and install MPLAB Harmony, a flexible, abstracted, fully integrated firmware development platform for PIC32 MCUs.
MPLAB Code Configurator	Learn about, download and install MPLAB Code Configurator (MCC), a tool that allows you to configure peripherals and then generate code for the configured peripherals. For 8- and 16-bit MCUs.
Microchip Libraries for Applications	Learn about, download and install MLA, useful for pre-built applications that use the stacks and the libraries in the MLA.
Difference from MPLAB v8	View differences between MPLAB X IDE and MPLAB IDE v8.
New Features in v3	See a list of new features available as of MPLAB X IDE v3.00.
Community	
Forums	Go to the Microchip forums web page.
MPLAB X IDE Forum	Register for the MPLAB X IDE forum.
MPLAB Harmony Forum	Register for the MPLAB Harmony forum.
MPLAB Code Configurator Forum	Register for the MPLAB Code Configurator forum.

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TABLE 2-2: MY MPLAB X IDE TAB

Recent Projects	
MyProject.c:	List of recently opened projects.
Extend MPLAB	
Selecting Simple or Full Featured Menus	On initial start-up, MPLAB X IDE displays simple menus. For more features, follow these instructions.
Download Compilers and Assemblers	Learn about, download and install MPLAB XC C compilers and other language tools.
Install More Plug-Ins	Open the plug-ins dialog.
Notes & Newsletters	
ANxxxx, TBxxxx	Featured application notes and technical briefs.
microSOLUTIONS E-newsletter	Featured newsletters.
All App Notes/ Newsletters	View all available.
References & Featured Links	
Data Sheets, etc.	Click a link to go to the item described.

TABLE 2-3: WHAT'S NEW TAB

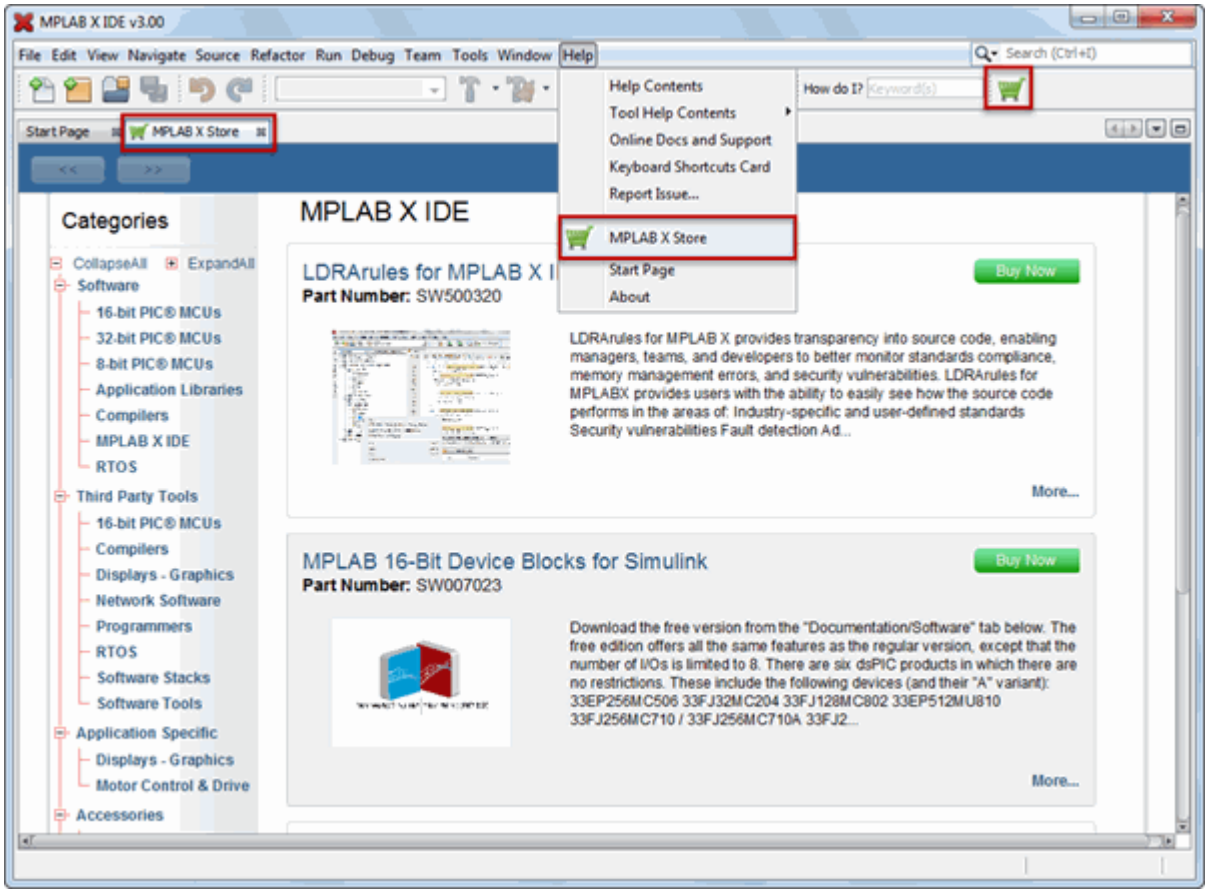
Data Sheets & Errata	
Data Sheet & Errata	List of featured data sheets and errata. To see a list of all these documents, click "All Data Sheets" or "All Errata".
Reference Manuals & Programming Spec	
Family Reference Manual, Device Programming Spec	List of featured reference manuals and programming specifications. To see a list of all these documents, click "All Reference Manuals" or "All Programming Specs".
Recently Released Software	
Source code	List of recent software supporting Microchip device development. To see a list of all these documents, click "All Recently Released Software".
Product & Corporate News	
New stuff, new news	List of featured Microchip products and news. To see a list of all these documents, click "All News".

2.8 SHOP THE MPLAB X STORE

Click on the MPLAB X Store tab to purchase tools from the Microchip store. The tab is formated to showcase some of the latest items for sale pertaining to MPLAB X IDE. You can also browse categories to find other items.

This tab may be accessed directly from the Help menu or from a toolbar icon.

FIGURE 2-3: MPLAB X STORE



Additional features are coming. A microchipDirect login is planned from the Start Page, My MPLAB IDE. You will then be able to:

- See alerts on software (like HPA expiring)
- Access to your mySoftware account, where you can register and download licenses and renew HPA

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2.9 LAUNCH MULTIPLE INSTANCES OF THE IDE

Some set up is required before using hardware tools (PICkit 3, etc.) with an instance of MPLAB X IDE. After any hardware tool setup, an instance of the IDE may be invoked from its own directory.

- Setting Up Hardware Tools to Work with Multiple Instances
- Invoking Instances of the IDE

2.9.1 Setting Up Hardware Tools to Work with Multiple Instances

By default, you can work with up to five (5) instances of the IDE. If you want to have more instances, you will need to modify the “mchpdefport” file manually.

2.9.1.1 USE AND FORMAT OF “MCHPDEFPORT” FILE

The “mchpdefport” file provides the information necessary for tool hot-plug use to both the IDE and to the low-level USB library (DLL, so, or dylib file). The format for this file is as follows:

```
localhost
30000
30002
30004
30006
30008
```

The first line indicates the host name on which the IDE is running.

The other lines represent port or socket numbers through which the low-level library communicates with the upper-level IDE. Each instance of the IDE will be assigned to a different port or socket. All communications between the instances of the IDE should be hidden from the user.

For up to five (5) instances of MPLAB X IDE, you do not need to alter this file. If you want more than five instances, you can edit the file to add more port or socket numbers.

2.9.1.2 LOCATION OF THE “MCHPDEFPORT” FILE

Within a default installation of the IDE, the “mchpdefport” file can be found in the following place, depending on the operating system:

OS	Location
Windows (64-bit)	`C:\Windows\system32` and `C:\Windows\SysWOW64` (**Note:** Both occurrences of “mchpdefport” must be modified.)
Windows (32-bit)	`C:\Windows\system32`
Linux	`/etc/.mplab_ide`
Mac (OS X)	`/etc/.mplab_ide`

2.9.2 Invoking Instances of the IDE

MPLAB X IDE requires that each instance has its own user directory. Therefore, preferences that are set or plug-ins that are added to one instance will not be reflected in another instance.

In order to invoke multiple instances, launch the IDE with the `--userdir` option and specify a directory.

2.9.2.1 WINDOWS OS

Create a shortcut with the `--userdir` option. For example, on Windows 7 OS:

1. Right click on the desktop and select *New>Shortcut*.
2. Browse to the installed MPLAB X IDE executable, by default at:
   `"C:\Program Files (x86)\Microchip\MPLABX\vx.xx\mplab_ide\bin\mplab_ide.exe"`
   where `vx.xx` is the MPLAB X IDE version.
3. At the end of that line, type the location of the user directory. You can either place your directory under the default location for this type of MPLAB X IDE information:
   `--userdir "C:\Users\MyFiles\AppData\Roaming\.mplab_ide\dev\anydir"`
   or you can place it where ever you like:
   `--userdir anydir`
4. Click **OK**.

2.9.2.2 LINUX OS

The installed version, run without any parameters (clicking on the desktop icon), will run with a user directory of `$(HOME)/.mplab_ide`. To change the user directory, run the `$InstallationDir/mplab_ide/bin/mplab_ide` shell script, passing the argument `--userid anydir`. For example, to run MPLAB X IDE in two different instances:

```
$ /opt/microchip/mplabx/vx.xx/mplab_ide/bin/mplab_ide --userdir
~/.anydir1 &
$ /opt/microchip/mplabx/vx.xx/mplab_ide/bin/mplab_ide --userdir
~/.anydir2 &
```

where `vx.xx` is the MPLAB X IDE version.

You can create desktop icons that have the user ID embedded, too.

2.9.2.3 MAC OS

Open a Shell window and type a command line listed below to execute your installation of MPLAB X IDE in an alternate user directory. You can either place your directory under the default location for this type of MPLAB X IDE information:

```
$/bin/sh /Applications/microchip/mplabx/vx.xx/mplab_ide.app/Contents/
Resources/mplab_ide/bin/mplab_ide --userdir "${HOME}/Library/
Application Support/mplab_ide/dev/anydir"
```

or you can place it wherever you like:

```
$/bin/sh /Applications/microchip/mplabx/vx.xx/mplab_ide.app/Contents/
Resources/mplab_ide/bin/mplab_ide --userdir anydir
```


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2.10 LAUNCH MULTIPLE VERSIONS OF THE IDE

Before the release of MPLAB X IDE v3.00, you could have different versions of the IDE on your PC by installing to different directories. Beginning with MPLAB X IDE v3.00, this is done by default, for example:

```
C:\Program Files (x86)\Microchip\MPLABX\v3.00
```

You can launch and run different versions at the same time. Each version has its own user directory.

You can launch a version of MPLAB X IDE and a version of MPLAB IDE (v8 or earlier) on the same PC, but keep in mind that the USB hardware driver limitations mentioned in **Section 2.3.2 “USB Driver Installation for Windows® XP/7/8 Operating Systems”**.

NOTES:

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Chapter 3. Tutorial

3.1 INTRODUCTION

This tutorial provides a guided example for working with an MPLAB X IDE project.

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3.2 SETTING UP THE HARDWARE AND SOFTWARE

The following information discusses preparation to begin using the MPLAB X IDE.

3.2.1 Tutorial Equipment

The products used in this tutorial are:

Tool	Web Page	Order Number
MPLAB® X IDE	http://www.microchip.com/mplabx	Free
MPLAB® XC32 C Compiler*	http://www.microchip.com/xc	SW006023-1 (Standard Version)
MPLAB® REAL ICE™ In-Circuit Emulator	http://www.microchip.com/realice	DV244005
Explorer 16 Development Board	http://www.microchip.com/explorer16	DM240001
PIC32MX360F512L PIM	http://www.microchipdirect.com/productsearch.aspx?Keywords=MA320001	MA320001

* You can get a free or evaluation edition of this compiler from the Microchip website. Download the compiler and, when installing, do not enter a license number.

3.2.2 Installation and Set Up

See **Chapter 2. "Before You Begin"** to install MPLAB X IDE, set up the emulator (install USB drivers and properly connect to your target), and install the 32-bit language tools. Then, launch MPLAB X IDE and begin this tutorial.

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3.3 CREATING AND SETTING UP A PROJECT

The following information discusses setting up a project in MPLAB X IDE, which is required to develop your application code.

3.3.1 Create a New Project

MPLAB X IDE is project-based, so you must set up a project to work on your application.

Create a new project by performing either of the following actions:

- On the **Start** page, click the **Learn & Discover** tab, “Dive In” section, and the “Create New Project” link
- From the menu bar on top of the window, click *File>New Project* (or Ctrl+Shift+N)

The New Project Wizard will launch to guide you through creating a new project.

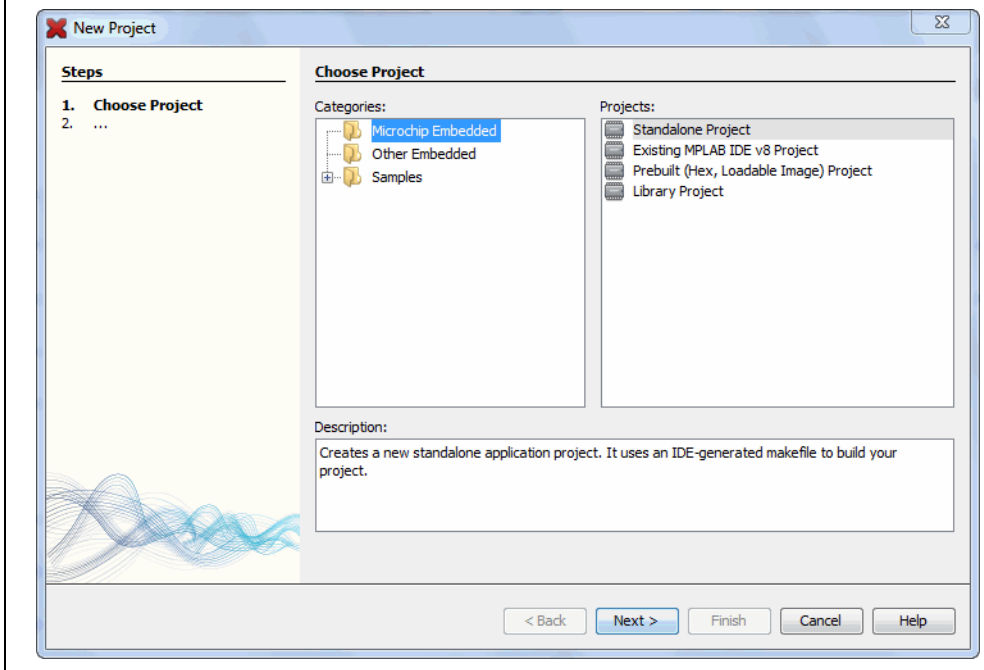
STEP 1

Step 1 asks you to choose a project category. For this tutorial, choose “Microchip Embedded”.

Secondly, choose a project type. For this tutorial, choose “Standalone Project”.

Click **Next>** to move to the next dialog.

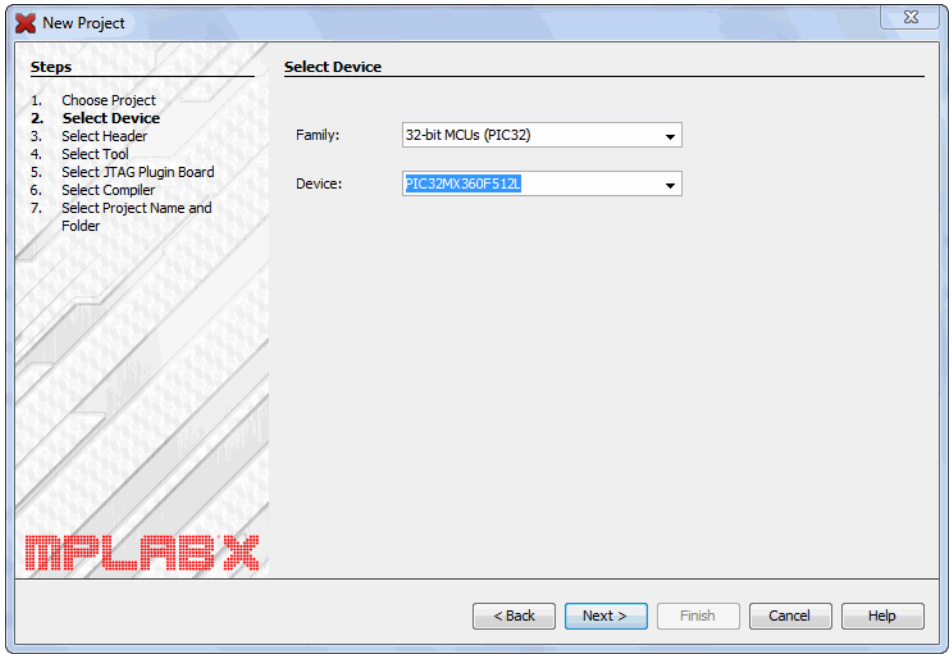
FIGURE 3-1: PROJECT WIZARD – CHOOSE PROJECT



STEP 2

Step 2 is for choosing your device, in this case PIC32MX360F512L. When you are done, click **Next>**.

FIGURE 3-2: PROJECT WIZARD – SELECT DEVICE



STEP 3

Step 3 appears only if a header is available for your selected device. Since there is no header for the PIC32MX360F512L device, MPLAB X IDE skips this step.

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STEP 4

Step 4 selects the tool.

Tool support for the selected device is signified by the colored circles (lights) in front of the tool name. If you cannot see the colors, mouse over a light to pop up text about support.

Light	Color	Support
●	Green	Full (implemented, and fully tested)
●	Yellow	Beta (implemented, but not fully tested)
●	Red	None

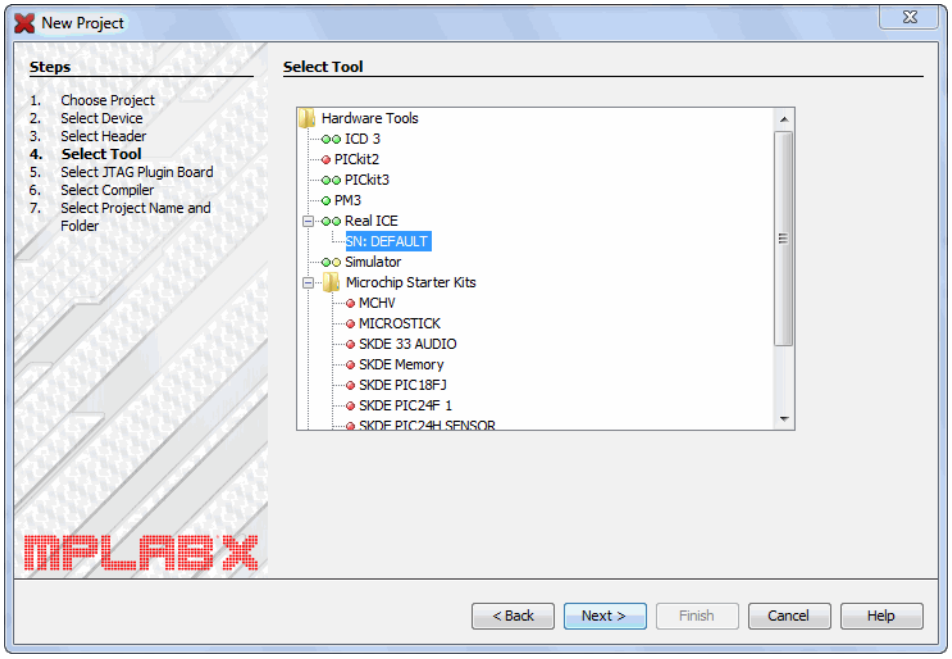
For some tools, there are two lights next to the tool name, where the *first light* is the left-most light and the *second light* is to the right of the first.

Light No.	Debug Tools	Simulator
1	Debugger Support	Core (Instruction Set) Support
2	Programmer Support	Peripheral Support

For the hardware tools, you will notice that a serial number (SN) is specified below any tool that is connected to your computer. This allows you to select from several connected hardware tools.

Select your tool and then click **Next>**.

FIGURE 3-3: PROJECT WIZARD – SELECT TOOL



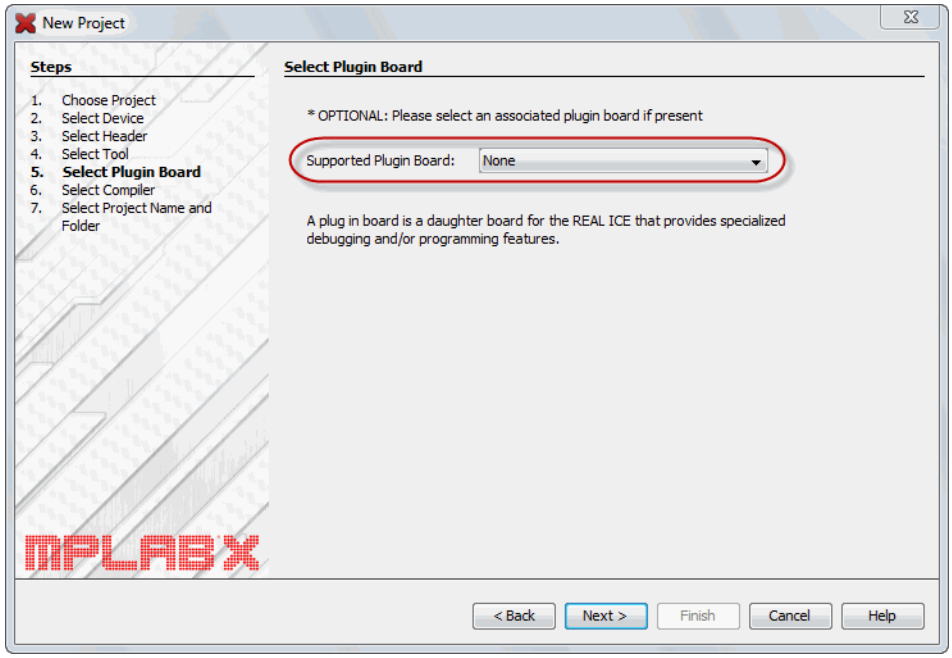
STEP 5

Step 5 appears only if MPLAB REAL ICE in-circuit emulator is selected as the tool.

For the MPLAB REAL ICE in-circuit emulator, you may specify a plug-in board to use. A plug-in board is the circuit board that is inserted into the emulator's driver board slot. Since the Explorer 16 board works with either the Standard or High-Speed Communications driver boards, leave the "Supported Plugin Board" as "None".

Select your tool and then click **Next>**.

FIGURE 3-4: PROJECT WIZARD – SELECT PLUGIN



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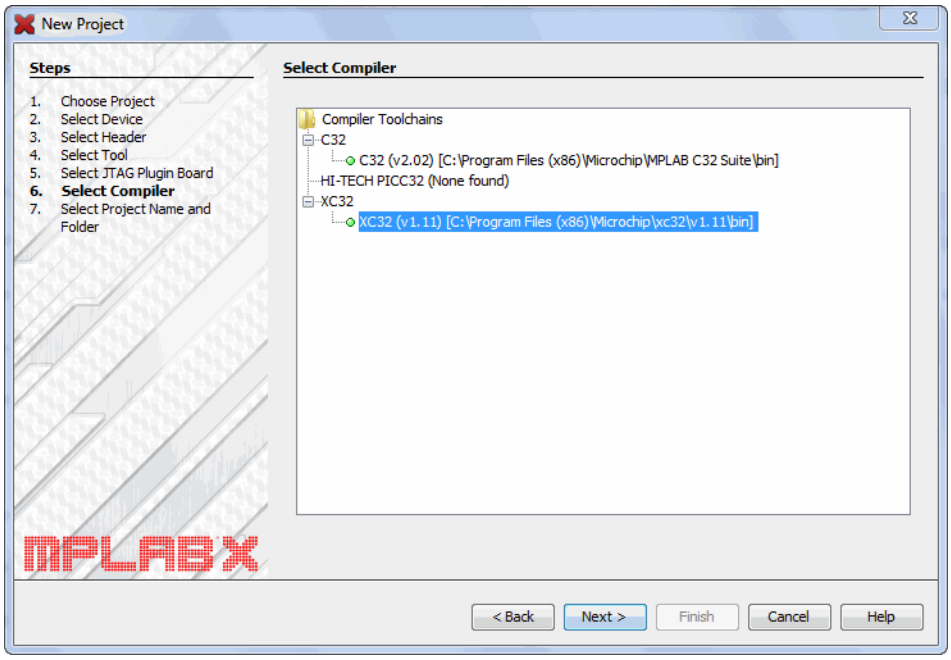
STEP 6

Step 6 selects the language tool, either a C compiler or assembler. Again, the colored circle (light) in front of the compiler name signifies the device support level. Mouse over for text.

The version and installation location of a language tool is displayed beneath that tool. This allows you to select from several installed language tools.

Select your tool and then click **Next>**.

FIGURE 3-5: PROJECT WIZARD – SELECT LANGUAGE TOOL



STEP 7

Step 7 selects the project name, location and other project options.

Enter the project name `MyProject`.

By default, projects will be placed in:

- Windows XP – `C:\Documents and Settings\`*`UserName`*`\MPLABXProject`
- Windows 7/8 – `C:\Users\`*`UserName`*`\MPLABXProjects`
- Linux – `/home/`*`UserName`*`/MPLABXProjects`
- Mac – `/Users/`*`UserName`*`/MPLABXProjects`

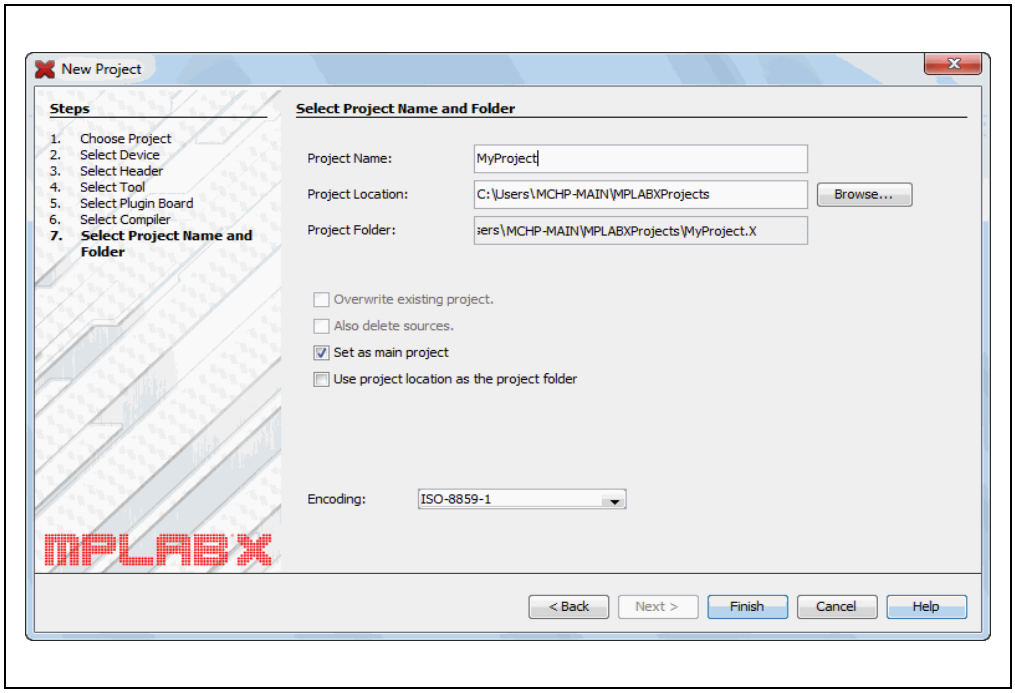
If the Project Location does not point to the default location, browse to the appropriate location.

Check "Set as main project" to make this your main project. Leave "Use project location as project folder" unchecked.

This tutorial was produced with the encoding set to ISO-8859-1 (Latin 1) so you do not need to change this setting.

When you are done, select **Finish** to complete new project creation.

FIGURE 3-6: PROJECT WIZARD – SELECT PROJECT NAME AND FOLDER



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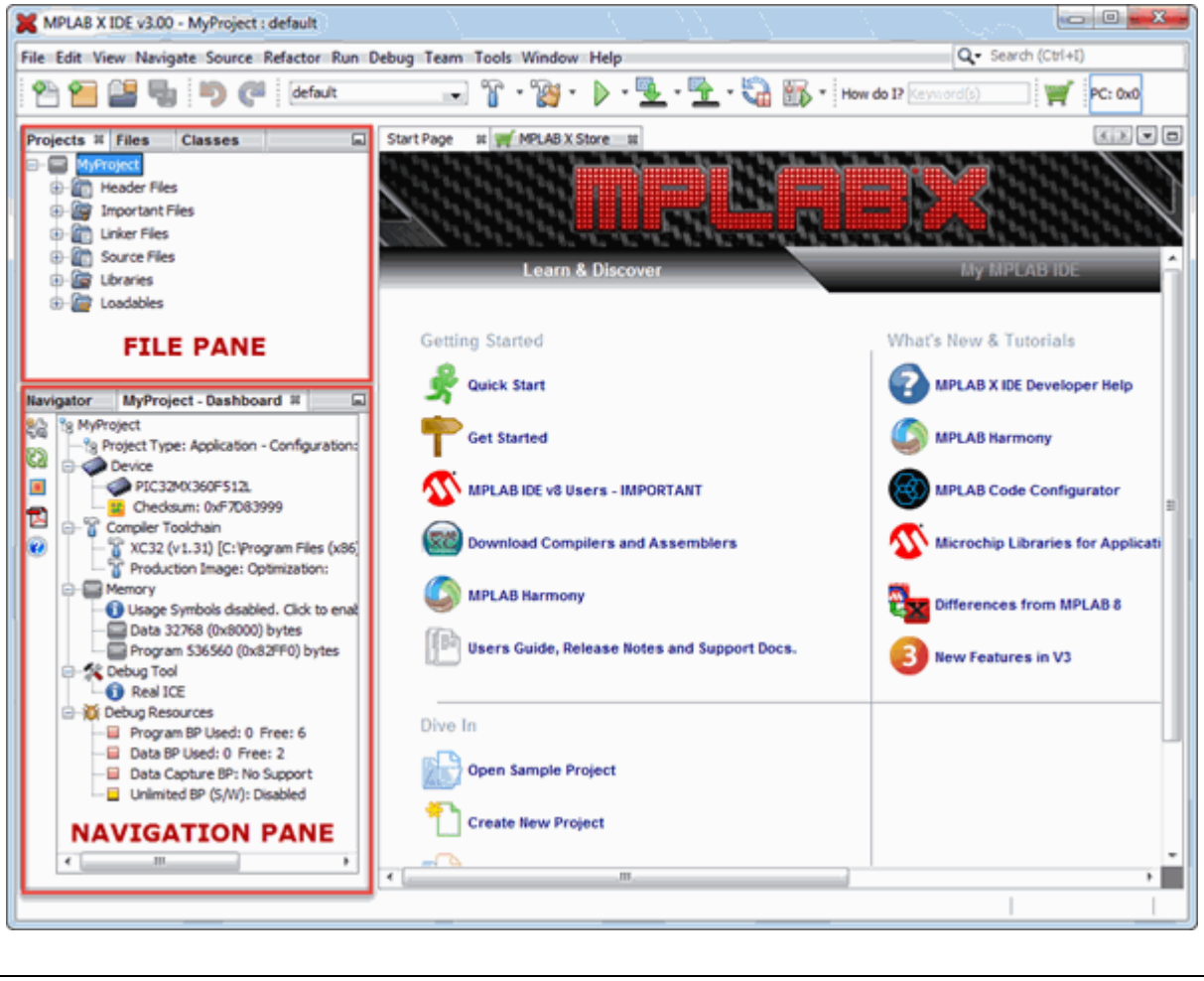
3.3.2 View Changes to the Desktop – File and Navigation Panes

Once you have created your project, the project tree appears in the Projects window, which is located in the File Pane. The Dashboard window (with information about your project) is below it, in the Navigation Pane.

- **File pane** – contains four tabbed windows. In this tutorial, we will focus on the Projects window, which displays the project tree, with files grouped by category.
  - Projects
  - Files
  - Classes and Services (not shown automatically) windows.
- **Navigation pane** – displays information on the file or project selected. For a project, the Dashboard shows details about the project.

FIGURE 3-7: MPLAB X IDE DESKTOP



If you double click on any file name in the File pane, the related file will open in the Editor pane (see **Section 3.3.8 "View Changes to the Desktop – Editor Pane"**). To close the tab, click on the "x" next to the file name.

Right click on the project name in the File pane of the Projects window to view the pop-up (context) menu. You can do the same on the project's subfolders.

3.3.3 View or Make Changes to Project Properties

Once a project has been created, you can view or change the project properties in the Project Properties dialog.

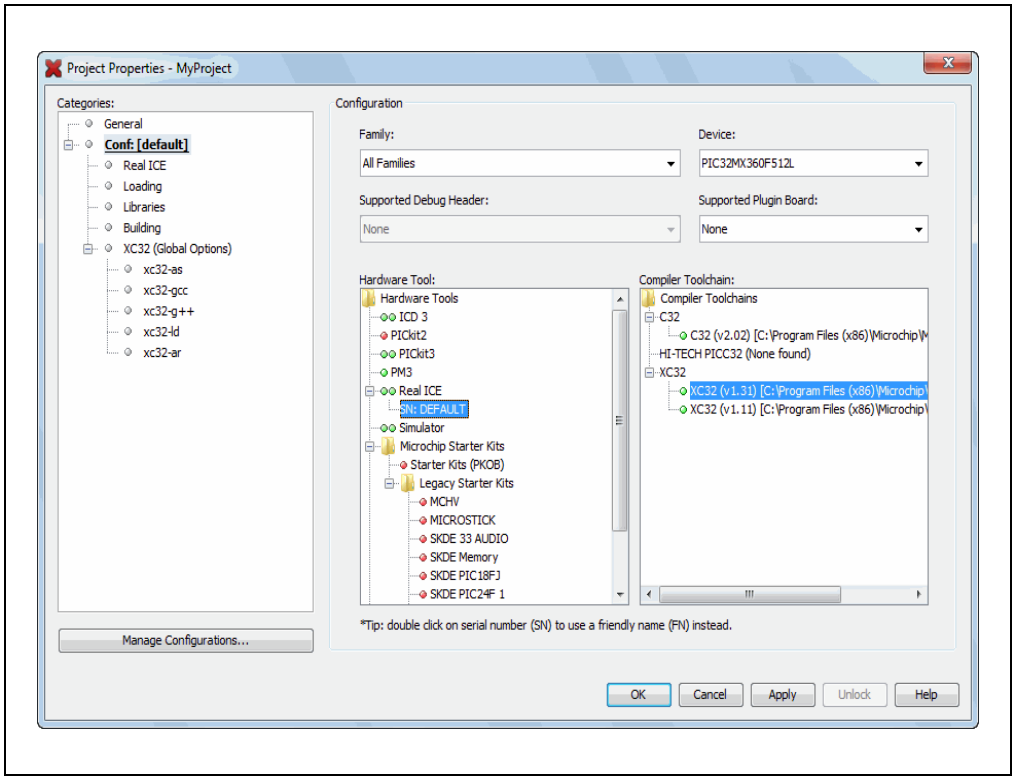
Access this dialog by performing one of the following actions:

- Right click on the project name in the Projects window and selecting "Properties".
- click on the project name in the Projects window and then selecting *File>Project Properties*.

Click the "Conf:[default]" category to reveal the general project configuration, such as the project device, related debug/programmer tool, and language tool. Do not change any of these items for this tutorial unless you have made a mistake in previous sections.

Then update in this dialog and click **Apply**.

FIGURE 3-8: PROJECT PROPERTIES DIALOG



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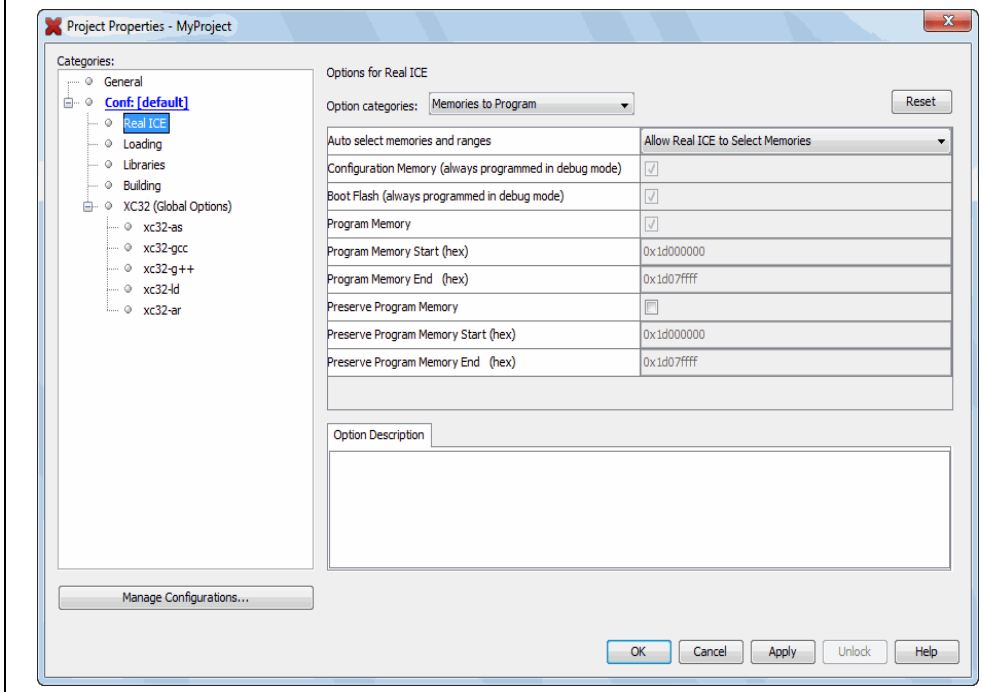
3.3.4 Set Up or Change Debugger or Programmer Options

To set up or change debugger/programmer tool options:

Click on REAL ICE to see related set up options. For more on what these options do, see the emulator documentation.

Do not make any changes for this tutorial.

FIGURE 3-9: TOOL SETUP PAGE



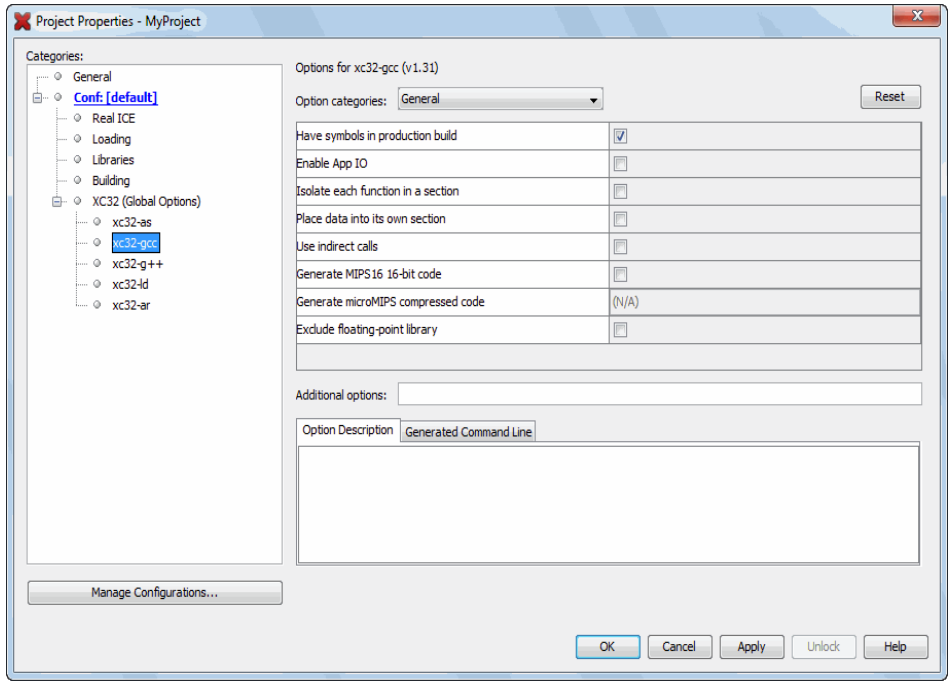
3.3.5 Set Up or Change for Language Tool Options

To set up or change language tool options:

Click on your language tool to see related set up options. For more on what these options do, see your language tool documentation.

Do not make any changes for this tutorial.

FIGURE 3-10: LANGUAGE TOOL SET UP PAGE



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3.3.6 Set Language Tool Locations

To see which language tools are available to MPLAB X IDE, and view or change their paths:

- **For Mac OS X**:
  Access the build tools from *mplab_ide>Preferences>Embedded>Build Tools* from the main menu bar.
- **For other operating systems:**
  Access the build tools from *Tools>Options>Embedded>Build Tools*.

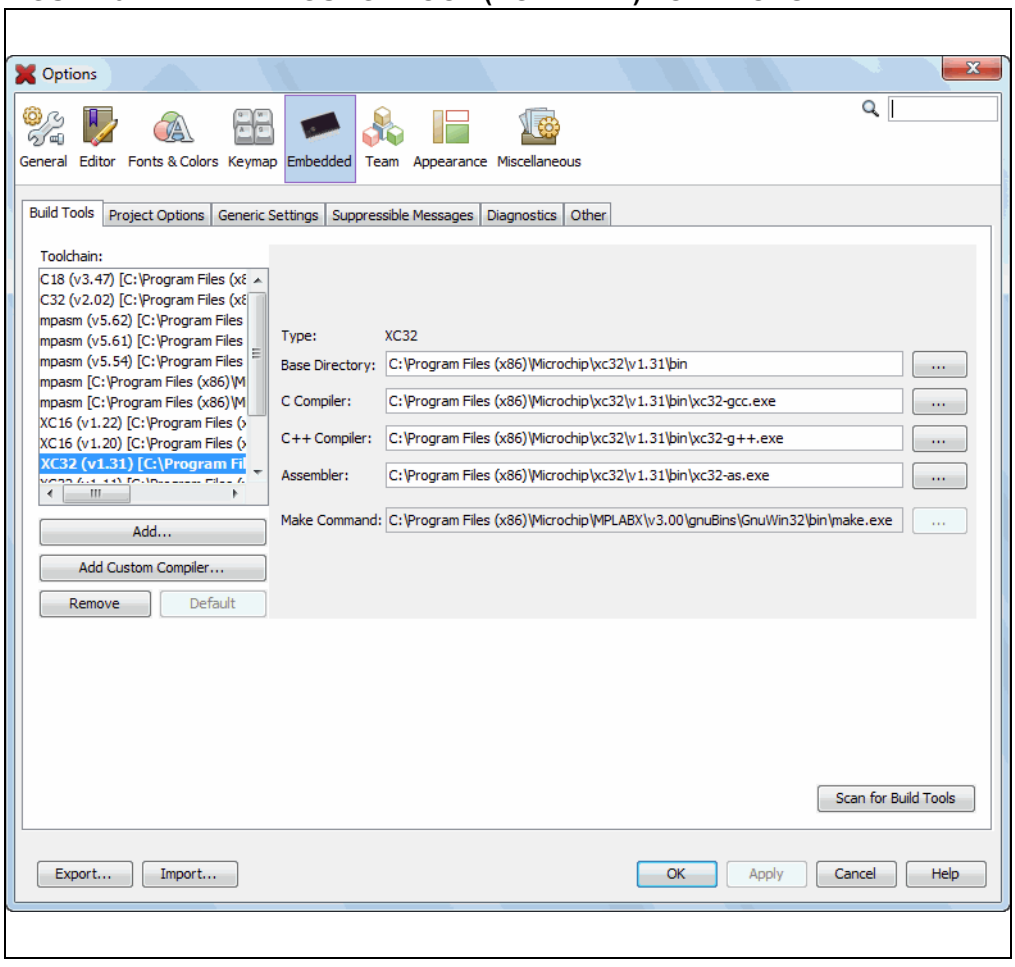
The Toolchain window should automatically populate with all installed toolchains. If you do not see your tool listed, try the following:

- **Scan for Build Tools** – scans the environment path and lists the language tools installed on the computer.
- **Add** – manually add the tool to the list by entering the path to the directory containing the tool executable(s), i.e., base directory. Typically, this is the `bin` subdirectory in the tool installation directory.

If you have more than one version of a compiler available, select one from the list.

Ensure that the XC32 toolchain is selected for this tutorial.

FIGURE 3-11: LANGUAGE TOOL (COMPILER) LOCATIONS



3.3.7 Add a New File to the Project

For this tutorial, you will create a new file containing the code listed below.

1. In the Projects window, right click on the Source Files folder of the project tree and select *New>C Main File*.
2. In the "New C Main File" window, name the file `led_message.c` and then click **Finish**. You should now see the file listed under Source Files, and a new Editor window with the file name on the tab.
3. Delete the code in the Editor window and paste in the code from the listing below. (This code is from the "PIC32 Explorer 16 LED Example Application".)

Code Listing for `led_message.c`:

```
/********************************************************************
 *
 *                  Message via 8 LEDs
 *
 ********************************************************************
 * FileName:        led_message.c
 * Dependencies:    xc.h
 *
 *
 * Processor:       PIC32
 *
 * Complier:        MPLAB XC32 v1.40
 *                  MPLAB X IDE v3.05
 * Company:         Microchip Technology, Inc.
 *
 * Software License Agreement
 *
 * The software supplied herewith by Microchip Technology Incorporated
 * (the "Company") for its PIC32 Microcontroller is intended
 * and supplied to you, the Company's customer, for use solely and
 * exclusively on Microchip PIC32 Microcontroller products.
 * The software is owned by the Company and/or its supplier, and is
 * protected under applicable copyright laws. All rights are reserved.
 * Any use in violation of the foregoing restrictions may subject the
 * user to criminal sanctions under applicable laws, as well as to
 * civil liability for the breach of the terms and conditions of this
 * license.
 *
 * THIS SOFTWARE IS PROVIDED IN AN "AS IS" CONDITION. NO WARRANTIES,
 * WHETHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING, BUT NOT LIMITED
 * TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A
 * PARTICULAR PURPOSE APPLY TO THIS SOFTWARE. THE COMPANY SHALL NOT,
 * IN ANY CIRCUMSTANCES, BE LIABLE FOR SPECIAL, INCIDENTAL OR
 * CONSEQUENTIAL DAMAGES, FOR ANY REASON WHATSOEVER.
 *
 * $Id: led_message.c 5898 2007-10-23 19:39:48Z rajbhartin $
 *
 ********************************************************************/

/*
** Message in a bottle
**
** Explorer 16 version (long delays)
**
** Thanks to Lucio DiJasio for letting us use this example.
**
```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```
** Run this example on Explorer 16 board with a PIC32MX PIM.
** Hold the board vertically from the PICtail connector size
** and wave the board back-and-forth to see message "HELLO" on LEDs
*/

#include <xc.h>

// Config settings
// POSCMOD = HS, FNOSC = PRIPLL, FWDTEN = OFF
// PLLIDIV = DIV_2, PLLMUL = MUL_16
// PBDIV = 8 (default)
// Main clock = 8MHz /2 * 16    = 64MHz
// Peripheral clock = 64MHz /8  =  8MHz

// Configuration Bit settings
// SYSCLK = 64 MHz (8MHz Crystal/ FPLLIDIV * FPLLMUL / FPLLODIV)
// PBCLK = 8 MHz
// Primary Osc w/PLL (XT+,HS+,EC+PLL)
// WDT OFF
// Other options are don't care
//
#pragma config FPLLMUL = MUL_16, FPLLIDIV = DIV_2, FPLLODIV = DIV_1,
FWDTEN = OFF
#pragma config POSCMOD = HS, FNOSC = PRIPLL, FPBDIV = DIV_8



// 1. define timing constant
#define SHORT_DELAY (50*8)
#define LONG_DELAY(400*8)

// 2. declare and initialize an array with the message bitmap
char bitmap[30] = {
    0xff,// H
    0x08,
    0x08,
    0xff,
    0,
    0,
    0xff,// E
    0x89,
    0x89,
    0x81,
    0,
    0,
    0xff,// L
    0x80,
    0x80,
    0x80,
    0,
    0,
    0xff,// L
    0x80,
    0x80,
    0x80,
    0,
    0,
    0x7e,// O
    0x81,
    0x81,
```

```
    0x7e,
    0,
    0
    };

// 3. the main program
main()
{
    // disable JTAG port
    DDPCONbits.JTAGEN = 0;

    // 3.1 variable declarations
    int i;           // i will serve as the index

    // 3.2 initialization
    TRISA = 0;      // all PORTA as output
    T1CON = 0x8030; // TMR1 on, prescale 1:256 PB

    // 3.3 the main loop
    while( 1)
    {
        // 3.3.1 display loop, hand moving to the right
        for( i=0; i<30; i++)
        {// 3.3.1.1 update the LEDs
            PORTA = bitmap[i];

            // 3.3.1.2 short pause
            TMR1 = 0;
            while ( TMR1 < SHORT_DELAY)
            {
            }
        } // for i

        // 3.3.2 long pause, hand moving back to the left
        PORTA = 0;      // turn LEDs off
        TMR1 = 0;
        while ( TMR1 < LONG_DELAY)
        {
        }
    } // main loop
} // main
```


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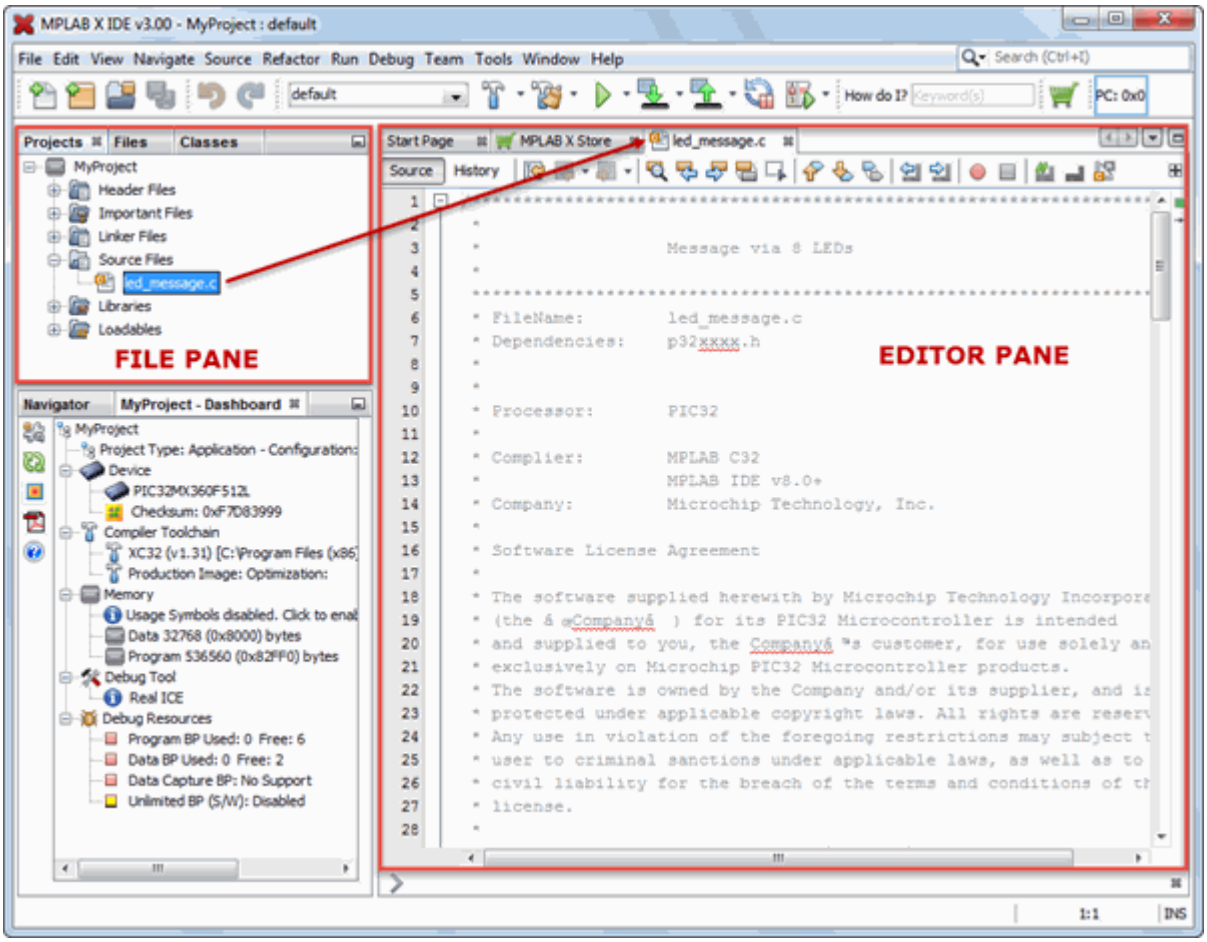
3.3.8 View Changes to the Desktop – Editor Pane

The file will appear in the File Pane under the project specified; and a tab with the file's name will appear in the Editor Pane.

Editor pane – a pane to view and edit project files. The Start Page also is visible here.

FIGURE 3-12: MPLAB X IDE DESKTOP – FILE AND EDITOR PANES



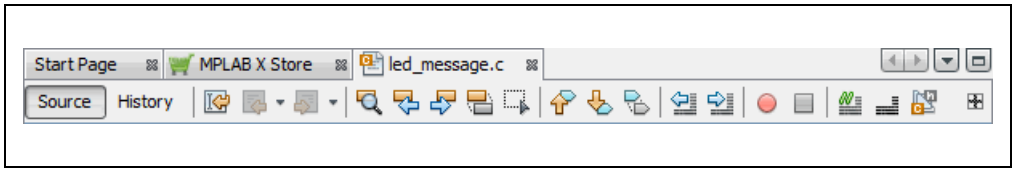
3.3.9 Editor Usage

The sample code should not need to be edited. However, when you need to edit your code, you will be using the NetBeans editor. C compiler information regarding the editor is available from the NetBeans help topic *C/C++/Fortran Development>C/C++/Fortran Project Basics>Navigating and Editing C/C++/Fortran Source Files*. A list of features is available under **Chapter 7. "Editor"**.

To use editor features, go to the:

- Edit menu (see **Section 11.2.2 "Edit Menu"**.)
- Editor toolbar located at the top of each file's Editor window.
- Window right click (context) menu.

FIGURE 3-13: EDITOR TOOLBAR



3.3.10 Configuration Bits

Microchip devices must be configured to operate correctly. This is accomplished through the use of configuration bits found in registers located in a special section of device memory (i.e., configuration memory). These bits must be set in code. However, you can temporarily change Configuration bits during a debug session in the Configuration Bits window (*Window>PIC Memory Views>Configuration Bits*). Then you may export the setting by right clicking in the window and selecting "Generate Source Code to Output". You can copy this code from the Output window into your code.

In the sample code, Configuration bits are already set. For your own application, you must set up the Configuration bits.

For a summary of Configuration bits settings for different devices, see **Appendix A. "Configuration Settings Summary"**.

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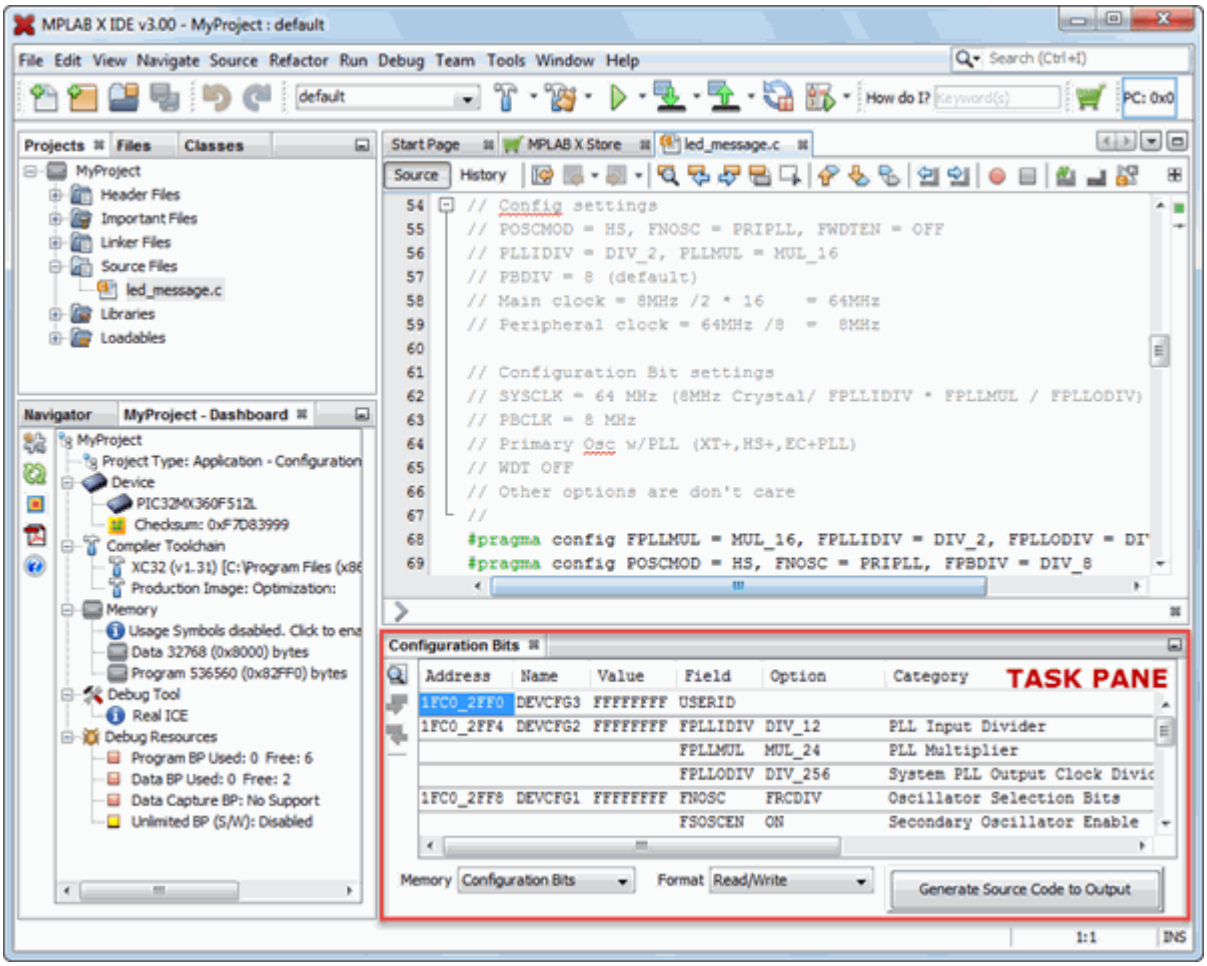
3.3.11 View Changes to the Desktop – Task Pane

When you open a PIC Memory Views window, such as Configuration Bits, it will open in the Task Pane.

Task pane – a pane to display task output from building, debugging, or running an application.

FIGURE 3-14: MPLAB X IDE DESKTOP – TASK PANE



3.4 RUNNING AND DEBUGGING CODE

The following information discusses using the MPLAB X IDE to run or debug your code.

3.4.1 Build a Project

For MPLAB X IDE, it is not necessary to build the project first and then run or debug. Building is part of the run and debug processes. For initial development or major changes, however, you may want to make sure that the project builds before attempting to run or debug.

To build a project:

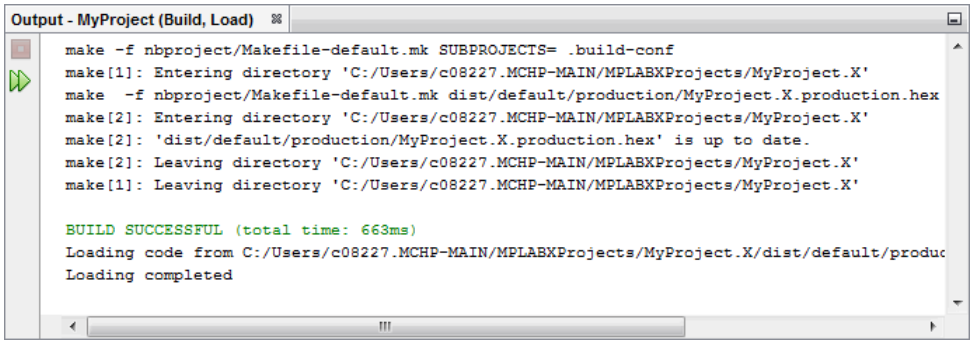
- In the Projects window, right click on the project name and select "Build". You may also select "Clean and Build" to remove intermediary files before building.
- Click on the "Build Project" or "Clean and Build Project" toolbar icon.

Build Icon

Clean and Build Icon

Build progress will be visible in the Output window, located in the Task Pane. For this tutorial, the code should build successfully.

FIGURE 3-15: OUTPUT SUCCESSFUL BUILD



To view checksum information:

Open the Dashboard window (*Window>Dashboard*) if it is not already open to see the checksum after a build.

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3.4.2 Run Code

After the code builds successfully, you can attempt to run the application. Click on the "Make and Program Device Project" icon (or select *Run>Run Project*) to run your program.

Make and Program Device Project Icon

The lights on the demo board should be flickering. Wave the board back and forth to see the word, "Hello".

Run progress will be visible in the Output window as well.

Use the **Hold in Reset** button to toggle between device Reset and running.

Hold in Reset Icon

You can add a "Run Project" icon to the toolbar if you wish (*View>Toolbars>Customize*).

Run Icon

3.4.3 Debug Run Code

For this tutorial, the code used has been tested and runs successfully. However, your own code may need to be debugged as you develop your application.

To Debug Run the tutorial code, click on the "Debug Project" icon (or select *Debug>Debug Project* or *Debug>Step Into*) to begin a debug session.

Debug Run Icon

Debug Run progress will be visible in the Output window.

To halt your application code:

Click on the "Pause" icon (or select *Debug>Pause*) to halt your program execution.

To run your code again:

Click on the "Continue" icon (or select *Debug>Continue*) to start your program execution again.

To end execution of your code:

Click on the "Finish Debugger Session" icon (or select *Debug>Finish Debugger Session*) to end your program execution.

For more details on debugging C code projects, see the NetBeans help topic *C/C++/Fortran Development>Debugging C/C++/Fortran Applications with gdb*.

The difference between Run and Debug Run will become apparent when working with debug features, beginning with **Section 3.4.4 "Control Program Execution with Breakpoints"**.

3.4.4 Control Program Execution with Breakpoints

When debugging code, it can be useful to suspend execution at a specific location in code so that variable values can be examined. To do this, use breakpoints.

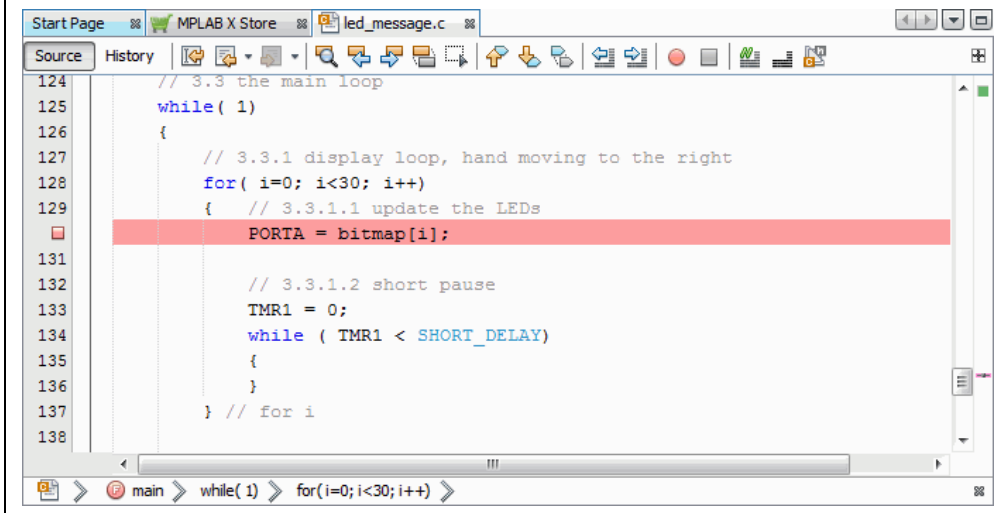
Set a breakpoint on the following line of code:

```
PORTA = bitmap[i];
```

To set a breakpoint on a line, do one of the following:

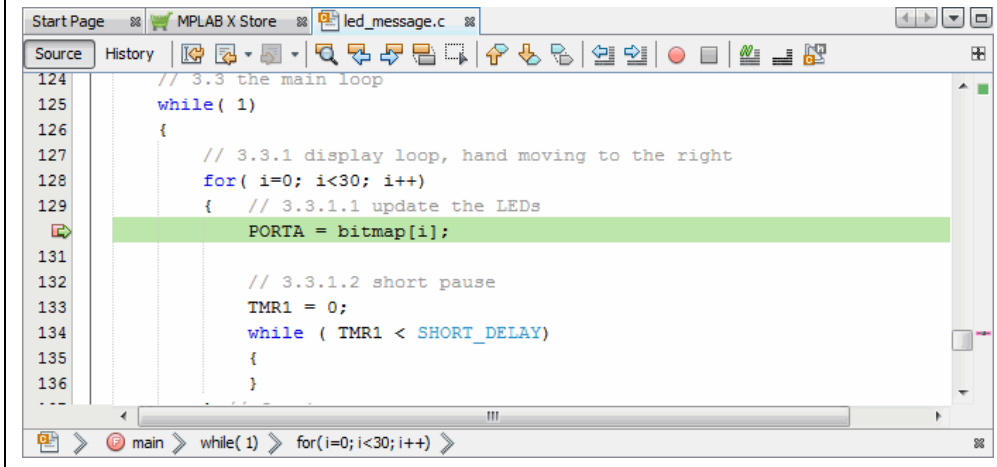
- Click the left margin of the line in the Source Editor
- Press Ctrl-F8

FIGURE 3-16: BREAKPOINT SET IN CODE



Debug Run the tutorial program again. The program will halt at the breakpoint. Hover over the `bitmap[]` variable to see its values.

FIGURE 3-17: PROGRAM EXECUTION HALTED AT BREAKPOINT



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To clear the breakpoint do one of the following:

- Repeat the step to set a breakpoint
- Select *Debug>Toggle Breakpoint*

For more on breakpoints, see the NetBeans help topics under *C/C++/Fortran Development>Debugging C/C++/Fortran Applications with gdb>Setting C/C++/Fortran Breakpoints*.

3.4.5 Step Through Code

Use one of the stepping functions on the Debug menu and Debug toolbar to move through code either from the beginning of code or after a breakpoint halt. Examine changes in variable values (see next section) or determine if the program flow is correct.

There are several ways to step through code:

- Step Over – Executes one source line of a program. If the line is a function call, it executes the entire function and stops.
- Step Into – Executes one source line of a program. If the line is a function call, it executes the program up to the function's first statement and stops.
- Step Out – Executes one source line of a program. If the line is a function call, it executes the functions and returns control to the caller.
- Run to Cursor – Runs the current project to the cursor's location in the file and stops program execution.

For more on stepping, see the NetBeans help topics under *C/C++/Fortran Development>Debugging C/C++/Fortran Applications with gdb>C/C++/Fortran Debugging Sessions>Stepping Through Your C/C++/Fortran Program*.

3.4.6 Watch Symbol Values Change

Watch the values of symbols that you select change in the Watches window. Determining if these values are as expected during program execution will help you to debug your code.

To create a new watch:

1. Select *Debug>New Watch*. The New Watch dialog will open (see below).
2. Enter a Watch expression, in this case `PORTA`, and then click **OK**. The Watches window will now appear on the desktop with the symbol.

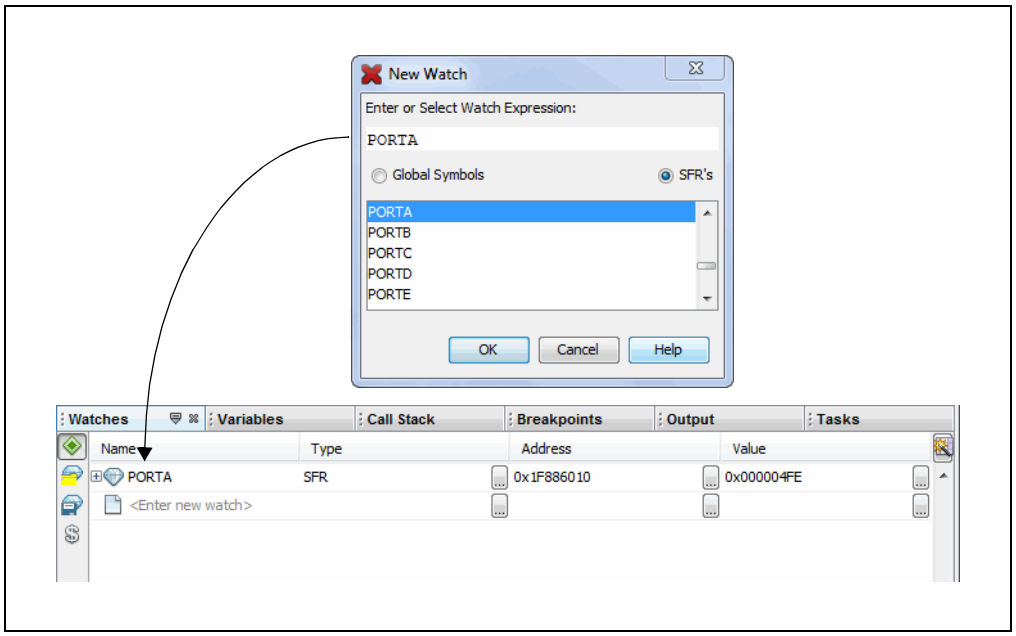
OR

1. Right click on PORTA in code and select "New Watch".
2. The Watches window will open with PORTA in it.

OR

1. Select *Window>Debugging>Watches*.
2. Drag and drop PORTA from the editor window into the Watches window.

FIGURE 3-18: WATCHES WINDOW WITH SYMBOL



To view symbol changes:

1. Debug Run and then Pause your program.
2. Click the **Watches** tab to view the window and see the symbol value. (Red text means a change.)

For more on watches, see the NetBeans help topics under *C/C++/Fortran Development>Debugging C/C++/Fortran Applications with gdb> Viewing C/C++/Fortran Program Information>Creating a C/C++/Fortran Watch*.

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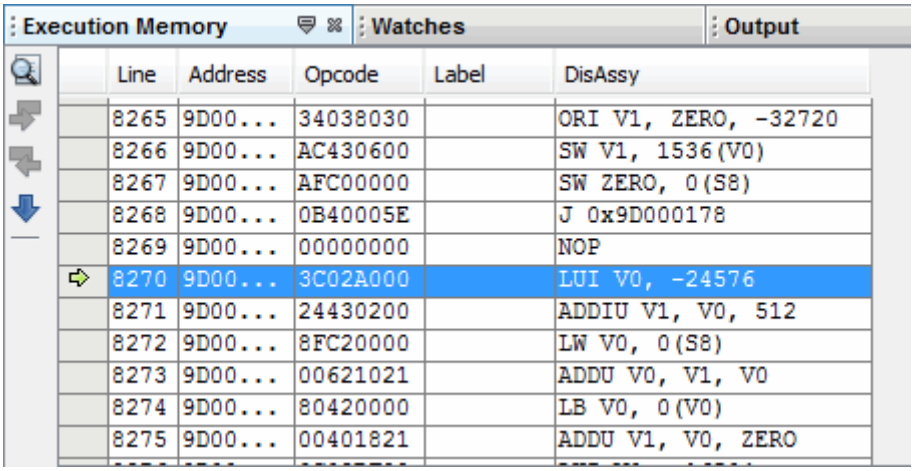
3.4.7 View Device Memory (including Configuration Bits)

MPLAB X IDE has flexible, abstracted memory windows that provide a customizable view of differing types of device memory. From a Memory window, select the type of memory and memory format in drop-down boxes.

Begin by viewing Flash memory:

1. Select *Window>PIC Memory Views>Execution Memory*.
2. The Execution Memory window will open showing the last halt location.

FIGURE 3-19: MEMORY WINDOW CONTENT



Change the memory view by:

- Selecting another window from the *Window>PIC Memory Views* list.
- Using the drop-down “Memory” menu on the window.

To set Memory window options:

Right clicking in the Memory window will pop up a menu with various options such as display options, fill memory, table import/export, and output to file. For more information on this menu, see **Section 12.9.13 “Memory Window Menu”**.

To refresh the Flash Memory window:

1. Halt your program (Finish Debugger Session).
2. Click on the icon named “Read Device Memory”.

Read Device Memory Icon

3.4.8 Program a Device

After your code is debugged, you can program it onto a target device.

First, check the programming options in the Project Properties window. For this tutorial, no options will be changed.

Second, you program the device in one of two ways:

- Click **Run**: The project is built (if necessary) and device is programmed. The program will immediately begin execution on completion of programming.
- Click **Make and Program Device**: The project is built (if necessary) and device is programmed. The program will NOT immediately begin execution on completion of programming. You will need to disconnect the hardware tool from the target board before the application will run.

Other programming-related functions are:

- **Hold in Reset**: Toggle the device between Reset and Run.
- **Read Device Memory**: Transfer what is in target memory to MPLAB X IDE.

Programming-related icons are:


Run Icon


Hold In Reset Icon


Make and Program Device Icon


Read Device Memory Icon

Note:	Not all programming functions are in the MPLAB X IDE. For additional programming support, see the MPLAB IPE included with the MPLAB X IDE installation.

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Chapter 4. Basic Tasks

4.1 WORKING WITH MPLAB X IDE PROJECTS

The following steps show how to work with projects in MPLAB X IDE

Preliminaries

1. Before You Begin, install MPLAB X IDE, set up any hardware tools (install USB drivers and properly connect to your target) and install language tools for your selected device. Then launch MPLAB X IDE to begin.

Create and Build a Project

1. Create a New Project by using the New Project wizard. Then View Changes In Desktop Panes.
2. View or Make Changes to Project Properties in the Project Properties dialog. Also Set Up or Change Debugger/Programmer Tool Options and Set Up or Change Language Tool Options in the same dialog.
3. Set Language Tool Locations and Set Other Tool Options in the Tools Options dialog.
4. Create a New File to add to your project or Add Existing Files to a Project. Enter or edit your application code to the File window.
5. Discover other features for Editor Usage.
6. Add and Set Up Library and Object Files.
7. Set File and Folder Properties to keep or exclude individual files or entire folders from the build.
8. Set Build Properties for your project. Here you may select the project configuration type, pre- and post-build steps, using the checksum as the user ID, and loading an alternative hex file on build.
9. Build a Project.

Execute Code

1. Run Code with the Run menu.
2. Debug Run Code with the Debug menu.

Debug Code

1. Control Program Execution with Breakpoints. Set breakpoints in-line or via the Breakpoint window.
2. Step Through Code as the program executes.
3. Watch Symbol Values Change in the Watches and Variables windows.
4. View/Change Device Memory (including Configuration Bits). Memory types are dependent on the device selected.

Program a Device

1. Program a Device using simple toolbar buttons.

4.2 CREATE A NEW PROJECT

MPLAB X IDE is project-based, so you must set up a project to work on your application.

New projects can be created by selecting either:

- Start Page, **Learn and Discover** tab, "Dive In", "Create New Project"
- *File>New Project* (or Ctrl+Shift+N)

The New Project wizard will launch to guide you through new project set up.

4.2.1 Step 1: Choose Project

Step 1 asks you to choose a project category. In most cases you will choose a project type from "Microchip Embedded":

The following options are available to choose for a project category:

- Standalone Project – Create a new C and/or assembly code project. This type of project is shown in this section.
- Existing MPLAB IDE v8 Project – Convert your existing MPLAB IDE v8 project into an MPLAB X IDE project. For details see Section 5.2 "Import MPLAB Legacy Project".
- Prebuilt (Hex, Loadable Image) Project – Load an existing project image into MPLAB X IDE. For details, see Section 5.3 "Prebuilt Projects".
- User Makefile Project – Create a project that makes use of an external makefile. For details, see Section 6.5 "Create User Makefile Projects".
- Library Project – Create a new C and/or assembly code project that will build into a library, instead of an executable hex file. For details, see Section 5.6 "Library Projects".

Other options are also available:

- Other Embedded Projects – projects from other vendors.
- Sample Projects – includes ready-to-use projects for different device families and project templates for different device families.

After you have made your selections, click **Next>** to move to the next dialog.

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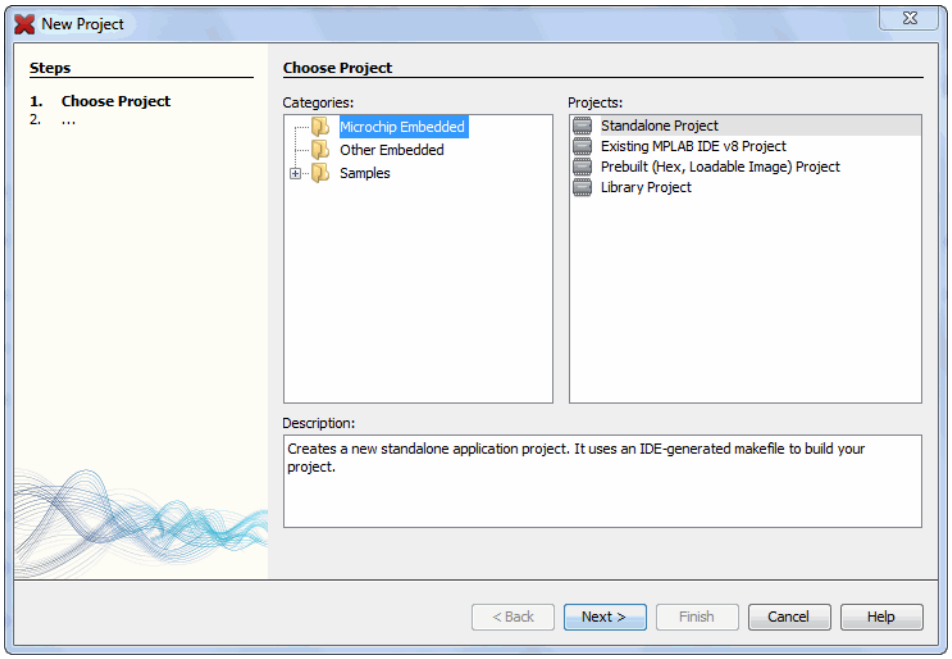
FIGURE 4-1: PROJECT WIZARD – CHOOSE PROJECT



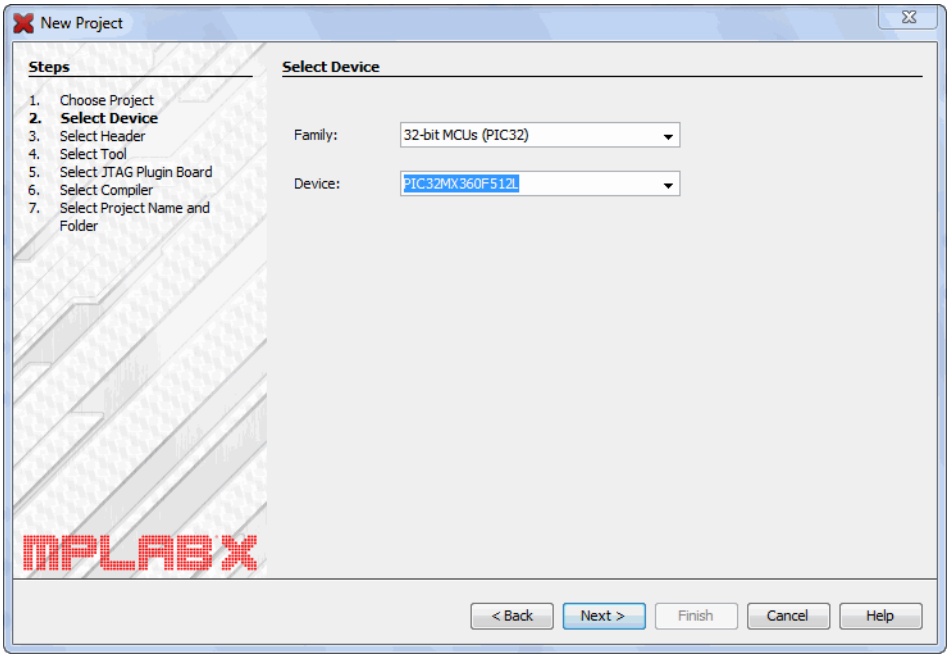
4.2.2 Step 2: Select Device

Step 2 selects the device you will be using in your application from the "Device" drop-down list. To narrow your selection list, chose a Family first.

For LF devices, be aware that you will need to set up your physical device to be powered by a lower voltage than "F" type devices, typically 3.3 V instead of 5.0 V. If a higher voltage will damage your device, MPLAB X IDE will display a Warning dialog to remind you.

Click **Next>**.

FIGURE 4-2: PROJECT WIZARD – SELECT DEVICE



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4.2.3 Step 3: Select Header

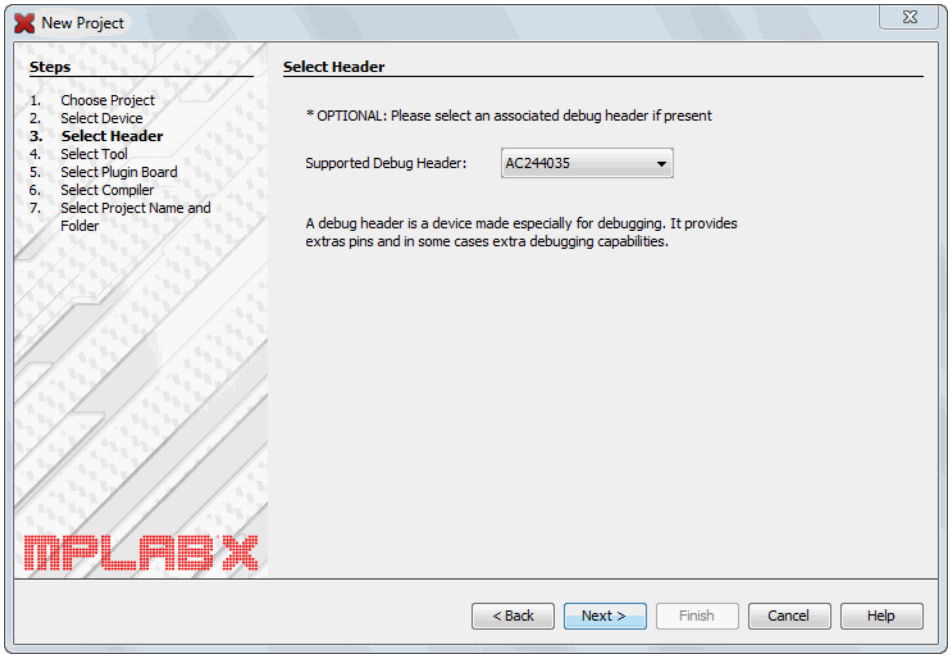
Step 3 appears if a header is available for your selected device. To determine if a header is required for debug or if your device has on-board debug circuitry, consult the PDF or online help version of either:

- "*Processor Extension Pak and Debug Header Specification*" (DS51292)
- "*Emulation Extension Pak and Emulation Header User's Guide*" (DS50002243)

Then choose whether or not to use a header. Click **Next>** when done.

> **Note:** You can select a header later (if one is available) using the Project Properties window.

FIGURE 4-3: PROJECT WIZARD – SELECT HEADER



4.2.4 Step 4: Select Tool

Step 4 selects the tool.

Tool support for the selected device is signified by the colored circles (lights) in front of the tool name. If you cannot see the colors, mouse over a light to pop up text about support.

Light	Color	Support
●	Green	Full (Implemented and fully tested)
●	Yellow	Beta (Implemented but not fully tested)
●	Red	None

For some tools, there are two lights next to the tool name, where the *first light* is the left-most light and the *second light* is to the right of the first.

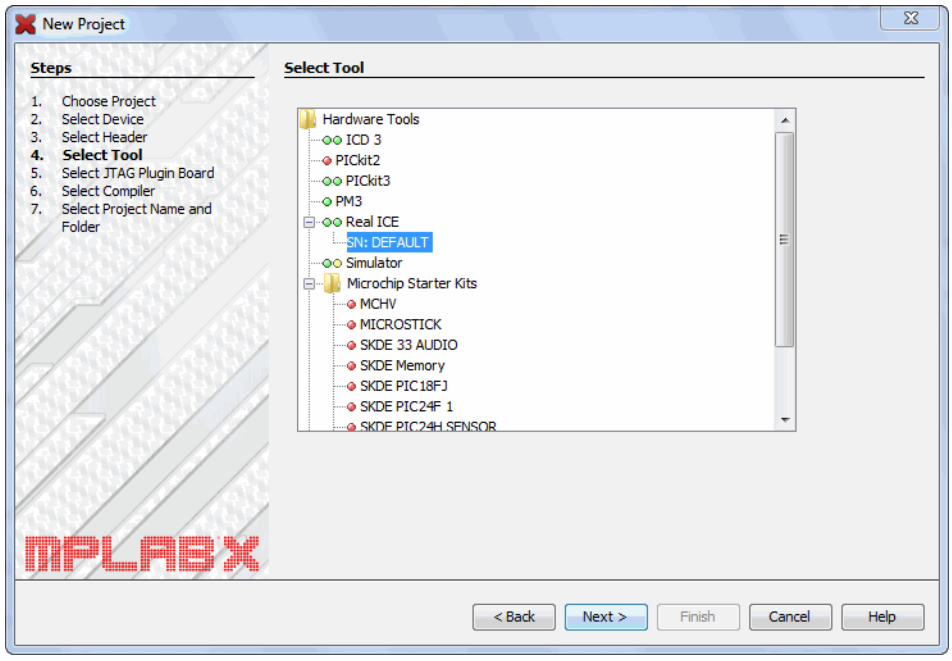
Light No.	Debug Tools	Simulator
1	Debugger Support	Core (Instruction Set) Support
2	Programmer Support	Peripheral Support

For the hardware tools, you will notice that a serial number (SN) is specified below any tool that is connected to your computer. This allows you to select from several connected hardware tools.

If you are using a third-party hardware tool, ensure you have properly installed that tool if you do not see it listed here. For more information, see Section 6.7 "Work with Third-Party Hardware Tools".

Select your tool and then click **Next>**.

FIGURE 4-4: PROJECT WIZARD – SELECT TOOL



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4.2.5 Step 5: Select Plug-In Board

Step 5 selects the plug-in board.

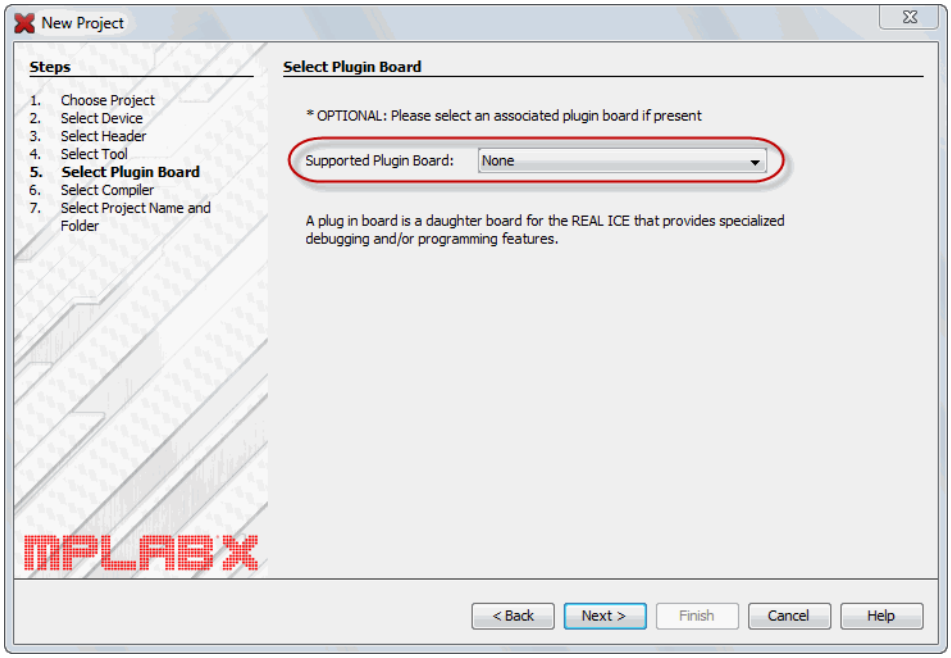
For the MPLAB REAL ICE in-circuit emulator, you may specify a plug-in board to use. A plug-in board is the circuit board that is inserted into the emulator's driver board slot.

TABLE 4-1: EMULATOR PLUGIN BOARDS

Supported Plugin Board	Board Description
None	Standard Communications driver board
None	High-Speed Communications driver board
JTAG Driver Board	JTAG Adapter board
Power Monitor Board	Power Monitor board (also inserts into logic probe connector)

Select your tool and then click **Next>**.

FIGURE 4-5: PROJECT WIZARD – SELECT PLUGIN



4.2.6 Step 6: Select Compiler

Step 6 selects the language tool, either a C compiler or an assembler. Again, the colored circle (light) in front of the compiler name signifies the device support level. Mouse over it for text.

If you do not see your language tool listed or you do not see any support, ensure you have installed the tool. Then look under *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Embedded** button, **Build Tools** tab, to ensure MPLAB X IDE can find the tool. If your tool is listed, then your project device may not be supported by your tool. Consider selecting or installing another language tool that supports the device.

Current Language Tools provide new device support. Legacy tools do not.

TABLE 4-2: MICROCHIP LANGUAGE TOOLS – CURRENT

Toolchain	Full Name	Device Support
XC8	MPLAB XC8 C Compiler	8-bit
XC16	MPLAB XC16 C Compiler	16-bit
XC32	MPLAB XC32 C Compiler	32-bit
MPASM	MPASM Assembler, MPLINK Object Linker and Utilities	8-bit

TABLE 4-3: MICROCHIP LANGUAGE TOOLS – LEGACY

Toolchain	Full Name
8-Bit Device Language Tools	
C18*	MPLAB C Compiler for PIC18 MCUs
HI-TECH PICC	HI-TECH C Compiler for PIC10/12/16 MCUs
HI-TECH PICC18	HI-TECH C Compiler for PIC18 MCUs
16-Bit Device Language Tools	
ASM30**	MPLAB Assembler, Object Linker and Utilities for PIC24 MCUs and dsPIC DSCs
C30	MPLAB C Compiler for PIC24 MCUs and dsPIC DSCs
C24	MPLAB C Compiler for PIC24 MCUs (subset of C30)
dsPIC	MPLAB C Compiler for dsPIC DSCs (subset of C30)
HI-TECH DSPICC	HI-TECH C Compiler for PIC24 MCUs and dsPIC DSCs
32-Bit Device Language Tools	
C32	MPLAB C Compiler for PIC32 MCUs
HI-TECH PICC32	HI-TECH C Compiler for PIC32 MCUs

* Most compilers come with an assembler, linker, and utilities. But MPLAB C18 is supported by the MPASM toolchain.

** No longer included with MPLAB X IDE as of v1.30. Please use the assembler that comes with one of the 16-bit compilers.

For more on each language tool, consult the language tool documentation.

For third-party language toolchains (CCS, etc.), see the "Readme for Third Party Tools.htm" file on the Start Page, "Release Notes and Support Documentation".

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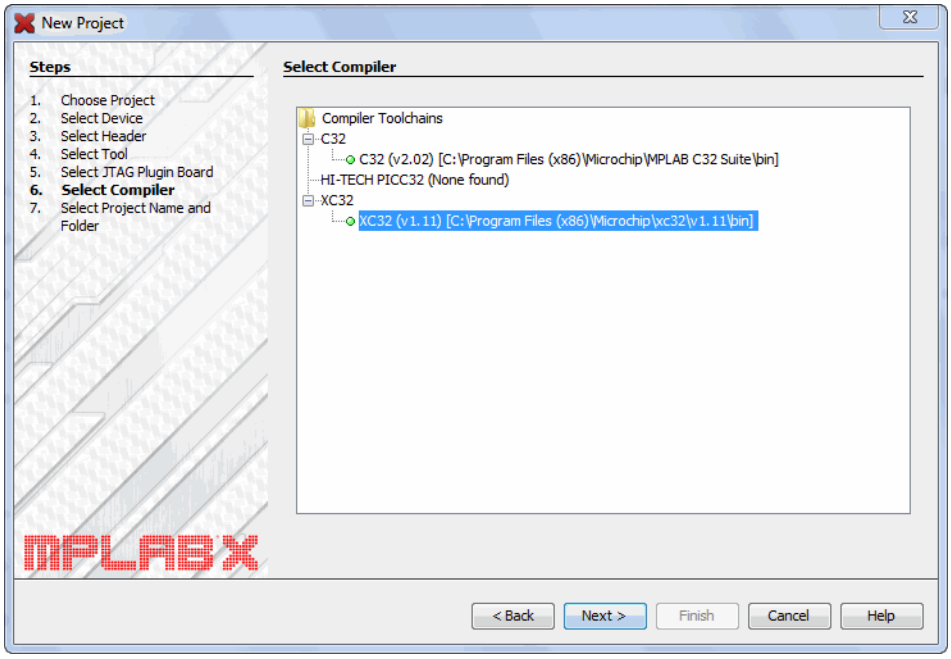
Select your tool and then click **Next>**.

FIGURE 4-6: PROJECT WIZARD – SELECT LANGUAGE TOOL



4.2.7 Step 7: Select Project Name and Folder

Step 7 selects the project name, location and other project features. When you are done, click **Finish** to complete new project creation.

Project Name, Location and Folder

Enter the project name. By default, the name will be appended with `.X`. This is not required and simply a convention. You can delete this if you wish in the "Project Folder" text box.

Browse to a folder location. You can create a new project folder if you need one. By default, projects will be placed in:

- Windows XP – `C:\Documents and Settings\`*`UserName`*`\MPLABXProject`
- Windows 7/8 – `C:\Users\`*`UserName`*`\MPLABXProjects`
- Linux – `/home/`*`UserName`*`/MPLABXProjects`
- Mac – `/Users/`*`UserName`*`/MPLABXProjects`

However, you may choose to put them in your own location.

Main Project

Check "Set as main project" to specify this project as your main project.

Project Location and Folder

Check "Use project location as project folder" to create the project in the same folder as the project location.

This is useful if you are importing an MPLAB IDE v8 project and want to maintain the same folder for your MPLAB X IDE project (as when you want the build to be the same.)

MPLAB X IDE uses a folder to store a project information whereas MPLAB IDE v8 uses a `.mcp` file. Therefore you can only have one MPLAB X IDE project share a folder with an MPLAB IDE v8 project (`.mcp` file).

Encoding

Select the encoding for the project. The default is ISO-8859-1 (Latin 1) character set.

This selection will specify the code syntax coloring, which can be edited under *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Fonts and Colors** button, **Syntax** tab.

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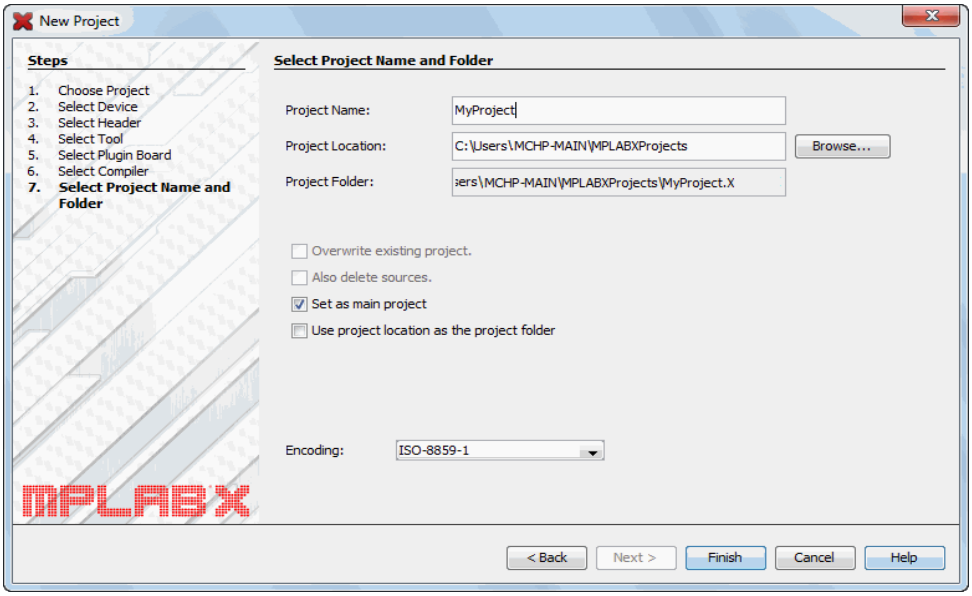
FIGURE 4-7: PROJECT WIZARD – SELECT PROJECT NAME AND FOLDER



4.2.8 Changing the Project Configuration Type

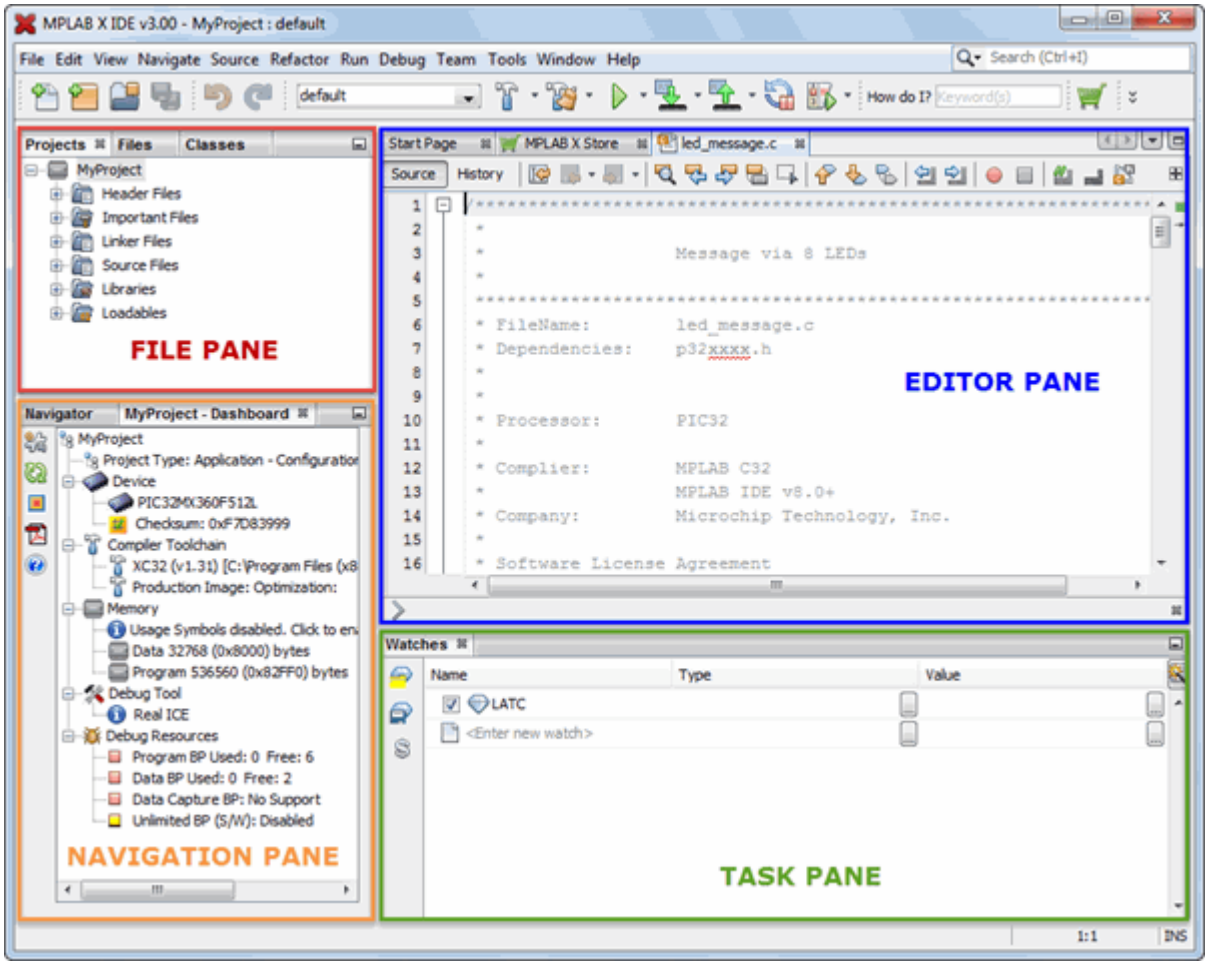
You can change a Standalone (Application) project to a Library project by changing the Configuration Type. For details, see Section 4.14.1 “Change Project Configuration Type”.

4.3 VIEW CHANGES IN DESKTOP PANES

When you have created your project, the project tree will appear in the Projects window, which is located in the File Pane. Also visible will be the Dashboard window, with information about your project, in the Navigation Pane. Adding a file to the project (discussed later) will open the file contents in an Editor window found in the Editor Pane. Debug and memory windows will appear in the Task Pane.

- **File pane** – pane with four tabbed windows:
  - The Projects window displays the project tree with files grouped by category.
  - The Files window displays the project files according to the folder organization on your computer.
  - The Classes window displays any classes and their functions, variables and constants in the code. Double click on an item to see its declaration.
  - The Services window displays services available to use for code development.
- **Navigator pane** – displays information on the symbols and variables in the file selected in the File pane.
- **Editor pane** – for viewing and editing project files. The Start Page and MPLAB X Store are also visible here.
- **Task pane** – displays task output from building, debugging, or running an application.

FIGURE 4-8: MPLAB X IDE DESKTOP



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Double click on any file name in the File pane and the related file will open in the Editor pane under a tab next to the Start Page. To close the tab, click on the “x” next to the file name.

Right click on the project name in the File pane, Projects window, to view the pop-up (context) menu. Do the same with the project’s subfolders.

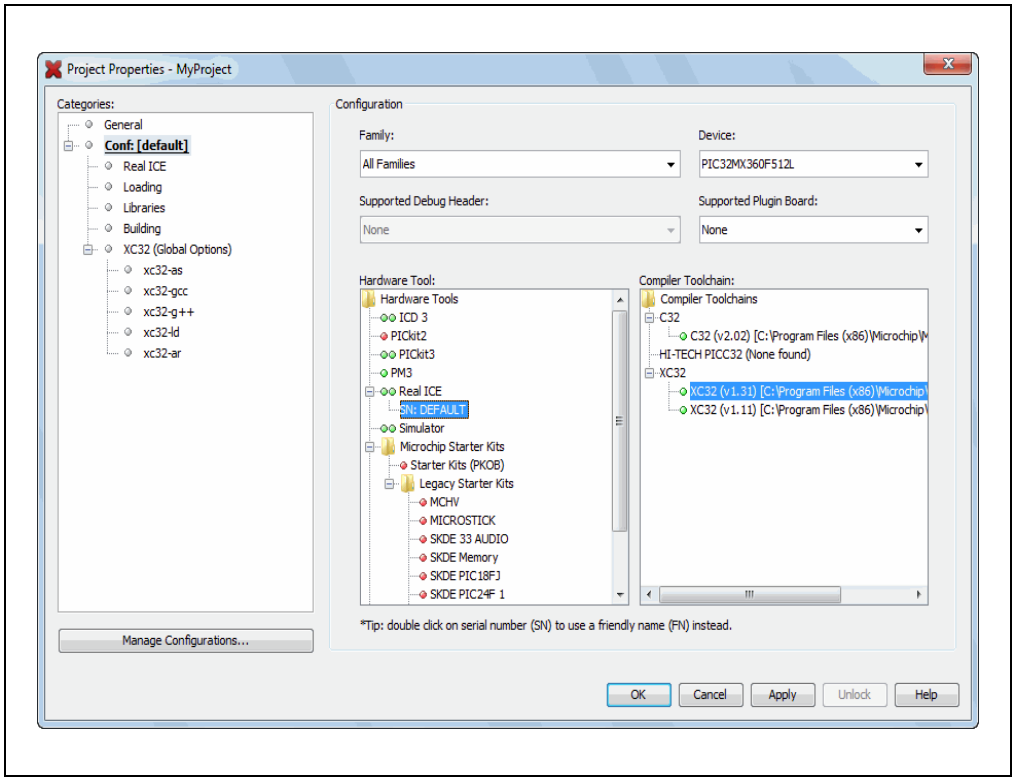
4.4 VIEW OR MAKE CHANGES TO PROJECT PROPERTIES

Once a project has been created, you can view or change the project properties in the Project Properties dialog. Access this dialog by performing either of the following actions:

- Right click on the project name in the Projects window and select “Properties”.
- Click on the project name in the Projects window and then select *File>Project Properties*.

Click the “Conf: [default]” category to reveal the general project configuration, such as the project device, related debug/programmer tool, and language tool. To change any of these items, refer to steps 4 and 5 of Section 4.2 “Create a New Project”.

FIGURE 4-9: PROJECT PROPERTIES DIALOG

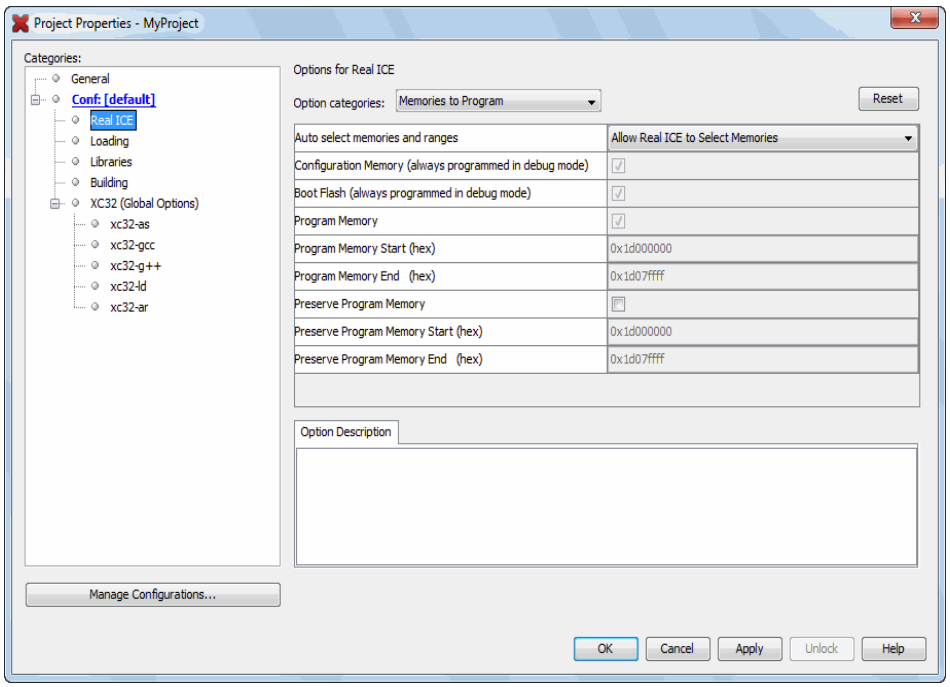


4.5 SET UP OR CHANGE DEBUGGER/PROGRAMMER TOOL OPTIONS

Set options for your tools in the Project Properties window.

Click on your hardware tool or simulator (beneath Conf:[default]) to see related setup options. For more on what these options mean, see your tool documentation.

FIGURE 4-10: TOOL SETUP PAGE



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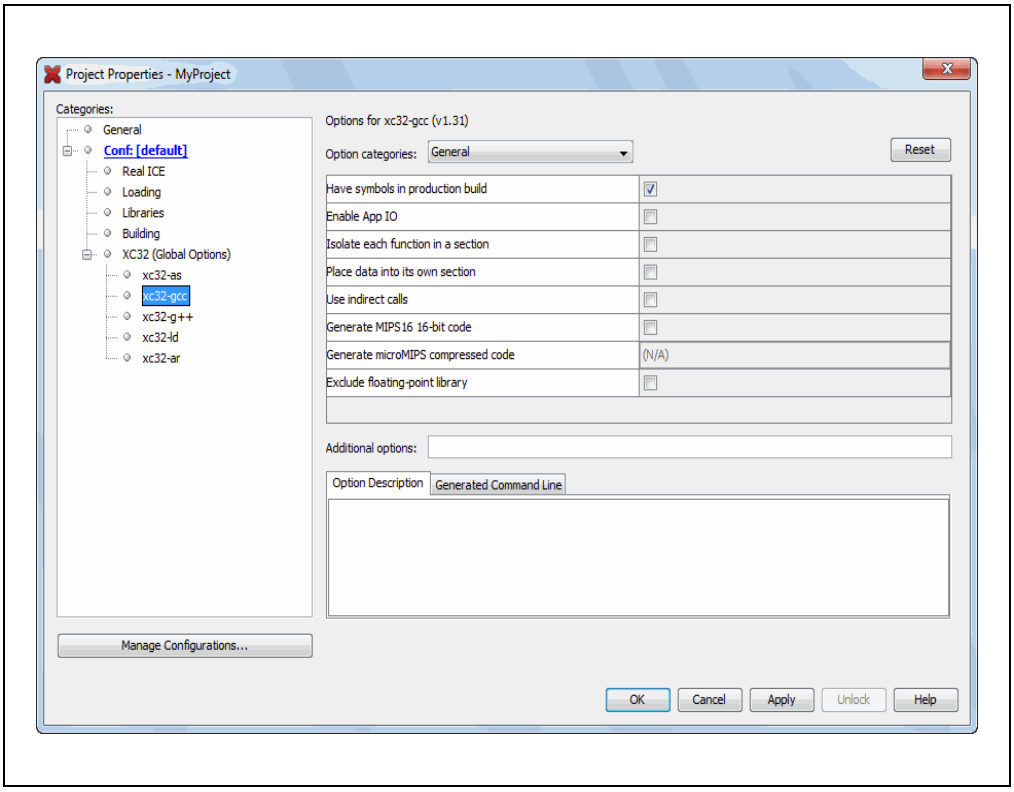
4.6 SET UP OR CHANGE LANGUAGE TOOL OPTIONS

Click on your language tool to see related setup options in the Project Properties window. For more on what these options mean, see your language tool documentation.

See the NetBeans help topic *C/C++/Fortran Development>Working with C/C++/Fortran Projects>Setting Project Properties* for additional help.

FIGURE 4-11: LANGUAGE TOOL SET UP PAGE



4.6.0.1 IDE OPTIONS VS. COMMAND LINE OPTIONS

Options entered into the IDE may differ in format from those entered on the command line. Click on an option name to see more information on that option in the **Option Description** tab. Also, after entering or selecting option data, click the **Generated Command Line** tab to view its contents and ensure the command line code generated by the option is what you expected.

4.6.0.2 GLOBAL OPTIONS

Set global options that apply to all language tools in the language toolsuite. Also use the **User Comments** tab to enter information about why certain options were selected.

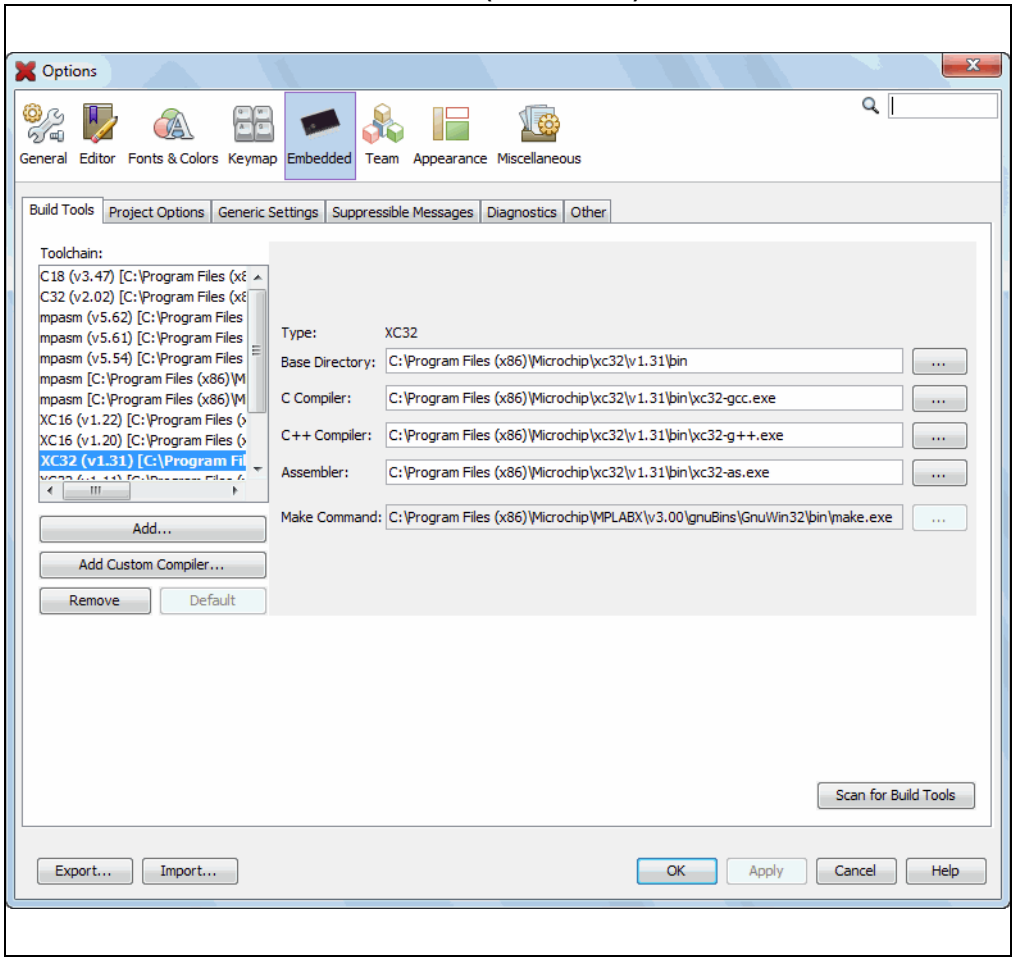
4.7 SET LANGUAGE TOOL LOCATIONS

To see which language tools are available to MPLAB X IDE, and to view or change their paths, use the following instructions:

- **For Mac OS X** – Access the build tools from: *mplab_ide>Preferences>Embedded>Build Tools* from the main menu bar.
- **For Other OS –** Access the build tools from: *Tools>Options>Embedded>Build Tools*.

The window should automatically populate with all installed toolchains.

FIGURE 4-12: LANGUAGE TOOL (COMPILER) LOCATIONS



4.7.1 Add or Change a Toolchain

If you do not see your tool listed under "Toolchain", try the following features:

- **Scan for Build Tools** – scan the environment path and list the language tools installed on the computer.
- **Add** – manually add the tool to the list by entering the path to the directory containing the tool executable(s), i.e., base directory. Typically, this is the `bin` subdirectory in the tool installation directory.

If you have more than one version of a compiler available, select one from the list.

To change the path of a tool, enter the new path or browse for it.

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4.7.2 Remove a Toolchain

To remove an existing toolchain:

1. Click to select the toolchain from the list.
2. Click the **Remove** button.

This will NOT uninstall the compiler from your computer; it will only remove MPLAB X IDE awareness of this compiler. To add the toolchain back, see Section 4.7.1 “Add or Change a Toolchain”.

If you want to uninstall a compiler from your computer, remove the reference to the compiler in MPLAB X IDE first, as specified above. Then uninstall the compiler. If you uninstall the compiler first and then start MPLAB X IDE, the toolchain paths will appear in red. To remove the reference to this uninstalled compiler, follow the steps above.

4.7.3 About Toolchain Paths

MPLAB X IDE searches for toolchains under default installation paths and the PATH environmental variable. An example default path for MPLAB XC16 under a Windows 64-bit operating system is:

`C:\Program Files (x86)\Microchip\xc16\vx.xx\bin`

When you install a compiler, you have the choice to determine the location. You can either:

- install at the default location or at a different location

OR

- add the location to the PATH

If you are installing at a location different from the default, you should add that location to the PATH.

If you do not choose to have the installer add a new location to the PATH, you can point MPLAB X IDE to the compiler location in *Tools>Options*, **Embedded** button, **Build Tools** tab.

Finally, you can manually add the new location to the PATH variable.

If the toolchain is known to MPLAB X IDE, but the path cannot be found, the path will appear in red text.

4.8 SET OTHER TOOL OPTIONS

In addition to the build paths, you may set up other options. Select from the following tabs in the Options window, Embedded category:

- Project Options – Set project-related options, such as make options and whether paths are defaulted to relative or absolute (Section 12.14.2 "Project Options Tab").
- Generic Settings – Set up project features (Section 12.14.1 "Generic Settings Tab").
- Suppressible Messages – Select messages to be suppressed (Section 12.14.5 "Suppressible Messages Tab")
- Diagnostics – Set up the log file to capture errors and other problems for further review (Section 12.14.6 "Diagnostics Tab")
- Other – Edit the lists of accepted file extensions for C source files and header files (Section 12.14.7 "Other Tab").

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4.9 CREATE A NEW FILE

New files can be created by doing one of the following:

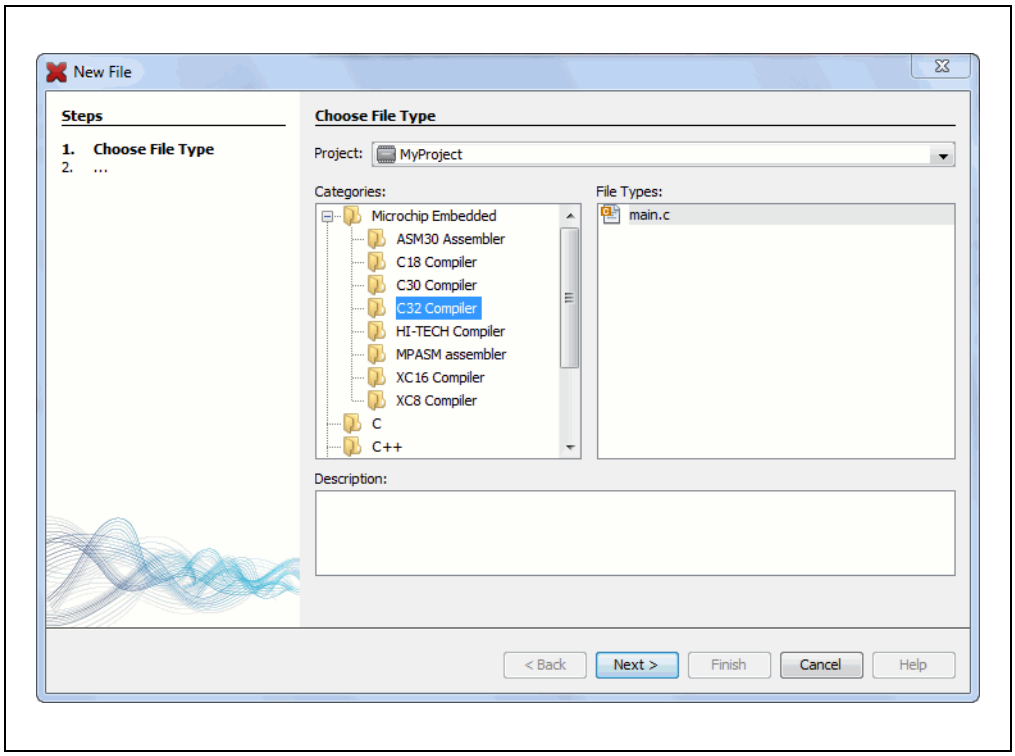
- Select *File>New File* (or Ctrl+N)
- Right click on the project in the Project/File window and select *New>Other*
- Right click on a logical folder (e.g., Source Files) in the Project/File window and select *New>Other*

A New File Wizard with launch to guide you through new file setup.

Step 1. Choose File Type

Choose the file category by expanding “Microchip Embedded” to find an appropriate selection. Then select a file type.

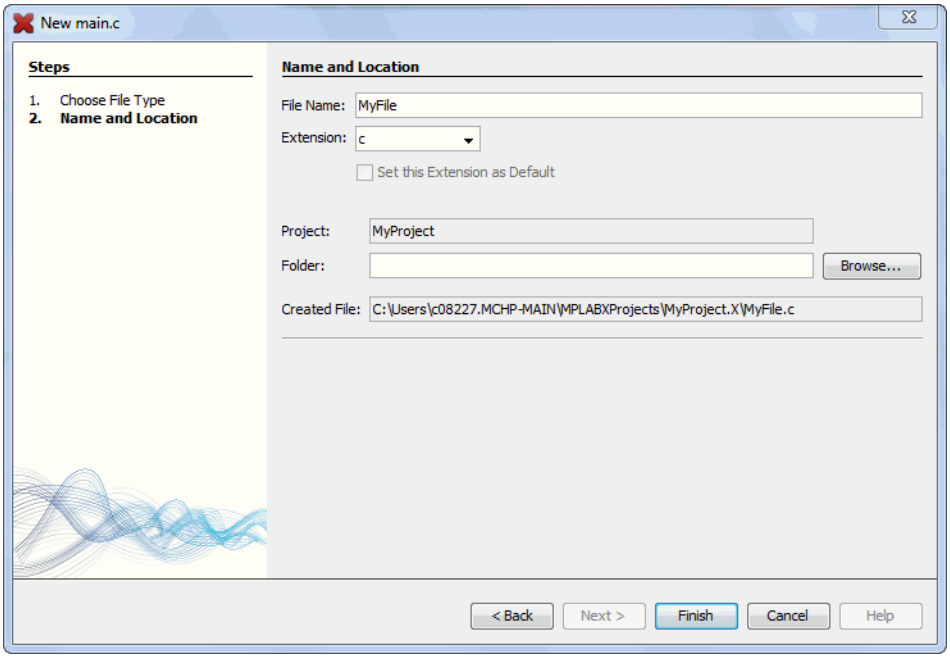
FIGURE 4-13: FILE WIZARD – CHOOSE CATEGORY AND TYPE



Step 2. Name and Location:

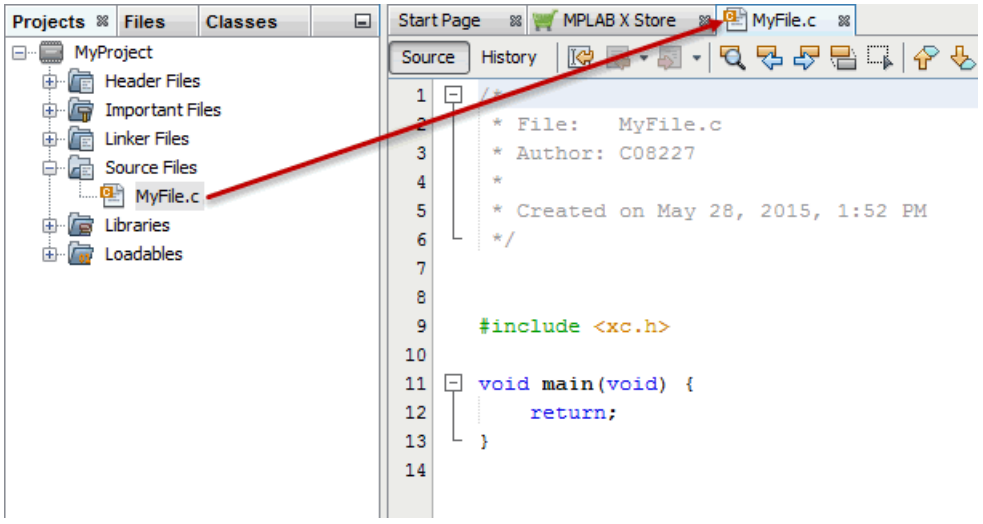
Name the file and place it in the project folder.

FIGURE 4-14: FILE WIZARD – CHOOSE ASSOCIATED PROJECT



The file will appear in the File pane under the project specified. A tab with the file's name will appear in the Editor pane. Enter your file content under this tab. The text in the file will have syntax color based on its file type.

FIGURE 4-15: NEW FILE – MYFILE.C



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4.10 ADD EXISTING FILES TO A PROJECT

Existing files can be added to a project by doing one of the following:

- Right click on the project in the Project/File window and select “Add Existing Item”
- Right click on a logical folder (e.g., Source Files) in the Project/File window and select “Add Existing Item”

4.10.1 Files in Project Folder

When adding a file, you can choose whether to add it as:

- Auto – let MPLAB X IDE decide how best to locate the file
- Relative – specify the file location relative to the project (the most portable project)
- Absolute – specify the file location by an absolute path
- Copy – copy the specified file to the project folder

The file will appear in the File pane under the project specified. A tab with the file’s name will appear in the Editor pane.

4.10.2 Files Outside of Project Folder

When adding a source file that is not in the project folder, add the file as “Relative”. This creates an external folder (`_ext`) so the project can find the file when it is building.

To make use of navigation features such as the `//TODO` action item and file context menus, you must tell the project where the files are located. To do this:

1. In the Projects window, right click on the project name and select “Properties”.
2. Under “Categories”, click “General”.
3. Next to “Source Folders”, click **Add**.
4. Browse to the path of the external file(s) you have added to the project. Select **Select**.
5. Click **Apply** or **OK**. Then rebuild the project.

When you import an MPLAB IDE v8 project, the source files are a not in the project folder. Use *File>Import>MPLAB IDE v8 Project* to automatically import the files.

4.10.3 File Order in Project

The order in which you add files to the project will determine their link order. If you have imported a project from MPLAB IDE v8, the order will be determined by the `.mcp` file.

A new file added to the project will be linked last. If you remove a file and then re-add it, it moves to the end of the link list.

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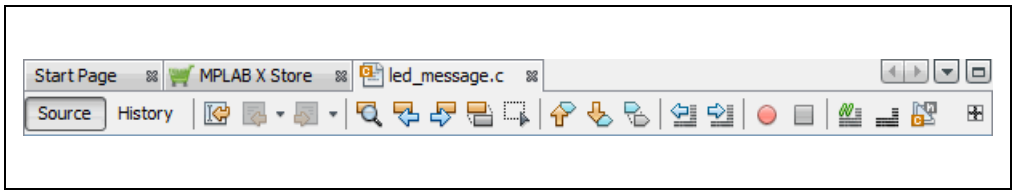
4.11 EDITOR USAGE

To create new code or change existing code, use the NetBeans editor. C compiler information regarding the editor is available the NetBeans help topic *C/C++/Fortran Development>C/C++/Fortran Project Basics>Navigating and Editing C/C++/Fortran Source Files*. A list of features is available under **Chapter 7. "Editor"**.

To use editor features, go to the:

- Edit menu (see Section 11.2.2 "Edit Menu")
- Editor toolbar located at the top of each file's Editor window
- Window right click (context) menu.

FIGURE 4-16: EDITOR TOOLBAR



To set editor properties:

1. Select *Tools>Options* (*mplab_ide>Preferences* for Mac OS X) to open the Options dialog.
2. Click on the **Editor** button. Then click on a tab to set up Editor features.
3. Click on the **Fonts and Colors** button. Then click on a tab to set up color options.

To navigate through files and format your code:

1. Select items from the Navigate menu to navigate to inside and outside files.
2. Select items from the Source menu to format, comment, and auto-complete code.

To use code folding:

For details on code folding, see Section 7.6 "Code Folding".

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4.12 ADD AND SET UP LIBRARY AND OBJECT FILES

You can reference library files to be used by the linker in the following locations:

- the Libraries folder in the Projects window
- the Project Properties dialog

Additional library file set up can be done in the language tool librarian.

4.12.1 Libraries Folder

In the Projects window, right click on the Libraries folder to see these options:

- **Add Library Project**

  Make a project that produces a library as its output required for your project, i.e., establish a dependency. For more on this, see the NetBeans help topic *C/C++/Fortran Development>C/C++/Fortran Project Basics>Building C/C++/Fortran Projects>Creating Dependencies Between C/C++/Fortran Projects*.
- **Add Library/Object File**

  Add an existing library file or pre-built (object) file to the project.
- **Properties**

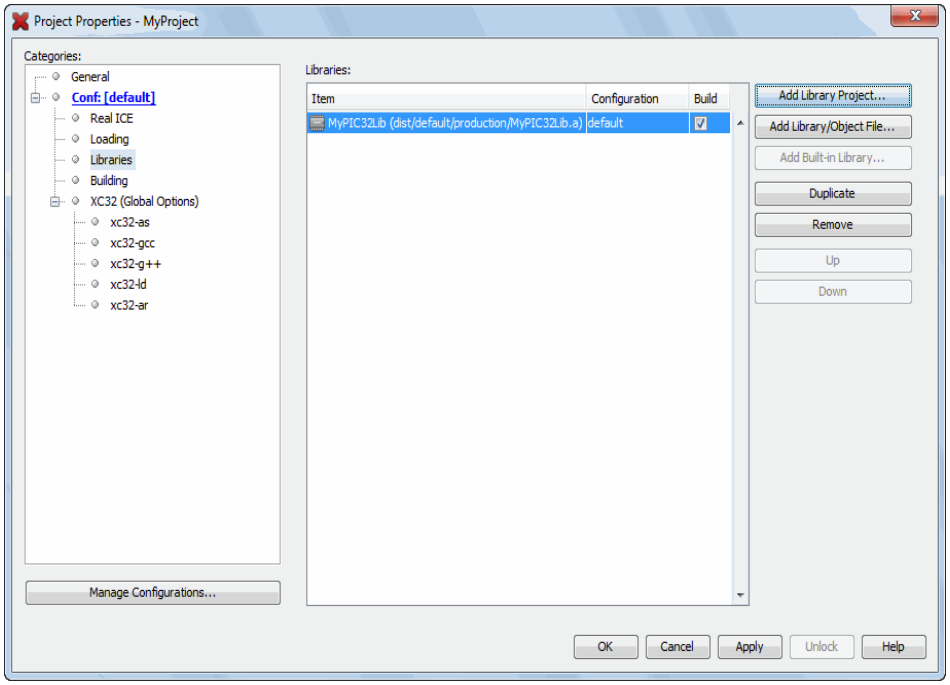
  Open the project's Properties window to select additional options (see next section).

4.12.2 Project Properties Window: Libraries Category

Open the Project Properties window and click on the "Libraries" category. Any files added to the Libraries folder in the Projects window will be visible here. You may add additional files and manage these files using the buttons on the right.

The order of files in the library list determines link order, which is important when the libraries included in the project reference each other. Libraries referencing objects from a secondary library should be placed higher in the link order list. An incorrect link order may result in an "undefined reference to" error during linking. For details on link order, see the "MPLAB XC16 Assembler, Linker and Utilities User's Guide" (DS50002106), Section 8.4.16 "`--library` *`libname`* (`-l` *`libname`*)".

FIGURE 4-17: MANAGE LIBRARY/OBJECT FILES AND SET UP LINK ORDER



4.12.3 Project Properties Window: Librarian Category

Open the Project Properties window and click on the librarian under your language tool category. Consult your language tool documentation to determine the executable name of your librarian.

In the left pane, click on the name of the linker. Then, in the right pane, select the option "Libraries". Choose library options from this list.

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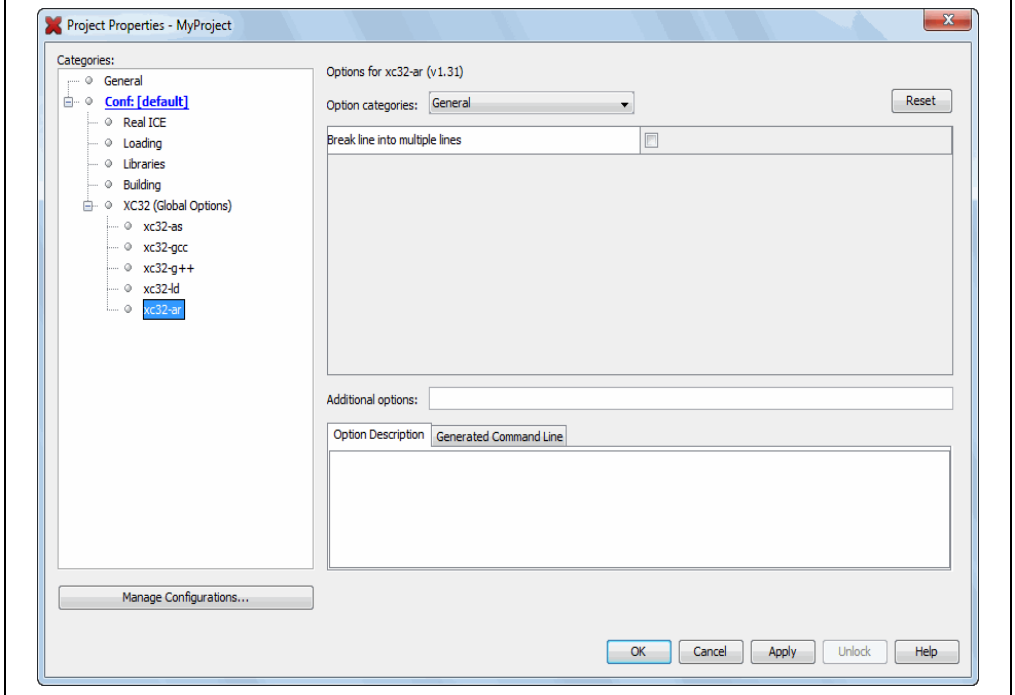
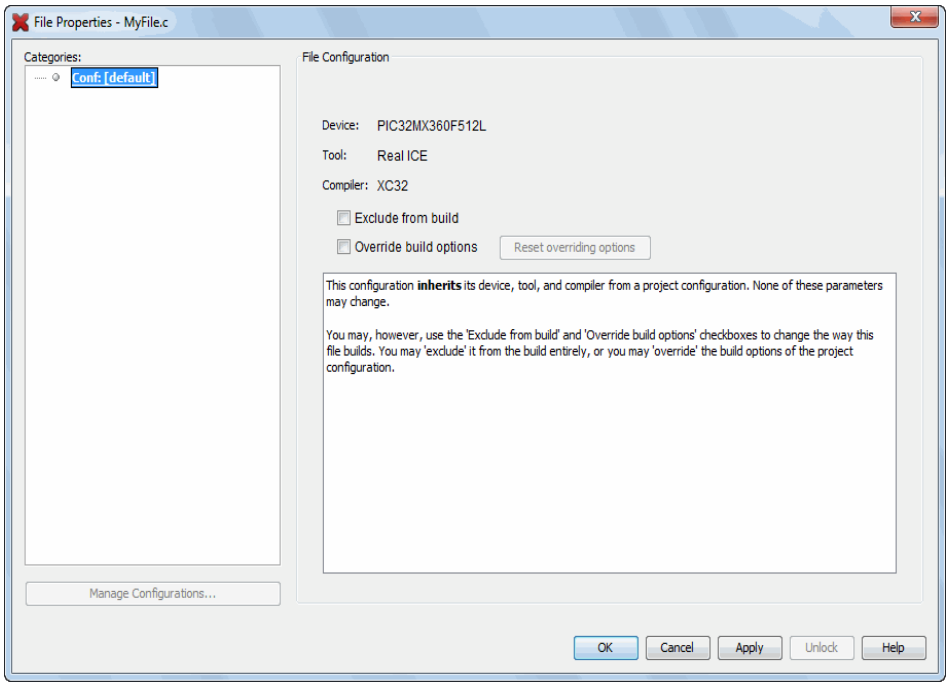
FIGURE 4-18: SET UP LIBRARIES OPTIONS IN THE LIBRARIAN



4.13 SET FILE AND FOLDER PROPERTIES

A project file can be built differently from other files in the project using the File Properties dialog. Access this dialog by right clicking on the file name in the Projects window and selecting "Properties". Select to exclude the file from the project build or override the project build options with the ones selected here. To override build options, check the checkbox and then click "Apply" to see selection options appear under "Categories".

FIGURE 4-19: FILE PROPERTIES



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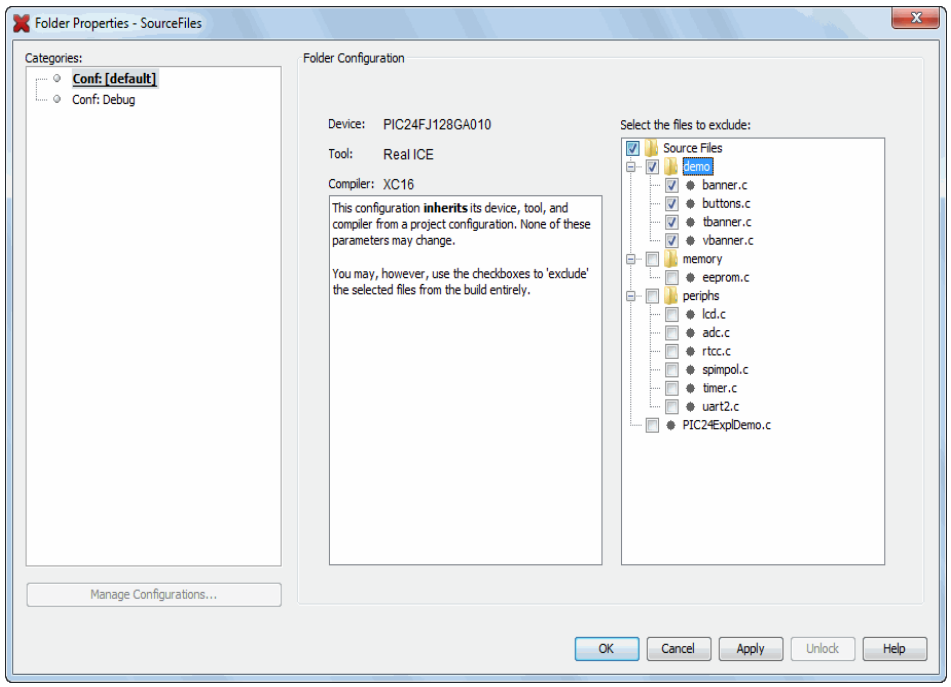
An entire (virtual) folder can be excluded from the build process by right clicking on the folder name in the Projects window and selecting “Properties”. Select to exclude folders or individual files from the build. Selecting a folder that is above other folders will select the entire contents of that folder. You can deselect files or other folders as you wish.

FIGURE 4-20: FOLDER PROPERTIES

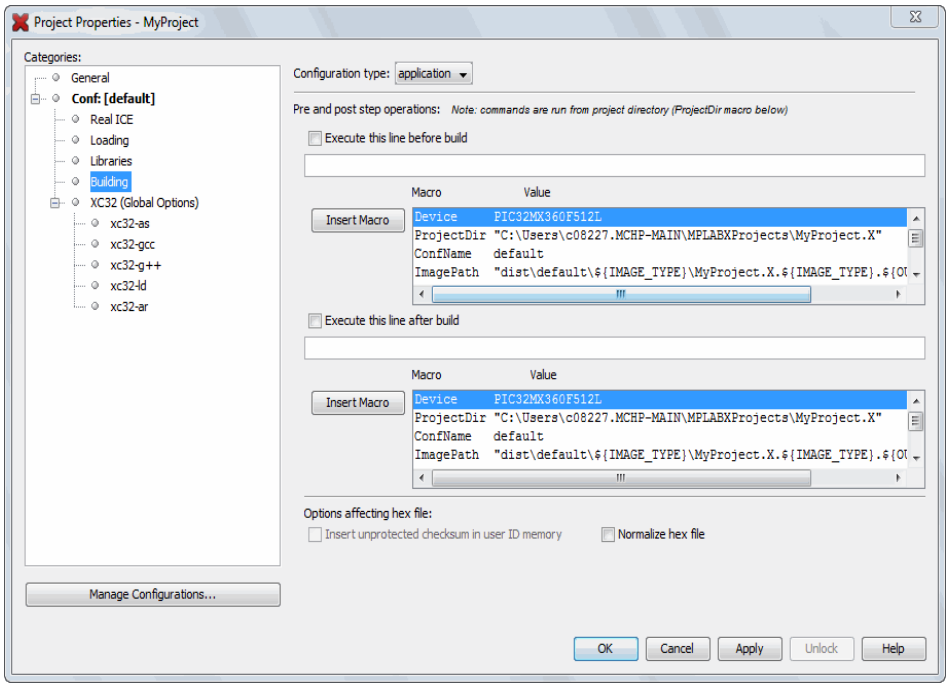


4.14 SET BUILD PROPERTIES

Before building the project, you may want to set up additional build properties:

- Change Project Configuration Type
- Execute this line before/after the build
- Insert checksum in user ID memory
- Normalize hex file

FIGURE 4-21: MAKE OPTIONS BUILD PROPERTIES

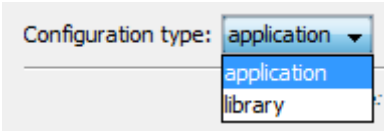


4.14.1 Change Project Configuration Type

As of MPLAB X IDE v2.15, when you create a Standalone or Library project in the New Project wizard, you are creating a project with either a configuration type "application" or "library" respectively. This means you can switch the configuration type of your existing project if you wish, with the caveats specified in the following sections.

Prebuilt and User Makefile projects are unaffected by this feature (i.e., they may not be changed to a different type of project once created.)

FIGURE 4-22: CONFIGURATION TYPE DROP-DOWN BOX



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4.14.1.1 SWITCHING FROM A STANDALONE TO A LIBRARY PROJECT

When switching project configuration type from “application” to “library”, it is your responsibility to **remove** `main()`. Also, any loadables in the “application” project will not be built/linked once the configuration type is “library”. For more on loadables, see Section 5.4 “Loadable Projects, Files and Symbols”.

If the toolchain (i.e., XC8) does not support libraries, then the combo box will be disabled and you cannot switch the configuration to “library”.

4.14.1.2 SWITCHING FROM A LIBRARY TO A STANDALONE PROJECT

When switching project configuration type from “library” to “application”, it is your responsibility to **add** `main()`.

4.14.2 Execute this line before/after the build

Type in a command to be executed at the very beginning or at the very end of the build process. These commands are inserted into the `nbproject/Makefile-$CONF.mk` file and allow you to customize the build process. If you need to refer to some of the project-related items (like the image name) in the script or program you are calling, use the supplied macros.

You can type the macros yourself or click **Insert Macro** to copy the macro name into the current position in the edit box. Commands are run in the make process with the current directory being set to the MPLAB X IDE project directory. The project directory is defined as the project that contains the `nbproject` folder

TABLE 4-4: MACROS

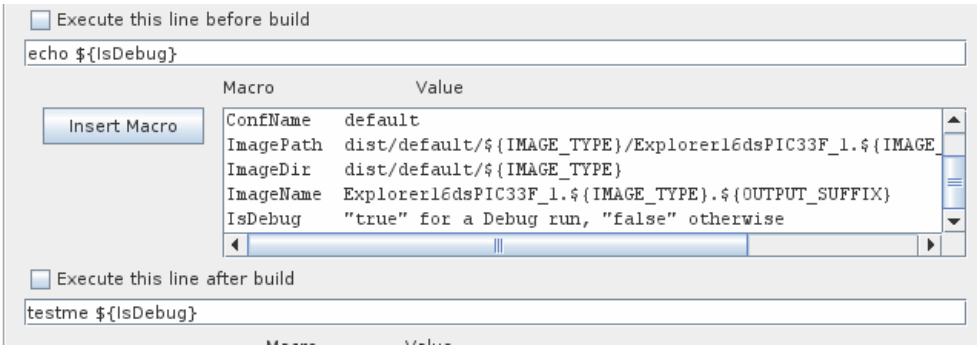
Name*	Function
`Device`	device for the current-selected project configuration
`IsDebug`	“true” for a Debug Run; “false” otherwise
`ProjectDir`	location of the project files on the PC
`ConfName`	name of the currently-selected project configuration
`ImagePath`	path to the build image
`ImageDir`	directory containing the build image
`ImageName`	name of the build image

* Additional macros may be available, depending on which compiler is used.

EXAMPLE 4-1: EXECUTE A PROCESS ONLY DURING DEBUG

On the window shown below, click the `IsDebug` macro to select it, then click **Insert Macro** to insert it into a script.

FIGURE 4-23: BUILD PROPERTIES – PRE/POST BUILD



Check the value of `$1` (Linux or Mac OS) or `%1` (Windows OS) in the script being run.

Bash Code Example

```
#!/bin/bash
echo is $1
if [ "$1" == "true" ]; then
  echo We are in debug
else
  echo We are in production
fi
```

Batch Code Example

```
@echo off
if "%1" == "true" goto debug
:production
@echo We are in production
goto end
:debug
@echo We are in debug
:end
```

4.14.3 Insert checksum in user ID memory

If it is supported by the device (not grayed out), click the check box to use the checksum number that was generated by the build as the user ID.

For the PIC32 family of devices, the checksum is dependent on the USER ID. Therefore, this feature is not supported under PIC32 devices.

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4.14.4 Normalize hex file

A hex file is normalized when line addresses are in incremental order and data is buffered to be one size (16 bytes), where possible.

For example, the following lines (records) are from the file `myfile.hex`, output from the MPLAB XC16 C compiler/linker:

```
:0801f800361e0000361e000057
:020000040000fa
:10020800361e0000361e0000361e0000361e000096
```

When this file is normalized, the file data looks like this:

```
:10022800361E0000361E0000361E0000361E000076
:10023800361E0000361E0000361E0000361E000066
:10024800361E0000361E0000361E0000361E000056
```

which is of the format:

```
:bbaaaarrdd...ddcc
```

where:

`:`	Start record
`bb`	Byte count
`aaaa`	Address
`rr`	Record type
`dd`	Data
`cc`	Checksum

In MPLAB X IDE, the application HEXMATE is used to normalize Intel hex files. When the “Normalize hex file” option is checked, the following is called after a build:

`hexmate` *`myfile`*`.hex -o`*`myfile`*`.hex`

Essentially HEXMATE unpacks the entire hex file and arranges the data at the addresses specified by the hex file. It then repackages the resulting memory image into a new hex file. In the resulting file, all the data is ascending order and is contiguous. If there is a gap in the addresses, then there will also be a gap in the output file (there is no filling of unused addresses).

For more information on using HEXMATE, see the *MPLAB XC8 C Compiler User’s Guide* (DS50002053) in the `docs` folder of the installed MPLAB XC8 C compiler. Although HEXMATE is described in the MPLAB XC8 documentation, it can be used with any compiler.

A normalized hex file is useful for programming code (such as a bootloader) over a serial connection, as the variation of record bytes is minimized.

4.15 BUILD A PROJECT

For MPLAB X IDE, it is not necessary to build the project first and then run or debug. Building is part of the run and debug processes. For initial development or major changes, however, you may want to make sure that the project builds before attempting to run or debug.

To build a project:

- In the Projects window, right click on the project name and select "Build". You may also select "Clean and Build" to remove intermediary files before building.
- Click on the "Build Project" or "Clean and Build Project" toolbar icon.

Build progress will be visible in the Output window.

Available build functions are:

TABLE 4-5: BUILD OPTIONS ON TOOLBAR BUTTONS

Button Icon	Function	Description
	Build Project	Make all the files in the project.
	Build for Debugging	Make all the files in the project and add a debug executive to the built image.
	Clean and Build	Remove previous build files and make all the files in the project.
	Clean and Build for Debugging	Remove previous build files and make all the files in the project. Add a debug executive to the built image.

To view errors in the Output window:

1. Right click in the Output window and select "Filter".
2. In the Filter dialog, check "Match" and enter ": error" to show only errors in the Output window that stopped the build.
3. Toggle the filter on and off using <Ctrl>-<G>.

See you language tool documentation for a discussion of errors.

To view checksum information:

- Open the Dashboard window (see Section 5.18 "View the Dashboard Display") to see the checksum after a build.

For more information on building your project, also see the NetBeans help topic *C/C++/Fortran Development>C/C++/Fortran Project Basics>Building C/C++/Fortran Projects*.

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4.16 RUN CODE

After the code builds successfully, you can run the application.

4.16.1 How Run Works

When you click the **Run Project** toolbar button, the following occurs:

- a build is done, if the make process determines that it is necessary
- for in-circuit debuggers/emulators and programmers, the target device is automatically programmed with the image (without the debug executive) and the device is released to run, i.e., no breakpoints or other debug features are enabled
  Note: To hold a device in Reset after programming, click “Hold in Reset” instead of “Run Project”.

Hold in Reset

- for simulators, the application executes, without debugging capability

Run progress is visible in the Output window.

4.16.2 Run Considerations

When running your program, consider that MPLAB X IDE operation connects to the hardware tool at runtime (Run or Debug Run). Consequently, settings made in MPLAB X IDE are passed to the tool only at runtime. Settings changed during a halt are updated only when runtime is initiated again.

To always be connected to the hardware tool (like MPLAB IDE v8), see *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Embedded** button, **Generic Settings** tab, “Maintain active connection to hardware tool” checkbox.

See Section 4.23 “Program a Device”.

4.16.3 Running Your Application Code

1. In the Projects window, select your project or make it the main project (right click on the project and select “Set as main project”).
2. Click on the “Make and Program Device” icon (or select *Run>Run Project*) to run your program.

Make and Program Device

Run progress is visible in the Output window.

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4.17 DEBUG RUN CODE

If your code does not run successfully, you should debug it. Running the code in debug mode is called a Debug Run.

4.17.1 How Debug Run Works

When you click the "Debug Project" toolbar button, the following occurs:

- a build is done, if the make process determines that it is necessary
- for in-circuit debuggers/emulators, the target device or header is automatically programmed with the image (including the debug executive) and a debug session is started
- for simulators, a debug session is started

Debug Run progress is visible in the Output window.

4.17.2 Debug Macros Generated

MPLAB X IDE generates debug macros for use with Microchip language tools. Macros passed to Microchip compilers and assemblers are shown in Table 4-6.

TABLE 4-6: MICROCHIP TOOLS DEBUG MACROS

Macro Name	Assoc. Tool	Function
`__DEBUG`	All	specifies that this is a debug build

`__MPLAB_REAL_ICE__`
`__MPLAB_ICD3__`
`__MPLAB_PK3__`
`__MPLAB_PICKIT2__`
	XC8	specifies the hardware debug tool in use
		The format is `__MPLAB_xxx__`, where *xxx* represents the hardware tool specifier.

`__MPLAB_DEBUGGER_REAL_ICE`
`__MPLAB_DEBUGGER_ICD3`
`__MPLAB_DEBUGGER_PK3`
`__MPLAB_DEBUGGER_PICKIT2`
	XC16, XC32, MPASM	specifies the hardware debug tool in use
		The format is `__MPLAB_DEBUGGER_xxx`, where *xxx* represents the hardware tool specifier.

`__MPLAB_DEBUGGER_PIC32MXSK`	XC32	specifies the starter kit in use

You can use these macros in your own code. For example:

```
#ifdef __DEBUG
  fprintf(stderr,"This is a debugging message\n");
#endif
```

4.17.3 Debug Considerations

When debugging your code, consider the following issues:

- You need to be in a debug session (debug mode) to activate many debugging features – for example, to view variable values in the watch or memory windows.
- MPLAB X IDE operation connects to the hardware tool at runtime (Run or Debug Run). This means that settings made in MPLAB X IDE will be passed to the tool only at runtime. Settings changed during a halt are updated only when runtime is initiated again.

  To always be connected to the hardware tool (like MPLAB IDE v8), see *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Embedded** button, **Generic Settings** tab, "Maintain active connection to hardware tool" checkbox.
- For some applications you may need to break down the debug steps for independent execution. To do this, use the steps under *Debug>Discrete Debugger Operation*.

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4.17.4 Debugging Your Application Code

To debug your application code:

1. In the Projects window, select your project or make it the main project (right click on the project and select “Set as main”.)
2. Click on the “Debug Project” icon (or select *Debug>Debug Project* or *Debug>Step Into*) to begin a Debug Run.

Debug Project

To halt your application code:

Click on the “Pause” icon (or select *Debug>Pause*) to halt your program execution.

To run your code again:

Click on the “Continue” icon (or select *Debug>Continue*) to start your program execution again.

To end execution of your code:

Click on the “Finish Debugger Session” icon (or select *Debug>Finish Debugger Session*) to end your program execution.

The difference between Run and Debug Run will become apparent when working with debug features, beginning with Section 4.18 “Control Program Execution with Breakpoints”.

To launch the debugger:

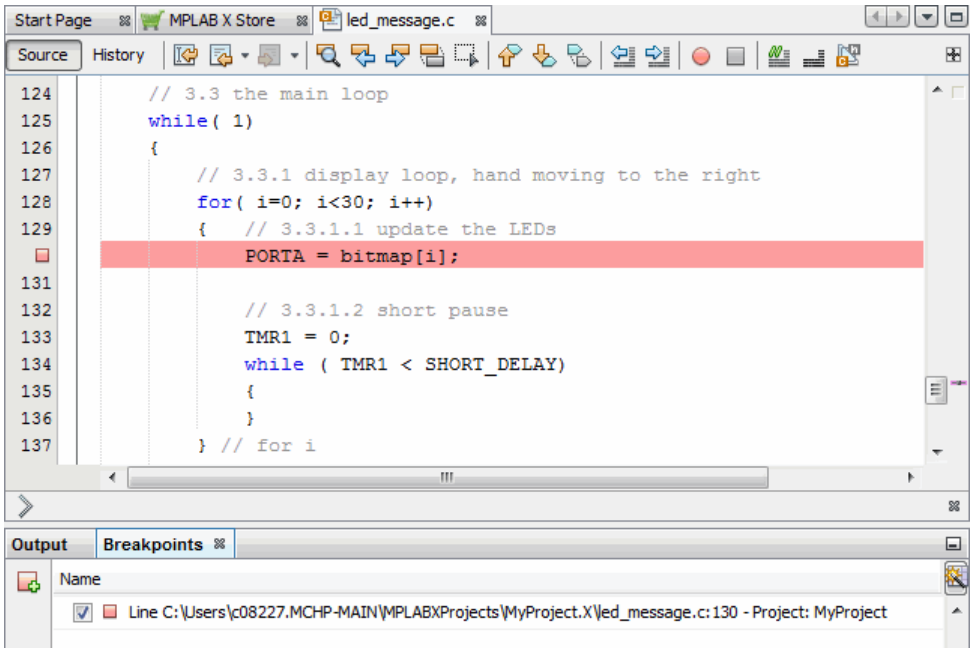
If your code is built for debugging and you simply want to launch the debug tool, you can do so by selecting the down arrow next to the “Debug Project” icon and selecting “Launch Debugger”.

4.18 CONTROL PROGRAM EXECUTION WITH BREAKPOINTS

When debugging code, it can be useful to suspend execution at a specific location in code so that variable values can be examined. To do this, use breakpoints.

For more on breakpoints, see the NetBeans help topics under *C/C++/Fortran Development>Debugging C/C++/Fortran Applications with gdb>Setting C/C++/Fortran Breakpoints*.

FIGURE 4-24: BREAKPOINT AND BREAKPOINTS WINDOW



4.18.1 Set/Clear a Simple Breakpoint

To **set** a breakpoint on a line, do one of the following:

- Click the left margin of the line in the Source Editor
- Press Ctrl+F8

To **clear** the breakpoint, do one of the following:

- Repeat the step to set a breakpoint
- Select *Debug>Toggle Breakpoint*

4.18.2 Set Breakpoints with the Breakpoint Dialog

To set a breakpoint with the New Breakpoint dialog:

1. Select *Debug>New Breakpoint*.
2. Select the breakpoint type and other options in the New Breakpoint dialog.

Options available for each breakpoint type are discussed in detail under Section 12.5.1 "New Breakpoint Dialog".

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4.18.3 Set/Clear Breakpoints in the Breakpoints Window

To view and toggle the breakpoint in the Breakpoints window, do the following:

1. Select *Window>Debugging>Breakpoints*.
2. Toggle the breakpoint by checking/unchecking the checkbox.

To set a breakpoint with the New Breakpoint dialog, click on the icon at the top left of the window.

4.18.4 Set a Breakpoint Sequence (Device Dependent)

A breakpoint sequence is a list of breakpoints that execute, but do not halt, until the last breakpoint is executed. Sequenced breakpoints can be useful when there is more than one execution path leading to a certain instruction and you only want to exercise one specific path.

To create a Breakpoint Sequence:

1. Right click on an existing breakpoint or shift click to select a group of existing breakpoints and right click on the group.
2. From the pop-up menu, go to “Complex Breakpoint” and select “Add a New Sequence”.
3. Enter a name for your sequence in the dialog box and click **OK**.
4. The breakpoint(s) will appear under the new sequence.
5. To add additional existing breakpoints to the sequence, right click on the breakpoint and select *Complex Breakpoint>Add to Name*, where *Name* is the name of the sequence.
6. To add new breakpoints to the sequence, right click on the sequence and select “New Breakpoint”.

To select the Sequence Order:

1. Expand on a sequence to see all items.
2. Right click on an item and select *Complex Breakpoints>Move Up* or *Complex Breakpoints>Move Down*. Sequence execution of breakpoints is bottom-up; the last breakpoint in the sequence occurs first.

To Remove a Sequence or Breakpoint, either:

1. Right click on the item and select “Disable” to **temporarily** remove the item.
2. Right click on the item and select “Delete” to **permanently** remove the item.

4.18.5 Set a Breakpoint Tuple (Device Dependent)

For MPLAB X IDE, a tuple represents an Anded list of breakpoints. ANDed breakpoints can be useful when a variable is modified in more than one location and you need to break only when that variable is modified in one particular location.

Only two breakpoints can be ANDed and these must consist of one program memory breakpoint and one data memory breakpoint. Breakpoint 1 AND breakpoint 2 must occur at the same time before a program halt.

To create a Breakpoint Tuple:

1. Click on the icon in the upper left of the Breakpoints window to open the New Breakpoint dialog.
2. Create an address breakpoint. Click **OK** to add it to the Breakpoints window.
3. Repeat steps 1 and 2 to create a data breakpoint.
4. Right click on one breakpoint and select *Complex Breakpoint>Add to New Tuple*.
5. Enter a name for your tuple in the dialog box and click **OK**.
6. The breakpoint will appear under the new tuple.
7. Right click on the other breakpoint and select *Complex Breakpoint>Move to Name*, where *Name* is the name of the tuple.

To Remove a Tuple or Breakpoint, do one of the following:

1. Right click on the item and select "Disable" to temporarily remove the item.
2. Right click on the item and select "Delete" to permanently remove the item.

4.18.6 Hardware Breakpoint Usage

If you are halted at a line of code and do one of the following:

switch from a software breakpoint to a hardware breakpoint

OR

set a hardware breakpoint

be aware that performing a Debug Run will cause a halt on the same line of code. Debug Run again to continue program execution or perform a single step to execute the code on the breakpoint line.

4.18.7 Breakpoint Applications

To determine the timing between breakpoints use the stopwatch (see Section 5.14 "Use the Stopwatch").

To determine breakpoint resources open the Dashboard window (see Section 5.18 "View the Dashboard Display") to see the number of available and used breakpoints and whether software breakpoints are supported.

4.18.8 Breakpoint Usage Considerations

Starter kits, in-circuit debuggers (including PICkit 2 and 3) and the MPLAB REAL ICE in-circuit emulator support a limited number of breakpoints. The number of breakpoints available is dependent on the device selected. To see the number of breakpoints available and keep track of the number you have used, see the Dashboard window (Section 5.18 "View the Dashboard Display").

The following MPLAB X IDE features use breakpoints to accomplish their functions:

- Step Over
- Step Out
- Run to Cursor
- Reset to Main

If you attempt to use one of these features when no breakpoints are available, a dialog will be displayed telling you that all resources are used.

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4.19 STEP THROUGH CODE

Use one of the stepping functions on the Debug menu and Debug toolbar to move through code either from the beginning of the code or after a breakpoint halt. Examine changes in variable values (see next section) or determine if the program flow is correct.

There are several ways to step through code:

- Step Over – executes one source line of a program
  If the line is a function call, executes the entire function then stops.
- Step Into – executes one source line of a program
  If the line is a function call, executes the program up to the function's first statement and stops.
- Step Out – executes one source line of a program
  If the line is a function call, executes the functions and returns control to the caller.
- Run to Cursor – runs the current project to the cursor's location in the file and stops program execution.

In addition to the Editor window, you can single-step through code in the Disassembly window (Section 5.15 "View the Disassembly Window"), and program memory in a Memory window.

For more on stepping, see the NetBeans help topics under *C/C++/Fortran Development>Debugging C/C++/Fortran Applications with gdb>C/C++/Fortran Debugging Sessions>Stepping Through Your C/C++/Fortran Program*.

4.20 WATCH SYMBOL VALUES CHANGE

Watch the values of symbols that you have selected change in the Watches window. Knowing whether these values are set as expected during program execution will help you to debug your code.

The following symbols may be added to a Watches window:

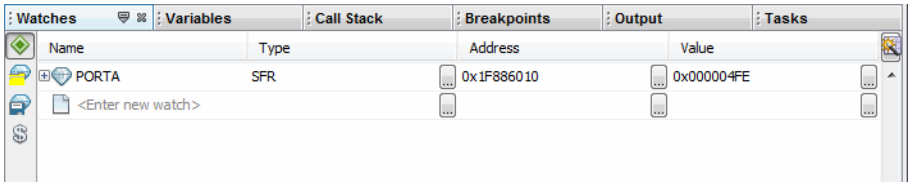
- Global symbols – visible after a build
- SFRs – special function registers (device dependent)
- Absolute addresses

In general, you must Pause from a Debug Run to be able to see updated values. However, some tools allow runtime updates (you can see the values change as your program is running). Check your tool documentation to see if it supports this feature.

For all devices except PIC32 MCUs, symbols used in a runtime watch must be sized to match the device memory. That is, you need 8-bit symbols when using an 8-bit device.

For C-language enumerated types, you may enter either the enum label (text) or integer value in the window. For labels, be aware that they are case sensitive.

FIGURE 4-25: WATCHES WINDOW – PROGRAM PAUSE



To view the Watches window do one of the following:

- Select *Window>Debugging>Watches* to open the window.
- Click the **Watches** tab in the Output window if the window is already open.

To create a new watch directly:

You can add a symbol to the Watches window directly by doing one of the following:

- Double click in the name column and type in a global symbol, SFR, or absolute address (0x300).
- Right click on a global symbol or SFR in the Editor window and select "New Watch".
- Select the global symbol or SFR in the Editor window and drag-and-drop it into the Watches window.

To create a new watch using the New Watch dialog:

You can add a symbol or SFR to the Watches window by doing one of the following:

- Right click in the Watches window and select "New Watch" or select *Debug>New Watch*. Click the selection buttons to see either Global Symbols or SFRs. Click on a name from the list and then click **OK**.
- Select the symbol or SFR name in the Editor window and then select "New Watch" from the right click menu. The name will be populated in the window. Click **OK**.

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To create a new runtime watch:

Before you add a runtime watch to the Watches window, you need to set up the clock:

1. Right click on the project name and select “Properties”.
2. Click on the debug tool name (e.g., Real ICE), and select the “Clock” option category.
3. Set the runtime instruction speed.

To add a global symbol or SFR as a runtime watch, follow the instructions under To create a new watch using the New Watch dialog:, except select “New Runtime Watch” instead of “New Watch”.

For all devices except PIC32 MCUs, symbols used in a runtime watch must be sized to match the device memory. That is, you need 8-bit symbols when using an 8-bit device.

To view symbol changes:

1. Debug Run and then Pause your program.
2. Click the **Watches** tab to make the window active.
3. For watch symbols, continue to Debug Run and Pause to see changing values. For runtime watch symbols, continue Debug Run and watch the values change as the program executes.

You must be in a debug session to see the values of symbols – global symbols, SFRs, arrays, register bitfields, etc.

To change the radix of a watch symbol:

Right click in the line of the symbol and select “Display Value As”.

To perform other tasks:

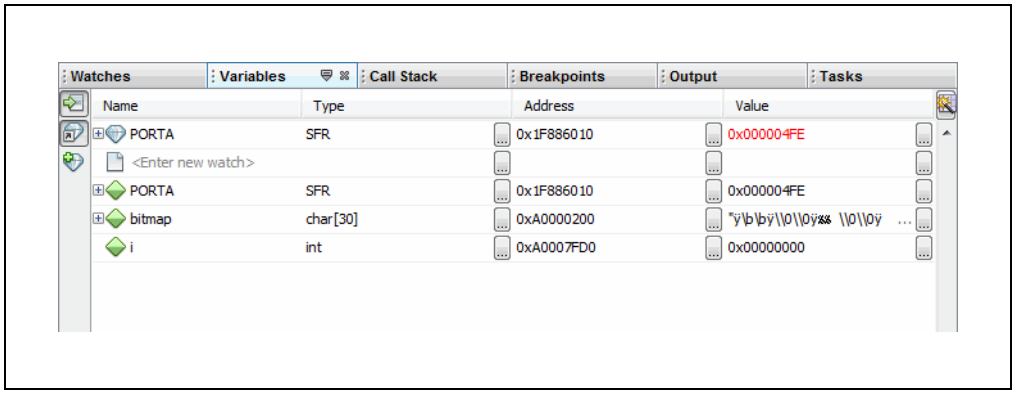
For more on watches, see Section 12.16 “Watches Window”.

4.21 WATCH LOCAL VARIABLE VALUES CHANGE

Watch the values of local variables change in the Variables window. Determining if these values are as expected during program execution will help you to debug your code.

In general, you must Pause from a Debug Run to be able to see updated values. However, some tools allow runtime updates. Check your tool documentation to see if it supports this feature.

FIGURE 4-26: VARIABLES WINDOW – PROGRAM PAUSE



To view the Variables window do one of the following:

- Select *Window>Debugging>Variables* to open the window.
- Click the **Variables** tab in the Output window if the window is already open.

To view variable changes:

1. Debug Run and then Pause your program.
2. Click the **Variables** tab to view the window and see the local variable value.

To change the radix of a variable:

- Right click in the line of the variable and select "Display Value As".

To perform other tasks:

For more on variables, see the NetBeans help topics under *C/C++/Fortran Development>Debugging C/C++/Fortran Applications with gdb>Viewing C/C++/Fortran Program Information>C and C++ Variables and Expressions in the IDE*.

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4.22 VIEW/CHANGE DEVICE MEMORY (INCLUDING CONFIGURATION BITS)

MPLAB X IDE has flexible, abstracted memory windows that provide a more customized view of the different types of device memory during debug. You must Pause from a Debug Run to be able to see updated values in this window.

4.22.1 View Device Memory

1. Click a window in a pane to make the pane active. The memory window will open in this pane.
2. Select a memory view from *Window>PIC Memory Views*. The available choices are explained in the following tables:

TABLE 4-7: MEMORY VIEWS – 8- AND 16-BIT DEVICES

Type	Description
Program Memory	all program memory (ROM) on the device
File Registers	all file register (RAM) memory on the device
SFRs	all Special Function Registers (SFRs)
Peripherals	all SFRs by Peripheral
Configuration Bits	all Configuration registers
EE Data Memory	all EE Data memory on the device
User ID Memory	User ID memory

TABLE 4-8: MEMORY VIEWS – 32-BIT DEVICES

Type	Description
Execution Memory	all Flash memory on the device
Data Memory	all RAM memory on the device
Peripherals	all Special Function Registers (SFRs)
Configuration Bits	all Configuration registers
CPU Memory	all CPU memory
User ID Memory	User ID memory

3. When a Memory window is open, you may further modify your view by selecting the type of memory and memory format in drop-down boxes.

FIGURE 4-27: MEMORY AND MEMORY FORMAT SELECTION

TABLE 4-9: MEMORY WINDOW OPTIONS – 8- AND 16-BIT DEVICES

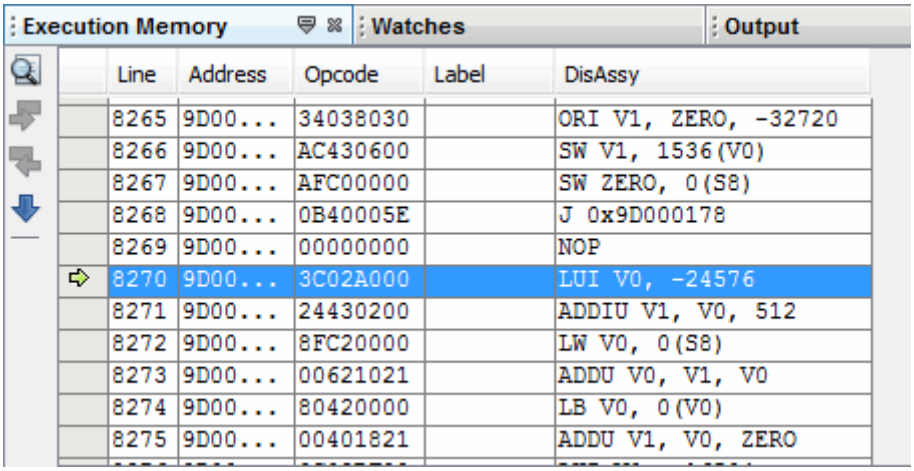
Option	Value	Description
Memory	File Registers	all file register memory on the device
	Program	all program memory on the device
	SFR	all Special Function Registers (SFRs)
	Configuration Bits	all Configuration registers
	EEPROM	all EEPROM memory
	User ID	User ID memory
Format	Data	Data Memory (RAM)
	Code	Program Memory (ROM)

TABLE 4-10:MEMORY WINDOW OPTIONS – 32-BIT DEVICES

Option	Value	Description
Memory	RAM Memory	all RAM memory on the device
	Flash Memory	all Flash memory on the device
	Peripheral	all Special Function Registers (SFRs)
	Configuration Bits	all Configuration registers
	CPU Memory	all CPU memory
	Memory	all memory
	User ID	User ID memory
Format	Data	Data Memory (RAM)
	Code	Program Memory (ROM)

4. After a Debug Run and then Pause, the window will populate with the memory chosen.
5. Close the window by clicking the "x" on that window's tab.

FIGURE 4-28: MEMORY WINDOW CONTENT



4.22.2 Change Device Memory

You must Debug Run your code to change memory values. You cannot change memory during a Run.

Note: The data will change only during the Debug Run. Your application code is not changed.

Use the following information to change memory values:

- Change a value in the Memory window by clicking in the appropriate column and selecting or entering new data. For some windows, the text will be red to show a change.
- The Fill memory feature is found on the context (right click) menu of most Memory windows.
- For program memory, you must rebuild to see the changes. Use *Debug>Discrete Debugger Operation* to program the target and launch the debugger with the changed data.

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4.22.3 Set Memory Window Options with the Context Menu

Right clicking in the Memory window will pop up a context menu with various options such as display options, fill memory, table import/export and output to file. For more information on this menu, see Section 12.9.13 “Memory Window Menu”.

4.22.4 Set Configuration Bits

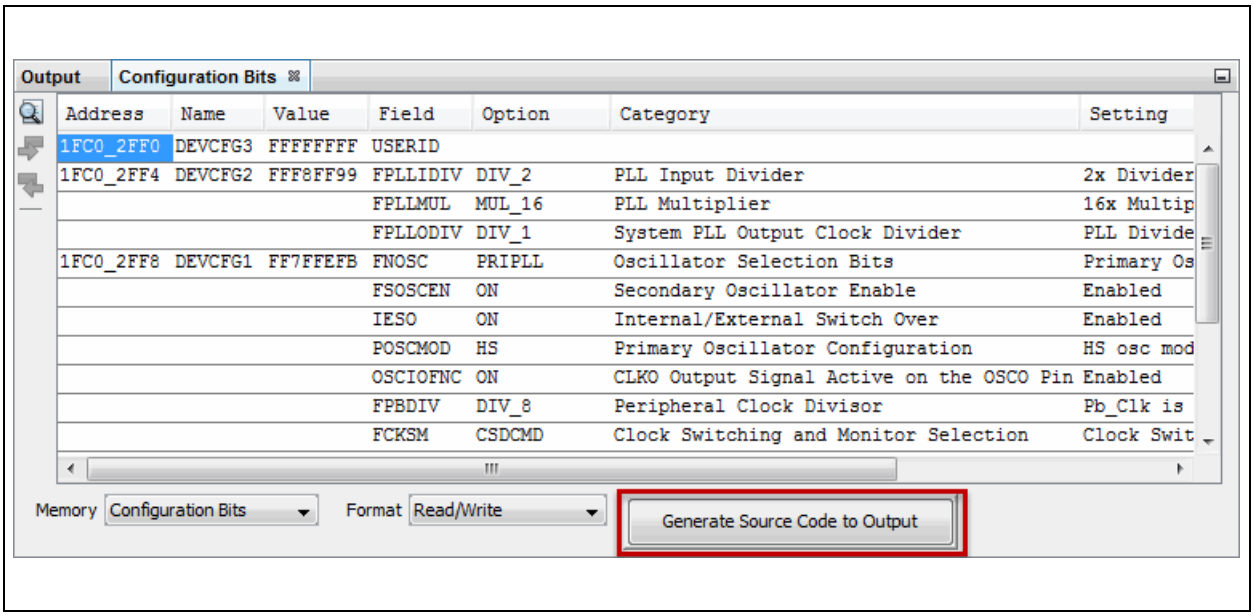
You must set Configuration bits in code. To aid you in developing your Configuration bit settings, you can use the Configuration Bits window (see Section 4.22.1 “View Device Memory”.)

You can temporarily change Configuration bits during a debug session in the Configuration Bits window (see Section 4.22.2 “Change Device Memory”.) Once you have the settings you want, select “Generate Source Code to Output”. You can then copy the code from the Output window into your code.

You cannot edit the Configuration bits if you are not in a debug session. Also, if you rebuild, all changes in the Configuration Bits window will be lost.

For a summary of Configuration bits settings for different devices, see **Appendix A. “Configuration Settings Summary”**.

FIGURE 4-29: CONFIGURATION BITS WINDOW



4.22.5 Refresh Selected Memory Windows

For Memory windows showing program, EEPROM, user ID, or configuration bits memory, you can refresh the view by doing the following:

1. If you are debugging, halt your program unless your tool and device support Debug Reads (see below).
2. Click on the icon named "Read Device Memory".

Read Device Memory Icon

Debug Reads

For most devices, you must halt your program (Finish Debugger Session) before you can read device memory. For some devices, you can read while in debug mode (Debug Read). You will know that this is available as the "Read Device Memory" icon will not be grayed out when you are debugging.

Currently, MPLAB REAL ICE in-circuit emulator and MPLAB ICD 3 support Debug Reads.

Debug Reads are done at target oscillator speeds so if the target is running very slow, a read may take a long time. You can force a fast ICSP read by finishing the debug session and then doing a read since ICSP reads will always be done when not in a debug session.

4.23 PROGRAM A DEVICE

Once your code is debugged, you can program it onto a target device.

4.23.1 Set Project Programming Properties

Set up programming options in the Project Properties window:

1. Right click on the project name in the Projects window and select "Properties".
2. Under "Categories", click on the hardware tool you will use to program your code, e.g., PM3.
3. Review the settings under the "Memories to Program" options category.
   If you wish to use a Preserve Memory option, ensure that your code is ***not*** code protected. Code is preserved when the programmer reads the section it needs to save, performs a bulk erase of the device, reprograms the device and then rewrites the area that is preserved with what was saved.
4. Review the settings under the "Program Options" options category.
5. Depending on your hardware tool, there may be other programming option categories. Review each one to ensure the settings are correct for your project.
6. When using RTDM with DMCI, Motor Control applications, etc., you will need to check the checkbox "Load symbols when programming or building for production (slows process)" under the "Loading" category.

For more information about programming options, please consult your hardware tool documentation.

After the programming options are set up as you desire, you may proceed to program the device.

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4.23.2 Perform Programming

To program your target device with debugged code, click the toolbar button **Make and Program Device Project**.

Other programming-related functions are shown in the Table 4-11. The first function is activated by clicking on the button. For other functions, click on the down arrow next to the button icon.

TABLE 4-11: PROGRAMMING FUNCTIONS ON TOOLBAR BUTTONS

Button Icon	Function	Details
	Make and Program Device	The project is built (if necessary) and the device is programmed. The program will immediately begin execution on completion of programming.
	Program Device for Debugging	The device is programmed from a debug image. The program will immediately begin execution on completion of programming.
	Program Device for Production	The device is programmed from a production image. The program will immediately begin execution on completion of programming.
	Programmer to Go PICkit 3	Use the Programmer to Go feature of PICkit 3.
	Read Device Memory	Transfer what is in target memory to MPLAB X IDE.
	Read Device Memory to File	Transfer what is in target memory to the specified file.
	Read EE/Flash Data Memory to a File	Transfer what is in target data memory to the specified file.
	Hold In Reset	Toggle the device between Reset and Run.

4.23.3 Program Using the MPLAB Integrated Production Environment

Not all programming functions are in the MPLAB X IDE. For additional programming support, see the MPLAB IPE included with the MPLAB X IDE installation.

Desktop Icon for MPLAB IPE

NOTES:

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Chapter 5. Additional Tasks

5.1 PERFORMING ADDITIONAL TASKS

The following steps show how to perform more tasks in MPLAB X IDE

Work with Projects

1. Open an MPLAB IDE v8 project in MPLAB X IDE by using the Import MPLAB Legacy Project wizard.
2. Open a prebuilt image (Hex, COF or ELF) using the Prebuilt Projects import wizard.
3. Use Loadable Projects, Files and Symbols to combine or replace project hex files. A common application is using loadables for combining bootloaders and application code, as in Loadable Projects and Files: Bootloaders.
4. Create Library Projects to build their output as a library.
5. Create projects from Other Embedded Projects or Sample Projects.
6. Work with Other Types of Files, not just Microchip ones. Also Modify or Create Code Templates to change the default file templates that you use in your project.
7. Switch Hardware or Language Tools used in your project.
8. Modify Project Folders and Encoding of an existing project.
9. Speed Up Build Times using parallel make.

Debug Code

1. Use the Stopwatch to determine the timing between breakpoints.
2. View the Disassembly Window to see disassembled code.
3. To navigate function calls, View The Call Stack or View The Call Graph.
4. View the Dashboard Display to see project information such as breakpoint resources, checksums and memory usage.

Manage Code

1. Improve Your Code* by using refactoring and profiling tools.
2. Control Source Code by using built-in file history or a version control system.
3. Collaborate on Code Development and Error Tracking* by using a team server and an issue tracking system.

Add Functionality

1. Add Plug-In Tools to aid code development.

* To see this feature, refer to the **Start Page**, **My MPLAB X IDE** tab, "Extend MPLAB" section, "Selecting Simple or Full-Featured Menus" topic.

5.2 IMPORT MPLAB LEGACY PROJECT

The Import Legacy Project wizard will import an MPLAB IDE v8 project into an MPLAB X IDE project with the following considerations:

- **MPLAB IDE v8 workspace settings will not be transferred.**
  Settings that were saved in a workspace in MPLAB IDE v8 (such as tool settings) will not be transferred to the new MPLAB X IDE project. Refer to the MPLAB IDE v8 help for what is stored in a workspace (*MPLAB IDE Reference>Operational Reference>Saved Information*.)
  Project settings, such as compiler, linker, and assembler options, will be transferred to the new MPLAB X IDE project.
- **An MPLAB IDE v8 project using the "MPLAB C Compiler for PIC24 MCUs and dsPIC DSCs" (aka MPLAB C30) and a COFF debug file format may have changes.**
  - The MPLAB X IDE project will be converted to the ELF/DWARF debug file format unless the project uses COFF libraries, in which case the project format will continue to be COFF.
  - MPLAB IDE v8 is case insensitive to file extensions such as `.c` and `.C`. However, MPLAB X IDE is case sensitive and associates `.c` to C code files and `.C` to C++ code files. Therefore, if you import an MPLAB IDE v8 project with C code specified as `.C`, MPLAB X IDE will rename the `.C` files to `.c` to avoid incorrect compiler behavior.
- **An MPLAB IDE v8 project imported into MPLAB X IDE may not build the same as the original project.**
  Do not use `__FILE__`, `assert()`, `__TIME__`, or `__DATE__` in your project code or the build (and checksum) will be different.

5.2.1 Open the Wizard

There are two ways to open this wizard – the Start Page option and the New Project option.

5.2.1.1 START PAGE OPTION

- On the **Start Page**, click on the **Learn & Discover** tab, "Dive In" section, "Import MPLAB Legacy Project" link. Or Select *File>Import>MPLAB IDE v8 Project*.
- The "Import Legacy Project" wizard opens.

5.2.1.2 NEW PROJECT OPTION

To open the New Project wizard, do one of the following:

- On the **Start Page**, click on the **Learn & Discover** tab, "Dive In" section, "Create New Project" link.
- *File>New Project* (or Ctrl+Shift+N)

A wizard will launch to guide you through new project set up.

- **Step 1. Choose Project:** select the "Microchip Embedded" category and choose from the project type "Existing MPLAB IDE v8 Project".
  Click **Next>**.
- The "Import Legacy Project" wizard opens.

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5.2.2 Import Legacy Project Wizard

Follow the steps below to import your MPLAB IDE v8 project. Click **Next>** to move to the next step.

- **Step 1 or 2. Import Legacy Project:** enter or browse to the legacy project.
- **Step 2 or 3. Select Device:** select the device you will be using in your application from the “Device” drop-down list.

  To narrow your selection list, choose a Family first.
- **Step 3 or 4. Select Header:**

  This step will appear if a header is available for your selected device.

  To determine if a header is required for debug or if your device has on-board debug circuitry, consult the *Processor Extension Pak and Debug Header Specification* (DS51292 or online help). Then choose whether or not to use a header.
- **Step 4 or 5. Select Tool:** select the development tool you will be using to develop your application from the list.

  The level of tool support for the selected device will be displayed next to the tool name. That is, green for full support, yellow for beta support, and red for no support yet.
- **Step 5 or 6. Select Compiler:** select the language tool (compiler) you will be using to develop your application from the list.

  The level of tool support for the selected device will be displayed next to the tool name. That is, green for full support, yellow for beta support and red for no support.
- **Step 6 or 7. Select Project Name and Folder:**

  It is recommended that you do not change the default name and location to preserve maintainability of both projects.

  File Locations:

  The new project will not copy the source files into its folder, but instead will reference the location of the files in the v8 folder.

  To create an independent MPLAB X IDE project, create a new project and copy the MPLAB IDE v8 source files to it.

  Main Project:

  Check the checkbox to make this project the main project on import.

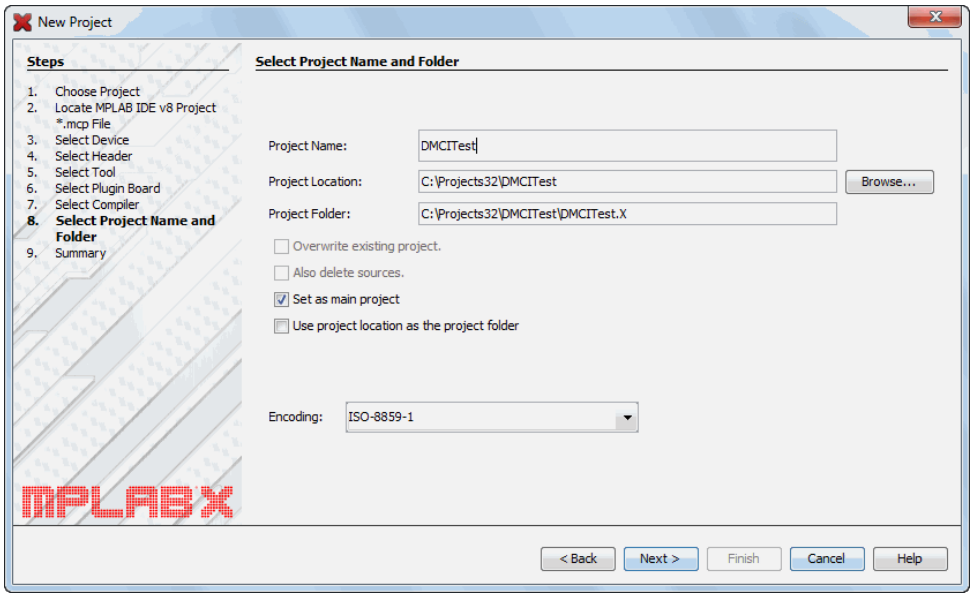
  File Formatting:

  “ISO-8859-1” is the default character encoding used when importing a project from MPLAB IDE v8.

  You should select the encoding that matches the one that is used in the imported project. For example, if the MPLAB IDE v8 format is “950 (ANSI/OEM – Traditional Chinese Big5)”, then select “Big5” from the drop-down list.
- **Step 7 or 8. Summary:**

  Review the summary before clicking **Finish**. If anything is incorrect, use the **Back** button to go back and change it.
- The legacy project will open in the Projects window, see Figure 5-1.

FIGURE 5-1: IMPORT LEGACY – SELECT PROJECT NAME AND FOLDER



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5.3 PREBUILT PROJECTS

Create a project from a prebuilt loadable image (Hex, COF, or ELF files) by using the Import Image File wizard.

> **Note:** To program a prebuilt image into a device, you will click the **Make and Program Device** button even though it will only program the device (no make).

There are two ways to open this wizard, the Start Page and the New Project options.

5.3.1 Start Page Option

- On the **Start Page**, click on the **Learn & Discover** tab, “Dive In” section, “Import Hex (Prebuilt) Project” link. Or Select *File>Import>Hex/ELF (Prebuilt) File*.
- The “Import Image File” wizard opens.

5.3.2 New Project Option

To open the New Project wizard, do one of the following:

- On the **Start Page**, click on the **Learn & Discover** tab, “Dive In” section, “Create New Project” link.
- *File>New Project* (or Ctrl+Shift+N)

A wizard will launch to guide you through new project set up.

- **Step 1. Choose Project:** select the “Microchip Embedded” category and choose from the project type “Prebuilt (Hex, Loadable Image) Project”. Click **Next>**.
- The “Import Image File” wizard opens.

5.3.3 Import Image File Wizard

Follow the steps below to import your image file. Click **Next>** to move to the next step.

- **Step 1 or 2. Import Image File:** select the name and location of your image file.
  You may browse to a location.
- **Step 2 or 3. Select Device:** select the device you will be using in your application from the “Device” drop-down list.
  To narrow your selection list, choose a Family first.
- **Step 3 or 4. Select Header:**
  This step will appear if a header is available for your selected device.
  To determine if a header is required for debug or if your device has on-board debug circuitry, consult the *Processor Extension Pak and Debug Header Specification* (DS51292 or online help). Then choose whether to use a header.
- **Step 4 or 5. Select Tool:** select the development tool you will be using to develop your application from the list.
  The level of tool support for the selected device will be displayed next to the tool name. That is, green for full support, yellow for beta support and red for no support yet.
- **Step 6 or 7. Select Project Name and Folder:** select a name and location for your new project.
- You may browse to a location.
- **Step 7 or 8. Summary:** review the summary before clicking **Finish**.
  If anything is incorrect, use the **Back** button to go back and change it.
- The new project will open in the Projects window.

For information on exporting a project as hex, see Section 12.13.2 “Projects Window – Project Menu”.

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5.4 LOADABLE PROJECTS, FILES AND SYMBOLS

Use loadable projects and files to combine projects, combine hex files, combine projects and hex files or replace the project hex file. The HEXMATE application is used to merge project or loaded hex files into one file. For more information on using this application, see the *MPLAB XC8 C Compiler User's Guide* (DS50002053) in the `docs` folder of the installed MPLAB XC8 C compiler. See also Section 9.7.8 "HEXMATE Conflict Report Address Error".

Use loadable symbols to load debug symbols during a production build or program, as when using RTDM with DMCI, Motor Control applications, etc.

Loadable projects or files are useful for creating combined bootloader and application code. See Section 5.5 "Loadable Projects and Files: Bootloaders".

The combinations of current projects and loadables are listed below.

TABLE 5-1: LOADABLE COMBINATIONS

Current Project	Loadable	Caveat
Stand-Alone Existing MPLAB IDE v8 Library	Stand-Alone	None
	Hex file	None
	COF/ELF file	• Can debug, but not build. An error will be displayed in the Output window.
Prebuilt (Hex)	Hex file	• No auto checking for overlapping memory areas. • Can debug, but not build. **Build** button will be disabled.
	COF/ELF file	
Prebuilt (COF/ELF)	Hex file	
	COF/ELF file	

The options are listed below.

TABLE 5-2: LOADABLE OPTIONS

Add Loadable Project(s)	Load one or more existing projects into your current project. When you build your current project, all projects will be built and the hex files will be combined into one. All debug files will be combined as well (COFF or ELF).
Add Loadable File(s)	Load one or more existing hex files into your current project. When you build your current project, the hex file will be combined with the other hex files into one file. **Note:** You will no longer be able to debug the project that contains hex file(s). Use Loadable Projects for debugging.
Add Alternate File	Load an alternate hex file to be used. This options provides a post-build step where you may copy or move your project hex file to another location, use a tool such as HEXMATE to merge your file with another hex file, and then load the file back into the IDE.

To set up and use loadables, see:

- Projects Window – Loadables Setup
- Project Properties Window – Loading Setup
- The Preferred Method to Use Loadables

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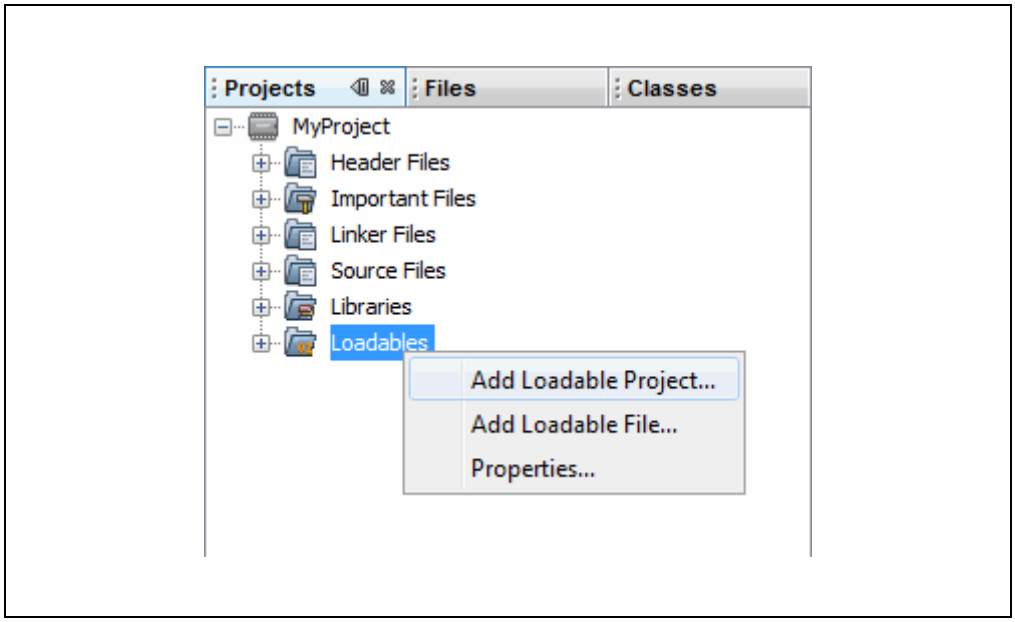
5.4.1 Projects Window – Loadables Setup

Right Click on the “Loadables” folder in the Projects window (Figure 5-2) and select an option:

- Add Loadable Project – select to add an existing project to your current project. Repeat to add additional projects.
- Add Loadable Files – select to add an existing hex file to your current project. Repeat to add additional hex files.
- Properties – Open the Project Properties window for Loading. See Section 5.4.2 “Project Properties Window – Loading Setup”.

Build your current project to build all projects and combine hex files into one. Any debug files will also be combined.

FIGURE 5-2: PROJECTS WINDOW – LOADABLES FOLDER



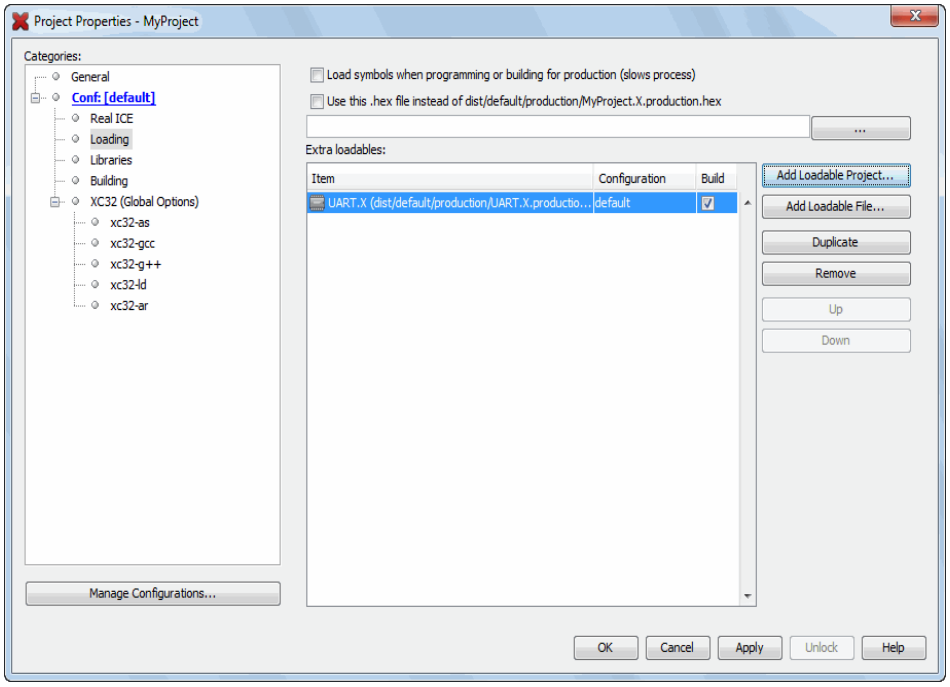
5.4.2 Project Properties Window – Loading Setup

Open the Project Properties window (*File>Project Properties*) and click on “Loading”.

- Combining the Current Project with Other Projects
- Combining the Current Project Hex File with Other Hex Files
- Loading an Alternative Hex File
- Loading Debug Symbols During Program/Build

See also, Section 9.6 “MPLAB X IDE Issues”

FIGURE 5-3: PROJECT PROPERTIES – LOADING



5.4.2.1 COMBINING THE CURRENT PROJECT WITH OTHER PROJECTS

1. Click **Add Loadable Project**. The Add Loadable Project dialog will appear.
2. Browse to a project and select it.
3. Under "Configuration" select a build configuration to use for this project. If you have not added different configurations to this project, you will only see "default".
4. Under "Store path as" select how to store information about the path to the loadable project. Choose from:
   a) Auto – allow MPLAB IDE to determine whether the loadable project path should be relative or absolute based upon the its location.
   If the main project directory contains the loadable project, the reference is a relative path. Otherwise, the reference is an absolute path.
   b) Relative – reference the loadable project with a relative (to the main project) path.
   This is the preferred way to add paths.
   c) Absolute – reference the loadable project with an absolute path.
   There are cases when this mode is useful, but these paths often require correction when a project is moved from one system to another.
5. Click **Add** to close the dialog.
6. In the Project Properties window, ensure the "Build" checkbox is checked if you want to build this project when you build the current project.
7. If you have added more than one project, the order shown here will determine the order in which the hex files will be added to the current project's hex file. Use **Up** and **Down** to change the order.
8. Click **Apply** or **OK** to accept the changes.

The next time you build the current project, the projects listed here will also be built (if "Build" is checked) and their hex files will be combined with the current project's hex file to create a single output hex file. Any debug files will also be combined.

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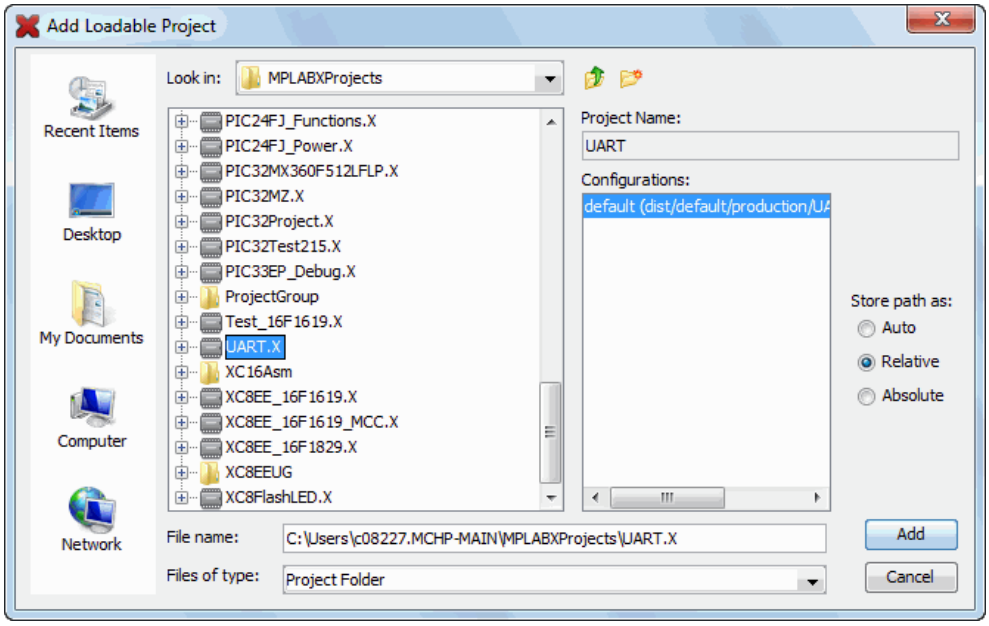
FIGURE 5-4: ADD LOADABLE PROJECT



5.4.2.2 COMBINING THE CURRENT PROJECT HEX FILE WITH OTHER HEX FILES

1. Click **Add Loadable File**. The Add Loadable File dialog will appear.
2. Browse to a hex file and select it.
3. Under “Store path as” select how to store information about the path to the loadable file. Choose from:
   a) Auto – Allow MPLAB IDE to determine whether the loadable file path should be relative or absolute based upon the its location.
   If the main project directory contains the loadable file, the reference is a relative path. Otherwise, the reference is an absolute path.
   b) Relative – Reference the loadable file with a relative (to the main project) path.
   This is the preferred way to add paths.
   c) Absolute – Reference the loadable file with an absolute path.
   There are cases when this mode is useful, but these paths often require correction when a project is moved from one system to another.
4. Click **Add** to close the dialog.
5. In the Project Properties window, if you have added more than one file, the order shown here will determine the order in which the hex files will be added to the current project’s hex file. Use **Up** and **Down** to change the order.
6. Click **Apply** or **OK** to accept the changes.

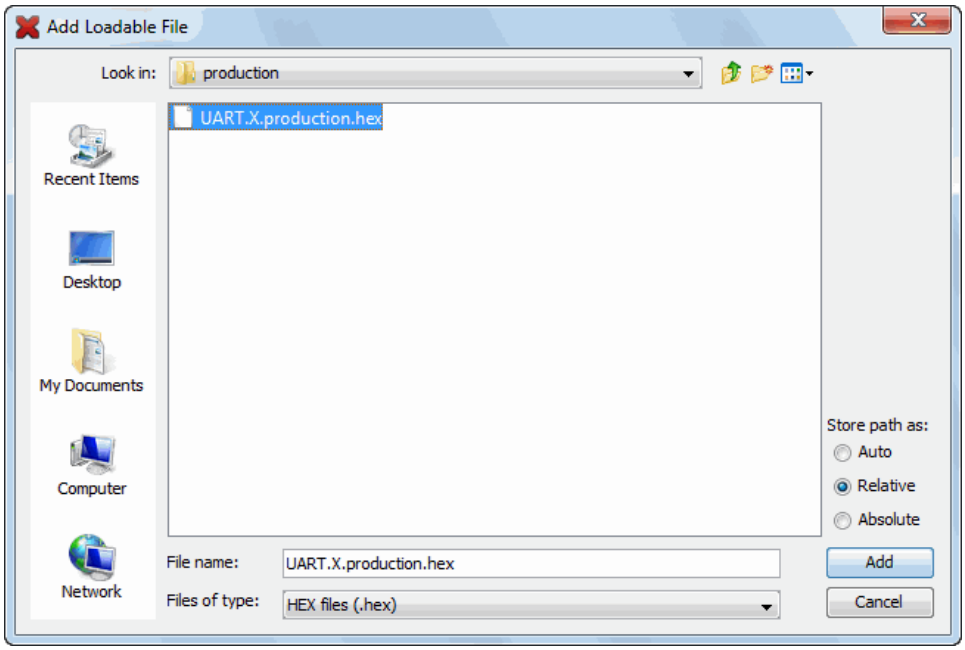
The next time you build the current project, the hex files listed here will be combined with the current project’s hex file to create a single output hex file.

To load debug symbols during a production build or program

By default the checkbox “Load symbols when programming or building for production (slows process)” is unchecked. In this case, only the hex file is loaded.

Checking this checkbox will load the hex file and all debug symbols. Doing this will slow the programming/building process. However, this option is required when using RTDM with DMCI, Motor Control applications, etc.

FIGURE 5-5: ADD LOADABLE FILE



5.4.2.3 LOADING AN ALTERNATIVE HEX FILE

1. Click to check "Use this .hex file instead of *MainProjectHexFile*".
2. Click the ellipses (...) to open the Add Loadable File dialog. For details on adding the hex file using this dialog, see Section 5.4.2.2 "Combining the Current Project Hex File with Other Hex Files".

The next time you build the current project, the alternative hex file will load on build complete.

5.4.2.4 LOADING DEBUG SYMBOLS DURING PROGRAM/BUILD

The checkbox to "Load symbols when programming or building for production (slows process)" allows you to load debug symbols when programming, as when using RTDM with DMCI, Motor Control applications, etc. Otherwise the checkbox should be left unchecked to speed up programming and building (default).

5.4.3 The Preferred Method to Use Loadables

The recommended way to use loadables is:

1. Select the project that sets the device configuration bits and initialization as the main project (right click and select "Set as Main Project"). The loadable should not have device configuration settings as this will conflict with the main project.
2. Add the other projects as loadables to this main project. If the project being loaded has more than one project configuration, be sure to specify that when loading.

Specifying the project containing the loadables as the main project ensures that a change in any loadable will be picked up by the build when the **Build** button is pressed.

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5.5 LOADABLE PROJECTS AND FILES: BOOTLOADERS

To combine a bootloader with application code:

1. Create one project for your application and one project for your bootloader.
2. Load the bootloader project or hex file into the application project. See Section 5.4.1 “Projects Window – Loadables Setup” or Section 5.4.2 “Project Properties Window – Loading Setup” for how to do this.

The next time you build your application project, the resulting hex file will be a combined bootloader/application hex file. Any debug files will also be combined.

For build errors, see Section 5.4.3 “The Preferred Method to Use Loadables” or the sections below.

Consideration #1: MPLAB C Compiler for PIC18 MCUs (MPLAB C18)

This compiler provides application start-up code (`c018x.o`) that begins at the reset vector (address 0) for use in initializing the software stack, optionally initializing the `idata` section, and jumping to `main()`. If this start-up code is left in an application, there will always be a conflict with the bootloader code reset and you will get a linker error message about a data conflict.

A resolution would be to edit the start-up code to begin at an address other than 0.

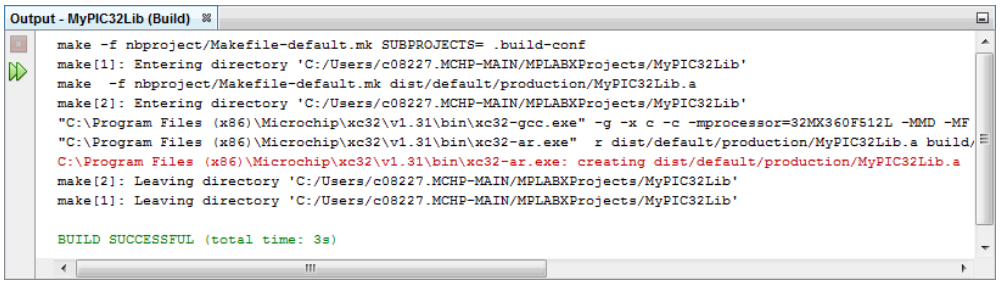
Consideration #2: MPLAB XC8 – PIC18 MCU Example

The following Microchip webinar details how to combine a bootloader with application code for a PIC18 MCU using MPLAB XC8 and MPLAB X IDE:
“Linking PIC18 Bootloaders & Applications”

5.6 LIBRARY PROJECTS

Create a new library project that uses an IDE-generated makefile to build your project as a library file instead of an executable (see text in red).

FIGURE 5-6: LIBRARY PROJECT EXAMPLE



To begin, open the New Project wizard by doing one of the following:

- On the **Start Page**, click on the **Learn & Discover** tab, "Dive In" section, "Create New Project" link.
- *File>New Project* (or Ctrl+Shift+N)

A wizard will launch to guide you through new project set up. Click **Next>** to move to the next step.

- **Step 1. Choose Project:** select the "Microchip Embedded" category and choose from the project type "Library Project".
- **Step 2. Select Device:** select the device you will be using in your application from the "Device" drop-down list. To narrow your selection list, chose a Family first.
- **Step 3. Select Header:**

  This step will appear if a header is available for your selected device.

  To determine if a header is required for debug or if your device has on-board debug circuitry, consult the *Processor Extension Pak and Debug Header Specification* (DS51292 or online help). Then choose whether or not to use a header.
- **Step 4. Select Tool:** select the development tool you will be using to develop your application from the list.

  The level of tool support for the selected device will be displayed next to the tool name. That is, green for full support, yellow for beta support and red for no support yet.
- **Step 5. Select Compiler:** select the language tool (compiler) you will be using to develop your application from the list.

  The level of tool support for the selected device will be displayed next to the tool name. That is, green for full support, yellow for beta support and red for no support.
- **Step 6. Select Project Name and Folder:** select a name and location for your new project. You may browse to a location.

The new project will open in the Projects window.

You can change your Library project to a Standalone (Application) project if you wish. For details, see Section 4.14.1 "Change Project Configuration Type".

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5.7 OTHER EMBEDDED PROJECTS

MPLAB X IDE can create a project from selected, other embedded projects.

1. Select *File>New Project*.
2. Click on “Other Embedded” under “Categories” and select from a list of available embedded projects.
3. Continue to create an MPLAB X IDE project.

This feature imports your existing files into an MPLAB X IDE project. Conversion of other embedded project settings or code is not yet available.

For information on how to work with MPLAB X IDE, see:

- Chapter 3. “Tutorial”
- Chapter 4. “Basic Tasks”

For information on available compilers, see:

http://www.microchip.com/xc

5.8 SAMPLE PROJECTS

Create a sample project to help you learn about Microchip devices, tools and MPLAB X IDE.

1. Select *File>New Project*.
2. Click on “Samples>Microchip Embedded” under “Categories” and select from a list of available embedded projects (that blink demo board lights) or template projects. Read the Description for more information.

Part numbers for demo boards are as follows:

Explorer 16 Demo Board: DM240001

PICDEM 2 Plus: DM163022-1

5.9 WORK WITH OTHER TYPES OF FILES

When selecting *File>New File*, you are presented with many types of files. Using Microchip compiler files has been explored previously. However, there are other types of files you can select depending on your project language tool or need to create a specific file.

TABLE 5-3: FILE TYPES

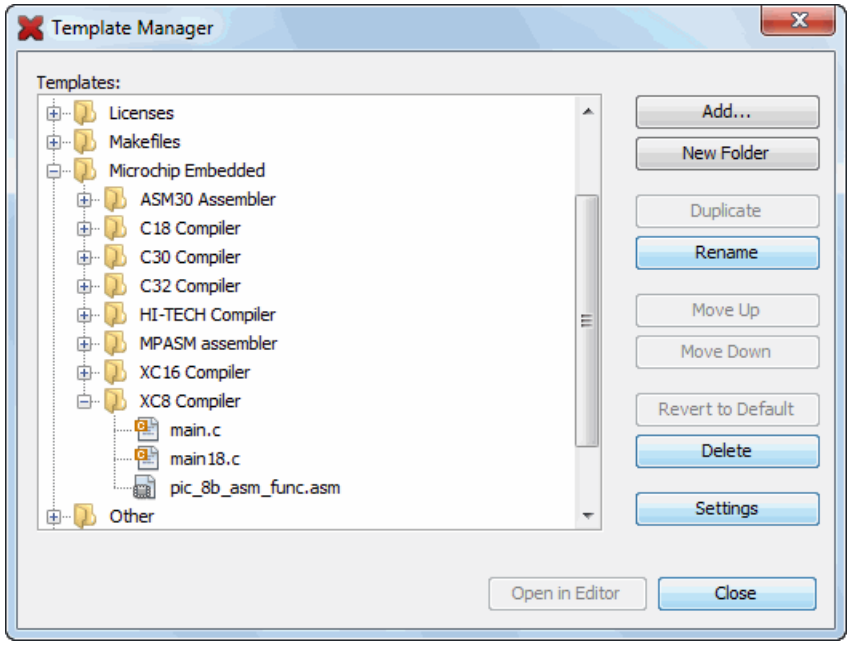
Category	File Type
Microchip Embedded	Files for language tools that are supported in MPLAB X IDE Select your compiler folder to see the available file types.
C	Generic C files
C++	Generic C++ files
Assembler	Generic assembly files
Shell Scripts	Shell script files: Bash, C, Korn, etc.
Makefiles	Makefile files
XML	XML files
Other	Other types of files, such as HTML, JavaScript, etc. If you do not see the type of file you want listed here, select “Empty File”. In the next window, name the file with the desired extension.

5.10 MODIFY OR CREATE CODE TEMPLATES

When you create a file to add to your project (Section 4.9 "Create a New File"), a template is used for the new file. To change this template, select *Tools>Templates* and then "Open in Editor" to edit a template. You may also use "Add" or "Duplicate" in this dialog to create new templates.

"New Folder" can be used to create a new folder to hold templates. Be aware that MPLAB X IDE filters out all but Microchip Embedded, Shell Scripts, Makefiles and Other, so files or folders should be created under those folders.

FIGURE 5-7: TEMPLATE MANAGER



You may set template options by selection *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Editor** button, **Code Templates** tab (as shown below).

An option of note for C code is the "fcom" option. In an Editor window, type "fcom" and then press "Tab" to insert the following text into the source code:

```
// <editor-fold defaultstate="collapsed" desc="${comment}">
${selection}${cursor}// </editor-fold>
```

This option allows you to hide/view sections of code.

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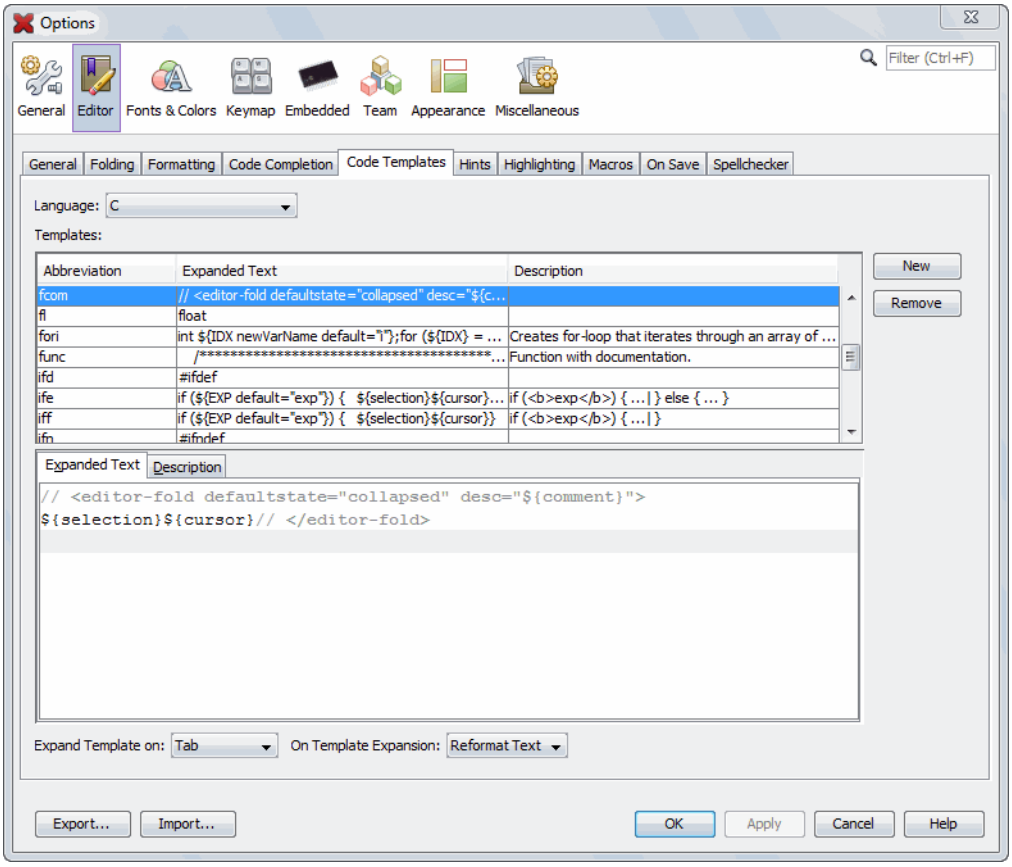
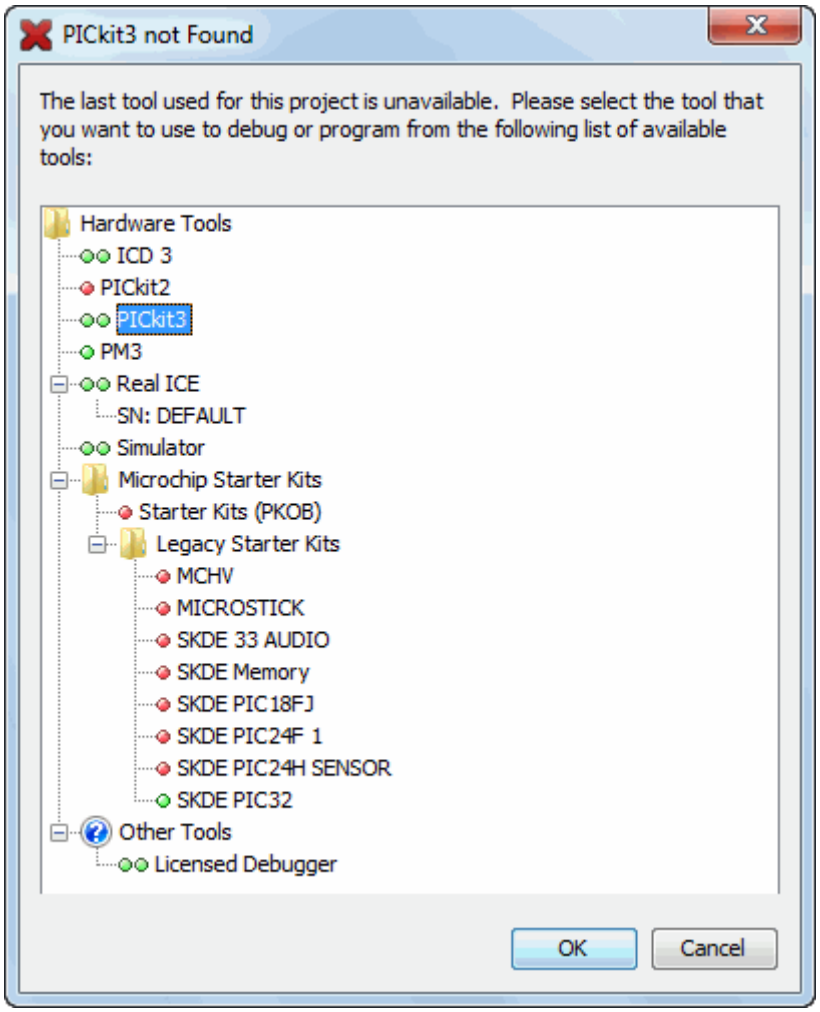
FIGURE 5-8: TEMPLATE OPTIONS



5.11 SWITCH HARDWARE OR LANGUAGE TOOLS

When you attempt to Run or Debug Run a project that has a debug tool selected that is not the one currently connected, MPLAB X IDE will pop up a dialog asking if you would like to make another hardware tool the project tool.

FIGURE 5-9: SWITCH HARDWARE TOOL DIALOG



You may also plug in two or more hardware tools and switch between them in the Project Properties dialog (*File>Project Properties*).

To switch between different versions of compiler toolchains (language tools), use the Project Properties dialog.

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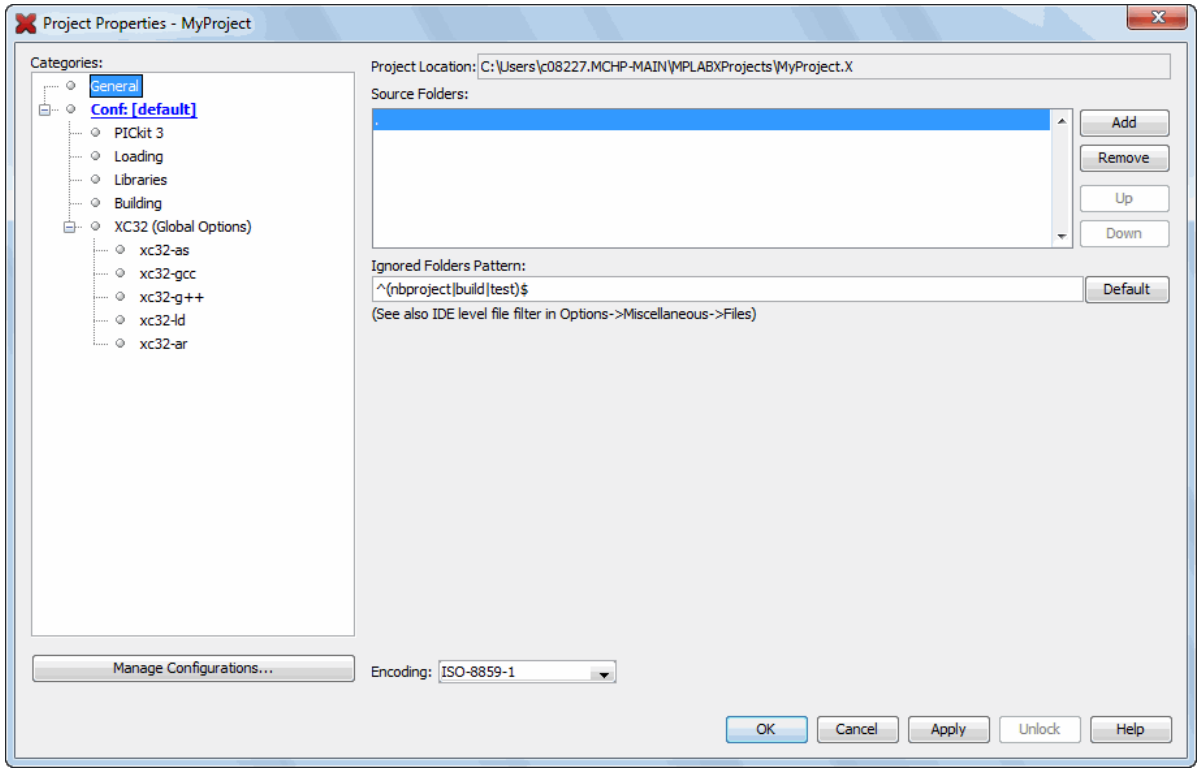
5.12 MODIFY PROJECT FOLDERS AND ENCODING

When you created your project, you specified the project folder and encoding. Once the project is created, you may add or ignore project folders and change the project encoding using the “General” category in the Project Properties window.

TABLE 5-4: PROJECT PROPERTIES – GENERAL CATEGORY

Option	Description
Project Location	View the current project location. See Section 8.9 “Moving, Copying or Renaming a Project” to change the project location.
Source Folders	Add folders for MPLAB X IDE to search when looking for project files. **Note:** Adding files outside the project folder may make the project less portable.
Ignored Folders Pattern	Ignore folders in the project folder according to the regular expression pattern specified.
Encoding	Change the project encoding. This selection will specify the code syntax coloring, which can be edited under *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Fonts and Colors** button, **Syntax** tab.

FIGURE 5-10: PROJECT PROPERTIES – GENERAL



5.13 SPEED UP BUILD TIMES

Depending on the configuration of your computer, you may be able to use parallel make (see Section 12.14.2 "Project Options Tab") to speed up your project build times. Not all language tools support parallel make.

Another option is to consider your operating system (OS). Some OS's have faster file accessing. MPLAB X IDE supports Windows, Linux and Mac OS's. Research which one might be right for you.

5.14 USE THE STOPWATCH

Use the stopwatch to determine the timing between two breakpoints.

To use the Stopwatch:

1. Add a breakpoint where you want to start the stopwatch.
2. Add another breakpoint where you want to stop the stopwatch.
3. Select *Window>Debugging>Stopwatch*. Click on the Properties icon on the left of the window and select the start and stop breakpoints.
4. Debug Run the program again to get the stopwatch timing result.

FIGURE 5-11: STOPWATCH SETUP

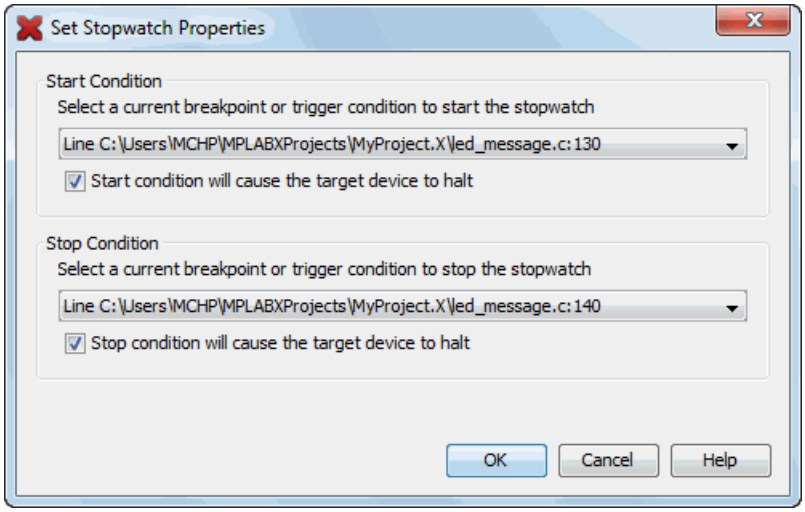
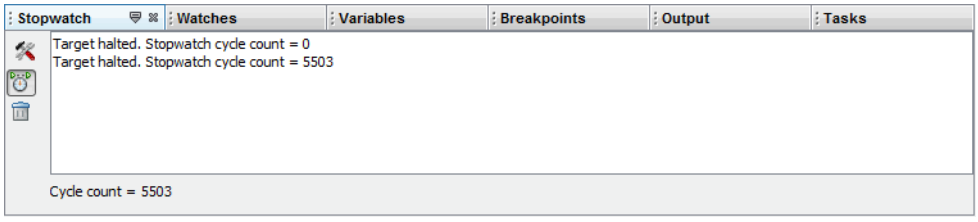


FIGURE 5-12: STOPWATCH WINDOW WITH CONTENT



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The stopwatch has the following icons on the left side of the window:

TABLE 5-5: STOPWATCH ICONS

Icon	Icon Text	Description
	Properties	Set stopwatch properties. Select one current breakpoint or trigger to start the stopwatch and one to stop the stop-watch.
	Reset Stopwatch on Run	Reset the stopwatch time to zero at the start of a run.
	Clear History	Clear the stopwatch window.
	Clear Stopwatch	(Simulator Only) Reset the stopwatch after you reset the device.

5.15 VIEW THE DISASSEMBLY WINDOW

View disassembled code in this window. Select *Window>Debugging>Output>Disassembly Listing File* to open the window.

This information may also be found in the listing file produced by the linker. Open this file by selecting *File>Open File* and browsing for the `ProjectName.lst` file.

A quick way to view the entire disassembly file is to right click in the Disassembly window and select “Disassembly Listing File”.

Note: The Disassembly window will disassemble each instruction, but has no history of banking associated with the instruction. Therefore, SFR names displayed in the window will be for Bank 0.

5.16 VIEW THE CALL STACK

For 16- and 32-bit devices, a software Call Stack window is available to view `CALL`s and `GOTO`s in executing C code. This window is not applicable for assembly code. (It is recommended that code optimization be turned off when using the call stack.)

The Call Stack window displays functions and their arguments listed in the order in which they were called in the executing program.

To view the call stack:

1. Debug Run and then Pause your program.
2. Select *Window>Debugging>Call Stack*. A Call Stack window will open. See also Section 12.4 “Call Stack Window”.

For more on the call stack, see the NetBeans help topic *C/C++/Fortran Development>Debugging C/C++/Fortran Applications with gdb>Using the C/C++/Fortran Call Stack*.

5.17 VIEW THE CALL GRAPH

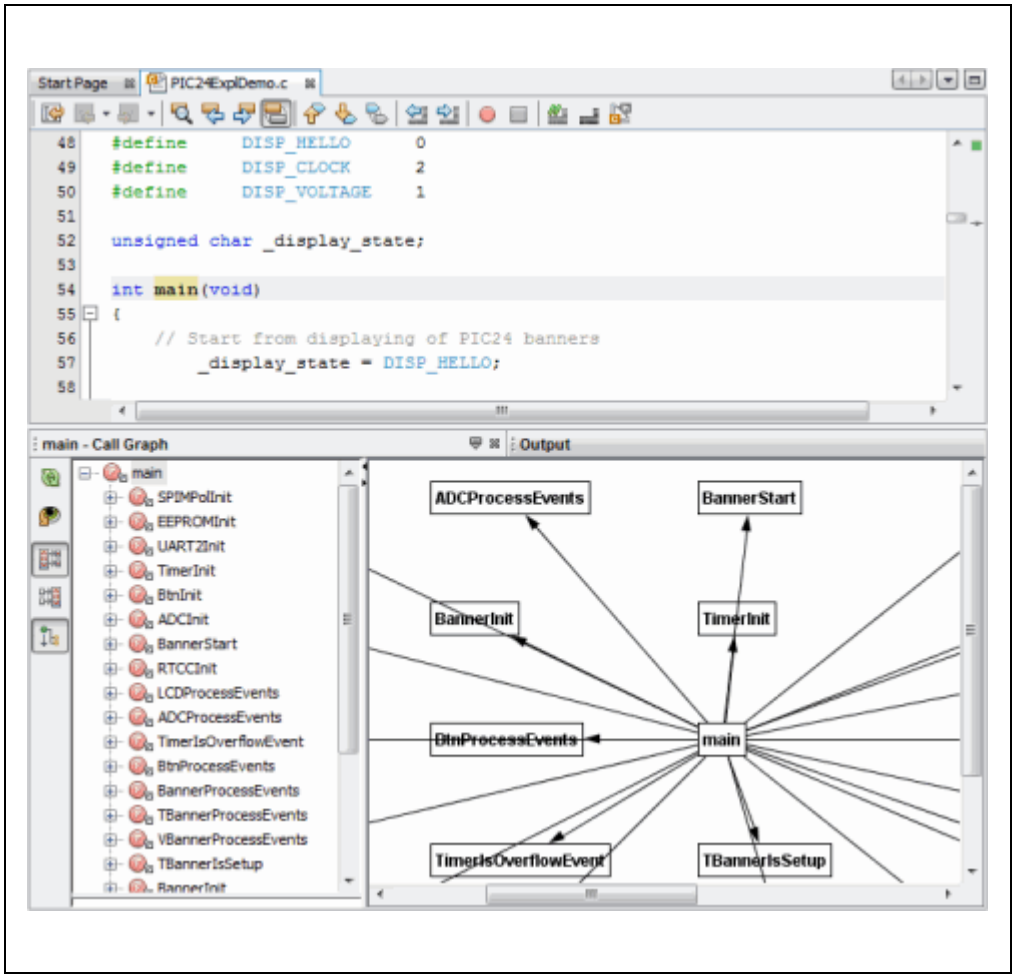
The Call Graph window displays a tree view of either the functions called from a selected function, or the functions that call that function.

To view the call graph:

Right click on a function and select "Show Call Graph" from the drop-down menu.

For more information, see the NetBeans help topic *C/C++/Fortran Development>Working With C/C++/Fortran Projects>Navigating Source Files and Projects>Using the Call Graph*.

FIGURE 5-13: CALL GRAPH OF MAIN FUNCTION



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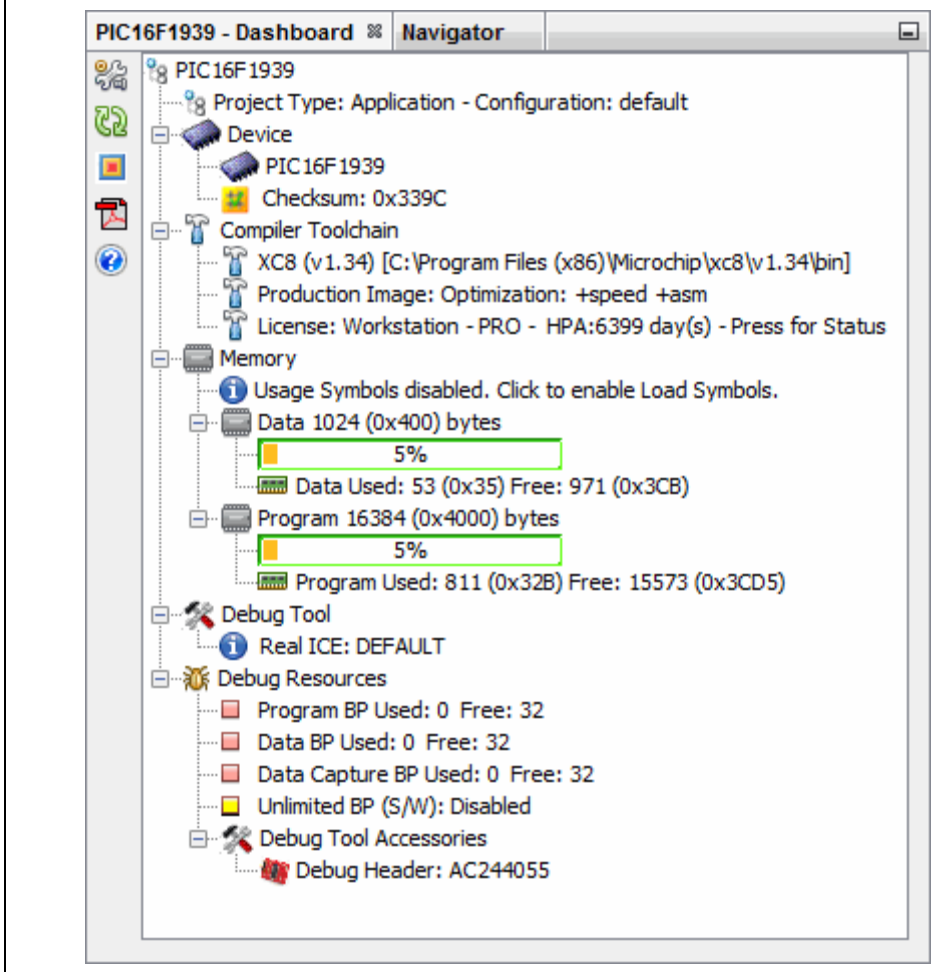
5.18 VIEW THE DASHBOARD DISPLAY

Select *Window>Dashboard* to display project information.

FIGURE 5-14: DASHBOARD DISPLAY



The project displayed will either be:

- The active project in the Projects window, if no main project is selected (*Run>Set Main Project>None*)
  Click on a project in the Projects window to make it active.
- The main project
  No other project, active or inactive, will be displayed.

5.18.1 Dashboard Groups

Dashboard window project information is grouped into specific sections.

TABLE 5-6: DASHBOARD GROUPS

Group	Definition and Content
Project Name	• name of the **active/main project** • **project type** (application or library) and the **project configuration** (default or user-defined)
Device	• project device • any **status flags** generated during a Run or Debug Run • **checksum** of what is loaded into device memory. You must build to see this. Refer to Section 6.10 "Checksums".
Compiler Toolchain	• **project toolchain name** (e.g., XC8), the tool **version number** in ( ) and the **path** to the executable files in [ ]. • **image type** (Production or Debug) and toolchain **optimization** level, which corresponds to license type. For more on optimizations, see your language tool documentation. • information on the **compiler license***: For more on compiler licenses, see: http://www.microchip.com/mplabxc. - license type: Workstation or Network - license mode: FREE, STD or PRO - license seats: total number of seats available - licenses available: the number of licenses available - HPA – days until HPA ends - Expire – days until the license expires - Press for status – See status in Output window * You must have at least MPLAB XC8 v1.34, MPLAB XC16 v1.25, or MPLAB XC23 v1.40 for this to be visible.
Memory	• usage symbols disabled. Click to enable Load Symbols. Click to open Project Properties window, Loading category. Check "Load symbols when programming or building for production (slows process)". • **type of memory** (Data or Project) and the **amount available** on the device. • **Memory Used** should be a guide to the amount of memory remaining. The compilers output a Memory Summary that details usage for Program Space, Configuration Bits, ID location, and EEPROM (if on the device). The sum of these memory spaces, allowing for word sizes, should agree with the Dashboard Program Used. The Map file should be examined when your device has smaller amounts of memory.
Debug Tool	**Hardware Debug Tools** • debug tool **name** and serial number • debug tool **connection**. The connection is only active during a Debug Run, Run, or programming. Otherwise it is inactive. To keep the tool connection active at all times, go to *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Embedded** button, **Generic Settings** tab, and check "Maintain active connection to hardware tool". • click the **Refresh Debug Tool Status** button to see hardware debug tool firmware versions and current voltage levels. **Simulator** • debug tool **name**, i.e., Simulator. • **Click for Simulated Peripherals** to see a list of supported device peripherals.

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TABLE 5-6: DASHBOARD GROUPS (CONTINUED)

Group	Definition and Content
Debug Resources	**Hardware Breakpoints** The number of breakpoints currently being **used** and the number of break-points **free** for the project device. **Software Breakpoints** Whether software breakpoints **supported** on the project device. **Debug Tool Accessories** Which, if any, debug tool accessories are used in this project, such as debug headers?

5.18.2 Dashboard Icons

Icons on the left side of the Dashboard window provide access to functions.

TABLE 5-7: SIDEBAR ICONS

Icon	Function
	**Project Properties** Displays the Project Properties dialog.
	**Refresh Debug Tool Status** Click this to see hardware debug tool details.
	**Toggle Software Breakpoint – Enabled/Disabled** Click to alternately enable or disable software breakpoints. The state of this feature is shown in the icon: Red center: Disabled Green center: Enabled **Black** center: Not supported – when you have exceeded the number of break points available for your device or tool.
	**Open Device Data sheets** Get a device data sheet from the Microchip web site (http://www.microchip.com/). Click to either open a saved, local data sheet or open a browser to go to the Microchip web site to search for a data sheet.
	**Compiler Help** Click to open the Master Index (if available) for documents in the `docs` folder of the compiler installation directory.

5.19 IMPROVE YOUR CODE

Improve your code by using code refactoring and/or profiling.

> **Note:** To see this feature, refer to the **Start Page**, **My MPLAB X IDE** tab, "Extend MPLAB" section, "Selecting Simple or Full-Featured Menus" topic.

Refactoring code is a method of making code simpler without changing its functionality. Currently you can do the following with C code:

- Find function usages throughout files
- Rename functions and parameters throughout files

For more information, see Section 7.7 "C Code Refactoring".

Profiling code is an examination of CPU Usage, Memory Usage, and Thread Usage tools, all observed while the program is running. The profiling tools run automatically whenever you run your C project.

5.20 CONTROL SOURCE CODE

When developing a complex application that consists of many files, especially as part of a team, controlling source code changes becomes a necessity. MPLAB X IDE provides a built-in method of source file versioning and supports external revision (source or version) control programs.

5.20.1 Local History

MPLAB X IDE has a built-in local file history feature, a benefit of the NetBeans platform. This feature provides built-in versioning support for local projects and files that is similar to conventional version control systems. Available tools include a local DIFF and file restoration.

To see local history for a file, right click on the file in the Project or File window and select *History>Show History*. Any past changes to the file should be listed there.

To revert to a previous version, right click on the file in the Project or File window and select *History>Revert to*. The Revert to dialog opens with any previous versions of the document. Select one and click **OK** to revert to that version.

5.20.2 Revision (Source/Version) Control Systems

Several revision control systems (RCSs) may be used with MPLAB X IDE. Once set up, revision control actions can be accessed through a context menu.

5.20.2.1 SUPPORTED SYSTEMS

Currently supported source/version control systems are:

- Git – http://git-scm.com/
- Subversion – http://subversion.tigris.org/
- Mercurial – http://mercurial.selenic.com/

5.20.2.2 REVISION CONTROL SYSTEM USAGE

To use source/version control:

1. Team menu – select a version control program from the submenus and set up that version control program
2. *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Miscellaneous**, **Versioning** – set up version control options
3. *Window>Versioning* – open version control windows

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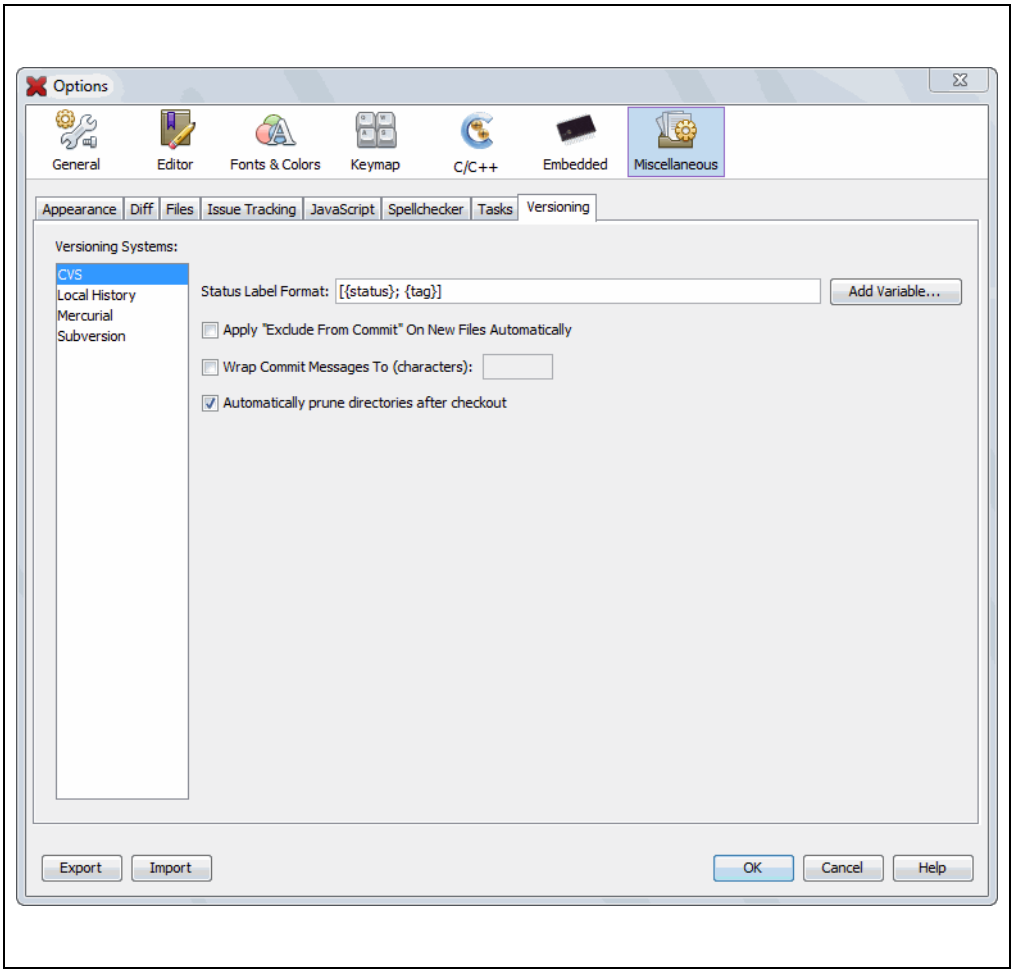
FIGURE 5-15: VERSION CONTROL OPTIONS



5.20.2.3 RESOLVING CONFLICTS IN REVISION CONTROLLED FILES

Inevitably, conflicts will arise between a file you are trying to check in and the same file in the revision system repository that others have modified.

To understand how these issues can be resolved, see the example below.

EXAMPLE 5-1: CONFLICT IN CONFIGURATIONS.XML

To resolve conflicts on the file `configurations.xml`:

1. Conflicts will be announced in:
   a) warning dialogs
   b) the output window
2. Click on the **Files** tab in the Projects window. Expand the `nbproject` folder. Find the file named `configurations.xml`. It should be in red font, signifying conflicts.
3. Right click on `configurations.xml` and select *RCS>Resolve Conflicts*, where RCS is your revision control system This will open the Merge Conflicts Resolver window.
4. The Merge Conflicts Resolver window allows you to fix conflicts. For more information, see the NetBeans help topics under *IDE Basics>Using the IDE Help System>Versioning Applications with Version Control*.

5. After fixing the errors, close the project. If the right click context menu for the project does not work, close the project using *File>Close Project*.
6. Reopen the project. The conflicts should be resolved.

5.20.2.4 PROJECT FILES TO SAVE

There are project files that need to be saved into a repository.

The following table lists project files that either need or do not need to be committed to a version control repository.

TABLE 5-8: PROJECT FILES SAVED TO REPOSITORY

Directory or File(s)	Commit?
Project directory	
`Makefile`	✓
Source files	✓
build directory	✗
dist directory	✗
nbproject directory	
`configurations.xml`	✓
`project.properties`	✓
`project.xml`	✓
`Makefile-*`	✗
`Package-*`	✗
private directory	✗

Green Check: required to generate the project image
Red X: these directories/files are regenerated and therefore do not need to be saved

See Section 8.3 "Files Window View" for more on the project structure.

For more on using local file history and/or source control, see the NetBeans help topics under *IDE Basics>Using the IDE Help System>Versioning Applications with Version Control*.

5.20.2.5 BUILD A PROJECT WITH READ-ONLY FILES

To build a project where files have been checked into a repository and some may then be read only:

1. Commit the minimum number of files to source control. This is explained in Section 5.20.2.4 "Project Files To Save".
2. Make the files `nbproject/configurations.xml` and `nbproject/project.xml` writeable.

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5.21 COLLABORATE ON CODE DEVELOPMENT AND ERROR TRACKING

Collaborate on code development with your group using a team server (such as Kenai.com) supported inside MPLAB X IDE.

> **Note:** To see this feature, refer to the **Start Page**, **My MPLAB X IDE** tab, "Extend MPLAB" section, "Selecting Simple or Full-Featured Menus" topic.

Supporting menu items are:

- *Team* – the main team server menu. Log into your account, create or open your project, share your project, get resources, send a chat message or show your contact list.
- *File>Open Team Project* – open an existing team project.

Collaborate on tracking bugs by using issue tracking systems, namely Bugzilla™ and JIRA® (plug-in required).

Supporting menu items are:

- *Windows>Services* – right click on "Issue Tracker" to add an issue tracker.
- *Team>Find Issues* – In the Issue Tracker window, select the project's issue tracker, select criteria, and click Search.
- *Team>Report Issues* – in the Issue Tracker window, select the project's issue tracker, specify the issue details, and click Submit.

For more on team projects and issue tracking, see the NetBeans help topics under *IDE Basics>Using the IDE Help System>Working in a Collaborative Environment*.

To find out more about these tools, see the following:

- Kenai – http://kenai.com/
- Bugzilla – http://www.bugzilla.org/
- JIRA – http://www.atlassian.com/software/jira/

5.22 ADD PLUG-IN TOOLS

MPLAB X IDE plug-in tools, like DMCI, are available from either the Plugin Manager in the IDE or the Embedded Code Source web site.

- Add Plug-Ins from the Plugin Manager
- Add Plug-Ins from Embedded Code Source
- Upgrade Plug-Ins
- Configure Update Centers
- Plug-In Code Location

5.22.1 Add Plug-Ins from the Plugin Manager

To view and install available plugins:

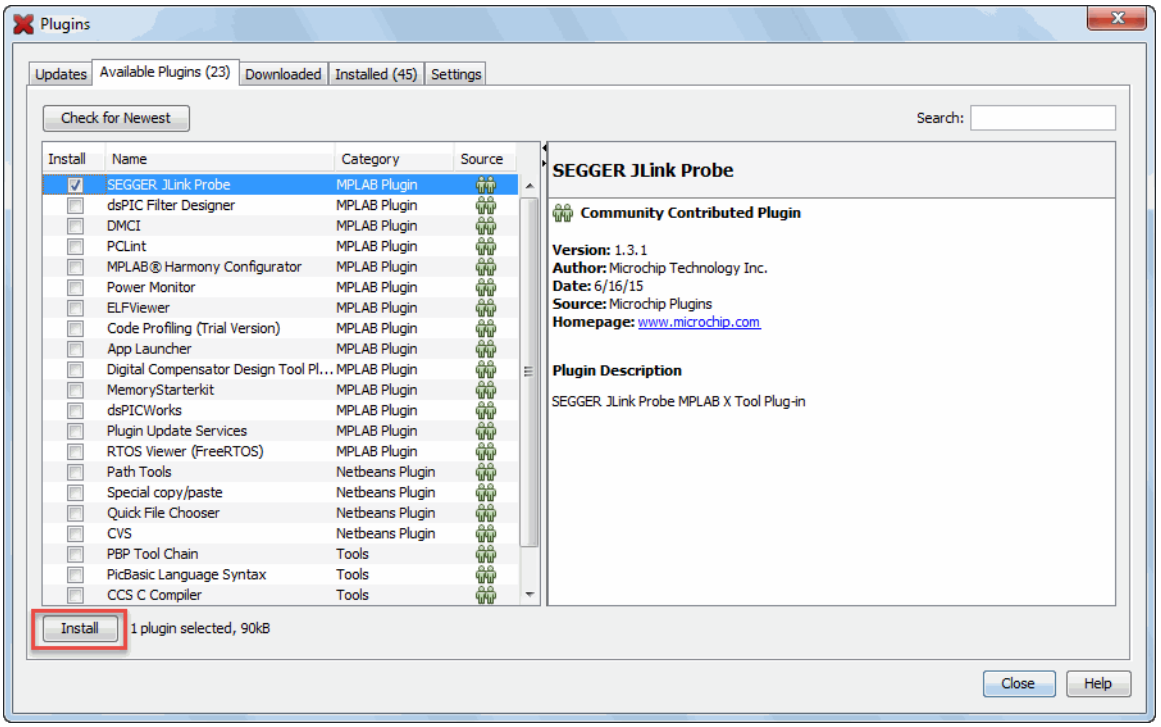
1. In MPLAB X IDE, select *Tools>Plugins* and click on the **Available Plugins** tab.
2. Select your plug-in by checking its checkbox and then click **Install** (Figure 5-16).
3. Follow the on-screen instructions to download and install your plug-in.

> **Note:** Some plugins may be dependent on the modules in other plugins for their functionality to be implemented. The Plugins Manager warns you when this is the case.

4. Once installed, the plugin will be listed under the **Installed** tab, where it can be deactivated, reactivated or uninstalled.
5. Look for your tool under *Tools>Embedded*. If you do not see it, you may need to close and re-open MPLAB X IDE.

Click the **Help** button to read more about installing plug-ins.

FIGURE 5-16: AVAILABLE MICROCHIP PLUG-IN TOOLS



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5.22.2 Add Plug-Ins from Embedded Code Source

To view, download and install available plugins:

1. Go to the Embedded Code Source web site: http://www.embeddedcodesource.com/category/mplab-x-plugins
2. Select a plugin and follow the instructions on the web site to download to a folder on your computer.
3. Extract the `.nbm` file from the downloaded ZIP file.
4. In MPLAB X IDE, select *Tools>Plugins* and click on the **Downloaded** tab.
5. Click **Add Plugins**. Find and select the `.nbm` file and **Open** it (Figure 5-17).
6. Click **Install** to install the plugin. Ensure that the checkbox next to the plugin name is checked (Figure 5-18).
7. Follow the on-screen instructions to download and install your plug-in.

> **Note:** Some plugins may be dependent on modules in other plugins in order for the functionality to be implemented. The Plugins Manager warns you when this is the case.

8. Once installed, the plugin will be listed under the **Installed** tab, where it can be deactivated, reactivated or uninstalled.
9. Look for your tool under *Tools>Embedded*. If you do not see it, you may need to close and re-open MPLAB X IDE.

FIGURE 5-17: DOWNLOADED MICROCHIP PLUG-IN TOOLS

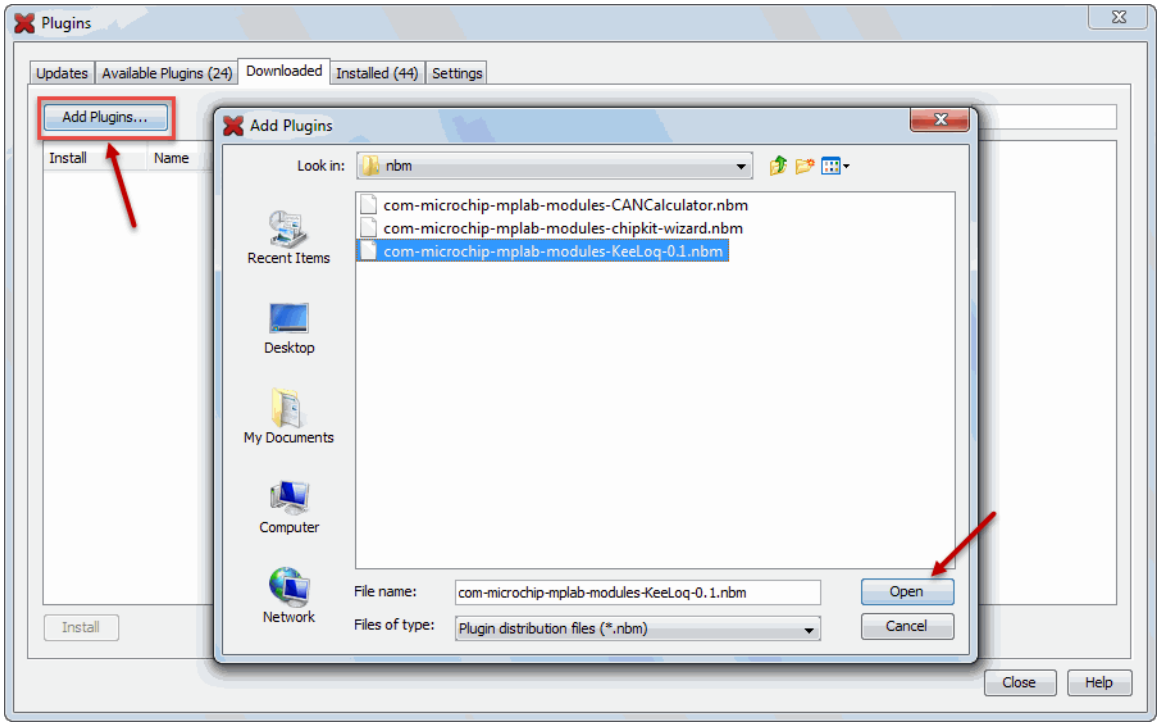
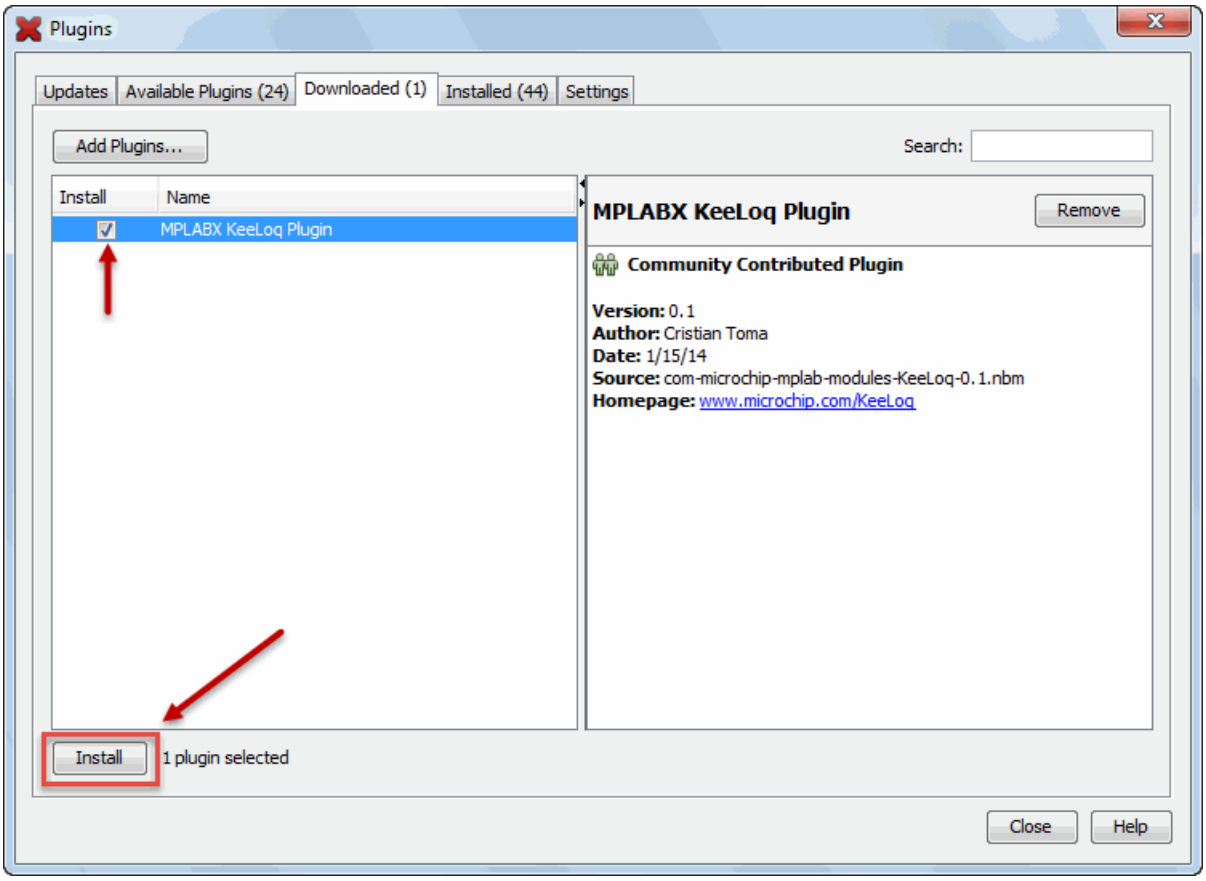


FIGURE 5-18: INSTALL DOWNLOADED MICROCHIP PLUG-IN TOOLS



5.22.3 Upgrade Plug-Ins

To determine if there is an update for your plugin:

1. In MPLAB X IDE, select *Tools>Plugins* and click on the **Updates** tab.
2. Click **Check for Updates**.
3. If any updates appear, ensure that the checkbox next to the plugin name is checked and then click **Update**.
4. Follow the on-screen instructions to update your plug-in.

Installing a new version of MPLAB X IDE will NOT update your installed plug-ins. Plug-ins are tested against a versioned interface of a release. Not all plug-ins can be migrated between versions so they are not carried over. This is true for NetBeans, also. So, you may need to reinstall your plugins when you install a new version of MPLAB X IDE.

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5.22.4 Configure Update Centers

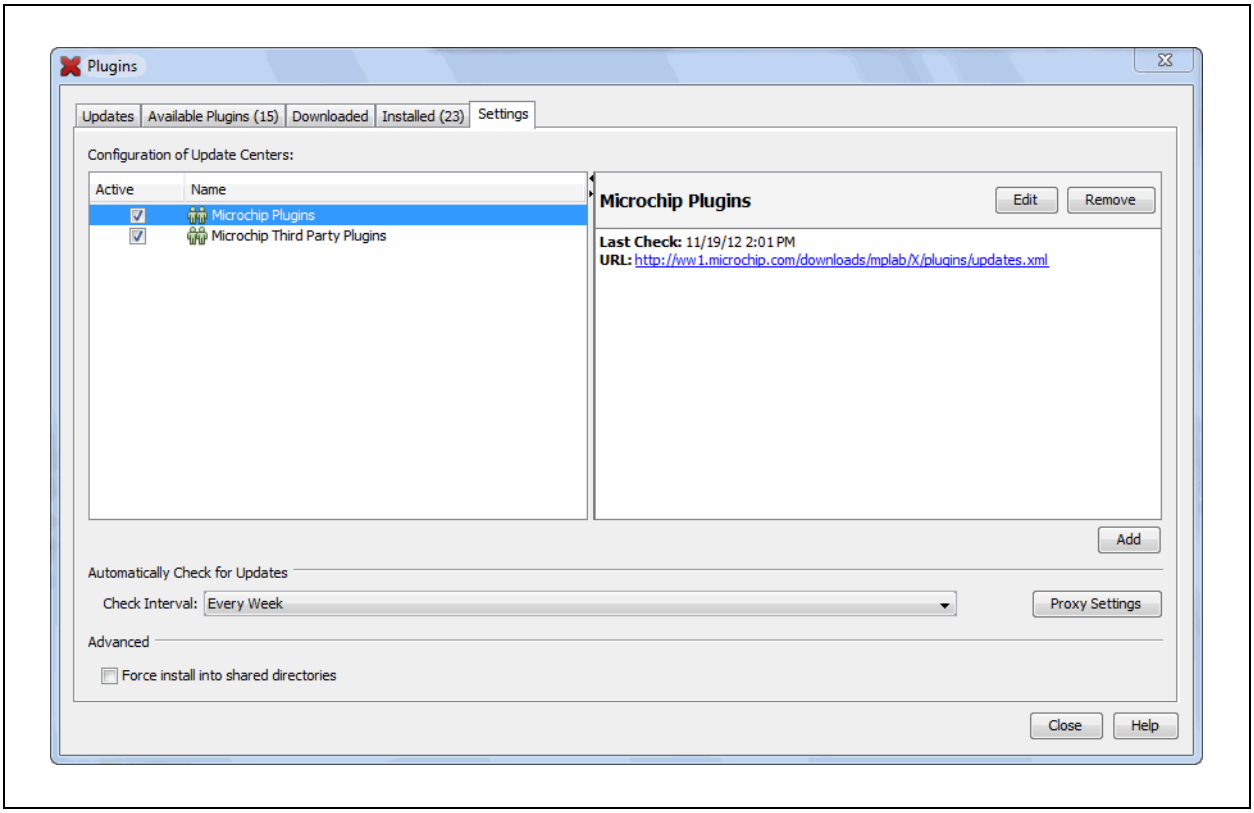
To see available plugins in the Plugins window, you must have one or more update centers configured. MPLAB X IDE comes with two Microchip Update Centers already configured:

- http://ww1.microchip.com/downloads/mplab/X/plugins/updates.xml
- http://ww1.microchip.com/downloads/mplab/X/thirdpartyplugins/updates.xml

To configure another Update Center in the Plugin Manager:

1. Select *Tools>Plugins* and click the **Settings** tab.
2. Click the **Add** button to open the Update Center Customizer dialog.
3. Enter a name for the update center.
4. Enter a URL for the update center.
5. Click **OK**.

FIGURE 5-19: CONFIGURE MICROCHIP UPDATE CENTER



5.22.5 Plug-In Code Location

Plug-In code is stored with MPLAB X IDE user configuration data. See Section 8.7 “Viewing User Configuration Data”.

NOTES:

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Chapter 6. Advanced Tasks & Concepts

6.1 INTRODUCTION

This chapter provides a guide for performing advanced tasks in MPLAB X IDE. Other features are discussed in **Chapter 4. "Basic Tasks"** and **Chapter 5. "Additional Tasks"**.

Tasks

- Speed Up MPLAB X IDE
- Work with Multiple Projects
- Work with Multiple Configurations
- Create User Makefile Projects
- Package an MPLAB X IDE Project
- Work with Third-Party Hardware Tools
- Log Data
- Customize Toolbars

Concepts

- Checksums
- Configurations

6.2 SPEED UP MPLAB X IDE

If MPLAB X IDE is operating too slowly, consider the following:

- Increase the Computer Heap
- Debug Tool Usage

6.2.1 Increase the Computer Heap

You can modify the amount of memory allocated to MPLAB X IDE in the file `mplab_ide.conf`. We recommend you back up this file before you start editing it. If you change the contents of this file, the changes will be operative the next time you run MPLAB X IDE.

Windows OS 64 Bit

`C:\Program Files (x86)\Microchip\MPLABX\vx.xx\mplab_ide\etc`

Windows OS 32 Bit

`C:\Program Files\Microchip\MPLABX\vx.xx\mplab_ide\etc`

Linux OS

`/opt/microchip/mplabx/vx.xx/mplab_ide/etc`

Mac OS X

`/Applications/microchip/mplabx/vx.xx/Contents/Resources/mplab_ide/etc`

where `vx.xx` is the MPLAB X IDE version.

The following line contains the default values:

```
default_options="-J-Dnb.FileChooser.useShellFolders=false
-J-Dcrownking.stream.verbosity=very-quiet -J-Xms256m -J-Xmx512m
-J-XX:PermSize=128m -J-XX:MaxPermSize=384m -J-XX:+UseConcMarkSweepGC
-J-XX:+CMSClassUnloadingEnabled"
```

The bolded areas are:

-Xms256m tells the JVM to start with at least 256 MB for the heap.

-Xmx512m tells the JVM to allocate as much as 512 MB for the heap, but no more.

-XX:PermSize=128m tells the JVM to allocates 128 MB for space needed to keep track of additional data that does not go on the heap.

-XX:MaxPermSize=384m tells the JVM to allocate no more than 384 MB for the additional data that does not go on the heap.

You should not need to modify the PermSize or the MaxPermSize unless you get the error `java.lang.OutOfMemoryError: PermGen space`.

In general, the most important area is `-Xmx512m`; this limits the maximum amount of heap that MPLAB X IDE will use. It might seem that having a large amount of heap could be helpful. However, memory used for MPLAB X IDE means less memory for other applications and system functions.

You can monitor how much memory the IDE is using by enabling the Memory monitor. Either right click on an empty space in the toolbar area and select memory, or select *View>Toolbars>Memory*.

The upper number will not go above 512 MB unless you change the value in `mplab_ide.conf`. It is recommended that you change the `-Xmx512m` setting in 128 MB increments. If you have a lot of memory, you can increase it by more than 128 MB, but make sure you leave enough memory for the rest of the system.

6.2.2 Debug Tool Usage

If using debug tools slows down MPLAB X IDE, try the following:

- Only display windows you need to view. The MPLAB X IDE debugger will examine each open window when a debug tool is used.
- Reduce updates in the Stack window during debug stepping. In the *Tools>Options* window, **Embedded** button, **Generic Settings** tab, check "Disable auto refresh for call stack view during debug sessions" and "On mouse-over structure and array expressions, evaluate integral members only".

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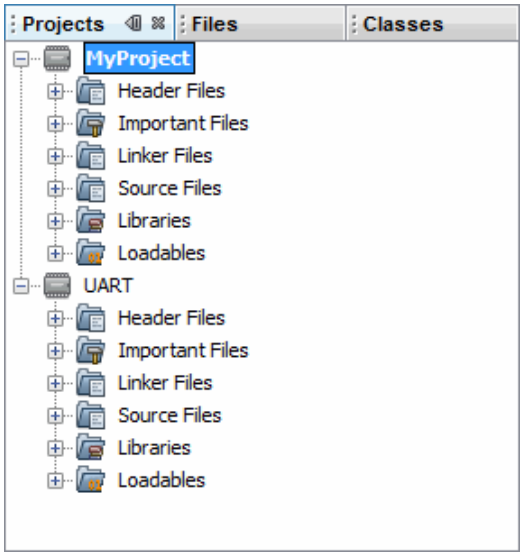
6.3 WORK WITH MULTIPLE PROJECTS

MPLAB X IDE allows you to work with more than one project.

Multiple projects can be opened in MPLAB X IDE and viewed in the Projects window. For more about this window, see Section 12.13 “Projects Window”.

FIGURE 6-1: MULTIPLE PROJECTS IN THE PROJECTS WINDOW



Active Projects

Projects may be made active by clicking on them in the Projects window.

You can also work without setting an active project. In that case the IDE will know which project you are working on by context, i.e., if you set the editor focus on a file, then the project that owns that file will become the project that receives the actions, e.g., when you press the **Debug Run** button.

Main Project

A single project can be selected as the main project by doing one of the following:

- right clicking the project name and selecting “Set as Main Project”.
- selecting *Run>Set Main Project*.

The main project name will then appear in **bold**.

It is your choice whether to explicitly make a project the ‘main’ project, or you use the editor focus to select the main project.

If you have set a main project and wish to remove it, do the following:

1. Right click in an empty area of the Projects view.
2. Use “Set Main Project” to change the active project or to select no active project.

To work with multiple projects:

1. Create (*File>New Project*) or open (*File>Open Project*) two or three projects.
2. Start debugging each project, i.e., click on a project in the Projects window and then select *Debug>Debug Project*.
3. Open the Sessions window (*Window>Debugging>Sessions*) and you can switch between any currently running debug sessions.

When one debug session is switched to another, the Watches window and variables plus the memory will switch to show the currently selected project being debugged. The Status bits should also follow the debug project. The Dashboard will follow the last selected whether it is a debug project or a project in the project window. This is by design.

To group multiple projects:

Another way to work with multiple projects is in groups. Select *File>Project Group* and pick or create a project group.

For more on creating project groups, see the NetBeans help topic Project Group: Create New Group Dialog Box.

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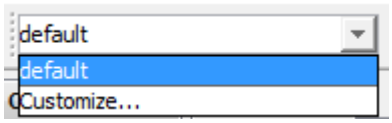
6.4 WORK WITH MULTIPLE CONFIGURATIONS

MPLAB X IDE allows multiple build configurations for the same project. This may be useful for code that can be compiled on multiple platforms (such as the Microchip Application Libraries Demo Projects.)

When you create a new project, a “default” configuration is created. To create your own configuration, start by doing one of the following:

- Use the drop down menu on the toolbar and select “Customize” (Figure 6-2). The Project Properties dialog will open.
- Open the Project Properties dialog by right clicking on the project name and selecting “Properties”.

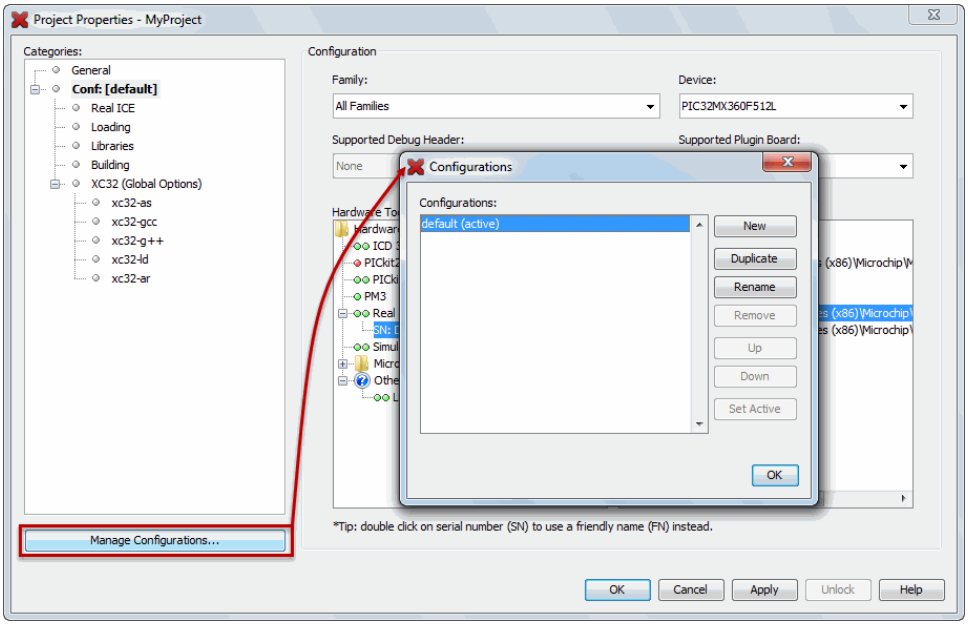
FIGURE 6-2: PROJECT CONFIGURATION DROP-DOWN BOX



In the Project Properties dialog, click **Manage Configurations** to open the Configurations dialog. Existing configurations can be renamed or a new configuration can be added or duplicated from an existing one.

When more than one configuration is created for a project, the active one can be selected from **Manage Configurations** or from the drop-down menu.

FIGURE 6-3: PROJECT PROPERTIES – CONFIGURATIONS DIALOG

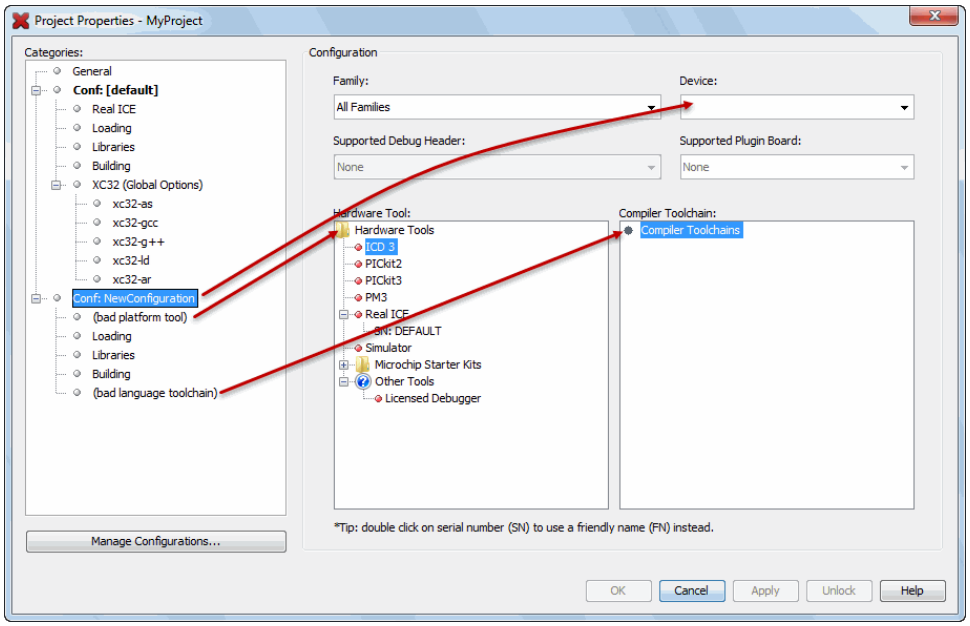


6.4.1 Add a New Configuration

If a new configuration is added, some items must be assigned in the Project Properties dialog.

- Device – You must select this first to see the hardware tool and compiler support.
- Hardware Tool
- Compiler Toolchain

FIGURE 6-4: NEW CONFIGURATION



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6.4.2 Add a Duplicate Configuration

You can add a configuration that is the duplicate of an existing one, and then make edits to that.

One reason to make a duplicate configuration is to create your own debug configuration. Although MPLAB X IDE provides debug macros for use with Microchip tools (Section 4.17.2 “Debug Macros Generated”), you may want to use your own debug macros or you may want to set up the same debug capabilities with third-party tools.

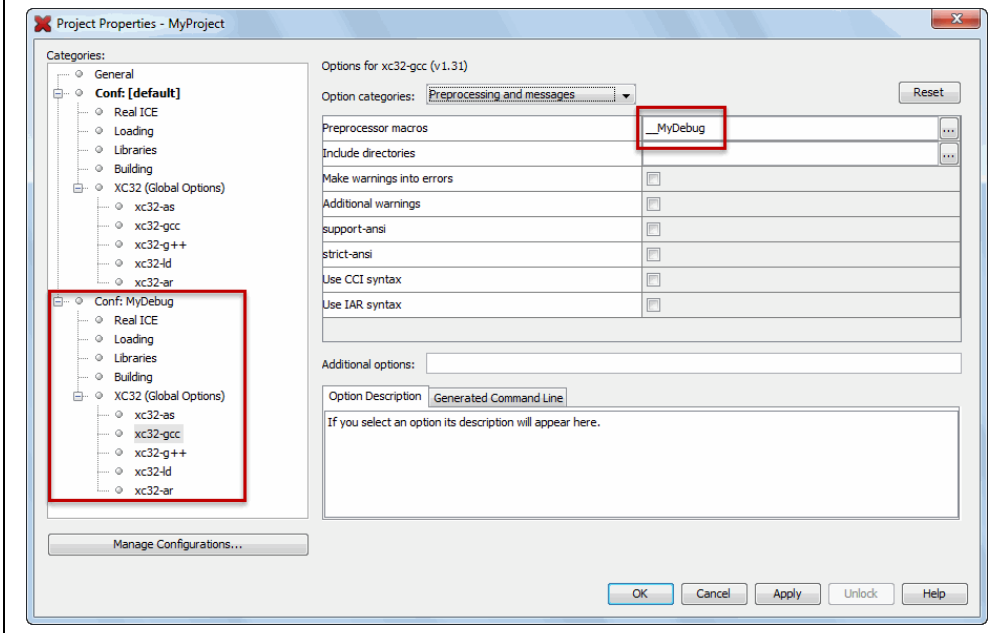
To set up a **debug configuration**:

1. In the Configuration dialog, select a project configuration and click **Duplicate**.
2. Click **Rename** and enter a name in the New Configuration Name dialog, such as “MyDebug”.
3. Click **OK** twice to return to the Project Properties dialog. The Debug configuration (Conf: MyDebug) should now be visible.
4. Click on the compiler in the toolchain. Under the “Preprocessing and messages” options category, locate the option that allows you to define a macro and click on the associated text box.
5. In the pop-up dialog, enter a macro name, such as `__MyDebug`, and click **OK**.

You can now switch to the Debug configuration when you want to debug. You can use the preprocessor macro in conditional text:

```
#ifdef __MyDebug
  fprintf(stderr,"This is a debugging message\n");
#endif
```

FIGURE 6-5: DEBUG CONFIGURATION



6.5 CREATE USER MAKEFILE PROJECTS

Create a project that makes use of an external makefile. This is useful if you have a project that was built outside of MPLAB X IDE, but now you want to use MPLAB X IDE to do debugging.

To create the makefile project, use the New Project wizard.

6.5.1 New Project Setup

To open the New Project wizard, do one of the following:

- On the **Start Page**, click on the **Learn & Discover** tab, "Dive In" section, "Create New Project" link.
- *File>New Project* (or Ctrl+Shift+N)

A wizard will launch to guide you through new project setup.

- **Step 1. Choose Project:** Select the "Microchip Embedded" category and choose from the project type "User Makefile Project".
- **Step 2. Select Device:** Select the device used in your project from the "Device" drop-down list. To narrow your selection list, choose a Family first.
- **Step 3. Select Header:** This step will appear if a header is available for your selected device. To determine if a header is required for debug or if your device has on-board debug circuitry, consult the *Processor Extension Pak and Debug Header Specification* (DS51292) or *Emulation Extension Pak and Emulation Header User's Guide* (DS50002243) or online help file for both documents. Then choose whether or not to use a header.
- **Step 4. Select Tool:** Select the development tool you will be using to debug your application from the list.
  The level of tool support for the selected device will be displayed next to the tool name. That is, green for full support, yellow for beta support and red for no support, yet.
- **Step 5. Select Plugin Board:** This step will appear if a plugin board is available for your selected device. Drop down the list under "Supported Plugin Board" to see what it available.
- **Step 6. Select Project Name and Folder:** Select a name and location for your new project.
- **Step 7. Create User Makefile Project:** Enter data to set up your makefile project.

TABLE 6-1: SELECT PROJECT NAME AND FOLDER OPTIONS

Item	Description
Project Name	Specify a name for your project
Project Location	Enter or browse to a location for your project.
Project Folder	View the folder location based on the Project Name and Project Location. For information on the relation of the project folder to the working folder, see Section 6.5.2 "User Makefile Project Folder and Working Folder".
Set as main project	Set project created as the main project. Checked by default.
Use project location as project folder	Create the project in the same folder as the project location. This is useful if you are importing an MPLAB IDE v8 project and want to maintain the same folder for your MPLAB X IDE project (as when you want the build to be the same.) MPLAB X IDE uses a folder to store a project information whereas MPLAB IDE v8 uses an `.mcp` file. Therefore you can only have one MPLAB X IDE project share a folder with an MPLAB IDE v8 project (`.mcp` file).
Encoding	By default set as ISO-8859-1. There is usually no need to change this.

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TABLE 6-2: CREATE USER MAKEFILE PROJECT OPTIONS

Item	Description
Working Directory	Specify the location of the external project. This is the default location from where the build, debug build, and clean commands will be executed. For information on the relation of the project folder to the working folder, see Section 6.5.2 “User Makefile Project Folder and Working Folder”. Browsing to the directory is recommended as this will take care of formatting issues for you*.
Build command	When the command to Run is requested in MPLAB X IDE (icon or menu), perform the build according to this command instead. Build path*: For Windows, use quotes. For Linux or Mac OS, any spaces must be escaped.
Debug build command	When the command to Debug Run is requested in MPLAB X IDE (icon or menu), perform the debug build according to this command, instead. Debug build path*: For Windows, use quotes. For Linux or Mac OS, any spaces must be escaped. Also see: Section B.2 “Compiling for Debug Outside of MPLAB X IDE”.
Clean command	When the command to Clean is requested in MPLAB X IDE (icon or menu), perform the clean according to this command, instead. Clean path*: For Windows, use quotes. For Linux or Mac OS, any spaces must be escaped.
Image name	Enter the path and name of the production image file (hex). Image path*: Any spaces must be escaped.
Debug image name	Enter the path and name of the debug image file (elf or cof). Debug image path*: Any spaces must be escaped.
User Include Paths	Enter* or browse to the include file(s).
User Macros	Add or parse-and-add macros. **Edit**: Enter a macro or browse to a file containing one. **Parse**: Automatically parse a macro (MPLAB XC compilers only). Follow the instructions on the dialog. Once complete, choose to Replace any current macro(s) listed or Append to any current list of macros.

*** Instructions for General Data Entry:**

- Forward (/) slashes are recommended in your path. However, you may use backward (\) slashes instead.
- A path and file name without spaces is recommended. However, if you do have spaces, use escape spaces (backward slash before the space) when you enter a path and file name in this window. GNU Make is known to cause weird issues with spaces as spaces are their separators.

The new project will open in the Projects window.

Change Makefile project settings in the Project Properties window, “Makefile” category, after the project is created.

For information on exporting a project as hex, see Section 12.13.2 “Projects Window – Project Menu”.

6.5.2 User Makefile Project Folder and Working Folder

The project folder contains its own `Makefile` and `nbproject/Makefiles`. MPLAB X IDE will run the makefile in the project folder, and then change to the working folder (directory) and run the "Build command" or "Debug build command". In effect, GNU Make is run; and, then, whatever is specified as a build command is run.

The project folder may be located anywhere, with relation to the working folder, if absolute paths are used to define locations. However, this will make your project less portable. Make the working folder relative to the project folder (e.g., one level below the project folder) for your project to be more portable.

6.5.3 Example of a Makefile Project

This example shows how to create a user makefile project in MPLAB X IDE that will run either a batch file or make on user code that was created outside of the IDE. The user code consists of a single file `t.c`. The simple code contained in this file is listed below.

EXAMPLE 6-1: t.c CODE

```
#include <xc.h>

int main(void) {
  while(1) {
  }
  return 0;
}
```

For production the code is linked into `t_production.hex` and for debug the code is linked into `t_debug.elf`.

For this example, `t.c`, the batch file `makeme.bat` and the user makefile `Makefile` are assumed to be in the (Windows OS) directory:

`C:\Users\MCHP\MPLABXProjects\makestuff\myOwnCodeWithItsOwnMakefile`

Substitute your *`UserName`* for `MCHP` to recreate the example on your PC.

- User Makefile Project – Create Code From a Batch File
- User Makefile Project – Create Code From User Makefile
- User Makefile Project – Complete

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6.5.3.1 USER MAKEFILE PROJECT – CREATE CODE FROM A BATCH FILE

To compile the code, the simple batch file `makeme.bat` takes as arguments `production`, `debug` or `clean`. If `production` is passed then `t_production.hex` is built. If `debug` is passed then `t_debug.elf` is built. If `clean` is passed, then the `.elf` and `.hex` files are erased.

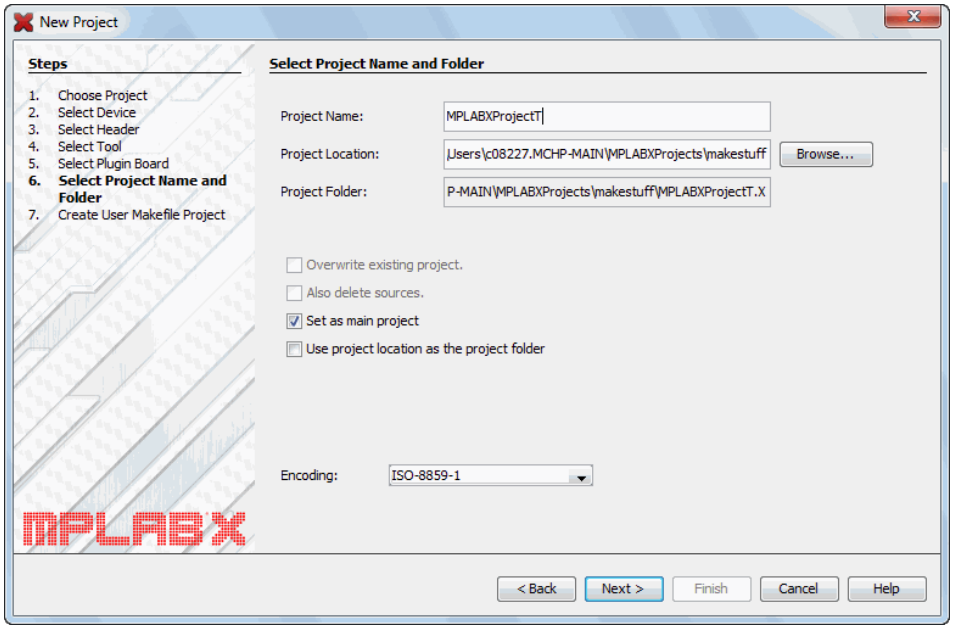
EXAMPLE 6-2: makeme.bat CODE

```
::assumes xc32-gcc and xc32-bin2hex are on the path
rem @echo off
set COMPILER=xc32-gcc
set BIN2HEX=xc32-bin2hex
set PROCESSOR=32MX360F512L

if "%1" == "production" goto production

if "%1" == "clean" goto clean

:debug
%COMPILER% -mprocessor=%PROCESSOR% -g -D_DEBUG -o t_debug.elf t.c
goto end

:production
%COMPILER%  -mprocessor=%PROCESSOR% -o t_production.elf t.c
%BIN2HEX% t_production.elf
goto end

:clean
del /F *.elf
del /F *.hex
goto end


:end
```

To create a new user makefile project in MPLAB X IDE, follow the steps in Section 6.5.1 "New Project Setup":

- **Step 1. Choose Project:** Select "Microchip Embedded", "User Makefile Project".
- **Step 2. Select Device:** Select PIC32MX360F512L as the device.
- **Step 3. Select Header:** None available for this device.
- **Step 4. Select Tool:** Select the hardware tool by SN or the Simulator. For this example, the Simulator was used.
- **Step 5. Select Plugin Board:** None used for this example.
- **Step 6. Select Project Name and Folder:** For this example, the Project Folder will be a sibling to `myOwnCodeWithItsOwnMakefile`. Therefore the Project Location will be: `C:\Users\MCHP\MPLABXProjects\makestuff`, The Project Name is `MPLABXProjectT`.

FIGURE 6-6: USER MAKEFILE PROJECT – SELECT PROJECT NAME AND FOLDER



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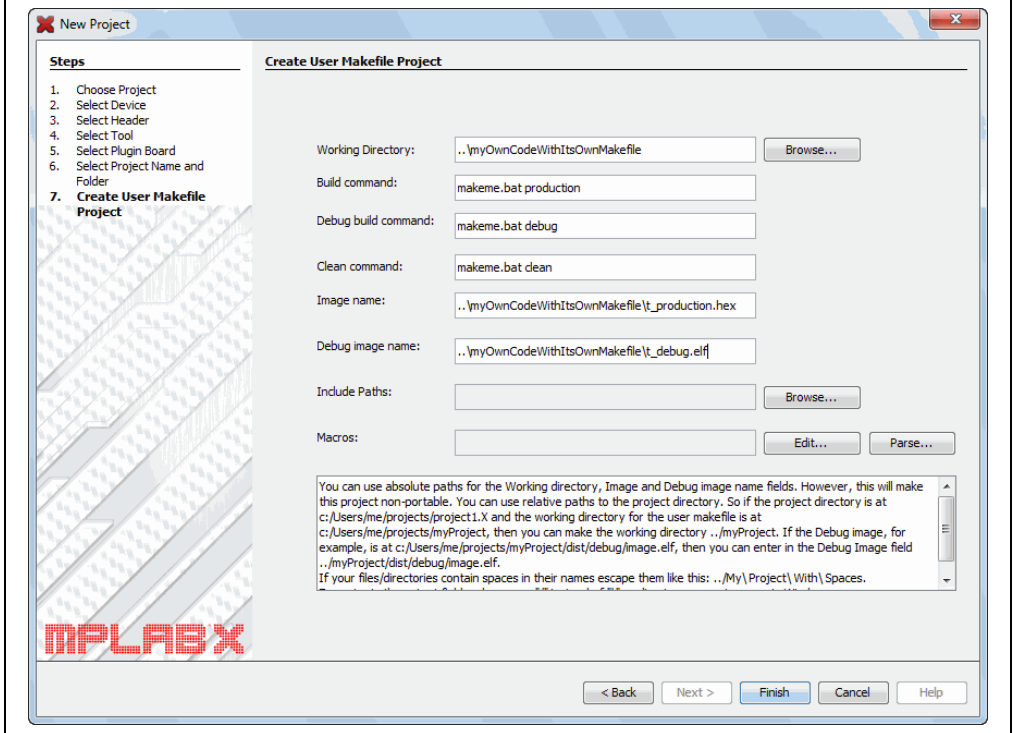
- **Step 7. Create User Makefile Project:** Enter information to set up your makefile project.

  The Working Directory is where the batch file build, debug build and clean commands will be run. This directory could be set as the absolute path:
  `C:\Users\MCHP\MPLABXProjects\makestuff\myOwnCodeWithItsOwnMakefile`.
  Doing this, however, makes the MPLAB X IDE project less portable. Therefore the Working Directory, Image name and the Debug image name will be entered as relative paths with respect to the MPLAB X IDE project directory.

  Click **Finish** to create the project.

FIGURE 6-7: USER MAKEFILE PROJECT – CREATE FROM BATCH



6.5.3.2 USER MAKEFILE PROJECT – CREATE CODE FROM USER MAKEFILE

To compile the code, the simple user makefile `Makefile` takes as arguments `production`, `debug` or `clean`. If `production` is passed then `t_production.hex` is built. If `debug` is passed then `t_debug.elf` is built. If `clean` is passed then the `.elf` and `.hex` files are erased.

EXAMPLE 6-3: USER MAKEFILE CODE

```
# Assumes xc32gcc and xc32bin2hex are on the path
COMPILER=xc32gcc
BIN2HEX=xc32bin2hex
PROCESSOR=32MX795F512L

production: t_production.hex
debug: t_debug.elf

t_debug.elf: t.c
    $(COMPILER) mprocessor=$(PROCESSOR) -g -D_DEBUG -o t_debug.elf
t.c

t_production.hex: t_production.elf
    $(BIN2HEX) t_production.elf

t_production.elf: t.c
    $(COMPILER) mprocessor=$(PROCESSOR) o t_production.elf t.c

clean:
    del /F *.hex
    del /F *.elf
```

To create a new user makefile project in MPLAB X IDE, follow steps 1-6 from Section 6.5.3.1 "User Makefile Project – Create Code From a Batch File". For Step 7, set up as per Figure 6-8.

The Working Directory is where the user Makefile build, debug build and clean commands will be run. The Working Directory, Image name and the Debug image name are entered as relative paths with respect to the MPLAB X IDE project directory.

MPLAB X IDE uses GNU Make to build, debug build and clean. As per Section 6.5.2 "User Makefile Project Folder and Working Folder", MPLAB X IDE will run the Makefile in the project folder, which will change directories to the working folder. There, make will look for a makefile and find the user-defined Makefile, which will define how to build, debug build, and clean.

> **Note:** Another way to define commands, for example the Build command, would be to use the `-f` option to specify the user makefile, as in: `make -f Makefile production`.

Click **Finish** to create the project.

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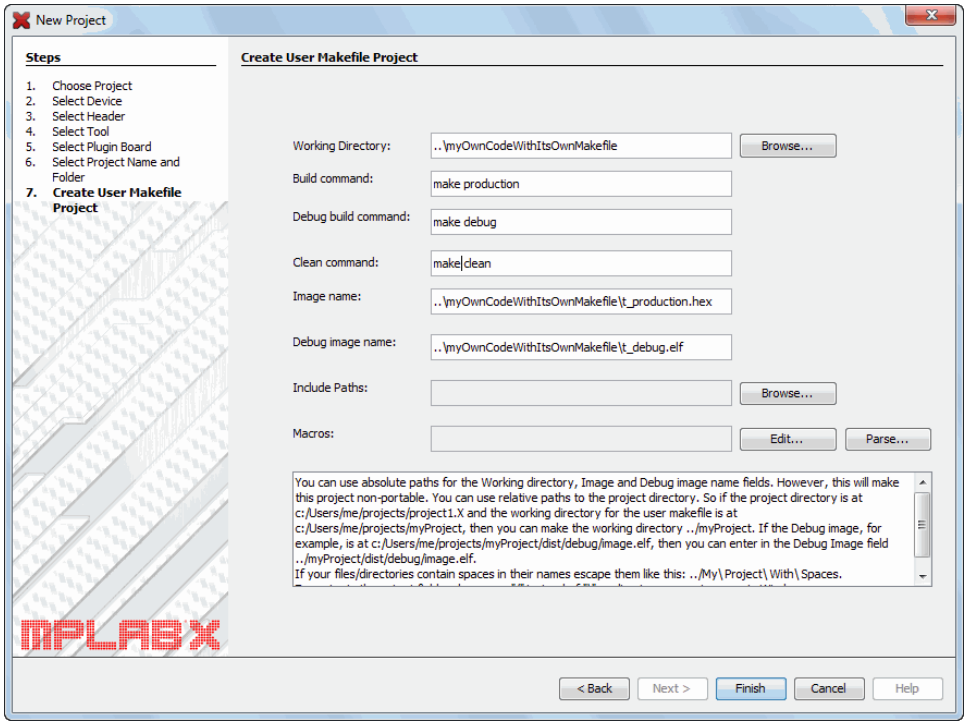
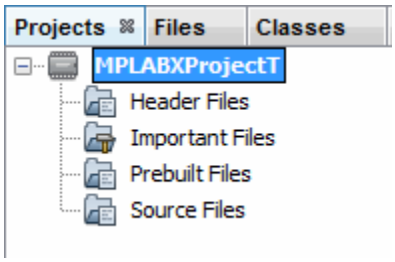
FIGURE 6-8: USER MAKEFILE PROJECT – CREATE FROM MAKEFILE



6.5.3.3 USER MAKEFILE PROJECT – COMPLETE

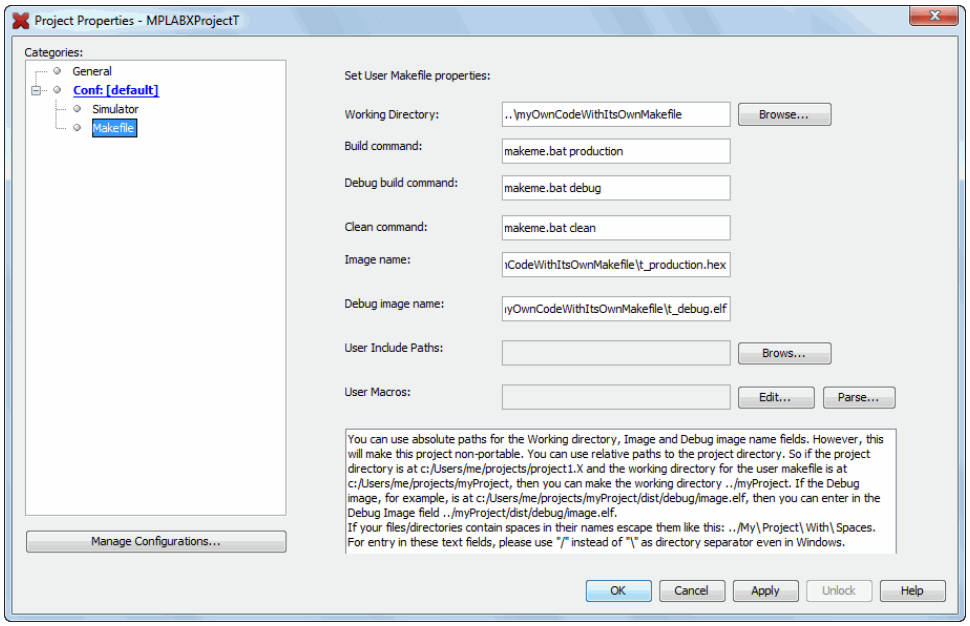
Once the project has been created, you should see the following in the Projects window. You can right click on the project name to build the project.

FIGURE 6-9: USER MAKEFILE PROJECT – PROJECT TREE



If you wish to change settings, right click on the project name and select “Properties”.

FIGURE 6-10: USER MAKEFILE PROJECT – PROJECT PROPERTIES



For this example, the results of build (`t_production.hex`) and debug build (`t_debug.elf`) are found in the `myOwnCodeWithItsOwnMakefile` working directory. As only the `MPLABXProjectT` project directory is visible in MPLAB X IDE, you will not see any changes in the IDE Projects window after a build.

6.6 PACKAGE AN MPLAB X IDE PROJECT

Right click on your project and select Package to package your project into a zip file (.zip) file. While MPLAB X IDE has the ability to zip files up, it cannot unzip them. So a separate program will be required to unzip the project.

To package the project, this feature examines the project file to determine the location of the project files to include. Only files contained in the project folder and those using relative, not absolute, paths will be included.

Items included in the package are the source files, makefile, and nbproject directory.

Header files are not included unless they have been added to the project. Therefore, the unzipped project may not build if any user-generated header files are required.

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6.7 WORK WITH THIRD-PARTY HARDWARE TOOLS

When working with third-party hardware tools, these basic installation requirements apply:

- Acquire and install any related USB drivers for the hardware. USB drivers are usually available from the third-party site, along with installation instructions.
- Install the MPLAB X IDE plugin for this tool. For details, see Section 5.22 “Add Plug-In Tools”.

When installation is complete, you should be able to see and select the hardware tool in the Project Properties dialog (see Section 4.4 “View or Make Changes to Project Properties”).

6.8 LOG DATA

Log files are useful for capturing your program execution and debugging problems.

When you have an MPLAB X IDE error or issue and need to contact technical support (see “Customer Support”), you should capture data in two log files: MPLAB X IDE log file and the NetBeans platform log file.

6.8.1 MPLAB® X IDE Log File

The MPLAB X IDE log file generates data based on the Java Logger class.

To set up a log file:

1. Select *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Embedded** button, **Diagnostics** tab.
2. Select a logging level from the drop-down box. For details, see Section 12.14.6 “Diagnostics Tab”.

   Note: The higher the logging level, the more data is collected, but the slower your application will run.

3. Select a location (path) for the log file.

To log data:

1. Set up the log file using logging level “Finest”.
2. Take note of the log file name and location.
3. Repeat the steps to cause the error or issue.
4. Find the log file(s) and send to technical support.

6.8.2 NetBeans Platform Log File

The NetBeans log file generates information on the executing NetBeans Platform.

To log data:

5. Open the log file the Output window by selecting *View>IDE log*.
6. Right click in the window and select “Clear”.
7. Repeat the steps to cause the error or issue.
8. Right click in the window and select “Save As” to save the text to a file.
9. Send the file to technical support

6.9 CUSTOMIZE TOOLBARS

You can customize MPLAB X IDE toolbars using the Customize Toolbars window. Select *View>Toolbars>Customize* to open the window.

Available icons include Clean Only, Run, Set PC to Cursor, etc.

Add a function to a toolbar:

Drag an icon from the Customize Toolbars window to a toolbar.

Remove a function from a toolbar:

Drag an icon from a toolbar to the Customize Toolbars window.

Add your own toolbar:

Click "New Toolbar" and name the new toolbar.

Change toolbar icon size:

- Click the checkbox "Small Toolbar Icons" to make the icons smaller.
- Uncheck to make the icons larger.

Revert to default toolbar:

Click "Reset Toolbars".

Available functions are shown in the tables below.

TABLE 6-3: BUILD FUNCTIONS

Function	Details
Make	performs a make (builds project files if they have been updated) without cleaning
Make Clean	cleans (remove previously built project files) and makes the project

TABLE 6-4: DEBUG FUNCTIONS

Function	Details
New Data Breakpoint	sets a new data breakpoint at the address
New Run Time Watch	adds the specified symbol to watch that will change value as the program runs/executes
New Watch	enters an expression or select an SFR to watch in the Watches window
PIC AppIO	opens the PIC AppIO window. Your debug tool and device must support Application I/O See your debug tool documentation for details.
Program Device for Debugging Main Project	programs the device from a debug image The program will immediately begin execution on completion of programming.
Disassembly	opens the disassembly window.
Disconnect from Debug Tool	disconnects communications between MPLAB® X IDE and the debug tool To reconnect, select Run/Debug Run.
Focus Cursor at PC	moves the cursor to the current PC address and centers this address in the window
PC Profiling	opens the PC Sampling window See MPLAB REAL ICE in-circuit emulator documentation for more on PC sampling and profiling.
Reset	resets the device.
Set PC at Cursor	sets the program counter (PC) value to the line address of the cursor
Step Instruction	executes one machine instruction. If the instruction is a function call, executes the function and returns control to the caller
Status Toolbar Action	displays the status toolbar
Launch Debugger Main Project	launches the debugger for the main project This is the final step of the discrete build process: Build, Program Target, Launch Debugger.It is useful for changing Memory window setting during debug and using starter kits.

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TABLE 6-4: DEBUG FUNCTIONS (CONTINUED)

Function	Details
Debug Main Project	debugs the main project
New Watch	enters an expression to watch in the Watches window
Attach Debugger	connects communications between MPLAB® X IDE and the debug tool A debug tool is automatically connected during a Run or Debug Run, and disconnected at the end of a run. To keep the debug tool connected at all times, check *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Embedded** button, **General Settings** tab, "Maintain active connection to hardware tool".
Continue	resumes debugging after "Pause" until the next breakpoint or the end of the program is reached.
Debug File	starts debugging session for currently selected file.
Debug Test File	starts debugging test for file in JUnit. (Java related)
Apply Code Changes	apply any changes in the code to the executing program.
Finish Debugger Session	ends the debugging session.
Make Callee Current	makes the method being called the current call Only available when a call is selected in the Call Stack window.
Make Caller Current	makes the calling method the current call Only available when a call is selected in the Call Stack window.
Pause	pauses debugging Use "Continue" to resume.
Run to Cursor	runs the current project to the cursor's location in the file and stops program execution
Step Into	executes one source line of a program If the line is a function call, the program is executed up to the function's first statement and then stops.
Step Over Expression	steps over the expression and then stops the debugging.
Step Out	executes one source line of a program If the line is a function call, the function is executed and control is returned to the caller.
Step Over	executes one source line of a program If the line is a function call, the entire function is executed and then the debugging stops.

TABLE 6-5: EDIT FUNCTIONS

Function	Details
Next Bookmark	cycles forward through the bookmarks
Previous Bookmark	cycles backward through the bookmarks
Clear Document Bookmarks	clears all bookmarks in the document
Quick Search	displays the Quick Search toolbar
Find in Projects	finds specified text, object names, object types within projects
Replace in Projects	replaces text, object names, object types within projects
Copy	copies the current selection to the clipboard
Cut	deletes the current selection and places it on the clipboard
Delete	deletes the current selection
Find	finds a text string
Paste	pastes the contents of the clipboard into the insertion point
Redo	reverses (one at a time) a series of Undo commands
Undo	reverses (one at a time) a series of editor actions, except Save

TABLE 6-6: HELP FUNCTIONS

Function	Details
Start Page	displays the Start Page.
Individual Help Files	displays individual pop-up help files, e.g., MPLAB® X IDE Help
Help	displays the Help window.

TABLE 6-7: PROFILE FUNCTIONS

Function	Details
Start Sampling IDE	begins sampling for PC Profiling/Sampling See MPLAB® REAL ICE™ in-circuit emulator documentation for more on PC sampling and profiling.

TABLE 6-8: PROJECT FUNCTIONS

Function	Details
Programmer to Go PICkit™ 3 Main Project	uses the Programmer to Go feature of PICkit™ 3
Erase Device Memory Main Project	erases device memory for the main project
Hold in Reset	toggles the device between Reset and Run
Make and Program Device Main Project	The main project is built (if necessary) and the device is programmed. The program will immediately begin execution on completion of programming.
Read Device Memory Main Project	transfers what is in target memory to MPLAB® X IDE
Read Device Memory to File	transfers what is in target memory to the specified file
Build Main Project	builds all the files of the main project
Build for Debugging Main Project	builds all the files of the main project for debugging
Clean and Build Main Project	cleans (removes) all generated files and then rebuilds all the files of the main project
Build Project	builds all the files of the selected project
Clean Main Project	cleans (removes) all generated files of the main project
Clean Project	cleans (removes) all generated files of the selected project.
Compile File	compiles the selected file using the project compiler
New File	launches New File wizard
New Project	launches New Project wizard
Open Project	opens an existing project
Clean and Build Project	cleans (removes) all generated files and then rebuilds all the files of the selected project
Run Main Project	The main project is built (if necessary) and the device is programmed. The program will immediately begin execution on completion of programming. Same as "Make and Program Device Main Project".
Run Project	The selected project is built (if necessary) and the device is programmed. The program will immediately begin execution on completion of programming.
Run File	runs the currently selected file
Test Project	starts JUnit test for current project (Java related)
Test File	starts JUnit test for current file (Java related)
Open Required Projects	opens dependent projects
Projects	opens the Projects window
Files	opens the Files window

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TABLE 6-9: CVS* FUNCTIONS

Function	Details
Commit	commits local changes to files into the repository
Diff	shows file revisions between repository versions and your local working copies
Show Annotations	displays commit message, author, date, and revision number information in the left margin of files open in the Source Editor
Revert Modifications	reverts local versions of files to versions stored in the repository
Update	updates local versions of files with changes committed to the repository

* CVS is not included with MPLAB® X IDE and must be acquired separately. For more on CVS, see http://www.nongnu.org/cvs.

TABLE 6-10: SYSTEM FUNCTIONS

Function	Details
Next Error	scrolls the Source Editor to the line that contains the next build error
Previous Error	scrolls the Source Editor to the line that contains the previous build error
Run SQL	runs SQL statements and scripts For more on SQL and data base support, see: • NetBeans Help>IDE Basics>Using the IDE Help System>Working with Web and Application Servers • NetBeans Help>IDE Basics>Using the IDE Help System>Working and Connecting with Databases
SQL History	provides a list of SQL statements that have been previously executed in the SQL Editor
Keep Prior Tabs	toggles keeping SQL results tabs from the previous execution open/closed
Open File	opens the Open dialog
Properties	opens the Project Properties window
Save	saves the current file
Save All	saves all open files. If the “Compile on Save” feature is selected, this will also compile/build project files.

TABLE 6-11: TERMINAL FUNCTIONS

Function	Details
org-netbeans-modules-dlight-terminal-action-LocalTerminal(→)	opens the Terminal window
org-netbeans-modules-dlight-terminal-action-RemoteTerminal(→)	opens the Remote Terminal window

TABLE 6-12: TOOLS FUNCTIONS

Function	Details
Check CVS	select CVS version control items For more on CVS, see http://www.nongnu.org/cvs.

TABLE 6-13: VIEW FUNCTIONS

Function	Details
Web Browser	opens the NetBeans download page in your default browser
IDE Log	shows the same information as *View>IDE Log*
Classes	opens the Classes window
Customize Zoom	customize zoom on data
Zoom In	zoom in on data
Zoom Out	zoom out on data

TABLE 6-14: WINDOW FUNCTIONS

Function	Details
Debug>Breakpoints	opens the Breakpoints window
Debug>Call Stack	opens the Call Stack window
Debug>Variables	opens the Variables window
Debug>Sessions	opens the Sessions window
Debug>Sources	opens the Sources window
Debug>Threads	opens the Threads window This window lists all threads in the current debugging session.
Debug>Watches	opens the Watches window
Select Document In>Select In Favorites	opens Favorites window and selects current document within it
Terminal	opens the Terminal window
Remote Terminal	opens the Remote Terminal window
Terminal (Experimental)	opens the Experimental Terminal window
Stopwatch	opens the Stopwatch window
Trace	opens the Trace window
Disassembly Listing File	opens the disassembly listing file in an editor window
Project Environment	opens the Project Environment (Dashboard) window
Analyzer	opens the Simulator Analyzer window
Stimulus	opens the Simulator Stimulus window
Services	opens the Services window
Output	opens the Output window
Properties	opens the Project Properties window
Call Graph	opens the Call Graph window
Hierarchy View	opens the Include Hierarchy window This lets you inspect all header and source files that are directly or indirectly included in a source file, or all source and header files that directly or indirectly include a header file.
Macro Expansion View	opens the Macro Expansion window This window expands macros in code.
Thread Map	opens the Threads window
Reporter Result	opens the Exception Reporter window for exception breakpoints
Favorites	opens the Favorites window.
Test Results	opens the unit Test Results window for C/C++ projects
Chat	opens a Team Chat window
Team	opens a team project. For more on team server projects See the NetBeans help topic, *IDE Basics>Using the IDE Help System>Working in a Collaborative Environment*.
Navigator	opens the Navigator window
Palette	opens the Palette window (Java related)
Find Usages Results	opens the Find Usages window
Refactoring Preview	opens a Preview window of refactoring results
Search Results	opens the Search window
Tasks	opens the Tasks window

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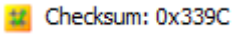
TABLE 6-15: XML FUNCTIONS

Function	Details
Check File	checks an XML file for well-formedness
Check DTD	opens the DTDs and XML Schemas Manager
Validate File	checks an XML file for syntax errors in accordance with an XML schema or DTD
XSL Transform	transform XML document(s) using an XSL stylesheet

6.10 CHECKSUMS

A checksum is a hexadecimal number derived from the application code and other settings of an MCU or DSC. Refer to your device programming specification for details on how the checksum is generated.

A checksum is created when a project is built. You can view the generated checksum in the Dashboard window: Section 5.18 “View the Dashboard Display”



Checksums are used to detect errors between builds. For example, consider a project built on one computer with one checksum. If that project is copied to another computer and built there, an identical checksum means the project was successfully copied while a different checksum means the copying failed.

Care should be taken when developing project code if the checksum is used for error detection. Do not use the compiler macros `__TIME__` or `__DATE__`. Also, do no use the macros `__FILE__` or `assert()` if file paths will change.

For some device, the checksum may be used as the user ID: Section 4.14.3 “Insert checksum in user ID memory”.

6.11 CONFIGURATIONS

The term "configuration" is used in many different contexts. The following table presents the terms, and definitions of them.

TABLE 6-16: CONFIGURATIONS CONTEXT

Term	Definition
Configuration Bits Configuration Fuses Configuration Words Configuration Bytes Configuration Registers	All of these terms refer to the physical section of device memory used to configure the device. See your device data sheet for available configuration settings.
Configuration Bits Window	The MPLAB X IDE window which displays the configuration settings available for the project device. For more on this window, see Section 4.22.4 "Set Configuration Bits".
Project Configuration	Build settings for the project. When a project is created, the configuration is "[default]". This name may be changed and multiple configurations may be created for the project. For more information, see Section 6.4 "Work with Multiple Configurations". This data is stored in the file `configurations.xml`.
Project Configuration Type	Settings for a specific type of project. This applies only to Standalone projects configured as "application" and Library projects configured as "library". For details, see Section 4.14.1 "Change Project Configuration Type".
User Configuration Data	MPLAB X IDE configuration settings created by the user. See Section 8.7 "Viewing User Configuration Data".

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Chapter 7. Editor

7.1 INTRODUCTION

MPLAB X IDE is built upon the NetBeans platform, which provides a built-in editor to create new code or change existing code.

C compiler information regarding the editor is available under the NetBeans help topic *C/C++/Fortran Development>Working with C/C++/Fortran Projects>Editing Source Files in C/C++/Fortran Projects>About Editing C and C++ Files*. MPLAB X IDE Editor features are discussed below.

- Source Editor General Tasks: Quick Reference
- Editor Usage
- Editor Options
- Editor Red Bangs
- Code Folding
- C Code Refactoring

7.2 SOURCE EDITOR GENERAL TASKS: QUICK REFERENCE

This topic describes common tasks for managing the Source Editor window.

TABLE 7-1: EDITOR QUICK REFERENCE

To perform this task	Follow these steps
Open a file that is not available in the Projects window or the Files window.	1. Choose *File>Open File*. 2. In the file chooser, navigate to the file. Then click Open.
Maximize the Source Editor.	Do one of the following: • Double-click a file's tab in the Source Editor. • Make sure that the Source Editor window has focus and then press Shift-Escape. • Choose *Window>Configure Window>Maximize*.
Revert a maximized Source Editor to its previous size.	Do one of the following: • Double-click a file's tab in the Source Editor. • Press Shift-Escape. • Choose *Window>Configure Wnidow>Restore*.
Display line numbers.	Choose *View>Show Line Numbers*.
View two files simultaneously.	1. Open two or more files. 2. Click the tab of one of the files and drag it to the side of the window where you want the file to be placed. When a red preview box appears to show you where the window will be placed, release the mouse button to drop the window. The window can be split horizontally or vertically, depending on where you drag the tab.
Split the view of a single file.	1. Right-click the document's tab in the Source Editor and choose Clone Document. 2. Click the tab of the cloned document and drag it to the part of the window where you want the copy to be placed.
Format code automatically.	Right-click in the Source Editor and choose Format. If any text is selected, only that text will be formatted. If no text is selected, then the whole file is formatted.

7.3 EDITOR USAGE

To begin using the Editor, create or open an existing file using *File>New File* or *File>Open File*, respectively. Additional controls and features are described in the following sections.

7.3.1 Desktop Controls

The following desktop items are associated with the Editor:

- File menu – opens a file in an Editor window (see Section 11.2.1 "File Menu").
- Edit menu – accesses edit commands (see Section 11.2.2 "Edit Menu").
- Editor toolbar – also accesses edit commands – located at the top of each file's Editor window (see Section 11.3.10 "Editor Toolbar").
- Window right-click (context) menu – for additional commands.

7.3.2 Hyperlinks in C Code

Hyperlink navigation lets you jump from the invocation of a function, variable, or constant to its declaration.

To use a hyperlink, do one of the following:

- Mouse over a function, variable, or constant while pressing <Ctrl> (Windows and Linux) or <Command> (Mac). A hyperlink appears, along with a tooltip with information about the element. Click the hyperlink and the editor jumps to the declaration. Press <Alt> + <Left Arrow> to jump back to the invocation.
- Mouse over an identifier and press <Ctrl> + <B> or <Command> + <B>. The editor jumps to the declaration. Press <Alt> + <Left Arrow> to jump back to the invocation.

Press <Alt> + <Left Arrow> and <Alt> + <Right Arrow> to move backward and forward through the history of the cursor position.

Also, see the NetBeans Help topic:

C/C++/Fortran Development>Working with C/C++/Fortran Projects>Navigating Source Files and Projects>Using Hyperlink Navigation

7.3.3 Hyperlinks in ASM Code

To navigate to header files included in assembly source files, press <Ctrl> (Windows and Linux) or <Command> (Mac) while placing the mouse cursor over the file name referenced by a `#include` statement. Then click the mouse select button to open the include file in its own file tab in the editor.

7.3.4 Editor Features of Note

The following table summarizes some of the more frequently-used features of the editor.

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TABLE 7-2: EDITOR FEATURES

Editor Feature	Reference
Unicode is supported.	By default, newly-created projects in the IDE use ISO-8859-1 character encoding. To change this: • Right click the project name in the Projects window and choose Properties. • In the left column under “Categories”, select “General”. • On the bottom of the page, find “Encoding” and change.
Code is colored based on syntax.	*Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Fonts and Colors** button, **Syntax** tab. Based on Encoding set during Project creation.
Errors are flagged as code is typed.	See the Netbeans Help topic: *C/C++/Fortran Development>Working with C/C++/Fortran Projects>Editing Source Files in C/C++/Fortran Projects>Error Highlighting*
Colored markers provide quick access to multiple symbols, errors, etc.	*Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Fonts and Colors** button, **Annotations** tab
Smart code completion makes suggestions and provides hints.	*Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Editor** button, **Code Completion** tab
Assembly and C code may be collapsed and expanded	Section 7.6 “Code Folding”
Right clicking on a function (`delay(x)`) finds usages. This can limit find within a function (e.g., a local `i` variable).	See the Netbeans Help topic: Find Usages dialog
Right clicking on a function (`delay(x)`) shows a call graph The call graph has buttons on the side to switch order, etc.	Section 5.17 “View The Call Graph”
Create comments with keywords (example: `//TODO`) in the source code and action items will be scanned and added automatically to the Action Items window.	See the Netbeans Help topic: Options Window: Team: Action Items
File history is available to view recent changes and revert, even without a version control system.	Section 5.20 “Control Source Code” – local history
Navigation is simplified with items such as “Go to file”, “Go to type”, “Go to symbol”, “Go to header”, and “Go to declaration”.	Section 11.2.4 “Navigate Menu”
Refactor options (rename functions and variables, find all functions, etc.) for improving code structure.	Section 7.7 “C Code Refactoring”

7.3.5 Editor Troubleshooting

For errors in code highlighted in the editor, see your compiler documentation. For information on error highlighting, see the NetBeans help topic *C/C++/Fortran Development>Working with C/C++/Fortran Projects>Editing Source Files in C/C++/Fortran Projects>Error Highlighting*.

Specific errors may be found under Section 9.7 “Errors”.

7.4 EDITOR OPTIONS

To set editor options:

1. Select *Tools>Options* (*mplab_ide>Preferences* for Mac OS X) to open the Options dialog.
2. Click on the **Editor** button. Then click on a tab to set up editor features.

Each tab and its options are listed below.

TABLE 7-3: GENERAL TAB

Item	Description
Code Folding	Check to enable Code Folding and select which types of code to fold. For more on Code Folding, see Section 7.6 "Code Folding".
Camel Case Behavior	Check to enable camel case navigation.

TABLE 7-4: FORMATTING TAB

Item	Description
Language	Select the programming language to which the formatting will apply.
Category	Select a category, currently only "Tabs and Indents".
Expand Tabs to Spaces	Check to make tabs into spaces.
Number of Spaces per Indent	Enter the equivalent number of spaces per indent.
Tab Size	Enter the size of a tab.
Right Margin	Enter the size of the right margin.

TABLE 7-5: CODE COMPLETION TAB

Item	Description
Language	Select the programming language to which code completion will apply.
Completion options	Check to enable code completion options. For more on code completion, see the NetBeans help topic: *C/C++/Fortran Development>Working with C/C++/Fortran Projects>Editing Source Files in C/C++/Fortran Projects>Using Code Completion*

TABLE 7-6: CODE TEMPLATES TAB

Item	Description
Language	Select the programming language to which the template will apply.
Templates	Enter template information for the language specified above. **Abbreviation:** Enter an abbreviation to type into the editor. **Expanded Text:** After typing the abbreviation and the "Expand template on" character(s), expand the abbreviation to this text in the editor. **Description:** Add an optional description of the template item. For more on code templates, see the NetBeans help topic *C/C++/Fortran Development>Working with C/C++/Fortran Projects>Editing Source Files in C/C++/Fortran Projects>Using Code Templates*
Expand template on	Select character(s) that will be typed into the editor to expand the abbreviated text to the expanded text.

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TABLE 7-7: HINTS TAB

Item	Description
Language	Select the programming language to which the hints will apply.
Hint Window	In the Hint window, select an occurrence and specify the “hint” you wish to receive in the event of the occurrence: Error, Warning or Warning on current line.

TABLE 7-8: MACROS TAB

Item	Description
Macros	Add, delete and define editor macros. • To create a new macro, click the **New** button, enter the name for the new macro, then select the new macro in the list and enter the code in the Macro Code editor. • To set a keyboard shortcut for a macro, select a macro from the list, click the **Set Shortcut** button and enter the shortcut in the dialog box. Use this shortcut to run your macro. • To remove a macro, select a macro from the list and click the **Remove** button. • To modify the macro code, select a macro from the list and edit the code in the Macro Code editor.
Macro Code	Click on the macro name above and then type in your macro code. For a list of macro keywords, see: https://netbeans.org/kb/docs/ide/macro-keywords.html **Note:** Generally, it is easier to add a new macro by recording it than by adding one manually in the Macro Code editor. Use *Edit>Start/Stop Macro Recording*.

7.5 EDITOR RED BANGS

The Source Editor highlights syntax and semantic errors, such as missing semicolons and unresolved identifiers, in your source code. Errors are shown in red underline and a red bang "glyph"  is displayed in the left margin of the editor window next to each line that contains an error. An error message is displayed when you mouse over the glyph.

> **Note:** Not all errors in the editor are actual errors, but may be unrecognized symbols. Try building your code to determine if it will build anyway. For more details, see Section 7.5.2 "Errors Caused by Unrecognized Symbols".

7.5.1 Error Conditions and Additional Marking

Errors may occur when you do one of the following:

- Type in new code
- Edit existing code
- Add an existing file to your project
- Move a file to a different location in your project
- Change the properties of the project or one of its source files

If there are any errors in a file, red marks are displayed in the error stripe on the right side of the editor window. The error stripe represents the whole file, not just the lines currently displayed. Double click a mark in the error stripe to jump to the line the mark represents.

7.5.2 Errors Caused by Unrecognized Symbols

A symbol that is unrecognized by a compiler preparser or parser could be marked as an error but may not actually be an error (the code will build). Therefore, if you suspect this type of error, try to build the project anyway.

For examples, see:

- Section 9.7.6 "For 8-bit code, #asm and #endasm cause red bangs in the Editor window"
- Section 9.7.7 "For 16-bit code, MPLAB XC16 packed attribute statement causes red bangs in the Editor window"

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7.6 CODE FOLDING

Code folding allows you to hide some sections of code so you can focus on others. Sections of C or assembly code may be collapsed (hidden) or expanded (displayed), depending on your selected options.

- Code Folding Usage
- Custom Code Folding
- Custom Code Folding – ASM
- Expand/Collapse Custom Code Folding

7.6.1 Code Folding Usage

Code folding is enabled by default. For most C or assembly code, sections of code that may be folded are signified by "-" and "+" icons to the left of the code.

- Enable and Set Up Code Folding
- Expand/Collapse Code Folding
- Code Folding – Inline Assembly and MPLAB C18 C

7.6.1.1 ENABLE AND SET UP CODE FOLDING

Use the following steps to enable and set up code folding:

1. Select *Tools>Options* (*mplab_ide>Preferences* for Mac OS X) to open the Options dialog.
2. Click on the **Editor** button.
3. Click on the **General** tab and check "Use code folding".
4. Check other options to specify sections to fold. If you do not see the type of code you want to fold listed there, you can do a custom fold.

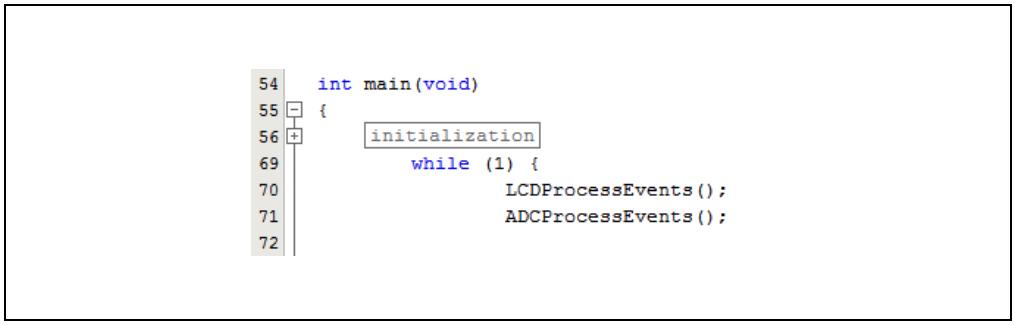
7.6.1.2 EXPAND/COLLAPSE CODE FOLDING

Within the editor, click the "-" icon next to a method and it folds. Click the "+" icon next to a folded method and it expands. Folded code is denoted by an ellipsis box. Hold the cursor over the ellipsis box and the IDE displays the collapsed method.

FIGURE 7-1: EXPANDED CODE

```
54  int main(void)
55  {
56      // <editor-fold defaultstate="collapsed" desc="initialization">
57      _display_state = DISP_HELLO; // Start from displaying of PIC24 banners
58      AD1PCFG = 0xffff; // Setup PortA IOs as digital
59      SPIMPolInit(); // Setup SPI to communicate to EEPROM
60      EEPROMInit(); // Setup EEPROM IOs
61      UART2Init(); // Setup the UART
62      TimerInit(); // Setup the timer
63      mLCDInit(); // Setup the LCD
64      BtnInit(); // Setup debounce processing
65      ADCInit(); // Setup the ADC
66      BannerStart(); // Setup the banner processing
67      RTCCInit(); // Setup the RTCC
68      // </editor-fold>
69          while (1) {
70                  LCDProcessEvents();
71                  ADCProcessEvents();
```

FIGURE 7-2: COLLAPSED CODE



7.6.1.3 CODE FOLDING – INLINE ASSEMBLY AND MPLAB C18 C

Code folding does not work for inline assembly code in MPLAB C18 when the `_asm` and `_endasm` directives are used. The work-around is to put the code block near the end of the code/file.

7.6.2 Custom Code Folding

To fold your own area of code, you can use customized code folding.

- Custom Code Folding – C
- Custom Code Folding – ASM
- Expand/Collapse Custom Code Folding

7.6.2.1 CUSTOM CODE FOLDING – C

To custom fold C code, do one of the following:

- Type the following comments around your code:

```
// <editor-fold defaultstate="collapsed" desc="user-description">
C code block to fold
// </editor-fold>
```

OR

- Type `fcom` and press the <Tab> key to automatically enter the comment text above.

After the comment has been entered, customize it for your code:

`defaultstate`	Enter either `collapsed` or `expanded`,
`desc`	Enter a description of the code. Once collapsed, this description can still be seen for reference.

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An example of custom code folding is shown below.

FIGURE 7-3: EXPANDED CODE

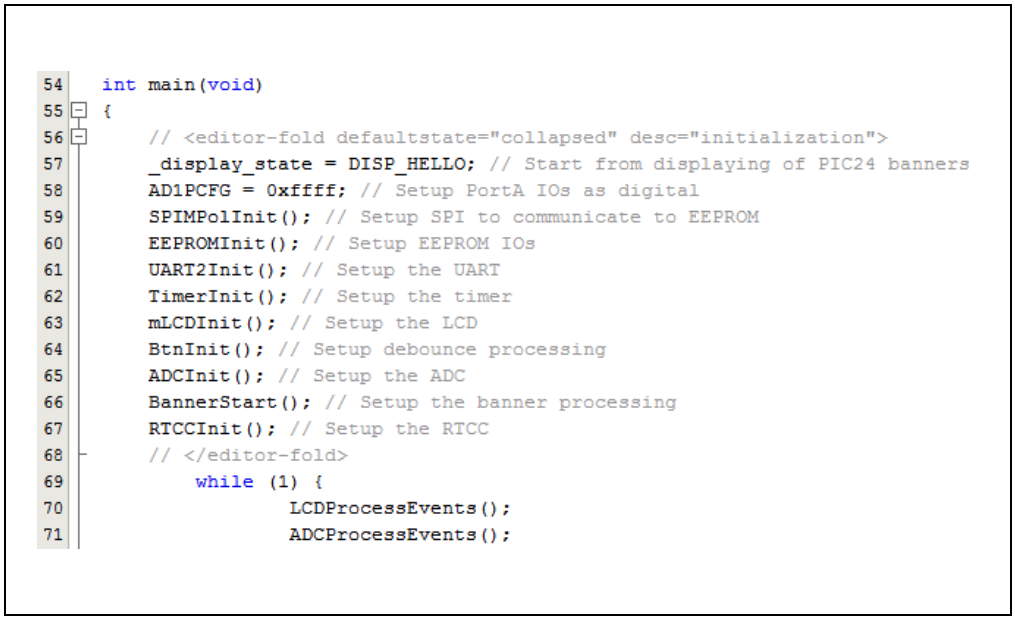
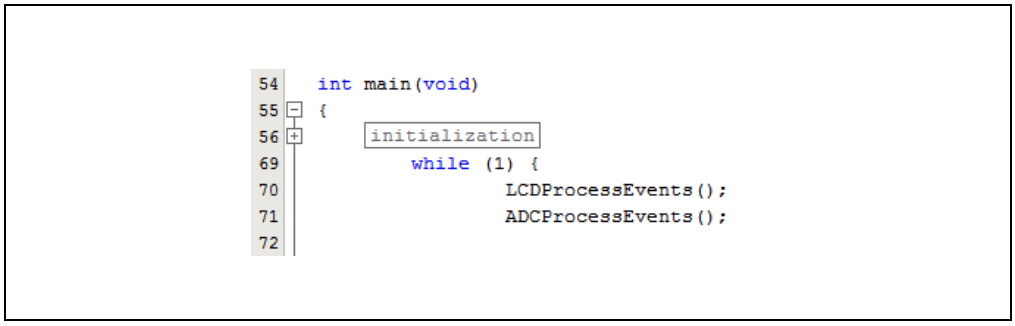


FIGURE 7-4: COLLAPSED CODE



For additional information see the NetBeans help topic *C/C++/Fortran Development>Working with C/C++/Fortran Projects>Editing Source Files in C/C++/Fortran Projects>Folding Blocks of Code*.

7.6.2.2 CUSTOM CODE FOLDING – ASM

To custom fold assembly code, do the following:

- For MPASM assembler or MPLAB XC16 assembler code, type the following comments around your code:

```
; <editor-fold defaultstate="collapsed" desc="user-description">
ASM code block to fold
; </editor-fold>
```

- For MPLAB XC32 assembler code, type the following comments around your code:

```
// <editor-fold defaultstate="collapsed" desc="user-description">
ASM code block to fold
// </editor-fold>
```

OR

- For MPASM assembler or MPLAB XC16 assembler code, type `fcom;` and press the <Tab> key to automatically enter the relevant comment text above.
- For MPLAB XC32 assembler code, type `fcom//` and press the <Tab> key to automatically enter the relevant comment text above.

Assembly code will fold in the same way that C code folds. For an example of code folding, see the C code example above.

7.6.2.3 EXPAND/COLLAPSE CUSTOM CODE FOLDING

To expand/collapse code blocks, go to the View menu, or right-click in the Editor window, and select one of the following:

1. *Code Folds>Collapse Fold* to hide the block of code.
2. *Code Folds>Expand Fold* to display the block of code.
3. *Code Folds>Collapse All* to hide all folding blocks of code.
4. *Code Folds>Expand All* to display all folding blocks of code.

For pictures of unfolded (expanded) and folded (collapsed) code, see Section 7.6.2.1 "Custom Code Folding – C".

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7.7 C CODE REFACTORING

Note: To see this feature, refer to the **Start Page**, **My MPLAB IDE** tab, “Extend MPLAB” section, “Selecting Simple or Full-Featured Menus” topic.

Refactoring is the use of small transformations to restructure code without changing any program behavior. Just as you factor an expression to make it easier to understand or modify, you refactor code to make it easier to read, simpler to understand, and faster to update. And just as a refactored expression must produce the same result, the refactored program must be functionally equivalent with the original source.

Some common motivations for refactoring code include:

- Making the code easier to change or easier to add a new feature
- Reducing complexity for better understanding
- Removing unnecessary repetition
- Enabling use of the code for other needs or more general needs
- Improving the performance of your code

The IDE’s refactoring features simplify code restructuring by evaluating the changes that you want to make, showing you the parts of your application that are affected, and making all necessary changes to your code. For example, if you use the Rename operation to change a class name, the IDE finds every usage of that name in your code and offers to change each occurrence of that name for you.

- Refactor Menu
- Undoing Refactoring Changes
- Finding Function Usages
- Renaming a Function or Parameter
- Moving, Copying and Safely Deleting C Code

7.7.1 Refactor Menu

When you use the IDE’s refactoring operations, you can change the structure of your code and have the rest of your code updated to reflect the changes you have made.

Refactoring operations are available on the Refactor menu (see Section 11.2.6 “Refactor Menu”).

7.7.2 Undoing Refactoring Changes

You can undo any changes that you made using the commands in the Refactor menu by following the steps below. When you undo a refactoring, the IDE rolls back all the changes in all the files that were affected by the refactoring.

To undo a refactoring command:

1. Go to the Refactor menu in the main menu bar.
2. Choose Undo.
   The IDE rolls back all the changes in all the files that were affected by the refactoring.

If any of the affected files have been modified since the refactoring took place, the Refactoring Undo is not available.

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7.7.3 Finding Function Usages

You can use the Find Usages command to determine each place a function is used in your project's source code.

To find where a function is used in your project:

1. In the Navigator window or the Source Editor window, right click the function name and choose Find Usages (Alt-F7).
2. The Find Usages command displays the code lines that call the function. In the Find Usages dialog box, click **Find**.

   The Usages window displays the file name and the line of code for each usage found in that file.

To jump to a specific occurrence of the function, do one of the following actions:

- In the Usages window, use the up and down arrow buttons in the left pane to navigate from one occurrence of the function to the next.
- Double click a line of code to open the file and position the cursor on that particular line of code.

Additional IDE Find Mechanisms

The other IDE tools that enable you to search for all the places where specific text is used in a project include:

- **Finding and Replacing Text**. Searches for all the places where specific text is used in a source file that is open in the Editor. Choose *Edit>Find* to open the Find dialog box, or choose *Edit>Replace* to open the Replace dialog box. These commands finds all matching strings, regardless of whether the string is a C code element.
- **Find in Projects**. As with the Find command, the Find in Projects command searches for matching strings, regardless of whether the string is a function name. Choose *Edit>Find in Projects* to open the "Find in Projects" dialog box and then type the string of text that you are looking for.

To find where a function is declared in a source file, you can double click the function in the Navigator window. If the function is declared in a different source file, right click the function and choose *Navigate>Go To Declaration* from the contextual menu.

7.7.4 Renaming a Function or Parameter

To rename a function or parameter and update references to it throughout your project:

1. In the Source Editor, right click the function or parameter and choose *Refactor>Rename* from the context menu.
2. In the Rename dialog box, type the New Name.
3. Optionally, click **Preview**. In the Refactoring window, at the bottom of the Source Editor, review the lines of code that will be changed and clear the checkbox of any code that you do not want changed.
4. Click **Do Refactoring** to apply the selected changes.

For quick in-place renaming, place the cursor in the item that you want to rename, and press Ctrl-R. Then, type the new name. To finish renaming, press **Escape**.

7.7.5 Moving, Copying and Safely Deleting C Code

These functions are specific to C++ code. See Section 11.2.6 "Refactor Menu".

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Chapter 8. Project Files and Folders

8.1 INTRODUCTION

There are several ways to view project files and folders in MPLAB X IDE:

- Projects Window View
- Files Window View
- Favorites Window View
- Classes Window View

Other MPLAB X IDE file and folder information includes:

- File or Folder Name Restrictions
- Viewing User Configuration Data
- Importing an MPLAB IDE v8 Project – Relative Paths
- Moving, Copying or Renaming a Project
- Deleting a Project

8.2 PROJECTS WINDOW VIEW

Project folders viewed in the Projects window are logical (virtual) folders. For more on this window, see Section 12.13 "Projects Window".

At the least, you will need to add source files. MPLAB X IDE will find many default files for you (header files, linker scripts). You may add library and precompiled object files, as well as edited header and linker script files. Files that will not be included in the build may be placed under "Important Files".

FIGURE 8-1: PROJECTS WINDOW – SIMPLE C CODE PROJECT

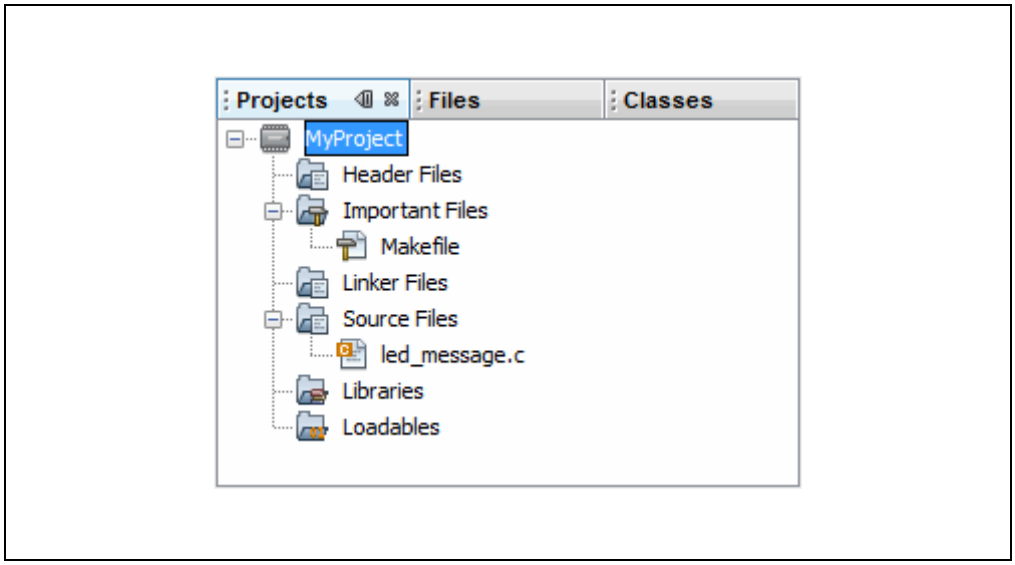

TABLE 8-1: PROJECTS WINDOW DEFINITIONS

Virtual Folder	Files Contained
`Header Files`	header files (`.h` or `.inc`)
`Library Files`	library files (`.a` or `.lib`)
`Linker Files`	linker files (`.ld`, `.gld` or `.lkr`)
`Object Files`	precompiled object files (`.o`)
`Source Files`	source files (`.c` or `.asm`)
`Important Files`	important files, such as makefiles Other documents can be placed here, such as data sheet PDFs.

8.3 FILES WINDOW VIEW

Project folders viewed in the Files window are actual folders (folders on your personal computer). For more on this window, see the NetBeans help topic "Files Window," as used with C code projects.

FIGURE 8-2: FILES WINDOW – SIMPLE C CODE PROJECT

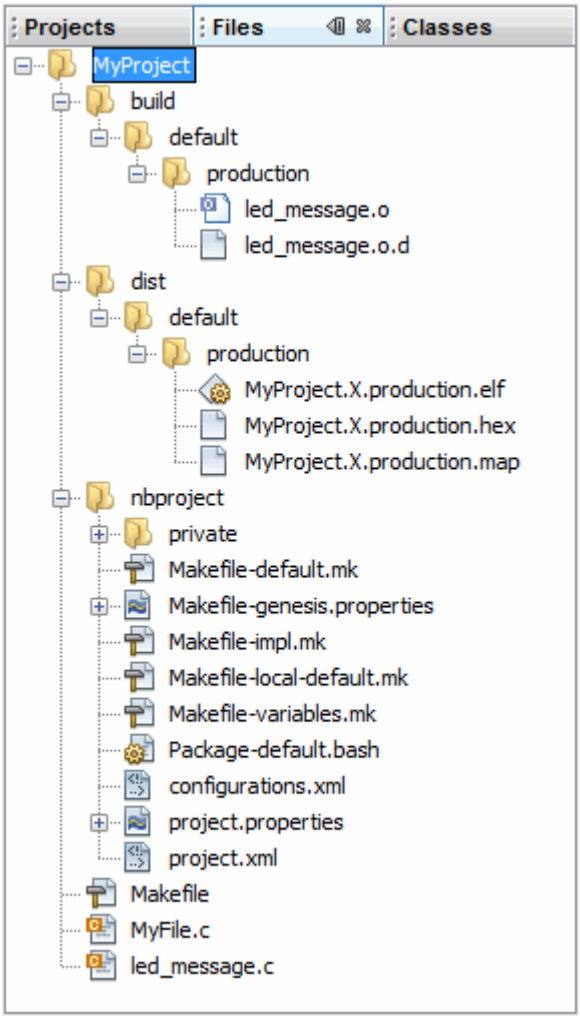

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TABLE 8-2: FILES WINDOW DEFINITIONS

Folder	Description
`MyProject`	The project folder, which contains the `Makefile` file and C code or assembly application files. `Makefile` is the master makefile for the project. This file is generated at project creation time and it is not touched after that (it will not be regenerated). You can make changes to this file if you are familiar with GNU Make. But MPLAB X IDE provides ways to add a pre-step and post-step (Project Properties) which can be used instead of modifying the `Makefile` itself.
`build`(1)	The intermediate files folder. Files are contained in subfolders depending on project configuration, usage and location. The build files are: • Run files (`.o`) • Dependency files (`.o.d`) • HI-TECH® intermediate files (`.p1`)
`dist`(1)	The output files folder. Files are contained in subfolders depending on project configuration, usage and location. The distribution files are: • Executable files (`.hex`) • ELF or COFF object files (`.elf` or `.cof`) • library files (`.a` or `.lib`)
`nbproject`	The makefile and metadata folder. Contains these files: • Project makefile • Configuration-specific makefiles • `project.xml` IDE-generated metadata file • `configurations.xml` metadata file
`default`, `MyConfig`(2)	The project configurations folders. If no configurations are created by the developer, all code is in `default`.
`production`, `debug`(2)	The production and debug versions folders.
`_ext`(2)	The external project files folder. If a file is referenced outside the project folder, it is listed here.

Note 1: You do not need to check these folders into source control. A build will create them. See also Section 5.20 “Control Source Code”.

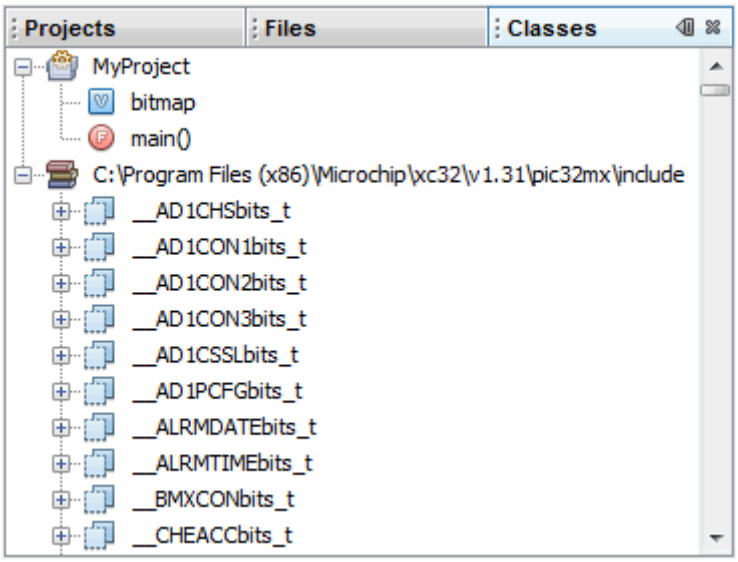
2: These items are not shown in Figure 8-2.

8.4 CLASSES WINDOW VIEW

For compilers that support C++, you can view the class files in your project using the Classes window (*Window>Classes*).

For more on this window, see the NetBeans help topic *C/C++/Fortran Development>Working with C/C++/Fortran Projects>Navigating Source Files and Projects>Using the Classes Window" as used with C++ code projects*.

FIGURE 8-3: CLASSES WINDOW – SIMPLE C CODE PROJECT



8.5 FAVORITES WINDOW VIEW

The Favorites window (*Window>Favorites*) enables you to access any file or folder on your computer or network, whether or not it is in a project.

When you first open the Favorites window, it only contains your computer's home directory.

- To add a file or folder, you can right click in the Favorites window and choose "Add to Favorites".
- To add a file, you can right click on the file name in the Projects window and select *Tools>Add to Favorites*.

For more on this window, see the NetBeans help topic "Favorites Window".

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8.6 FILE OR FOLDER NAME RESTRICTIONS

Do not use the following characters in your file or folder name:

- blank space
- tab: `\t`
- backslash: `\`
- asterisk: `*`
- square brackets: `[ ]`
- parenthesis: `( )`
- semicolon: `;`

The parenthesis characters in particular are problematic.

The restrictions are from the GNU Make used as a build tool in MPLAB X IDE.

8.7 VIEWING USER CONFIGURATION DATA

The MPLAB X IDE user directory (userdir) stores user configuration data such as window layouts, editor settings, menu and toolbar customizations, and various module settings such as the list of known compilers. In addition, when you install plugins (*Tools>Plugins*), the plugin information (code) is stored in the userdir, not in the MPLAB X installation directory.

To find out where your user directory is located, select *Help>About* and find the path next to **Userdir**.

This information is created and managed by MPLAB X IDE.

8.8 IMPORTING AN MPLAB IDE V8 PROJECT – RELATIVE PATHS

For an MPLAB IDE v8 project located at:

```
C:\MyProjects\mplab8project
```

On importing to MPLAB X IDE you will get:

```
C:\MyProjects\mplab8project\mplab8project.X
```

The MPLAB X IDE imported project is placed by default under the MPLAB IDE v8 project to preserve maintainability of both projects. However, you can place the MPLAB X IDE project folder anywhere. Also, the name of the project will be set as *`mplab8project`*`.X` but you can rename it if you wish. There is a convention to finish the name of an MPLAB X IDE project with `.X` but this is just a convention.

The new project will not copy the source files into its folder, but instead will reference the location of the files in the v8 folder. To create an independent MPLAB X IDE project, create a new project and copy the MPLAB IDE v8 source files to it.

For details, see Section 5.2 “Import MPLAB Legacy Project”.

8.9 MOVING, COPYING OR RENAMING A PROJECT

After you have created a project, you may realize you need to make changes. Using the commands on the context (right click) project menu, you can move, copy or rename your project from within MPLAB X IDE. There is also an option to delete the project. For details, see.Section 12.13.2 “Projects Window – Project Menu”

You can also use an external tool; the project file structure does not require you to use MPLAB X IDE.

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8.10 DELETING A PROJECT

To delete a project in MPLAB X IDE:

1. In the Projects window, right click on the project name and select "Delete".
2. In the "Delete Project" dialog, you can delete the project file from the computer or the project file with all of the source files. Make your selection and click **Yes**.
3. The project will be deleted so that MPLAB X IDE can no longer see it. However, some makefile information will remain on the computer.

To delete all project files from the computer:

1. Delete or close your project in MPLAB X IDE.
2. Exit MPLAB X IDE (see Note below).
3. Delete the files.

> **Note:** MPLAB X IDE does not release all resources assigned to a project when it closes. MPLAB X IDE runs on Java so releasing resources does not occur immediately. Under Java it is best to let the JRE decide when to call the garbage collection (GC) within the software code. However, you can force GC by enabling the memory toolbar and clicking on it.

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Chapter 9. Troubleshooting

9.1 INTRODUCTION

This section is designed to help you troubleshoot any problems, errors or issues you encounter while using MPLAB X IDE. If none of this information helps you, see "Support" for ways to contact Microchip Technology.

- USB Driver Installation Issues
- Cross-Platform (Operating System) Issues
- Windows Operation System Issues
- NetBeans Platform Issues
- MPLAB X IDE Issues
- Errors
- Forums

9.2 USB DRIVER INSTALLATION ISSUES

To install the correct USB drivers, see Section 2.3 "Install the USB Device Drivers (For Hardware Tools)".

To troubleshoot errors, see Section 2.3.2.7 "Tool Communication Issues".

9.3 CROSS-PLATFORM (OPERATING SYSTEM) ISSUES

If you plan on using MPLAB X IDE on different platforms (Windows, Mac, or Linux operating systems), be aware of these issues:

- Use the forward slash "/" in relative paths. The backslash "\" works only on Windows OS platforms. Example: `#include headers/myheader.h`.
- Linux OS is case-sensitive, so `genericTypeDefs.h` is not the same as `GenericTypeDefs.h`.

9.4 WINDOWS OPERATION SYSTEM ISSUES

Windows operating systems have a maximum path length of 260 characters. An explanation from Microsoft is found here:

https://msdn.microsoft.com/en-us/library/aa365247.aspx#maxpath

Although Windows will attempt to stop you from creating path lengths that are too long, it is possible to do this (from certain applications, cutting-and-pasting, etc.) If a project source file uses such a path, the project will not build correctly.

Additionally, there is a command line limitation:

Section 9.7.1 "Command line too long (Windows XP and later)"

9.5 NETBEANS PLATFORM ISSUES

The NetBeans platform may have issues concerning the platform release used for MPLAB X IDE. For more help, visit the NetBeans web site:

http://www.netbeans.org

See also:

http://netbeans.org/community/releases/index.html

9.5.1 Choosing "Inherited" as foreground color results in text for category being invisible in editor

When the Foreground color for Field is "Inherited" the text in popup completion window (tooltip) is invisible. The popup completion window shows unselected entries as white text on a white background. Scrolling down the list shows one entry at a time with white text on a blue background. Otherwise the feature seems to work normally.

This issue is recorded as a Netbeans Bugzilla issue for Fonts & Colors:

https://netbeans.org/bugzilla/show_bug.cgi?id=249766

Options->Fonts & Colors. Choosing "Inherited" option as foreground color for any [Syntax] category causes the text to be invisible in the editor. Looking at the preferences xml file "org-netbeans-modules-editor-settings-CustomFontsColors-tokenColorings.xml" it is clear that there is no linkage to a valid color for the foreground attribute of the affected category like "Field" or "Identifier".

Work-around:

1. Select *Tools>Options*, **Fonts & Colors** button, **Syntax** tab.
2. For "Language", choose "C".
3. Under "Category", click "Field".
4. To the left, see that "Foreground" is selected as "Inherited". Select a color from the list.
5. Click **OK**.

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9.6 MPLAB X IDE ISSUES

The following list are issues with MPLAB X IDE. If you do not see your issue here, look at documentation related to your project's debug and compiler tool.

- Importing an MPLAB IDE v8 Project – Settings
- Importing an MPLAB IDE v8 Project – Modified Linker Scripts
- Windows XP and Loadables
- MPLAB C18 C Compiler and Structures
- Project is Empty/Project Files Grayed Out

9.6.1 Importing an MPLAB IDE v8 Project – Settings

Settings that were saved in a workspace in MPLAB IDE v8 (such as tool settings) will not be transferred to the new MPLAB X IDE project. Refer to the MPLAB IDE v8 help for what is stored in a workspace (*MPLAB IDE Reference>Operational Reference>Saved Information*.)

9.6.2 Importing an MPLAB IDE v8 Project – Modified Linker Scripts

If you have modified your MPLAB IDE v8 project linker script so that it includes an object file, the linker will be unable to find the file when it is imported into MPLAB X IDE, because the build paths for MPLAB IDE v8 and MPLAB X IDE are different.

So you may see an error like:

```
<install path>ld.exe: cannot find file.o
```

since in MPLAB IDE v8 all build-related files are in one directory, whereas in MPLAB X IDE build files are in different subdirectories.

You can edit your linker script to work with MPLAB X IDE by using wild cards. For example, change:

```
/* Global-namespace object initialization - MPLAB v8*/
.init   :
{
  KEEP (crti.o(.init))
 :
} >kseg0_program_mem
```

to:

```
/* Global-namespace object initialization - MPLAB X*/
.init   :
{
  KEEP (*crti.o(.init))
 :
} >kseg0_program_mem
```

Alternatively, you can use an address attribute that allows you to place functions in C code.

```
int __attribute__((address(0x9D001000))) myfunction (void) {}
```

This allows you to place a function at an address without modifying the default linker script.

9.6.3 Windows XP and Loadables

When using a PC with Windows XP, the "Store path as" options on the Add Loadable Project/File dialogs do not work for "Auto" or "Absolute". You must use "Relative".

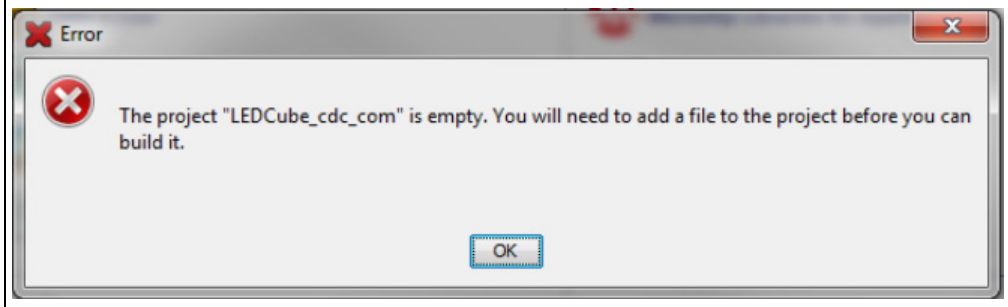
9.6.4 MPLAB C18 C Compiler and Structures

The pointer value of a structure in RAM memory will not be displayed correctly in the Watches window. This is because the compiler does not store complete debug information. The work-around is to use the MPLAB XC8 C compiler instead.

9.6.5 Project is Empty/Project Files Grayed Out

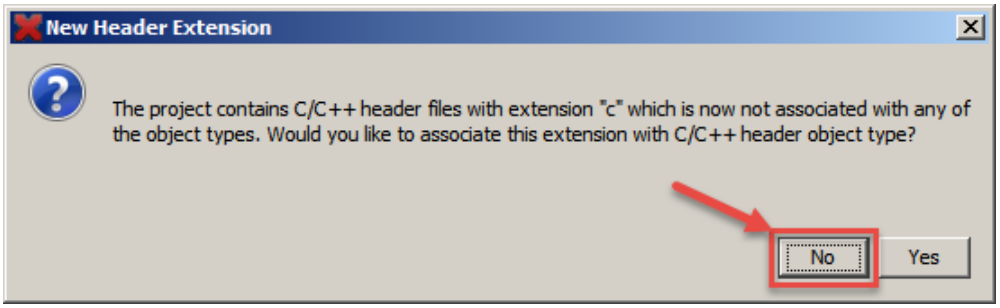
If you have loaded a corrupted project and answered a dialog question incorrectly, the Projects window could be grayed out and MPLAB X IDE will say the project cannot be built due to having no source files.

FIGURE 9-1: PROJECT EMPTY ERROR



The problem occurs when the corrupted project is being loaded into MPLAB X IDE. A dialog will appear asking if C source files should be associated with header files. You can correct the issue at this point by clicking "No" (the default).

FIGURE 9-2: NEW HEADER EXTENSION DIALOG



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However, if you say “Yes”, the source files are now seen as header files, and the project looks empty. To fix the project, you can use either of the following methods:

- Exit from MPLAB X IDE.
- Go to the MPLAB X IDE User Directory (specified in the *Help>About* dialog) and delete the directory for your version of MPLAB X IDE. For example, delete the folder `v3.05` from:
  `C:\Users\`*`UserName`*`\AppData\Roaming\mplab_ide\dev\v3.05`
- Launch MPLAB X IDE again.

OR

- Go to *Tools>Options*, **Embedded** button, **Other** tab.
- Remove ‘c’ from the header files association.
- Add ‘c’ to the source files association.
- Click **OK**.

9.7 ERRORS

Errors can take many forms in the IDE, most commonly as icons in windows or messages in the Output window. Hovering over icons will pop up text that may explain the issue. For text messages, please refer to online help to search for the error.

Some common errors and resolutions for the IDE or Editor are listed below:

- Command line too long (Windows XP and later)
- Couldn't reserve space for Cygwin™ heap (Windows 7 or 8)
- Could not access the URL through the external browser. Check the browser configuration
- Destination Path Too Long/The filename or extension is too long (Windows OS)
- The project *ProjectName* is empty
- For 8-bit code, #asm and #endasm cause red bangs in the Editor window
- For 16-bit code, MPLAB XC16 packed attribute statement causes red bangs in the Editor window
- HEXMATE Conflict Report Address Error
- Programming Errors

9.7.1 Command line too long (Windows XP and later)

When a project's makefile is run, each command that is executed is passed to the local native shell. For Windows XP and later operating systems, there is a limit of 8191 characters. Therefore, for a project with hundreds of C files that link, the limit could be surpassed and this error will be displayed.

Linux OS and Mac OS X can usually take very long command lines. If you want to find out how long for your system, you can type on the command line `getconf ARG_MAX`.

Response File Workaround

If you are using the MPLAB XC8 or MPLAB XC32 C compiler v1.01 and above, or MPLAB XC16 C compiler v1.22 and above, you may be able to use a response file when calling the linker to work around this issue.

- For MPLAB XC8, in the Project Properties window (*File>Project Properties*), click in "Categories" on "XC8 linker". Under "Option categories" select "Additional Options". Check the checkbox next to "Use response file to link".
- For MPLAB XC16, in the Project Properties window (*File>Project Properties*), click in "Categories" on "xc16-ld". Under "Option categories" select "General". Check the checkbox next to "Use response file to link".
- For MPLAB XC32, in the Project Properties window (*File>Project Properties*), click in "Categories" on "xc32-ld". Under "Option categories" select "General". Check the checkbox next to "Use response file to link".

Library Workaround

For all other compilers, you can create an MPLAB X IDE library project and move some source files from your main project to the library project. Then add the library project to your main project.

To create a library project select *File>New Project*, click the "Microchip Embedded" category, and then select "Library project" as the project.

To add the library to your main project, open the Project Properties window i.e., *File>Project Properties*), click in "Categories" under "Libraries", and then click the **Add Library Project** button.

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Archive Checkbox Workaround

For all MPLAB XC16 and MPLAB XC32, there is now a checkbox you can use when archiving long sets of files into libraries that might push the link line over the character limit. The “Break into multiple lines” option can be used to tell the compiler to break up the archive line into smaller lines to avoid this limitation.

Find this option in:

Project Properties window, “xc16-ar” or “xc32-ar” category, “General” option category, “Break into multiple lines” checkbox.

9.7.2 Couldn’t reserve space for Cygwin™ heap (Windows 7 or 8)

MPLAB X IDE uses the Cygwin MinGW in its make process. In Windows 7 or 8, you may have virtual memory allocation issues.

To change the Virtual Memory settings, click *Start>Control Panel*. Then click System and then *Security>System>Advanced Systems Setting or System Protection*. On the **Advanced** tab, click on the Performance **Settings** button. In this dialog click the **Advanced** tab and then click on the **Change** button. Enter a custom size value as follows:

- Initial Size (MB) = Currently Allocated (shown at the bottom)
- Maximum Size (MB) = Recommended (shown at the bottom)

Click **Set**, click **OK**, and reboot your personal computer.

9.7.3 Could not access the URL through the external browser. Check the browser configuration

In MPLAB X IDE, select *Tools>Options*, **General** Tab. In the “Web Browser” drop-down list, select your browser. Click **OK**.

For more information see:

Bug 21236 – Ext-Browser: Message “Could not access the URL” to guide from Tools menu:

http://netbeans.org/bugzilla/show_bug.cgi?id=21236

Bug 38211 – A problem with using IE external browser in the IDE:

http://netbeans.org/bugzilla/show_bug.cgi?id=38211

9.7.4 Destination Path Too Long/The filename or extension is too long (Windows OS)

Windows OS has a maximum path length of 260 characters. For details, see Section 9.4 “Windows Operation System Issues”.

9.7.5 The project *ProjectName* is empty

See Section 9.6.5 “Project is Empty/Project Files Grayed Out”.

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9.7.6 For 8-bit code, #asm and #endasm cause red bangs in the Editor window

The `#asm` and `#endasm` statements are valid constructs for declaring in-line assembly code within a HI-TECH PICC or MPLAB XC8 C program. But in the IDE Editor, the C preparser does not see these as valid directives and will display a red bang next to these statements. However, this code will still work.

If you want to eliminate the red bangs in the Editor, you can use the `asm()` statement. This is the preferred method of using in-line assembly for all MPLAB XC C compilers.

Example:

```
// Inline Code that causes error
    #asm
        movlw 0x20;
        nop;
        nop;
    #endasm

// Workaround for inline assembly - that will not cause error
// (Multi line asm code)
    asm("\
    movlw 0x20;\
    nop;\
    nop;");

// Workaround for inline assembly - that will not cause Error
// (Single line asm code)
    asm("movlw 0x20; nop; nop");
```

9.7.7 For 16-bit code, MPLAB XC16 packed attribute statement causes red bangs in the Editor window

The following statement is marked as an error by the compiler parser but will build:

```
unsigned long long Bits8 : 8 __attribute__ ((packed));
```

The parser rules for qualifiers allow for any order, but the expectation is that the qualifiers are all specified before the identifier. Therefore, these statements are of better form and will not produce an error:

```
unsigned long long attribute ((packed)) Bits8 : 8;
```

OR

```
attribute ((packed)) unsigned long long Bits8 : 8;
```


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9.7.8 HEXMATE Conflict Report Address Error

When HEXMATE generates a conflict report, the address of the conflict in the hex file is sometimes not the same as the address shown in a memory window (where the data resides in memory.) For example:

TABLE 9-1: HEX ADDRESS VS. MEMORY ADDRESS

Device Family	Address in Hex File	Address in Memory
Baseline	0x100	0x80*
Midrange	0x100	0x80*
PIC18 MCUs	0x100	0x100
16-bit Devices	0x100	0x80*
32-bit Devices	0x100	0x100

* For some devices, the address shown in the conflict report is twice as large as the address of the data in memory.

9.7.9 Programming Errors

If a device is unknowingly code protected, then programming it throws a programming failure error for a specific address region.

The “Erase Device Memory Main Project” function can help to determine if this is the programming issue. Find this function as an optional icon under Section 6.9 “Customize Toolbars” or use MPLAB IPE.

1. Ensure code protection is off in your code.
2. Erase the device the device memory, which will erase the configuration bit settings.
3. Reprogramming the device

If programming succeeds, then code protect was the issue.

Erase Device Memory Main Project Icon

9.8 FORUMS

If you do not see your issue here, check out our forums at:

http://www.microchip.com/forums/f238.aspx

Here you will find discussions and recently posted solutions to problems.

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Chapter 10. MPLAB X IDE vs. MPLAB IDE v8

10.1 INTRODUCTION

MPLAB X IDE differs considerably from MPLAB IDE v8 and before. The topics in this section will help you with migration issues.

- Major Differences
- Menu Differences
- Tool Support Differences
- Other Considerations

10.2 MAJOR DIFFERENCES

Because MPLAB X IDE is based on the NetBeans platform, many features will be different from MPLAB IDE v8. Please see the following for more detailed information:

- Chapter 2. "Before You Begin"
- Chapter 3. "Tutorial"
- Chapter 5. "Additional Tasks"

A short list of major feature differences is presented below:

1. **MPLAB X IDE is based on the open-source, cross-platform NetBeans platform.** Third parties can easily add functionality as plug-ins. MPLAB X IDE components that are specific to Microchip products are still proprietary.

   MPLAB IDE v8 is proprietary and Windows operating system based. Third parties can add to v8 with design information from the MPLAB development group.

2. **MPLAB X IDE is project-based (no workspaces).** In MPLAB X IDE, you must create a project to develop your application. Creating a project involves selecting a device, as well as selecting and setting up language tools, debug tools, programming tools and other project specifics. This ensures all items needed for successfully developing an application are present. Multiple project grouping is handled by multiple configurations.

   MPLAB IDE v8 is device-based. Although it is always highly recommended that you use a project in v8 to create your application, it is not required. Workspaces are used to contain some set up information, including multi-project grouping.

   As projects have changed significantly, reading Chapter 3. "Tutorial" is recommended.

3. **MPLAB X IDE allows multiple tool selection**

   Example 1: Connect several MPLAB ICD 3 debuggers into several computer USB ports. Then access the Project properties to easily switch between the debuggers, which are identified by their serial numbers (SN).

   Example 2: Connect one MPLAB ICD 3 debugger into a computer USB port and one MPLAB PM3 programmer into another USB port. Then access the Project properties to easily switch between the tools.

   MPLAB IDE v8 does not allow multiple tool selection.

4. **MPLAB X IDE allows multiple language tool version selection**

   Example: Install two versions of the MPLAB C Compiler for PIC18 MCUs. Then access the Project properties to easily switch between versions of compiler toolchains.

   MPLAB IDE v8 does not allow multiple language tool version selection.

5. **MPLAB X IDE allows multiple debug and programming sessions.** MPLAB X IDE allows you may have multiple debug sessions active in one IDE. For more information, see Section 6.3 "Work with Multiple Projects".

   MPLAB IDE v8 allowed one debug or programming session. MPLAB IDE v8 allowed you to have multiple projects open in the IDE. However, you could only debug or program with one project at a time.

6. **MPLAB X IDE allows multiple build configurations.** MPLAB X IDE allows more than one build configuration. For more information, see Section 6.4 "Work with Multiple Configurations".

   MPLAB IDE v8 allowed only two configurations. MPLAB IDE v8 allowed you to select only between "Release" or "Debug" from the Build Configuration drop-down box and have use of `__DEBUG` in your own code.

   To recreate the MPLAB IDE v8 functionality in MPLAB X IDE, you can create your own Debug configuration and `__DEBUG` macro by following the example in Section 6.4.2 "Add a Duplicate Configuration".

7. **MPLAB X IDE provides multi-step options to debug and program.** MPLAB X IDE has a "Debug Project" icon that builds, programs a target device with your program and a debug executive (for hardware tools) and runs your code in Debug mode in one click. Also available is a "Make and Program" icon that builds, programs a target device (for hardware tools) and runs your code in one click. If you do not want your program to run after make and program, use the "Hold in Reset" icon instead.

   MPLAB IDE v8 required several manual steps to debug or program. MPLAB IDE v8 had a procedure that required completion before debugging or running code:

   a) select the correct build configuration (Release or Debug)
   b) build/make your code
   c) program the target with the code (for hardware tools)
   d) run your code.

   For some tools, e.g., MPLAB Starter Kits, you still need to perform some steps independently. MPLAB X IDE provides this functionality under *Debug>Discrete Debugger Operation*.

8. **MPLAB X IDE uses configuration bits set in code.** MPLAB X IDE requires that Configuration bits be set in code. However, you may temporarily change Configuration bits in the Configuration bits window when in a debug session and then save these settings into a file to paste into your code later (see Section 4.22.4 "Set Configuration Bits").

   MPLAB IDE v8 used configuration bits set in code or a window. MPLAB IDE v8 allowed you to set Configuration bits in either code or the Configuration bits window. However, settings made in the window had to be manually entered into code.

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9. **MPLAB X IDE debug tools are only connected during a session.** MPLAB X IDE only connects debug or programmer tools to the target during a debug or programming session. Otherwise they are not connected.

   MPLAB IDE v8 debug tools were always connected. MPLAB IDE v8 connected to the debug and programmer tools as soon as the tool was selected. This configuration did not allow for multiple sessions.

   To maintain this connection at all times in MPLAB X IDE, like MPLAB IDE v8, go to *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Embedded**, **Generic Settings** tab, and check “Maintain active connection to hardware tool”.

10. **MPLAB X IDE information is consolidated in one display.** MPLAB X IDE has a Dashboard window that contains breakpoint resources, checksum and memory gauge information. See Section 5.18 “View the Dashboard Display”. This window organizes project information in one place.

    MPLAB IDE v8 information is spread over several displays. MPLAB IDE v8 had a breakpoint resources toolbar, checksum toolbar and memory gauge window. Each feature was accessed differently.

11. **MPLAB X IDE has many NetBeans features.** MPLAB X IDE has many NetBeans editing and debug features. (See NetBeans Help for more details.) Periodically, MPLAB X IDE will update the NetBeans platform it is based on. Then the IDE will be updated to the new NetBeans features. The MPLAB X IDE release notes will specify the NetBeans platform version that each version of MPLAB X IDE is built upon.

    MPLAB IDE v8 had its own, proprietary features. MPLAB IDE v8 was a proprietary product. As such, third-party and community development was more difficult.

10.3 MENU DIFFERENCES

The following tables highlight the menu changes from MPLAB IDE v8 to MPLAB X IDE. Due to the changes in MPLAB X IDE, not all MPLAB IDE v8 menu items will map identically. Major differences are discussed under Comments.

Additional menu items may be available in MPLAB X IDE. See the NetBeans help for details.

TABLE 10-1: FILE MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
New	File>New File	Select associated project in file wizard.
Add New File to Project		
Open	File>Open File	
Close	File>Close	
Save	File>Save	
Save As	File>Save As	
Save All	File>Save All	
Open Workspace	Not available	All data saved in projects
Save Workspace		
Save Workspace As		
Close Workspace		
Import	File>Import	Useful for importing prebuilt (hex/elf) files, MPLAB IDE v8 projects, or other embedded projects.
Export	Not available	The project hex file is located in the project folder, dist>default>production folder, for a default configuration.
Print	File>Print File>Print to HTML File>Page Setup	
Recent Files	File>Open Recent File	
Recent Workspaces	Not available	All data saved in projects
Exit	File>Exit	

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TABLE 10-2: EDIT MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
Undo	Edit>Undo	
Redo	Edit>Redo	
Cut	Edit>Cut	
Copy	Edit>Copy	
Paste	Edit>Paste Edit>Paste Formatted	
Delete	Edit>Delete	
Select All	Edit>Select All Edit>Select Identifier	
Find	Edit>Find Edit>Find Selection	
Find Next	Edit>Find Next Edit>Find Previous	
Find In Files	Edit>Find in Projects Edit>Replace in Projects	
Replace	Edit>Replace	
Go To	Navigate>Go to Line Navigate>Go to Declaration	
Go To Locator	Navigate>Go to Symbol	
Go Backward	Navigate>Back	
Go Forward	Navigate>Forward	
External DIFF	Tools>Diff	See also Tools>Options (mplab_ide>Preferences for Mac OS X), Miscellaneous, **Diff** tab
Advanced	Source>Format Source>Shift Left/Right Source>Move Up/Down Source>Toggle Comment	
Bookmarks	Navigate>Toggle Bookmark Navigate>Next Bookmark Navigate>Previous Bookmark	
Properties	Tools>Options>**Editor** tab Tools>Options>Fonts & Colors	Use mplab_ide>Preferences instead of Tools>Options for Mac OS X.

TABLE 10-3: VIEW MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
Project	Window>Projects	
Output	Window>Output	
Toolbars	View>Toolbars	
CPU Registers**	Window>PIC Memory Views>CPU	
Call Stack	Window>Debugging>Call Stack	
Disassembly Listing	Window>Debugging>Output>Disassembly Listing File	
EEPROM	Window>PIC Memory Views>EE Data Memory	
File Registers*	Window>PIC Memory Views>Data Memory	
Flash Data	Window>PIC Memory Views>Data Memory	
Hardware Stack	Debug>Stack	
LCD Pixel	Not available	
Locals	Window>Debugging>Variables	
Memory**	Window>PIC Memory Views>Execution Memory	
Program Memory*	Window>PIC Memory Views>Flash Memory	
SFR/Peripherals**	Window>PIC Memory Views>Peripherals	
Special Function Registers*	Window>PIC Memory Views>SFRs	
Watch	Window>Debugging>Watches	See also: Debug>New Watch
Memory Usage Gauge	Window>Dashboard	
Trace	Window>Debugging>Trace	See also: File>Project Properties to enable trace

* 8- and 16-bit devices
** 32-bit devices

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TABLE 10-4: PROJECT MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
Project Wizard	File>New Project	Always invoked for new project
New		
Open	File>Open Project File>Open Recent Project	
Close	File>Close Project	
Set Active Project	Run>Set Main Project	
Quickbuild	Not supported	A project is required for all development.
Package in .zip	Right click on project in Projects window, select ‘Package’	
Clean	Right click on project in Projects window, select ‘Clean’ or ‘Clean and Build’	
Locate Headers	Right click on project in Projects window, select “Locate Headers”	
Export Makefile	Not available.	See Appendix B. “Working Outside the IDE”.
Build All	Run>Run Project Debug>Debug Project	Programmer build/run Debug build/run
Make		
Build Configuration	File>Project Properties, click “Manage Configurations”	There used to be only two configurations: Release and Debug. Now you determine how many you need.
Build Options	File>Project Properties, click toolsuite tool	Language tool set up
Save Project	File>Save File>Save All	
Save Project As	File>Save As	
Add Files to Project	Right click on project folder in Projects window, select ‘Add Existing Item’	
Add New File to Project	Right click on project folder in Projects window, select ‘New’	
Remove File from Project	Right click on project file in Projects window, select ‘Remove From Project’	
Select Language Toolsuite	File>New Project File>Project Properties	
Set Language Tool Locations	Tools>Options, Embedded, Build tools	Use mplab_ide>Preferences instead of Tools>Options for Mac OS X.
Version Control	Team menu items	Other version control may be available as a plugin.

TABLE 10-5: DEBUGGER MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
Select Tool	File>New Project File>Project Properties	To select To change
Clear Memory	Not available. Use Fill Memory.	Window>PIC Memory Views>*Memory Window*, right click in window, select "Fill Memory"
Run	Run>Run Project Debug>Debug Project Debug>Continue	Programmer Run Debug Run Run from Halt
Animate	Not supported	
Halt	Debug>Pause	
Step Into	Debug>Step Into	
Step Over	Debug>Step Over	
Step Out	Debug>Step Out	
Reset	Debug>Reset	
Breakpoints	Debug>New Breakpoint Debug>Toggle Breakpoint	Set a breakpoint in code by clicking in the gutter next to a line of code.
Settings	File>Project Properties	
Stopwatch	Window>Debugging>Stopwatch	

TABLE 10-6: PROGRAMMER* MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
Select Programmer	File>New Project File>Project Properties	To select To change
Enable Programmer	Not available. Automatically enabled on programming.	Unless Tools>Options, Embedded, Generic Settings, "Maintain active connection to hardware tool" checked.
Disable Programmer	Not available. Automatically disabled on programming.	
Program	Make and Program Device	On Run toolbar
Verify	Not available	See MPLAB IPE
Read	Read Device Memory	On Run toolbar
Blank Check All	Not available	See MPLAB IPE
Blank Check OTP	Not available	See MPLAB IPE
Erase Flash Device	Available on custom toolbar	See Section 6.9 "Customize Toolbars"; also MPLAB IPE
Reset Program Statistics	Not available	See MPLAB IPE
Download OS	File>Project Properties, debug tool category, Firmware option	The IDE will automatically choose the most up-to-date firmware to download
Settings	File>Project Properties	

* For programmers, see also the MPLAB IPE.

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TABLE 10-7: TOOLS MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
Data Monitor and Control Interface (DMCI) and other plugins	Tools>Plugins Tools>Embedded	To install To use
MPLAB® Macros	Edit>Start Macro Recording Edit>Stop Macro Recording	After recording, you can enter a macro name and shortcut.
RTOS Viewer	Tools>Plugins Tools>Embedded	To install To use

TABLE 10-8: CONFIGURE MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
Select Device	File>New Project File>Project Properties	To select To change
Configuration Bits	Window>PIC Memory Views>Configuration Bits	
External Memory	Window>PIC Memory Views>*Program Memory*	External memory is displayed as part of program memory.
ID Memory	Window>PIC Memory Views>User ID Memory	
Settings	Tools>Options	Use mplab_ide>Preferences instead of Tools>Options for Mac OS X.

TABLE 10-9: WINDOW MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
Close All	Window>Close All Documents	
Cascade	Not supported.	For document management, see Window>Documents.
Tile Horizontally		
Tile Vertically		
Arrange Icons		
Window Sets		
Create Window Set		
Destroy Window Set		
Recent Windows		

TABLE 10-10: HELP MENU DIFFERENCES

MPLAB® IDE v8	MPLAB® X IDE	Comments
Topics	Help>Contents	To view PDFs, see Section 8.2 "Projects Window View".
Release Notes	Help>Online Docs and Support	
Driver Installation	Help>Online Docs and Support	
Check for Updates	Not available	Check the Microchip website for updates.
Web Links	Help>Online Docs and Support	
About MPLAB® IDE	Help>About	

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10.4 TOOL SUPPORT DIFFERENCES

The following table lists the available Microchip development tools and whether or not they will be supported in MPLAB X IDE.

TABLE 10-11: TOOL SUPPORT DIFFERENCES

Development Tool	In MPLAB® X IDE?
PICkit™ 3	✓
PICkit 2	✓
PICkit 1	✗
MPLAB® ICD 3	✓
MPLAB ICD 2	✗
MPLAB REAL ICE™ in-circuit emulator	✓
MPLAB ICE 2000	✗
MPLAB ICE 4000	✗
MPLAB PM3	✓
PRO MATE II	✗
PICSTART® Plus	✗
MPLAB VDI	✗

TABLE 10-12: PLUGIN SUPPORT DIFFERENCES

Plug-Ins*	In MPLAB® X IDE?
DMCI	✓
dsPIC® Filter Design**	✓
dsPICworks Data Analysis**	✓
Graphical Display Designer	✓
KEELOQ® Plugin	✓
Memory Starter Kit	✓
PC-Lint	✓
RTOS Viewer	✓

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TABLE 10-12: PLUGIN SUPPORT DIFFERENCES (CONTINUED)

Plug-Ins*	In MPLAB® X IDE?
AN851 Bootloader	✗
AN901 BLDC Tuning Interface	✗
AN908 ACIM Tuning Interface	✗
dsPIC30F SMPS Buck Converter	✗
dsPIC33F SMPS Buck/Boost Converter	✗
MATLAB®/Simulink®	✗
Segmented Display Designer	✗

* To see available plug-ins, select *Tools>Plugins*, "Available Plugins" tab.
** For Windows® operating systems only.

10.5 OTHER CONSIDERATIONS

There are other considerations when migrating from MPLAB IDE v8 projects to MPLAB X IDE:

- Section 9.6 "MPLAB X IDE Issues"

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Chapter 11. Desktop Reference

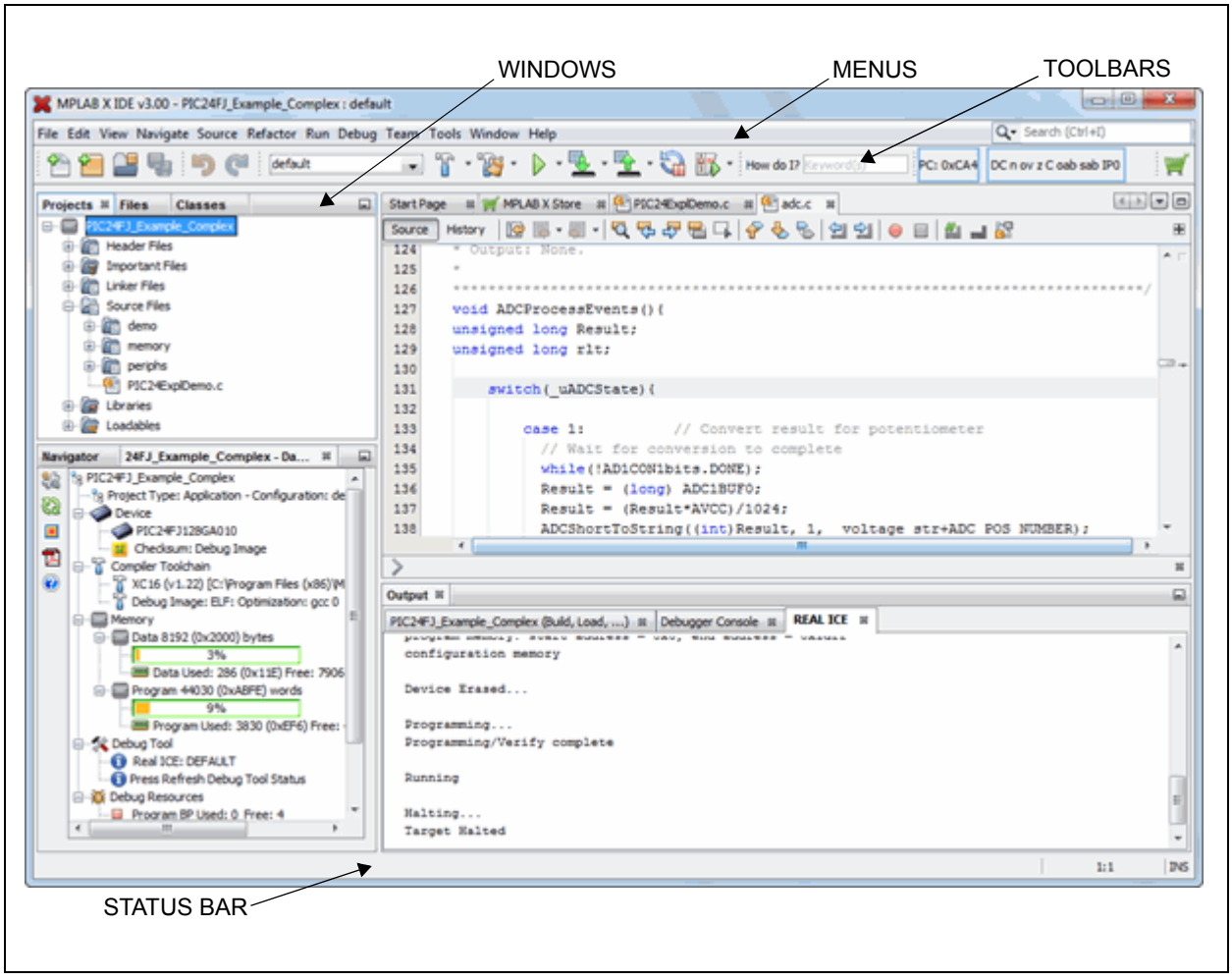
11.1 INTRODUCTION

The MPLAB® X IDE desktop is a resizable window that operates independent of the rest of the desktop items. The desktop consists of menus, toolbars, a status bar and tabbed windows (Figure 11-1). Menus, toolbars and the status bar are discussed here. Windows and dialogs are discussed in their own section.

> **Note:** When the NetBeans help topic refers to a workspace, it is talking about a desktop. It is ***not*** referring to the MPLAB IDE v8 (and earlier) workspace.

- Menus
- Toolbars
- Status Bar
- Grayed out or Missing Items and Buttons

FIGURE 11-1: MPLAB® X IDE DESKTOP



11.2 MENUS

Many MPLAB® X IDE functions are accessible as menu items through the menu bar located across the top of the desktop. Menu items followed by ellipses (...) will open a dialog. For more on dialogs, see Chapter 12. "MPLAB X IDE Windows and Dialogs".

Shortcut keys for menu items are listed next to the menu item. Example: The shortcut keys for "New File" are Control-N (CTRL+N). More shortcut key information is available from *Help>Keyboard Shortcuts Card*.

Menu items may be grayed out for various reasons. See Section 11.5 "Grayed out or Missing Items and Buttons".

Additional context menus are available by right clicking in a window. For more on these menus, see Section 12.13 "Projects Window".

Available menus are listed below.

> **Note:** See the **Start Page**, *My MPLAB IDE>Extend MPLAB>Selecting Simple or Full-Featured Menus* to see all available menus and menu items. Not all of these items will be applicable to embedded development.

- File Menu
- Edit Menu
- View Menu
- Navigate Menu
- Source Menu
- Refactor Menu
- Run Menu
- Debug Menu
- Team Menu
- Tools Menu
- Window Menu
- Help Menu

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11.2.1 File Menu

Below are the menu items in the File menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-1: FILE MENU OPTIONS

Command	Action
New Project	creates a new project with the New Project wizard
New File	creates a new file with the New File wizard
Open Project	opens an existing project
Open Recent Project	displays a list of all recently-opened projects for selection.
Import	imports one of the following: Hex/ELF... (Prebuilt) File – built with another tool MPLAB IDE v8 Project – launch Import Legacy Project wizard Other Embedded – import from another embedded platform From ZIP – import from a zipped project, i.e., unzip and import
Close Project	closes the current project
Close Other Projects	closes all projects except for the main project
Close All Projects	closes all open projects
Open File	opens an existing file
Open Recent File	displays a list of all recently-opened files for selection
Project Group	associates the current project with a group
Project Properties	opens the Project Properties dialog
Export Project	exports the current project To zip – Zip up the current project files.
Save	saves the current file
Save As	saves the current file under a new path and/or name
Save All	saves all open files If the “Compile on Save” feature is selected, this will also compile/build project files.
Page Setup	sets up the page for printing
Print	shows print preview of current file and allows printing
Print to HTML	prints the current file to a new file in HTML format
Exit	quits MPLAB® X IDE

11.2.2 Edit Menu

Below are the menu items in the Edit menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-2: EDIT MENU OPTIONS

Command	Action
Undo	reverses (one at a time) a series of editor actions, except Save
Redo	reverses (one at a time) a series of Undo commands
Cut	deletes the current selection and places it on the clipboard
Copy	copies the current selection to the clipboard
Paste	pastes the contents of the clipboard into the insertion point
Paste Formatted	pastes the formatted contents of the clipboard into the insertion point
Paste from History	pastes from Copy history
Delete	deletes the current selection
Select All	selects everything in the current document or window
Select Identifier	selects the word nearest the cursor
Find Selection	finds instances of the current selection
Find Next	finds next instance of found text
Find Previous	finds previous instance of found text
Find	finds a text string
Replace	finds a string of text and replaces it with the string specified
Find Usages	finds usages and subtypes of selected code
Find in Projects	finds specified text, object names, object types within projects
Replace in Projects	replaces text, object names, object types within projects
Start Macro Recording	starts recording keystrokes
Stop Macro Recording	stops recording keystrokes To manage macros, select *Tools>Options*, **Editor** button, **Macros** tab.

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11.2.3 View Menu

Below are the menu items in the View menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-3: VIEW MENU OPTIONS

Command	Action
Editors	selects an available editor to view your files History – Show the history of edits to this file. Source – Show the source code in this file.
Split	splits the current editor window and its contents into two windows, either vertically or horizontally oriented
Code Folds>Collapse Fold	If the insertion point is in a foldable section of text, collapses those lines into one line
Code Folds>Expand Fold	If the currently selected line in the Source Editor represents several folded lines, expands the fold to show all of the lines
Code Folds>Collapse All	collapses all foldable sections of text in the Source Editor
Code Folds>Expand All	expands all foldable sections of text in the Source Editor
Code Folds>Collapse Fold Tree	collapses all folds in a nested group of folds
Code Folds>Expand Fold Tree	expand all folds in a nested group of folds
Web Browser	opens the default web browser to the NetBeans home page
IDE Log	opens the log file in a tab of the Output window
Toolbars>File, etc.	shows the associated toolbar
Toolbars>Small Toolbar Icons	uses small icons on the toolbars
Toolbars>Reset Toolbars	resets to the default toolbar setup
Toolbars>Customize	customizes the items on an existing toolbar and allows creation of a new one
Show Editor Toolbar	shows the editor toolbar on the **File** tab
Show Line Numbers	shows line numbers in left margin
Show Non-printable Characters	shows characters even if they are not printable (non-ASCI)
Show Breadcrumbs	shows breadcrumbs, or the path to the file from the project file, on the bottom of the editor window
Show Indent Guide Lines	shows faint lines to represent indents
Show Diff Sidebar	shows the DIFF sidebar
Show Versioning Labels	shows version labels
Synchronize Editor with Views	synchronizes the editor with open views
Show Only Editor	shows editor window in full IDE window
Full Screen	expands window to full length and breadth of screen

11.2.4 Navigate Menu

Below are the menu items in the Navigate menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-4: NAVIGATE MENU OPTIONS

Command	Action
Go to File	finds and opens a specific file
Go to Type	finds and opens a specific class or interface
Go to Symbol	finds the symbol name as specified
Go to Previous Window	gives focus to the previously selected window
Go to Source	displays the source file containing the definition of the selected class
Go to Declaration	jumps to the declaration of the item under the cursor
Go to Super Implementation	jumps to the super implementation of the item under the cursor
Last Edit Location	scrolls the editor to the last place where editing occurred
Back	navigates back
Forward	navigates forward
Go to Line	jumps to the specified line
Toggle Bookmark	sets a bookmark on a line of code
Bookmark History Popup Next	goes to the next bookmark in the Bookmark window (Window>IDE Tools>Bookmarks)
Bookmark History Popup Previous	goes to the previous bookmark in the Bookmark window (Window>IDE Tools>Bookmarks)
Next Error	scrolls the Source Editor to the line that contains the next build error
Previous Error	Scrolls the Source Editor to the line that contains the previous build error
Select in Projects	Opens Projects window and selects current document within it
Select in Files	Opens Files window and selects current document within it
Select in Classes	Opens Classes window and selects current document within it
Select in Favorites	Opens Favorites window and selects current document within it

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11.2.5 Source Menu

Below are the menu items in the Source menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-5: SOURCE MENU OPTIONS

Command	Action
Format	formats the selected code or the entire file if nothing is selected
Remove Trailing Spaces	removes spaces at the end of the line
Shift Left	moves the selected line or lines one tab to the left
Shift Right	moves the selected line or lines one tab to the right
Move Up	moves the selected line or lines one line up
Move Down	moves the selected line or lines one line down
Move Code Element Up	moves the selected code element up one line
Move Code Element Down	moves the selected code element down one line
Duplicate Up	copies the selected line or lines one line up
Duplicate Down	copies the selected line or lines one line down
Toggle Comment	toggles the commenting out of the current line or selected lines
Complete Code	shows the code completion box
Insert Code	pops up a context aware menu that you can use to generate common structures such as constructors, getters, and setters
Fix Code	displays editor hints The IDE informs you when a hint is available when the light bulb is displayed.
Show Method Parameters	selects the next parameter You must have a parameter selected (highlighted) for this shortcut to work.
Show Documentation	shows documentation for item under the cursor
Insert Next Matching Word	generates the next word used elsewhere in your code as you type its beginning characters
Insert Previous Matching Word	generates the previous word used elsewhere in your code as you type its beginning characters
Inspect	runs the specified inspection on the selected file, package, or project
Scan for External Changes	scans file for changes made outside of MPLAB® X IDE

11.2.6 Refactor Menu

Below are the menu items in the Refactor menu. The items you see are dependent on the type of object (variable, function, etc.) you are refactoring. For more information, see Section 7.7 "C Code Refactoring".

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-6: REFACTOR MENU OPTIONS

Command	Action
Rename	Enables you to change the name of a variable or function to something more meaningful. In addition, it updates all source code in your project to reference the element by its new name.
Move	moves a class to another package or into another class In addition, all source code in your project is updated to reference the class in its new location
Copy	copies a class to the same or a different package
Safely Delete	checks for references to a code element and then automatically deletes that element if no other code references it
Change Function Parameter	changes the amount and name of parameters for the selected function

11.2.7 Run Menu

Below are the menu items in the Run menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-7: RUN MENU OPTIONS

Command	Action
Run Project	runs the main or selected project
Test Project	starts JUnit test for project (Java related)
Build Project	builds all the files in a project
Clean and Build Project	removes (cleans) previously generated project files and then rebuild the files in a project
Batch Build Project	builds multiple configurations of a project (only embedded available)
Set Project Configuration	selects project configuration – should be "default"
Set Main Project	sets the main project by selecting from a list of open projects
Run File	runs the currently selected file
Test File	Starts JUnit test for current file. (Java related)
Check File	Checks a file against a standard. (XML related)
Validate File	Validates a file against a standard. (XML related)
Repeat Build/Run	Runs again after halt
Stop Build/Run	Ends run

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11.2.8 Debug Menu

Below are the menu items in the Debug menu. For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-8: DEBUG MENU OPTIONS

Command	Action
Debug Project	Debugs the main or selected project
Debug File	Starts debugging session for currently selected file
Debug Test File	Starts debugging test for file in JUnit (Java related)
Discrete Debugger Operation	Performs debug operations one step at a time (discretely): Build, Program Target, Launch Debugger This is useful for changing the Memory window setting during debug and using starter kits.
Finish Debugger Session	Ends the debugging session
Pause	Pauses debugging – use “Continue” to resume.
Continue	Resumes debugging after “Pause” until the next breakpoint or the end of the program is reached
Step Over	Executes one source line of a program If the line is a function call, executes the entire function and then stops.
Step Into	Executes one source line of a program If the line is a function call, it executes the program up to the function’s first statement and then stops.
Step Out	Executes one source line of a program. Finishes execution of the current function and stops on the source line immediately following the call to that function.
Step Instruction	Executes one machine instruction If the instruction is a function call, it executes the function and returns control to the caller.
Run to Cursor	Runs the current project to the cursor’s location in the file and stop program execution
Reset	Resets the device
Set PC at cursor	Sets the program counter (PC) value to the line address of the cursor
Focus Cursor at PC	Moves the cursor to the current PC address and centers this address in the window
Stack>Make Callee Current	Makes the method being called the current call Only available when a call is selected in the Call Stack window.
Stack>Make Caller Current	Makes the calling method the current call Only available when a call is selected in the Call Stack window.
Stack>Pop Topmost Call	Pops the call on top of the stack
Stack>Pop To Current Stack Frame	Pops the current stack from to the top of the stack
Stack>Pop Last Debugger Call	Pops the last call from the debug tool to the top of stack
Toggle Line Breakpoint	Adds a line breakpoint or removes the breakpoint at the cursor location in the program
New Breakpoint	Sets a new breakpoint at the specified line, exception, or method
New Watch	Adds the specified symbol to watch
New Run Time Watch	Adds the specified symbol to watch that will change value as the program runs/executes

TABLE 11-8: DEBUG MENU OPTIONS (CONTINUED)

Command	Action
Disconnect from Debug Tool	Disconnects communications between MPLAB® X IDE and the debug tool To reconnect, select Run/Debug Run.
Run Debugger/Programmer Self Test	Performs a debug tool self-test For tools that support a self test, follow the tool documentation to set up the hardware and then run this test to confirm proper operation.

11.2.9 Team Menu

Below are the menu items in the Team menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-9: TEAM MENU OPTIONS

Command	Action
Shelve Changes	Temporarily sets aside some not yet committed changes in a working directory as a patch file
Git, Mercurial, Subversion	Displays submenus that are specific to each version management system Please see the product documentation for more on the submenu options.
History	Shows the history of a file or reverts file to history version
Find Issues	Finds an issue in a version control system
Report an Issue	Reports an issue to a version control system
Create Build Job	Creates a build using a version control system

11.2.10 Tools Menu

Below are the menu items in the Tools menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-10: TOOLS MENU OPTIONS

Command	Action
Embedded	Visible if a plug-in has been added – select the plug-in from the submenu.
Licenses	• Allows roaming in and out of compiler licenses • Allows activation of a license For more information, see XCLM documentation under your compiler install path, in the `docs` directory.
Apply Diff Patch	Select the Diff patch file and apply to your code
Diff	Compares two files selected in the IDE
Templates	Opens the Template Manager
DTDs and XML Schemas	Opens the DTDs and XML Schemas Manager
Plugins	Opens the Plugins Manager For details, see the NetBeans help topic: Managing Plugins in the IDE
Options	Opens the Options dialog For Mac OS X: Use *mplab_ide>Preferences*.

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11.2.11 Window Menu

Below are the menu items in the Window menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-11: WINDOW MENU OPTIONS

Command	Action
Projects	Opens the Projects window
Files	Opens the Files window
Classes	Opens the Classes window
Favorites	Opens the Favorites window
Services	Opens the Services window
Dashboard	Opens the Dashboard window See Section 5.18 “View the Dashboard Display”.
Navigator	Opens the Navigator window
Acton Items	Opens the Action Items window
Tasks	Opens the Task List window
Output	Opens or moves to front the Output window
Editor	Opens an empty editor window
Debugging>Output	Opens debugging output windows: Disassembly Listing File
Debugging>Variables	Opens the Local Variables debugger window
Debugging>Watches	Opens the Watches debugger window
Debugging>Call Stack	Opens the Call Stack debugger window
Debugging>Breakpoints	Opens the Breakpoints window
Debugging>Sessions	Opens the Sessions window
Debugging>Sources	Opens the Sources window
Debugging>Disassembly	Opens the Disassembly window
Debugging>PIC AppIO	Opens the Application In/Out window Applies to the MPLAB® REAL ICE™ in-circuit emulator.
Debugging>Trace	Opens the Trace window Applies to the Simulator or MPLAB REAL ICE in-circuit emulator.
Debugging>Stopwatch	Opens the Stopwatch window
Debugging>*Other*	Depending on the debug tool selected and plugins installed, there may be other Debugging options available.
Web>Web Browser	Opens your default web browser
Web>CSS	Opens the CSS Styles window Enables you to edit the declarations of rules for HTML elements and selectors in a CSS file.
IDE Tools>Bookmarks	Opens the Bookmarks window Displays a list of the bookmarks in your files in your open projects.
IDE Tools>Notifications	Opens the Notifications window Displays a list of the IDE errors and warnings that occurred in the current IDE session.
IDE Tools>Terminal	Opens a Terminal window for a local or remote host
IDE Tools>Processes	Opens the Processes window You can attach a debug tool to a running process

TABLE 11-11: WINDOW MENU OPTIONS (CONTINUED)

Command	Action
PIC Memory Views>*Memory*	Opens specified Memory window Memories shown depend on the project device.
Simulator>Stimulus	Opens the Simulator Stimulus window
Simulator>Analyzer	Opens the Simulator Analyzer window
Simulator>IOPin	Opens the Simulator IO Pin window
Configure Window> Maximize	Maximizes the active window to the full IDE window size
Configure Window>Float	Opens a floating IDE window with a tab
Configure Window> Float Group	Opens a floating IDE window group with tabs
Configure Window>Minimize	Minimizes the active window to standard size
Configure Window> Minimize Group	Minimizes the window group to standard size
Configure Window>Dock	Restores a floating tab to the main window
Configure Window> Dock Group	Restores a floating tab group to the main window
Configure Window> Clone Document	Opens a new tab for the same document
Configure Window> Split Window	Splits the active document either vertically or horizontally.
Configure Window< New Document Tab Group	Splits the editor window into two groups of tabs and separates the selected tab into the new group
Configure Window>Collapse Document Tab Group	Combines separate group of tabs into one group
Reset Window	Resets windows to their default settings
Close Window	Closes the current tab in the current window If the window has no tabs, the whole window is closed.
Close All Documents	Closes all open documents in the Source Editor
Close Other Documents	Closes all open documents except the active one
Document Groups	Create named document group(s)
Documents	Opens the Documents dialog box, in which you can save and close groups of open documents

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11.2.12 Help Menu

Below are the menu items in the Help menu.

For keyboard shortcuts of some of these menu items, see *Help>Keyboard Shortcuts Card*.

TABLE 11-12: HELP MENU OPTIONS

Command	Action
Help Contents	Displays a JavaHelp viewer with all installed help files
Tool Help Contents	Displays a single JavaHelp viewer with a single tool help file
Online Docs and Support	Opens the NetBeans support web page
Keyboard Shortcuts Card	Displays the keyboard shortcuts document
Report Issue	Opens a window to report an IDE issue to NetBeans
MPLAB X Store	Opens the MPLAB X Store tab
Start Page	Opens or moves the **Start Page** tab in front of any other open tabs
About	Displays a window about MPLAB® IDE

11.3 TOOLBARS

MPLAB IDE displays different toolbars depending on which features or tools you are using. The icons in these toolbars provide shortcuts to routine tasks. To add or remove icons from a toolbar, or create a new toolbar, see Section 6.9 "Customize Toolbars".

Toolbar buttons may be grayed out for various reasons. See Section 11.5 "Grayed out or Missing Items and Buttons".

Toolbars Available

The following basic toolbars are available.

- File Toolbar
- Clipboard Toolbar
- Status Flags Toolbar
- Undo/Redo Toolbar
- Run Toolbar
- Debug Toolbar
- Performance Toolbar
- MPLAB X Store
- How Do I Toolbar
- Editor Toolbar

Toolbar Features

Toolbars have the following features:

- Hover the mouse pointer over an icon to pop up the icon function.
- Click and drag the toolbar to another location in the toolbar area.
- Right click in the toolbar area to show/hide a toolbar or change the contents of some toolbars.
- Select *View>Toolbars* to show/hide a toolbar, change the contents of some toolbars or create a custom toolbar.

11.3.1 File Toolbar

The File Toolbar currently contains button icons for the following functions. These functions are also on the File menu.

- New File – Creates a new file with the New File wizard.
- New Project – Creates a new project with the New Project wizard.
- Open Project – Opens an existing project.
- Save All Files – Saves all open files.

11.3.2 Clipboard Toolbar

The Clipboard Toolbar currently contains button icons for the following functions. These functions are also on the Edit menu.

- Cut – Deletes the current selection and places it on the clipboard.
- Copy – Copies the current selection to the clipboard.
- Paste – Pastes the contents of the clipboard into the insertion point.

11.3.3 Status Flags Toolbar

The Status Flags Toolbar contains:

- PC – Program Counter (PC) current value.

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11.3.4 Undo/Redo Toolbar

The Undo/Redo Toolbar currently contains button icons for the following functions. These functions are also on the Edit menu.

- Undo – Reverses (one at a time) a series of editor actions, except Save.
- Redo – Reverses (one at a time) a series of Undo commands.

11.3.5 Run Toolbar

The Run Toolbar currently contains button icons for the following functions. These functions are also on the Run, Debug and project context menus.

- Set Project Configuration – Selects project configuration. Choose “default” or “Customize”.
- Build Project – Builds all the project files. Click on down arrow for other related options.
- Clean and Build Project – Deletes files from previous builds and then builds the all project files. Click on down arrow for other related options.
- Make and Program Device Project – Builds, programs the target and Runs the selected project. Click on down arrow for other related options.
- Hold in Reset – Builds, programs the target and holds in Reset the selected project.
- Read Device Memory – Reads target device memory and loads into MPLAB X IDE. Click on down arrow for other related options.
- Debug Project – Builds, programs the target and Debug Runs the selected project.

11.3.6 Debug Toolbar

The Debug Toolbar currently contains button icons for the following functions. These functions are also on the Debug menu.

- Finish Debugger Session – Ends the debugging session.
- Pause – Pauses debugging. Use “Continue” to resume.
- Reset – Runs the current project to the cursor’s location in the file and stop program execution.
- Continue – Resumes debugging until the next breakpoint or the end of the program is reached.
- Step Over – Executes one source line of a program. If the line is a function call, executes the entire function then stops.
- Step Over Expression – Steps over the expression and then stops the debugging.
- Step Into – Executes one source line of a program. If the line is a function call, executes the program up to the function’s first statement and stops.
- Step Out – Executes one source line of a program. If the line is a function call, executes the functions and returns control to the caller.
- Run to Cursor – Runs the current project to the cursor’s location in the file and stop program execution.
- Apply Code Changes – Apply any changes in the code to the executing program.
- Set PC at cursor – Sets the program counter (PC) value to the line address of the cursor.
- Focus Cursor at PC – Moves the cursor to the current PC address and centers this address in the window.

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11.3.7 Performance Toolbar

The Performance Toolbar displays items to help you improve performance, such as memory uses with optional garbage collection and application profiling.

11.3.8 MPLAB X Store

Use the MPLAB X Store toolbar icon to open the store tab on the desktop.

11.3.9 How Do I Toolbar

This feature requires an Internet connection.

Search for information on the Microchip Wiki. Enter your question in the text box.

See also Section 11.2.12 "Help Menu".

11.3.10 Editor Toolbar

The Editor Toolbar currently contains button icons for the following functions. These functions are also on the Edit and Source menus. This toolbar appears at the top of the tab containing the current file source code.

FIGURE 11-2: EDITOR TOOLBAR

- Source – View source code
- History – View the history of source code edits
- Last Edited – Moves to the line that contains the last edit made.
- Back – Navigates back.
- Forward – Navigates forward.
- Find Selection – Finds the first occurrence of the selected text.
- Find Previous Occurrence – Finds the previous occurrence of the selected text.
- Find Next Occurrence – Finds the next occurrence of the selected text.
- Toggle Highlight Search – Turns on/off text selected for search.
- Previous Bookmark – Cycles backwards through the bookmarks.
- Next Bookmark – Cycles forward through the bookmarks.
- Toggle Bookmark – Sets a bookmark on a line of code.
- Shift Left – Moves the selected line or lines one tab to the left.
- Shift Right – Moves the selected line or lines one tab to the right.
- Start Macro Recording – Start recording keystrokes.
- Stop Macro Recording – Stop recording keystrokes.
- Comment – Makes selected line into a comment by adding "//".
- Uncomment – Makes selected comment into a line by removing "//".
- Go to Header/Source – Moves between the header and related source code.

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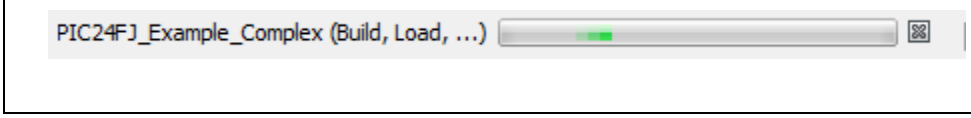
11.4 STATUS BAR

The status bar will provide up-to-date information on the status of your MPLAB IDE session. Editor information is also provided.

FIGURE 11-3: STATUS BAR EXAMPLE – DEBUG RUN



11.5 GRAYED OUT OR MISSING ITEMS AND BUTTONS

There are several reasons why a menu item, toolbar button or status bar item may be grayed out (unavailable) or missing:

- The item/button is related to a device feature that the selected device does not have, e.g., the PIC16F877A does not support external memory.
- The item/button is related to a tool feature that the selected tool does not have, e.g., “Step Out” is not available on MPLAB ICD 3.
- The item/button is project-related and no project has been selected, e.g., project build will not be available (No Active Project).
- The item/button is not supported for the selected device or tool.
- The item/button is performing its function and so cannot be selected again, e.g., “Run Project” is grayed out when the program is running.
- The item/button is mutually exclusive to another item, e.g., “Pause” is available when the program is running while “Continue” is grayed out, and “Continue” is available when the program is halted while “Pause” is grayed out.

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NOTES:

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Chapter 12. MPLAB X IDE Windows and Dialogs

12.1 INTRODUCTION

The MPLAB X IDE desktop is divided into panes containing tabbed windows. Not all of these are visible until a feature has been selected.

As an example, when you first open MPLAB X IDE, only the **Start Page** is open. After you open a project, the basic windows open – namely Project and Files in the top left pane, Navigator in the bottom left pane, and Output in the bottom right pane. The **Start Page** window moves into the top right pane.

MPLAB X IDE windows are a combination of basic NetBeans windows and MPLAB X IDE specific windows. Dialogs open when selected from menu items. As with windows, MPLAB X IDE dialogs are a combination of basic NetBeans dialogs and MPLAB X IDE specific dialogs. For information on NetBeans windows and dialogs, see Chapter 13. "NetBeans Windows and Dialogs".

12.2 MPLAB X IDE WINDOWS MANAGEMENT

Information on managing IDE windows may be found in the NetBeans help topic:

Managing IDE Windows

Additional window information is provided below.

12.2.1 Window Data Updates

Open windows are updated on a program halt (except for Flash memory windows, which must be read). A program halt includes a halt after a run and stepping. Halt updates can have the following effects:

- Speed – Updating takes time. To decrease update time, close any unused windows.
- Data overwrites – The value of a file register displayed in an open window is read on halt. See your device data sheet for the register operation on read.

12.2.2 Window Data Changes

MPLAB X IDE window data may be edited as described below. If you cannot edit the data, then this information is not available for you to change.

- Data may be edited "in place". Either double click to select an item and then type in a new value, or click on the ellipsis (...) next to an item and type the new value in the window that pops up.
- Data may be chosen from a drop-down list when only certain choices are possible.

12.2.3 Window Focus

To ensure that you have a window in focus, click not only on the window frame, but also on a button, a table cell, or a drop-down combo box.

12.3 MPLAB X IDE WINDOWS WITH RELATED MENUS AND DIALOGS

MPLAB X IDE uses some NetBeans windows as-is. However, other windows and their related menus are modified or created specifically for embedded use.

Specific Windows*	Related Menu
Call Stack Window	Window>Debugging>Call Stack
Breakpoints Window	Window>Debugging>Breakpoints
Customize Toolbars Window	View>Toolbars
Dashboard Window	Window
Hardware Stack Window	Window>PIC Memory Views>Hardware Stack
Memory Windows	Window>PIC Memory Views
Message Center	Window>Debugging>Output>Message Center
Output Window	Window>Output
Project Properties Window	File
Projects Window	Window
Tools Options Embedded Window	Tools>Options (Windows, Linux OS) mplab_ide>Preferences (Mac OS X)
Trace Window	Window>Debugging
Watches Window	Window>Debugging
Wizard Windows	File>New Project File>New File

* Depending on the tools you have installed, tool-specific windows may be available for viewing. See documentation about your tool for information regarding a specific window.

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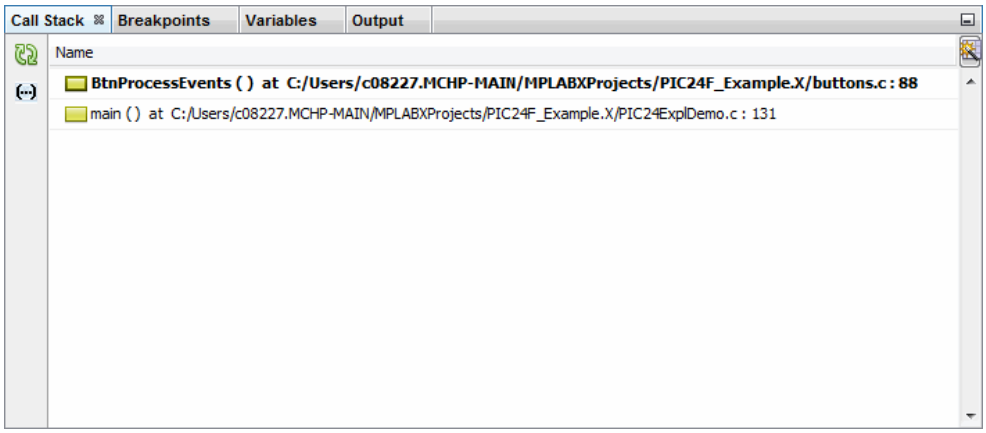
12.4 CALL STACK WINDOW

The Call Stack window displays C functions and their arguments listed in the order in which they were called in the executing program. C code that is not optimized works best.

The Call Stack is available for 16- and 32-bit devices. The window is updated on Debug Pause or Halt.

FIGURE 12-1: CALL STACK WINDOW



The following icons are available on the window on Pause or Halt.

TABLE 12-1: CALL STACK ICONS

Icon	Description
	Auto or Manual Refresh of Window Contents. Depends on the value of "Disable auto refresh for call stack view during debug sessions" under *Tools>Options>Embedded>Generic Settings* – Unchecked = false (default), checked = true. See Section 12.14.1 "Generic Settings Tab". False = Auto Refresh (Green Icon): The window contents are automatically updated on Pause or Halt. If the window is closed or not focused, selecting the window and clicking this button will display the updates without having to run and pause/halt again. True = Manual Refresh (Orange Icon): The window contents are not automatically updated on Pause or Halt. This button must be clicked to update window contents on a pause/halt.
	Select to disable/enable evaluation of function parameter variables.
	Change visible columns. For this window, show or hide location of call stack frame.

12.5 BREAKPOINTS WINDOW

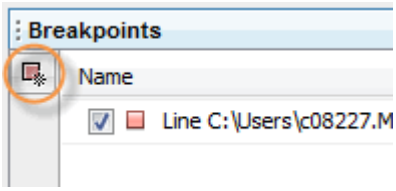
The Breakpoints window is used for setting and viewing breakpoints in code. Open the window by selecting *Window>Debugging>Breakpoints*.

For more on using the Breakpoints window, see Section 4.18 "Control Program Execution with Breakpoints".

12.5.1 New Breakpoint Dialog

Click the **Create New Breakpoint** button on the Breakpoint window to open the New Breakpoint dialog.

FIGURE 12-2: NEW BREAKPOINT BUTTON



The options available for the breakpoint are determined by the type of breakpoint selected, and the selected device (not all options are available for all devices).

12.5.2 Line Breakpoints

The following options are available for breakpoints specified on a line of code.

TABLE 12-2: BREAKPOINT TYPE: LINE – SETTINGS

Item	Description
Settings	Create a new Line break point with a left mouse click on the Editor gutter next to the file line. Or, select "Toggle Line Breakpoint" from the Editor context menu.

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12.5.3 Data Breakpoints

The following options are available for data memory breakpoints.

TABLE 12-3: BREAKPOINT TYPE: DATA – SETTINGS

Item	Description
Project	Select an open project from the drop-down list This is the project in which code will contain the breakpoint.
Symbols	Enter the name of a global symbol, or SFR, or browse to one by clicking **Symbols**. Accessing this symbol according to “Breaks on” triggers a pause in code execution.
Enable Range Address	Check to set a range breakpoint. Uncheck to set a single breakpoint.
Address Address (Start)	Depending on the selection of “Enable Range Address”, this item can be “Address” or “Address (Start)”. Enter a hexadecimal address in data memory Accessing this address according to “Breaks on” triggers a pause in code execution.
Address (End)	If “Enable Range Address” is checked, this box is enabled. Enter a hexadecimal address in data memory.
Breaks on	**Read**, **Write**, **Read or Write**: Break code execution when the symbol or address stated above is read, written, or either read or written. **Read Specific Value**, **Write Specific Value**, **Read or Write Specific Value**: Break code execution when the symbol or address stated above is read and has the value specified below, written with the value specified below, or either read or written according to the value specified below. **Note:** For dsPIC DSCs, there are read and write options for the X and Y buses.
Value	For the “Breaks on” selection of Read Specific Value, Write Specific Value, or Read or Write Specific Value, enter a hexadecimal value here.
Value Comparison	*For PIC16F1xxx devices only-* Compare to “Value” as specified: **= Value**: Equal to value **!= Value**: Not equal to value **> Value**: Greater than value **< Value**: Less than value
Data Value Mask	*For PIC16F1xxx devices only-* Use mask when comparing to “Value” Enter a value in the range 0x00 to 0xhh, where: 0x00: No bits compared 0xhh: All bits compared

TABLE 12-4: BREAKPOINT TYPE: DATA – PASS COUNT

Item	Description
Condition	Determine when the break specified under “Breaks on” occurs. **Always Break**: Always break when the “Breaks on” condition is met. **Break occurs Count Instructions after Event**: After an event (“Breaks on” condition) occurs, execute Count Instructions before actually breaking. **Event must occur Count times**: An event (“Breaks on” condition) must occur Count times before actually breaking.
Count*	According to the Condition specified, enter either a count for the number of instructions after an event or the number of events.

* See also Section “For some devices (PIC16F1xxx MCUs), enhanced event breakpoints actions are available.”.

TABLE 12-5: BREAKPOINT TYPE: DATA

Item	Description
Trigger Options	*For PIC16F1xxx devices only-* Select when to trigger, either: • Do not trigger out when breakpoint is reached • trigger out when breakpoint is reached
Interrupt Context	*For PIC16F1xxx devices only-* Interrupt Context qualifier for address/data breakpoints. Select from: • Always break (break in both ISR and main code) • Break in main line (non-interrupt) context only – break in main code only • Break in interrupt context only – break in ISR code only

12.5.4 Address Breakpoints

The following options are available for program memory breakpoints.

TABLE 12-6: BREAKPOINT TYPE: ADDRESS – SETTINGS

Item	Description
Project	selects an open project from the drop-down list This is the project in which code will contain the breakpoint.
Enable Range Address	Check to set a range breakpoint. Uncheck to set a single breakpoint.
Address Address (Start)	Depending on the selection of "Enable Range Address", this item may be "Address" or "Address (Start)". Enter a hexadecimal address in program memory. Accessing this address according to "Breaks on" triggers a pause in code execution.
Address (End)	If "Enable Range Address" is checked, this box is enabled. Enter a hexadecimal address in data memory.
Breaks on	**Program Memory Execution**: Break code execution when the address specified above is reached. **TBLRD Program Memory**: Break code execution when a table read to the address specified above occurs. **TBLWT Program Memory**: Break code execution when a table write to the address specified above occurs.

TABLE 12-7: BREAKPOINT TYPE: ADDRESS – PASS COUNT

Item	Description
Condition	determines when the break specified under "Breaks on" occurs **Always Break**: Always break when the "Breaks on" condition is met. **Break occurs Count Instructions after Event**: After an event ("Breaks on" condition) occurs, execute Count Instructions before actually breaking. **Event must occur Count times**: An event ("Breaks on" condition) must occur Count times before actually breaking.
Count*	according to the Condition specified, enters either a count for the number of instructions after an event or the number of events

* See also Section "For some devices (PIC16F1xxx MCUs), enhanced event breakpoints actions are available.".

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TABLE 12-8: BREAKPOINT TYPE: ADDRESS

Item	Description
Trigger Options	*For PIC16F1xxx devices only.* Select when to trigger, either: • Do not trigger out when breakpoint is reached • trigger out when breakpoint is reached
Interrupt Context	*For PIC16F1xxx devices only.* Interrupt Context qualifier for address/data breakpoints. Select from: • Always break (break in both ISR and main code) • Break in main line (non-interrupt) context only – break in main code only • Break in interrupt context only – break in ISR code only

12.5.5 Event Breakpoints

The following options are available for event breakpoints.

TABLE 12-9: BREAKPOINT TYPE: EVENT

Item	Description
Project	selects an open project from the drop down list This is the project whose code will contain the breakpoint.
Break on clock mode switch	breaks when the clock mode switches
Break on Reset instruction	breaks when a device Reset instruction occurs
Break on Sleep	breaks when Sleep is entered
Break on stack over/underflow	breaks when the stack either overflows or underflows
Break on wake up	breaks when the device wakes up from sleep
Break when watchdog timer has expired	breaks when the watchdog timer period has ended
Break on execution out of bounds	breaks when the program attempts to move out of normal program memory/space
Break on MCLR Reset	breaks on a Master Clear (MCLR) Reset
Break on trigger in signal	breaks when a Trigger In pulse is detected

* Select event(s) from the list that will cause executing code to pause (break). Some events may not be available for your device.

For some devices (PIC16F1xxx MCUs), enhanced event breakpoints actions are available.

Action	Description
Break	break (halt) execution per option specified
Trigger out	emit a trigger out pulse per option specified
Break and trigger out	break (halt) execution and emit a trigger out pulse per option specified

12.5.6 Pass Count Operation

Using a pass count allows you to delay breaking until after a specified count.

Break occurs Count Instructions after Event

Count is the number of instructions that execution passes after the breakpoint but before stopping.

For example,

- 0 specifies that execution stops immediately
- 1 specifies that execution stops after one additional instruction
- 10 specifies that execution stops after ten additional instructions

Event must occur Count times

Count is the number of times that execution passes the event until stopping.

For example,

- 0 specifies that execution stops immediately
- 1 specifies that execution passes the event one time, then stops the next time (the second time the event occurs)
- 10 specifies that execution passes the event ten times, then stops the next time (the eleventh time the event occurs)

12.6 CUSTOMIZE TOOLBARS WINDOW

You can customize MPLAB X IDE toolbars using the Customize Toolbars window. Select *View>Toolbars>Customize* to open the window.

For customization instructions, see Section 6.9 "Customize Toolbars".

12.7 DASHBOARD WINDOW

The Dashboard window contains general project information, such as checksums, memory usage, and breakpoint resources. See Section 5.18 "View the Dashboard Display" for details.

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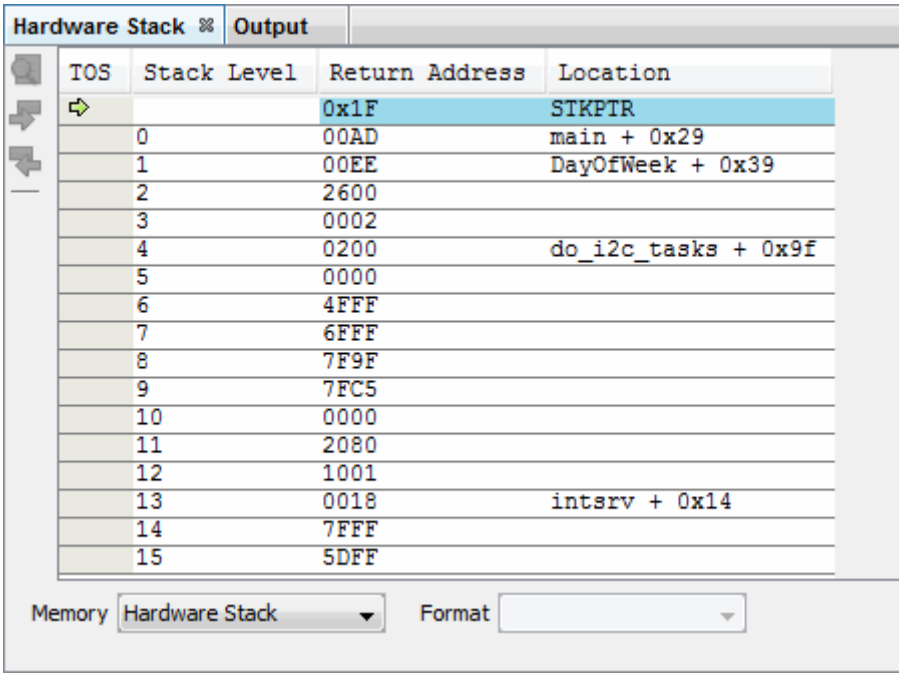
12.8 HARDWARE STACK WINDOW

View the contents of the hardware stack on halt.

To open the hardware stack window, select *Window>PIC Memory Views>Hardware Stack*. The first stack level is denoted by “0”.

FIGURE 12-3: HARDWARE STACK WINDOW



The following icons are available on the window on Pause or Halt.

TABLE 12-10: HW STACK ICONS

Icon	Description
Grayed Icons	Find, Find Next and Find Previous standard icons disabled. Since the whole stack is visible in the window, Find is not necessary.
	Auto or Manual Refresh of Window Contents. Depends on the value of “Disable auto refresh for call stack view during debug sessions” under *Tools>Options>Embedded>Generic Settings* – Unchecked = false (default), checked = true. See Section 12.14.1 “Generic Settings Tab”. False = Auto Refresh (Green Icon): The window contents are automatically updated on Pause or Halt. If the window is closed or not focused, selecting the window and clicking this button will display the updates without having to run and pause/halt again. True = Manual Refresh (Orange Icon): The window contents are not automatically updated on Pause or Halt. This button must be clicked to update window contents on a pause/halt.

12.9 MEMORY WINDOWS

Memory windows (*Window>PIC Memory Views*) display the many types of device memory, such as SFRs and Configuration bits. Use the "Memory" and "Format" drop-down boxes to customize your window.

For more on these controls, see Section 4.22 "View/Change Device Memory (including Configuration Bits)".

Available PIC Memory Views: 8- and 16-Bit Devices

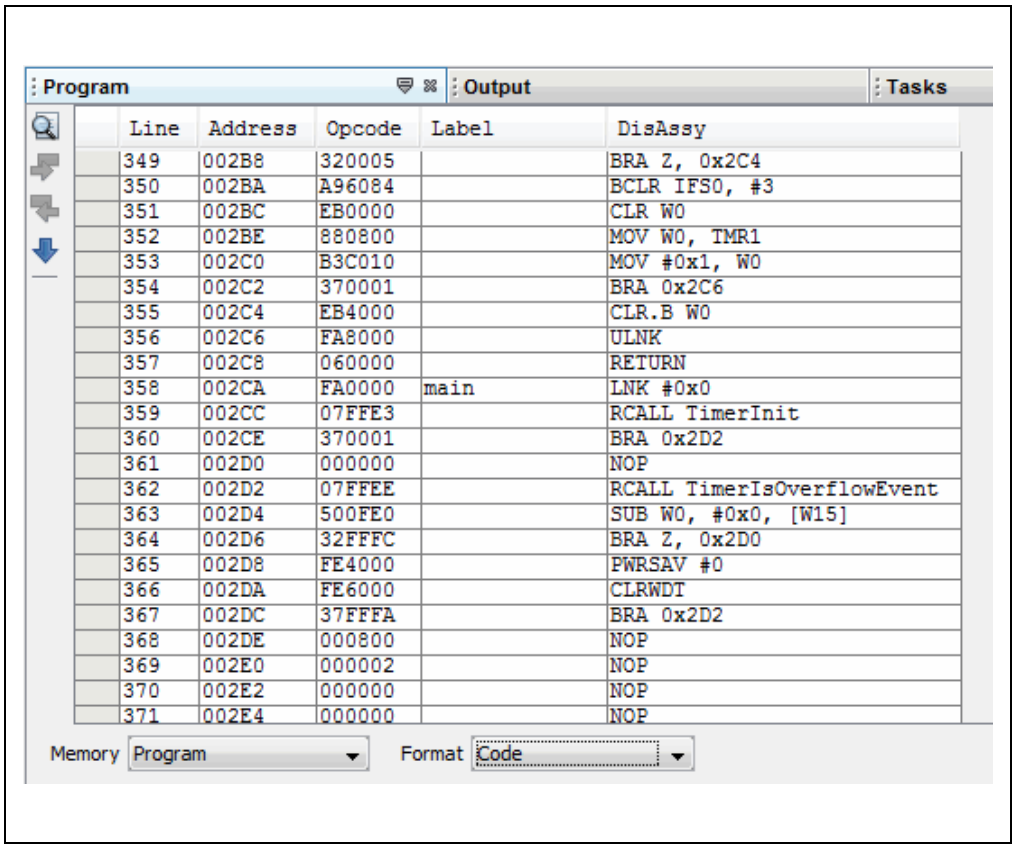
- Program Memory Window
- File Registers Window
- SFRs Window
- Configuration Bits Window
- EE Data Memory Window
- Other Memory Window

Available PIC Memory Views: 32-Bit Devices

- Execution Memory Window
- Data Memory Window
- Peripherals Window
- Configuration Bits Window
- CPU Registers Window
- User ID Memory Window

Memory Window Context (Right Click) Menu: the following section provides information about the context menu, Section 12.9.13 "Memory Window Menu".

FIGURE 12-4: MEMORY WINDOW WITH CONTENT



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12.9.1 Program Memory Window

The Program Memory window displays locations in the range of program memory for the currently selected processor. If external program memory is supported by the selected device and enabled, it will also appear in the Program Memory window.

For the MPLAB X Simulator, when a program memory value changes or the processor is halted, the data in the Program Memory window is updated.

For any Microchip hardware debug tool (e.g., MPLAB REAL ICE in-circuit emulator), when a program memory value changes or the processor is halted, the data in the Program Memory window is **not** updated; you must do a Read of device memory.

You may change the way opcodes are displayed in the program memory window by clicking one of the drop-down boxes on the bottom of the window:

- Code
- Hex
- PSV Mixed (dsPIC DSC/PIC24 devices only)
- PSV Data (dsPIC DSC/PIC24 devices only)

12.9.1.1 CODE

Code format displays disassembled hex code with symbols. The window will have the following columns:

- Debug Info – Information useful for debugging
  A pointer shows the current location of the program counter.
- Line – Reference line number
- Address – Opcode hexadecimal address
- Opcode – Hexadecimal opcode, shown in 2- or 3-byte blocks
  For most PIC MCUs, these blocks represent words.
  For PIC18CXXX devices, the blocks represent 2 bytes.
  For dsPIC DSC devices, the blocks represent 3 bytes.
- Label (Symbolic Only) – Opcode label in symbolic format.
- Disassembly – A disassembled version of the opcode mnemonic.

12.9.1.2 HEX

This format displays program memory information as hex code. The window will have the following columns:

- Address – Hexadecimal address of the opcode in the next column
- *Opcode Blocks* – Hexadecimal opcode, shown in 2- or 3-byte blocks
  For most PIC MCUs these blocks represent words. For PIC18CXXX devices, the blocks represent 2 bytes. For dsPIC DSC devices, the blocks represent 3 bytes. The opcode block that is highlighted represents the current location of the program counter.
- ASCII – ASCII representation of the corresponding line of opcode

12.9.1.3 PSV MIXED (dsPIC DSC/PIC24 DEVICES ONLY)

This format displays program memory as opcode and the PSV area (CORCON register, PSV bit set). The window will have the following columns:

- *Debug Info* – Information useful for debugging. A pointer shows the current location of the program counter.
- Line – Reference line number.
- Address – Opcode hexadecimal address.
- PSV Address – Data space hexadecimal address of the opcode.
- Data – Opcode formatted as data.
- Opcode – Hexadecimal opcode, shown in 3-byte blocks.
- Label – Opcode label in symbolic format.
- Disassembly – A disassembled version of the opcode mnemonic.

For more information, see the *dsPIC30F Family Reference Manual* (DS70046).

12.9.1.4 PSV DATA (dsPIC DSC/PIC24 DEVICES ONLY)

This format displays program memory as file registers, for when program space is visible in data space (CORCON register, PSV bit set). The window will have the following columns:

- Address – Program space hexadecimal address of the data
- PSV Address – Data space hexadecimal address of the data
- *Data Blocks* – Hexadecimal data, shown in 3-byte blocks
  The highlighted data block represents the current location of the program counter.
- ASCII – ASCII representation of the corresponding line of data

For more information, see the *dsPIC30F Family Reference Manual* (DS70046).

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12.9.2 File Registers Window

The File Registers window displays all the file registers of the selected device. When a file register value changes, or the processor is interrogated, the data in the File Registers window is updated.

> **Note:** To speed up debugging with certain hardware tools, close this window. Use the SFR or Watch window instead.

You may change the way data is displayed in the File Registers window by clicking one of the buttons on the bottom of the window.

12.9.2.1 HEX

This format displays file register information as hex data. The window has the following columns:

- Address – Hexadecimal address of the data in the next column
- *Data Blocks* – Hexadecimal data, shown in 1- or 2-byte blocks
- ASCII – ASCII representation of the corresponding line of data

12.9.2.2 SYMBOL

This format displays each file register symbolically with corresponding data in hex, decimal, binary and character formats. The window has the following columns:

- Address – Data hexadecimal address
- Symbol Name – Symbolic name for the data
- Radix Information – Hex, Decimal, Binary, Char
  Radix information is displayed in these four columns. Hex is shown in 1- or 2-byte blocks.

12.9.2.3 DUAL PORT (dsPIC33FJ DSC/PIC24HJ MCU DEVICES ONLY)

This format displays file register information as hex data. The window has the following columns:

- Address – Data hexadecimal address
- DMA Address – Offset from the silicon DMA address
- *Data Blocks* – Hexadecimal data, shown in 1- or 2-byte blocks
- ASCII – ASCII representation of the corresponding line of data

For information on dsPIC33F DSC and PIC24H MCU devices, see the Microchip web site for device data sheets and dsPIC33F and PIC24H Reference Manual sections.

12.9.2.4 XY DATA (dsPIC DSC DEVICES ONLY)

This format displays file register information as hex data. The window has the following columns:

- Address – X hexadecimal address of the data
- Y Bus – Y hexadecimal address of data, if supported
- *Data Blocks* – Hexadecimal data, shown in 2-byte blocks
- ASCII – ASCII representation of the corresponding line of data

For more information on dsPIC DSC devices, see “*dsPIC30F Family Reference Manual*” (DS70046).

12.9.3 SFRs Window

The Special Function Registers (SFRs) window displays the contents of the SFRs for the selected processor. The format provided by this window is more useful for viewing the SFRs than the normal file register window, since each SFR name is included and several number formats are presented. To view only a few SFRs, you might want to use a Watches window, which may help with speed issues when using hardware debug tools (i.e., faster window update rate).

Whenever a break occurs, the contents of the Special Function Registers are updated.

Visible Registers

If a data memory register is not physically implemented on a device, it may not appear in the SFR list. Some tools, such as simulators, may allow you to see registers that do not exist on the actual device, such as prescalers.

Single Stepping

If "Freeze Peripherals On Halt" is selected, the I/O port bits in the SFR or the Watches windows will not update when single stepping. The pin will be modified, but the read request to retrieve the new value is blocked by the freeze and cannot be updated until the next step or run command.

- Individual
- Peripheral

12.9.3.1 INDIVIDUAL

In this display, SFRs are listed by address.

Data is displayed in the following columns.

- Address – SFR hexadecimal address
- Name – Symbolic name for the SFR
- Radix Information – Hex, Decimal, Binary
  Radix information is displayed in these four columns. Hex is shown in 1-byte blocks.

12.9.3.2 PERIPHERAL

In this display, SFRs are grouped according to their related device peripherals.

Data is displayed in the following columns:

- Address – SFR hexadecimal address
- Name – Name of peripheral or symbolic name for the SFR
- Radix Information – Hex, Decimal, Binary, Char
  Radix information is displayed in these four columns. Hex is shown in 1-byte blocks.

Click the **Select Peripheral** button to view the SFRs for only the peripherals selected.

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12.9.4 Configuration Bits Window

Details about using the Configuration Bits window is discussed in Section 4.22.4 “Set Configuration Bits”.

Data is displayed in the following columns.

TABLE 12-11: CONFIGURATION BITS COLUMNAR DISPLAY

Column Head	Definition
Address	the address of the configuration word/byte
Name	the name of the Configuration Register
Value	the current value of the configuration word/byte
Field*	for configuration bits set in code, the field portion of the macro As an example, `WDTE` is the field portion of the macro `_WDTE_OFF`.
Option*	for configuration bits set in code, the option portion of the macro As an example, `OFF` is the option portion of the macro `_WDTE_OFF`.
Category	the name of the Configuration bit in the corresponding configuration word/byte
Setting	the current setting of the Configuration bit. Use the drop-down list to change the setting The Value of the configuration word/byte will change accordingly.

* Not all devices supported.

12.9.5 EE Data Memory Window

The EEPROM window displays EEPROM data for any microcontroller device that has EEPROM data memory (e.g., PIC16F1829). Data/opcode hex information of the selected device is shown.

For the MPLAB X Simulator, when an EEPROM register value changes or the processor is halted, the data in the EEPROM window is updated.

For any Microchip hardware debug tool (e.g., MPLAB REAL ICE in-circuit emulator), when an EEPROM register value changes or the processor is halted, the data in the EEPROM window is **not** updated; you must either do a Debug Read of device memory, if the device/header supports this, or you must exit from the debug session and then read the device data.

The start of EEPROM data memory needs to be specified for use with programmers. The table below shows some generic values, but please check the programming specification for your selected device to determine the correct address.

TABLE 12-12: PROGRAMMER – DATA EEPROM START ADDRESS

Device	Generic Start Address
Midrange MCUs	0x2100
Enhanced Midrange MCUs	0x1E000
PIC18F MCUs	0xF00000
PIC24 MCUs, dsPIC DSCs	0x7FFE00

This display format shows data in the following columns:

- Address – Hexadecimal address of the data in the next column
- Data Blocks – Hexadecimal data, shown in 1-, 2- or 4-byte blocks, selectable from the menu
- ASCII – ASCII representation of the corresponding line of data

12.9.6 Other Memory Window

This is a flexible memory window that allows you to select the other windows by using the Memory drop-down list on the bottom of the window.

12.9.7 Execution Memory Window

The Execution Memory window displays locations in the range of program and/or data memory for the currently selected PIC32MX device.

For the MPLAB X Simulator, when an execution memory value changes or the processor is halted, the data in the Execution Memory window is updated.

For any Microchip hardware debug tool (e.g., MPLAB REAL ICE in-circuit emulator), when an execution memory value changes or the processor is halted, the data in the Execution Memory window is **not** updated; you must do a Read of device memory.

You may select the type of memory displayed in the window by clicking on one of the tabs on the bottom of the window:

- Code View – Program Memory
- Data View – Data Memory

12.9.7.1 CODE VIEW – PROGRAM MEMORY

This format displays program memory information as hex code. The window will have the following columns:

- Line – Reference line number corresponding to memory address.
- Address – Physical hexadecimal address of the opcode.
- Opcode – Hexadecimal opcode, shown in 4-byte blocks. The opcode that is highlighted represents the current location of the program counter.
- Label – Opcode label in symbolic format.
- Disassembly – A disassembled version of the opcode mnemonic.

12.9.7.2 DATA VIEW – DATA MEMORY

This format displays data memory information as hex code. The window will have the following columns:

- Address – Hexadecimal address of the data in the next column.
- Data Blocks – Hexadecimal data, shown in 4-byte blocks.
- ASCII – ASCII representation of the corresponding line of data.

12.9.8 Data Memory Window

The Data Memory window displays locations in the range of data and/or program memory for the currently selected PIC32MX device.

You may select the type of memory displayed in the window by clicking on one of the tabs on the bottom of the window:

- Data View – Data Memory
- Code View – Program Memory

12.9.8.1 DATA VIEW – DATA MEMORY

This format displays data memory information as hex code. The window will have the following columns:

- Address – Hexadecimal address of the data in the next column.
- Data Blocks – Hexadecimal data, shown in 4-byte blocks.
- ASCII – ASCII representation of the corresponding line of data.

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12.9.8.2 CODE VIEW – PROGRAM MEMORY

This format displays program memory information as hex code. The window will have the following columns:

- Line – Reference line number corresponding to memory address
- Address – Physical hexadecimal address of the opcode
- Opcode – Hexadecimal opcode, shown in 4-byte blocks
  The opcode that is highlighted represents the current location of the program counter.
- Label – Opcode label in symbolic format
- Disassembly – A disassembled version of the opcode mnemonic

12.9.9 Peripherals Window

The Peripherals window displays the contents of the SFRs that relate to the device peripherals. To view only a few SFRs, you may prefer to use a Watch window, which may help with speed issues when using hardware debug tools (i.e., faster window update rate).

Whenever a break occurs, the contents of the SFRs are updated.

Visible Registers

If a data memory register is not physically implemented on a device, it may not appear in the SFR list. Some tools, such as simulators, may allow you to see registers that do not exist on the actual device, such as prescalers.

Single Stepping

If “Freeze Peripherals On Halt” is selected, the I/O port bits in the SFR or the Watch windows will not update when single stepping. The pin will be modified, but the read request to retrieve the new value is blocked by the freeze and cannot be updated until the next step or run command.

Data is displayed in the following columns.

- Address – SFR physical hexadecimal address.
- Virtual – SFR virtual hexadecimal address as defined by the Bus Matrix.
- Name – Symbolic name for the SFR.
- Radix Information – Hex, Decimal, Binary, Char
  You may add radix information to the display by right clicking on the column header bar. Hex is shown in 4-byte blocks.

12.9.10 Configuration Bits Window

Configuration bits available depend on the project device. Consult your device data sheet for options.

For more on the window, see Section 12.9.4 “Configuration Bits Window”.

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12.9.11 CPU Registers Window

The CPU Registers window displays the contents of the SFRs that relate to the device CPU. To view only a few CPU SFRs, you may prefer to use a Watches window, which may help with speed issues when using hardware debug tools (i.e., faster window update rate).

Whenever a break occurs, the contents of the CPU Registers are updated.

Visible Registers

If a data memory register is not physically implemented on a device, it may not appear in the SFR list. Some tools, such as simulators, may allow you to see registers that do not exist on the actual device, such as prescalers.

Single Stepping

If "Freeze Peripherals On Halt" is selected, the I/O port bits in the SFR or the Watches windows will not update when single stepping. The pin will be modified, but the read request to retrieve the new value is blocked by the freeze and cannot be updated until the next step or run command.

Data is displayed in the following columns.

- Address – SFR physical hexadecimal address.
- Name – Symbolic name for the SFR.
- Radix Information – Hex, Decimal, Binary, Char

  You may add radix information to the display by right clicking on the column header bar.
- Virtual – SFR virtual hexadecimal address as defined by the Bus Matrix.

12.9.12 User ID Memory Window

Some devices have memory locations where you can store checksum or other code identification (ID) numbers. These locations are readable and writable during program/verify. Depending on the device, they also may be accessible during normal execution through the `TBLRD` and `TBLWT` instructions.

Data is displayed in the following columns.

- Address – User ID hexadecimal address. Right click to view either the Virtual Address or Physical Address.
- User ID – Contents (in hex) of User ID memory.

Consult your device programming specification to determine what values may be entered here. For most devices, this sets the low nibble of the device ID word; the high nibble is set to '0'. The high nibble can be only be written to programmatically, such as by using Table Writes.

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12.9.13 Memory Window Menu

Right clicking in the Memory window will display various options as shown below. Not all options are available for all windows.

TABLE 12-13: MEMORY WINDOW MENU ITEM

Item	Description
Virtual Address Physical Address	display the type of address checked under the Address column
Hex Display Width	sets the hexadecimal display width (Options depend on the device selected.) 32-bit example: One byte, e.g., 00 01 02 ... 0E 0F Two bytes, e.g., 00 02 04 ... 0C 0E Four bytes, e.g., 00 04 08 0C
Run to Cursor	runs the program to the current cursor location
Set PC at Cursor	sets the Program Counter (PC) to the cursor location
Focus Cursor at PC	moves the cursor to the current PC address and centers this address in the window
Toggle Breakpoint	toggles (on/off) existing breakpoint
Symbolic Mode	displays disassembled hex code with symbols
Verbose Labels	shows internal compiler labels
Fill Memory	fills memory from Start Address to End Address with the value in Data Specify other options in the Fill Memory dialog.
Go To	goes to the address/function specified in the Go To dialog
Find	finds text specified in the Find dialog
Enable Multiline Rows	allows multiple lines in the Configuration Bits window
Output To File	writes the displayed window contents to a text file Specify a range of data to output in the Output to File Range dialog.
Import Table	imports tabular data from a file into a Memory window Specify a range of data to import in the Import Table Range dialog.
Export Table	exports tabular data from a Memory window into a file Specify a range of data to export in the Export Table Range dialog. Also, specify if the export is to be in a single column.
Print	prints the contents of this window **NOTE:** If you have a large memory device, the number of pages printed can become very large. A suggestion is to print the window contents to a file (Print dialog, **General** tab, “Print to File” checkbox) and then select which pages from the file you need to print.
Adjust Table Columns	adjusts the columns automatically

Right clicking on the **Window** tab will display other options, such as Close, Maximize/Minimize window, and Dock/Undock window.

12.10 MESSAGE CENTER

The Message Center is a window that collects all the output window messages and then presents them chronologically into one view. Different filters can be selected to display different relevant messages.

FIGURE 12-5: MESSAGE CENTER WINDOW

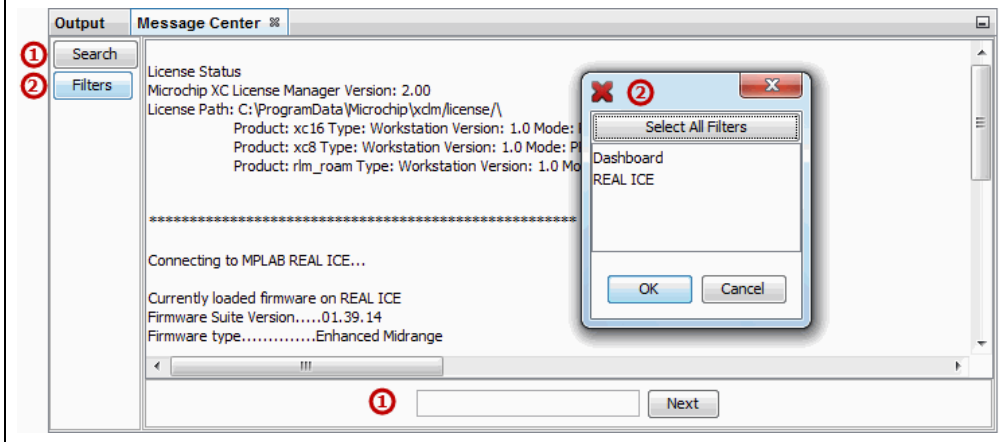

TABLE 12-14: MESSAGE CENTER BUTTONS

Number	Button	Function
1	Search	Toggle the search text box. When the search box is visible, enter text to search for that text string in the Message Center window.
2	Filters	By default, all messages that appear in the Output window are displayed in the Message Center window. Click this button to open a window with a list of Output window tabbed items. Filter messages displayed by selecting one or more from the list.

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12.11 OUTPUT WINDOW

The Task pane contains many windows, some inherited from NetBeans and some that are specific to MPLAB X IDE. The Output window contains the MPLAB X IDE output information. It is shown on tabs within the window.

TABLE 12-15: OUTPUT WINDOW TAB ITEMS

Item	Description
Debugger Console	shows main debug actions, such as “User program running”
Tool-specific	shows tool firmware version, device ID, and action status
Build, Load	shows information and status on the build, and program loading
Clean, Build, Load	shows information and status on the clean, build, and program loading
Peripheral Output	shows technical output from peripherals such as the UART, with the Simulator as the debug tool

Right clicking in the Output window will display various options as shown below.

TABLE 12-16: OUTPUT WINDOW MENU ITEMS

Menu Item	Description
Copy	copies selected text from the Output window to the clipboard
Paste	pastes selected text from the clipboard to the Output window
Find	finds the selected text, or enters other text to find, in the Output window You may use regular expressions and match case.
Find Next	finds the next occurrence of the Find text
Find Previous	finds the previous occurrence of the Find text
Filter	filters the output by text or regular expression
Wrap Text	wraps the text in the Output window
Larger Font	makes the font larger
Smaller Font	makes the font smaller
Choose Font	selects the font type, style and size
Save As	saves the selected text to a file
Clear	clears all text in the **Output window** tab
Close	closes the Output window

12.12 PROJECT PROPERTIES WINDOW

This window is used to view or change the project device, tools and tool settings. For more information, see:

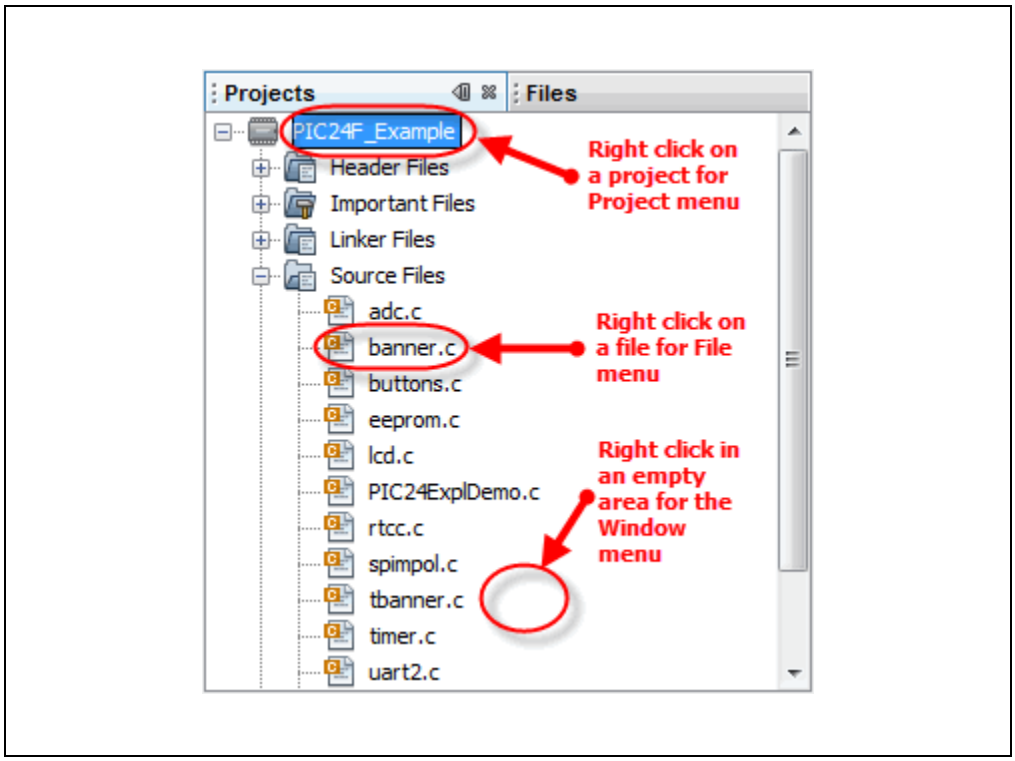
- Section 4.4 "View or Make Changes to Project Properties"
- Section 4.5 "Set Up or Change Debugger/Programmer Tool Options"
- Section 4.6 "Set Up or Change Language Tool Options"
- Section 5.4 "Loadable Projects, Files and Symbols"
- Section 4.12 "Add and Set Up Library and Object Files"
- Section 4.14 "Set Build Properties"

12.13 PROJECTS WINDOW

The Projects window is a NetBeans window. However, it has been customized to show the relevant logical (virtual) folders for an MPLAB X IDE project. Also, the context (right click) menus have been customized with items that are specific to MPLAB X IDE.

- Projects Window – Logical Folders
- Projects Window – Project Menu
- Projects Window – File Menu
- Projects Window – Window Menu

FIGURE 12-6: PROJECTS WINDOW CONTEXT MENUS



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12.13.1 Projects Window – Logical Folders

Additional logical folders have been added that apply to MPLAB X projects. Therefore, all folders displayed can be categorized as one of the following types of files:

- **Header Files** – MPLAB X IDE does not use this category when building. Consider it as a means to document a project's dependency on a header file, and a convenient method to access these files. You can double click on a file in the Projects window to open the file in an editor.
- **Linker Files** – You do not need to add a linker script to your project, because the project language tools will find the appropriate generic linker script for your device. So, this folder will be empty, unless you have created your own linker script.

  There should be only one file in this folder. If you have more than one linker script, only the first one has any effect – it is the linker script that the tool will use in the link step.
- **Source Files** – These are the only files that the toolchain will accept as input to its file commands.
- **Important Files** – Any file that does not fit into any of the other categories will end up in this folder.
  You can add project-specific data sheets (PDFs) to this location in the Projects window. Then, you can double click on the PDF to launch the data sheet. (This requires that a PDF reader is installed.)
- **Libraries** – The toolchain should take all of the files in this folder, as well as the object files, and include them in the final link step. For more information see Section 4.12 "Add and Set Up Library and Object Files".
- **Loadables** – Projects and files to combine with or replace your project hex files. For more information see Section 5.4 "Loadable Projects, Files and Symbols".

12.13.2 Projects Window – Project Menu

Right click on a project name in the Projects window to pop up the Project menu. Menu items are shown in Table 12-17.

TABLE 12-17: PROJECT CONTEXT MENU ITEMS

Menu Item	Description
New	adds a new item For MPLAB® X IDE, embedded file types are available.
Add Existing Item	adds an existing file to the project The path to the file may be auto (selected by MPLAB X IDE), absolute or relative. Additionally, you may choose to copy the file into the project folder.
Add Existing Items from Folders	adds all files contained in the specified folder(s) You may also specify a pattern to ignore certain folders from inclusion. Click **Default** to see the default pattern. See also *Tools>Options*, **Miscellaneous** button, **Files** tab, "Files ignored by the IDE".
New Logical Folder	creates a new logical folder To view actual folders, see the Files window.
Locate Headers	locates all the header files (.h) called out in the C code project files and presents them in a checklist window so they may be added to the project There are several reasons why you might want to add headers to your project: • The files can be opened from the Projects window under "Header Files" instead of hunting for them on your computer. • The project created by "Save Project As" will not contain header files unless they are added to the project; therefore this project may not build if any user-generated header files are required. • The zipped project created by "Package" will not contain header files unless they are added to the project; therefore the unzipped project may not build if any user-generated header files are required. This feature is able to locate user-generated header files for all Microchip toolchains.
Add Item to Important Files	adds an existing item to the project The path to the file may be auto (selected by MPLAB X IDE), absolute or relative. Additionally, you may choose to copy the file into the project folder. This is useful for adding simulator files, data sheet PDFs, and other files to the project for your reference.
Export Hex	exports the project build as a Hex file In MPLAB IDE v8, export is an extraction of memory objects. In MPLAB X IDE, export is the hex file result of a build; therefore, it needs to include all necessary auxiliary memory settings for configuration and EEPROM in code.
Build	builds the project according to the options selected in the Project Properties window **Note:** When you Debug or Run, your project is built automatically.
Clean and Build	cleans and then builds the project according to the options selected in the Project Properties window **Note:** When you Debug or Run, your project is built automatically.
Clean	cleans the project by deleting the outputs of previous builds
Package	packages the current project into a .zip file For details, see Section 6.6 "Package an MPLAB X IDE Project". "Locate Headers"

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TABLE 12-17: PROJECT CONTEXT MENU ITEMS (CONTINUED)

Menu Item	Description
Set Configuration	opens the Project Properties dialog so you can set the project configuration
Run	executes the project code For details, see Section 4.16 “Run Code”.
Debug	executes the project code in a debug environment For details, see Section 4.17 “Debug Run Code”.
Step In	steps through Paused code running in the debug environment For details, see Section 4.19 “Step Through Code”.
Make and Program Device	programs the target device and holds in Reset (do not run)
Set as Main Project	sets this project as the main project This is useful when you are working with multiple projects. See also Section 6.3 “Work with Multiple Projects”.
Open Required Projects	loads all other projects that are required for the selected project to run
Close	closes the selected project
Rename	renames the project
Move	moves the project to another location Along with the project, it moves the source files that are inside the project directory. Files outside the project directory are not moved. However, the project still maintains reference to the files outside the project directory – this is by design.
Copy	creates a copy of the project If the source files are within the project directory, the source files are also copied to the new location. Files outside the project directory are not copied. However, the project still maintains reference to the files outside the project directory – this is by design.
Delete	deletes the project files The project file is deleted but not the contents under the project directory. Only on selecting “Also delete sources” are all the source files deleted.
Code Assistance	selects assistance in creating code: code folding, code completion, etc.
Find	finds specific text in files in this project
Share on Team Server	shares this project on a Team Server For details, see Section 5.21 “Collaborate on Code Development and Error Tracking”.
Versioning	controls the version of the project by using a version control system For details, see Section 5.20 “Control Source Code”.
Local History	to view, or revert to, the local history for the project For details, see Section 5.20 “Control Source Code”.
Properties	sets project properties For MPLAB X IDE, the Project Properties window is specific to embedded development. See Section 12.12 “Project Properties Window”.

12.13.3 Projects Window – File Menu

Right click on a file name in the Projects window to pop up the File menu. Table 12-18 shows the specific menu items.

TABLE 12-18: FILE CONTEXT MENU ITEMS

Menu Item	Description
Open	opens this file in a tabbed Editor window.
Cut	removes the file from the project, but places a copy of it on the clipboard
Copy	places a copy of the file on the clipboard
Paste	to paste the clipboard copy of a file into the project
Compile File	compiles only the current file
Remove from Project	removes the file from the project This does not delete the file from the PC. To the delete the file from the project and the computer, use the Delete key.
Rename	renames the file.
Save as Template	saves the current file as a template file
Local History	to view, or revert to, the local history for the file For details, see Section 5.20 "Control Source Code".
Tools	file tools include: • **Apply Diff Patch:** applies an existing patch created by Diff • **Diff to:** shows the differences between this file and the one specified here • **Add to Favorites:** adds this file to the Favorites window
Properties	sets file properties differently from the project properties Select to exclude the file from the build or override the project build options by selecting a different configuration. See Section 4.13 "Set File and Folder Properties" for details.

12.13.4 Projects Window – Window Menu

Right click in an empty area in the Projects window to pop up the Window menu. Table 12-19 shows the specific menu items.

TABLE 12-19: FILE CONTEXT MENU ITEMS

Menu Item	Description
New Project	launches the New Project wizard For more information, see Section 4.2 "Create a New Project".
New File	launches the New File wizard For more information, see Section 4.9 "Create a New File".
Open Project	opens an existing project
Open Recent Project	opens an existing project for the list of recent projects
Open Project Group	opens an existing project group from the list of project groups
Run Project	runs the main project
Set Main Project	sets the main project from the list of open projects

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12.14 TOOLS OPTIONS EMBEDDED WINDOW

Open this window using *Tools>Options* (*mplab_ide>Preferences* for Mac OS X).

The Options window is a NetBeans window. However, it has been customized for MPLAB X IDE projects through the addition of an **Embedded** button. After clicking on this button, the following tabs and options will be available.

- Generic Settings Tab
- Project Options Tab
- Build Tools Tab
- Static Tools Tab
- Suppressible Messages Tab
- Diagnostics Tab
- Other Tab

12.14.1 Generic Settings Tab

Set up the log file and other project features.

TABLE 12-20: GENERIC SETTINGS TAB ITEMS

Item	Description
Open source file and locate line in editor when debugger halts	enables you to jump to a line of code on halt, such as caused by a breakpoint, to examine the code Disable to simply halt execution.
Clear tool output window on new session (debug, program, upload)	clears out the contents of the Output window when you begin a Run, Debug Run or upload
Halt build on first failure	When building, it halts the process on the first failure. The selected project language tool can be set up to determine which errors are produced. Go to the Project Properties dialog and select the language tool under "Categories". Then look for through the Option Categories to find one that allows you to set up errors, warnings, and/or messages.
Maintain active connection to hardware tool	If selected, it keeps hardware tool connected always, not just at runtime (MPLAB® IDE v8 behavior). When switching projects with this option selected (e.g., when developing bootloading applications), ensure tool and device are the same to avoid error messages.
Read Device Memory to File: Export only memory used	For the "Read Device Memory to File" icon/function, save only device memory used to a file.
Silent build	builds without generating messages in the Output window
Enable alternate watch list views during debug session	displays three watch view diamonds in the Watches window Associate a watch view with a watch variable. When you click on a watch view diamond, only the variables associated with that view will be displayed. So, this feature works like a filter.
Disable auto refresh for call stack view during debug sessions	Enable to automatically update contents on Pause or Halt. If the window is closed or not focused, selecting the window and clicking this button will display the updates without having to run and pause/halt again. Disable to manually update contents on Pause or Halt. This button must be clicked to update window contents on a pause/halt.
On mouse-over structure and array expressions, evaluate integral members only	Checked shows only integral members when mousing over structures or array expressions in code. Unchecked shows all members when mousing over structures or array expressions in code.
Hold-off period before memory view synchronization: Give priority to debug events (step over, step in, continue)	Specify a delay between when the device halts and when the device data is synced with a memory window. A longer delay can be set so that more single step executions can occur before an update. This is only applicable to general PIC Memory Views like file registers and data memory.
Reset @	selects an action on Reset **Main:** Stop at main() on Reset **Reset Vector:** Stop at the Reset vector on Reset
Debug start-up	selects an action on debug start **Run:** start execution immediately **Main:** stop at main() **Reset Vector:** stop at the Reset vector
Default Charset	selects the default character set for the project

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12.14.2 Project Options Tab

Set options related to the project.

TABLE 12-21: PROJECT OPTIONS TAB ITEMS

Item	Description
Make Options	Enter make options to use when building projects. These options are toolchain dependent. See your language tool documentation.
File Path Mode	specifies how to store file path information in a project **Auto:** paths to files inside project folder stored as relative; paths to files outside project folder stored as absolute **Always Relative:** all paths stored as relative to project folder **Always Absolute:** all paths stored as absolute (full path)
Save All Modified Files Before Running Make	If selected, saves all unsaved files in the IDE before running `make`. It is recommended to leave this property selected because modifications to files in the IDE are not recognized by make unless they are first saved to disk.
Reuse Output Tabs from Finished Process	When selected, output messages are displayed in the same tab in the Output window. When deselected, a new tab is opened for each new process.
Show profiler indicators during run (new projects only)	If selected, profiler tools such as CPU Usage and Memory Usage are set up to run by default when newly created projects are run. The tools that are shown are determined by the Profile Configuration selected in *Tools>Profiler Tools*.
Use parallel make (`make -j 2`*n*)	If selected, `make` will execute several processes at a time, where `-j` (or `--jobs`) is the option to run in parallel and `2`*n* is the number of processes, where *n* is the number of processors available on your computer. If your computer does not support parallel processing, parallel make will be disabled. If you wish, you can specify more processes by using "Make Options". Example: `-j 10`. **Note 1:** For MPLAB XC16 or MPLAB C30, Procedural Abstraction needs to be turned off to use parallel make (*File>Project Properties*, compiler category, "Optimizations" option category: uncheck "Unlimited procedural abstraction"). **Note 2:** MPASMX cannot run under parallel make, either as a toolchain or part of an MPLAB C18 project. The parallel make option is therefore ignored in projects using MPASMX toolchain or in projects using the C18 toolchain that contain at least one `.asm` file.
Force makefile regeneration when opening a project	Uncheck to allow MPLAB X IDE to determine whether or not a makefile should be regenerated when a project has opened (e.g., opening a project on a different computer). This is the default. Check to force regeneration of the makefile on project open. Use this if you suspect the makefile is not being regenerated when it needs to be. **Note:** Regeneration can take some time.

12.14.3 Build Tools Tab

The information on this tab is accessed differently for Mac computers. Access the build tools from *mplab_ide>Preferences* from the main menu bar. See Section 3.3.6 "Set Language Tool Locations".

Ensure that you have INSTALLED THE LANGUAGE TOOL or it will not show up on the "Toolchain" list. If you know you have installed it but it is not on the list, click **Scan for compilers**. If it is still not found click **Add** to add the tool to the list.

The following language tools are included with MPLAB X IDE:

- MPASM toolchain – includes MPASM assembler, MPLINK linker and utilities.

Other tools may be obtained from the Microchip web site (www.microchip.com) or third parties.

TABLE 12-22: BUILD TOOLS TAB ITEMS

Item	Description
Toolchain	shows a list of language tools installed on your computer Select the tool for your project and ensure that the paths (that apply) to the right are correct. **Base directory:** Path to the tool's main folder **C compiler:** Path to the C compiler (if available) **Assembler:** Path to the assembler (if available) **Make command:** Name of the make command generated by MPLAB® X IDE.
Add	adds a new language tool item to the list Also consider using **Scan for Build Tools**.
Add Custom Compiler	adds a customized compiler. In this case, you must specify Microchip devices supported.
Remove	removes a language tool item from the list This does not remove the language tool from the computer.
Default	Click on a tool and then click **Default** to make this tool the default compiler/assembler for the selected device.
Scan for Build Tools	scans the computer for installed compilers/assemblers in various default locations, ***not*** the whole system If you install in a different location, add the compiler manually.

12.14.4 Static Tools Tab

Select remote connections to use. Add a new connection for a Remote USB Tools Bridge, Remote Ethernet Tool or Generic Serial Port.

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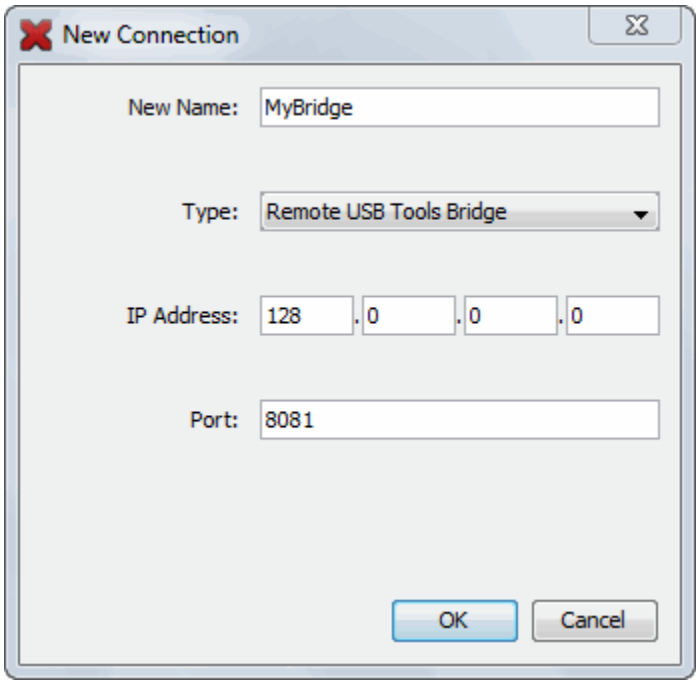
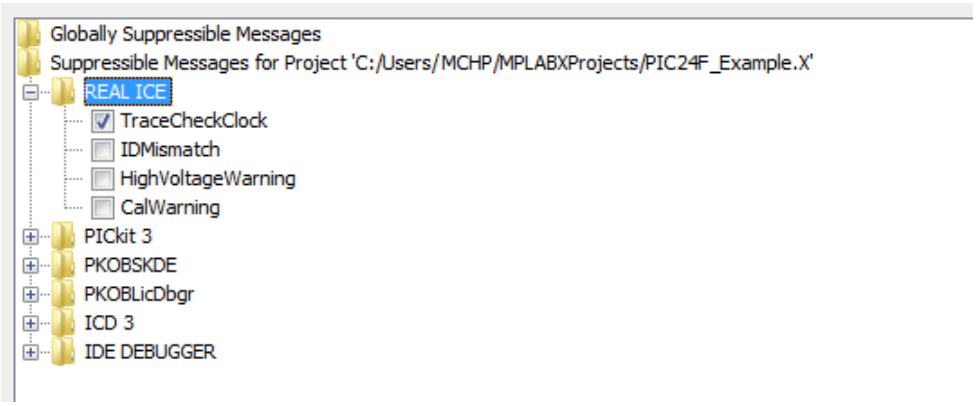
FIGURE 12-7: NEW STATIC TOOL



12.14.5 Suppressible Messages Tab

Select error and warming messages to suppress. Double click on available folders to drill down to available items to suppress.

FIGURE 12-8: SUPPRESSIBLE MESSAGES LIST



12.14.6 Diagnostics Tab

Set up the log file and other diagnostic features. See Section 6.8 "Log Data".

TABLE 12-23: DIAGNOSTICS TAB ITEMS

Item	Description
Logging Level	sets the message logging level **OFF:** no logging **SEVERE:** log severe (error) messages only **WARNING:** log warning messages only **INFO:** log informational messages only **CONFIG:** log configuration information only **FINE:** log some module to module communication **FINER:** log more module to module communication **FINEST:** log all module to module communication
Log File	The path and name of log file.
USB Circular Log	Applies only to MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 and PICkit 3.
Start New Logging Session/Pause Logging	Click buttons to begin a new logging session or pause the logging session in progress.
Circular USB log file location	specifies the path for the log file
Circular USB log file max size in KBs	specifies the size of the log file

12.14.7 Other Tab

Edit the lists of accepted file extensions for C/C++ and assembler source files and header files. Also, set the default extension for each type (displayed as bold)

TABLE 12-24: OTHER TAB ITEMS

Files	Default Extensions
C/C++ Header File	H, SUNWCCh, h, hpp, hxx, tcc
C++ File	C, c++, cc, cpp, cxx, mm
C File	c, i, m
Fortran File	not applicable. MPLAB X IDE does not support Fortran programming.
Assembly File	AS, ASM, S, as, asm, s
Assembly Include	INC, inc

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12.15 TRACE WINDOW

Tracing allows you to record the step-by-step execution of your code and examine this recording in the Trace window. Trace is currently available for the following tools:

- Simulator
- MPLAB REAL ICE in-circuit emulator

Right clicking on a trace column in the window will pop up the context menu (Table 12-25). Depending on the tool you are using, you may or may not see all menu items.

Dialogs associated with trace are defined in Table 12-26.

TABLE 12-25: TRACE WINDOW CONTEXT MENU

Menu Item	Description
Symbolic Mode	For the “Instruction” column, toggle between displaying literal register addresses (e.g., 0x5) or symbolic register macros (e.g., PORTA).
Go To	**Trigger:** move to the trigger line (0) **Top:** move to the top trace line **Bottom:** move to the bottom trace line **Trace Line:** specifies and goes to a trace line location Opens a Go To dialog.
Go To Source Line	selects a trace line and then selects this option to go to the corresponding line in source code
Display Time	For the “Cycle” column (will display if not previously visible): **As Hex Cycle Count:** displays cycle count as hexadecimal **As Decimal Cycle Count:** displays cycle count as decimal **In Seconds Elapsed:** displays cycle count in seconds elapsed **In Engineering Format:** displays cycle count in the appropriate engineering format (powers of 10^3)
Clear Trace File	clears the data in the trace display
Find	finds items in trace display Opens a Find dialog.
Output To File	saves the trace data to a file Opens Define Range dialog, which opens a Save dialog.
Print	print the data Opens a Print dialog.
Adjust Table Columns	adjusts the columns in the trace display to fit the data automatically
Reload View	reloads the original data view for the trace display at pause

TABLE 12-26: TRACE DIALOGS

Dialog	Description
Go To	specifies a trace line to go to
Find	finds a line number or other data in the trace display
Output to File Range	specifies a range of lines to output to a file Click **OK** to proceed to the Save dialog to save the data to a text file.
Save	save data to a text file
Print	specifies the printer, page setup, and appearance before printing

12.16 WATCHES WINDOW

Use the Watches window to watch the values of symbols that you select change. To open the Watches window, select *Window>Debugging>Watches*.

12.16.1 Watches Operation

For information on using the Watches window, see:

- Section 4.20 "Watch Symbol Values Change"
- the NetBeans Help topic *C/C++/Fortran Development>Debugging C/C++/Fortran Applications with gdb>Viewing C/C++/Fortran Program Information>Creating a C/C++/Fortran Watch*.

12.16.2 Watches Display

The display has the following features:

- Icons
- Columns
- Actions

12.16.2.1 ICONS

Icons are found to the left of the name object in the Name column:

TABLE 12-27: NAME COLUMN ICONS

Icon	Description
	Watch object
	Watch object in Program Memory
	Static field of an object
	Non-static field of an object

12.16.2.2 COLUMNS

You can change the columns displayed in the window by right clicking on a heading. See Section 12.16.4 "Change Visible Columns Dialog".

12.16.2.3 ACTIONS

Actions are on buttons on the left side of the window:

TABLE 12-28: NAME COLUMN ICONS

Button	Action
	Toggle button: - Show verbose (qualified) names of member fields. - Show brief (relative) names of member fields.
	Import watches from list file. Right click for options.
	Export all watches to list file.
	Set the default numeric format for the Value field.

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12.16.3 Watches Menus

Right click in a blank area of a Watches window (not a row) to open a Watches window menu with basic functions.

TABLE 12-29: WATCHES WINDOW MENU – WINDOW

Menu Item	Description
New Watch*	adds a new symbol to watch
New Runtime Watch*	*MPLAB REAL ICE In-Circuit Emulator Only* adds a new runtime watch for the selected symbol
Export All Watches to List File	exports information about the symbols to be watched to a file (`.xwatch`)
Delete All	removes all the watched symbols from the Watches window

* You can also right click in a symbol in code to add a New Watch or New Runtime Watch.

Right click on a row to open a Watches menu with additional functions that depend on whether a symbol is in the row or what debug tool you are using.

TABLE 12-30: WATCHES WINDOW MENU – ROW

Menu Item	Description
New Watch	adds a new symbol to watch
New Runtime Watch	*MPLAB REAL ICE In-Circuit Emulator Only* adds a new runtime watch for the selected symbol
Run Time Update Interval	*MPLAB REAL ICE In-Circuit Emulator Only* specifies the rate at which the symbol value will be updated “No Delay” will update as quickly as your personal computer is able. If you are seeing errors in the runtime data, you can add a delay to decrease the update speed.
Export Selected Watches to List File	exports information about the symbol(s) to be watched to a file (`.xwatch`) You can select more than one row using Shift click (select several rows in order) or Ctrl click (select several rows individually).
Export Data	exports watch data to a CVS file or as a literal string
Delete	deletes selected symbol row(s) from the watch list You can also select a row and hit the <Delete> key.
Delete All	removes all the watched symbols from the Watches window
Display Value Column as	displays the symbol value in the selected row in one of the formats listed
User Defined Size	specifies the size of the program memory symbol from the list

12.16.4 Change Visible Columns Dialog

Change the columns displayed in the Watches window by right clicking on a heading to pop up the "Change Visible Columns" dialog.

TABLE 12-31: CHANGE VISIBLE COLUMNS ITEMS

Dialog Item	If Checked
Name	shows the name of column (always checked)
Address	shows the memory address of variable
Binary	shows the binary formatted value
Char	shows the character formatted value
Decimal	shows the decimal formatted value
Hexadecimal	shows the hexadecimal formatted value
Type	shows the type of watch variable
Value	shows the value of watch expression (in hexadecimal)

12.16.5 Fractional Integer Properties Dialog

This dialog is intended to improve support for evaluating all fixed-point operation modes supported by dsPIC and PIC32 devices. View this dialog from the pop-up menu item *Display Value Column as>Fractional Integer* to select this feature, and *Display Value Column as>Fractional Properties* optionally afterwards.

TABLE 12-32: FRACTIONAL PROPERTIES DIALOG ITEMS

Dialog Item	Description
Variable	The name of the variable, for reference.
N*	The total number of bits available to represent the integer number.
Qm	The whole part of the fixed data format. 'm' represents the number bits used to specify the whole part.
Qn	The fractional part of the fixed data format. 'n' represents the number of bits used to specify the fractional part.
Signed*	Check to use a bit to represent a signed value.
Slider	Click and drag the slider to select the fixed point position (Qm vs. Qn) to be applied to the calculation of the fixed point fractional value.

* If the variable type is unknown, these items are made editable.

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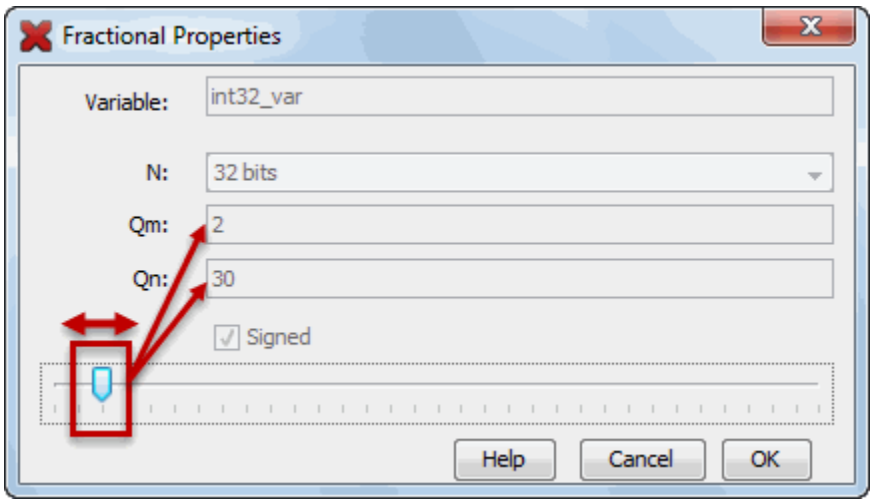
FIGURE 12-9: FRACTIONAL PROPERTIES DIALOG



12.17 WIZARD WINDOWS

MPLAB X IDE uses many NetBeans windows. However, some windows have been modified or created specifically for embedded use.

- New Project wizard – see Section 4.2 "Create a New Project"
- New File wizard – see Section 4.9 "Create a New File"
- Import Image File wizard – see Section 5.3.3 "Import Image File Wizard"

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Chapter 13. NetBeans Windows and Dialogs

13.1 INTRODUCTION

MPLAB X IDE windows are a combination of basic NetBeans windows and MPLAB X IDE specific windows. Dialogs open when selected from menu items. As with windows, MPLAB X IDE dialogs are a combination of basic NetBeans dialogs and MPLAB X IDE specific dialogs.

NetBeans windows and dialogs are discussed here, with references to documentation. For information on MPLAB X IDE specific windows and dialogs, see Chapter 12. "MPLAB X IDE Windows and Dialogs".

- NetBeans Specific Windows and Window Menus
- NetBeans Specific Dialogs

13.2 NETBEANS SPECIFIC WINDOWS AND WINDOW MENUS

NetBeans windows are discussed in NetBeans help or web documentation (see "Preface".) To open help on a window, click on the **Window** tab to select it and then hit the <F1> key. If no help can be found, select *Help>Help Contents* and click the help file's **Search** tab to search for information on that window. Or, see the NetBeans help topic "Managing IDE Windows".

To open most windows, see the Section 11.2.11 "Window Menu".

Windows may be docked and undocked (right click on the **Window** tab) and have window-specific pop-up, or context, menus with items such as Fill, Goto, and Edit Cells. Right clicking in a window or on an item in the window will pop up a context menu. Most content menu items are also located on menus on the desktop menu bar (see Section 11.2 "Menus").

Set up window properties by selecting *Tools>Options* (*mplab_ide>Preferences* for Mac OS X), **Miscellaneous** button, **Appearance** tab.

13.3 NETBEANS SPECIFIC DIALOGS

NetBeans dialogs are discussed in NetBeans help. To open help on a dialog, click the **Help** button on the dialog or, if there is no **Help** button, press the <F1> key. If no help can be found, select *Help>Help Contents* and click the help file's **Search** tab to search for information on that dialog.

To open most dialogs, see Section 11.2 "Menus".

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NOTES:

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Appendix A. Configuration Settings Summary

A.1 INTRODUCTION

Examples of how to set Configuration bits in code for different language tools and related devices are shown below. For more information on how to set Configuration bits, see your language tool documentation. For some language tools, a configurations settings document is available listing all configuration settings for a device. Otherwise, consult your device header file for macros.

Another option is to use the Configuration Memory window to set bits and then click "Generate Source Code to Output". See Section 4.22.4 "Set Configuration Bits".

The MPLAB Code Configurator (MCC) for 8- and 16-bit devices and MPLAB Harmony for 32-bit devices are tools that can be used to generate configuration bits, as well as project code, for you. See the Microchip website for more information on these tools.

- XC Toolchains
- MPASM Toolchain
- C18 Toolchain
- HI-TECH® PICC™ Toolchain
- HI-TECH® PICC-18™ Toolchain
- ASM30 Toolchain
- C30 Toolchain
- C32 Toolchain

A.2 XC TOOLCHAINS

To create code that is as portable as possible, refer to the "Common Compiler Interface (CCI)" chapter, config macro, in each of the following documents:

- MPLAB XC8 C Compiler User's Guide (DS50002053) or related help file
- MPLAB XC16 C Compiler User's Guide (DS50002071) or related help file
- MPLAB XC32 C Compiler User's Guide (DS50001686) or related help file

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A.3 MPASM TOOLCHAIN

Two types of assembler directives are used to set device configuration bits: `__config` and `config`. DO NOT mix `__config` and `config` in the same code.

A.3.1 __config

The directive `__config` is used for PIC10/12/16 MCUs. It may be used for PIC18 MCUs (excluding PIC18FXXJ devices) but the `config` directive is recommended. The syntax is as follows:

```
__config expr        ;For a single configuration word
```

or

```
__config addr, expr  ;For multiple configuration word
```

where:

addr: Address of the Configuration Word. May be literal but usually represented by a macro.
Note: Macros *must* be listed in ascending register order.

expr: Expression representing the value to which the specified Configuration bits will be set. May be literal but usually represented by a macro or macros ANDed together.

Macros are specified in the device include file (`*.inc`) that is located in the Windows operating system (OS) default directory:

```
C:\Program Files\Microchip\MPLABX\mpasmx
```

Directive case does not matter; `__CONFIG` or `__config` is acceptable. Macro case should match what is in the header.

Example – PIC10/12/16 MCUs

```
#include p16f877a.inc

;Set oscillator to HS, watchdog time off, low-voltage prog. off
__CONFIG _HS_OSC & _WDT_OFF & _LVP_OFF
```

Example – PIC18 MCUs

```
#include p18f452.inc

;Oscillator switch enabled, RC oscillator with OSC2 as I/O pin.
__CONFIG    _CONFIG1, _OSCS_OFF_1 & _RCIO_OSC_1

;Watch Dog Timer enable, Watch Dog Timer PostScaler count - 1:128
__CONFIG    _CONFIG3, _WDT_ON_3 & _WDTPS_128_3
```

A.3.2 config

The directive `config` is used for PIC18 MCUs (including PIC18FXXJ devices). The syntax is as follows:

```
config setting=value [, setting=value]
```

where:

setting: Macro representing a Configuration bit or bits.

value: Macro representing the value to which the specified Configuration bit(s) will be set. Multiple settings may be defined on a single line, separated by commas. Settings for a single configuration byte may also be defined on separate lines.

Macros are specified in the device include file (`*.inc`) that is located in the Windows OS default directory:

```
C:\Program Files\Microchip\MPLABX\mpasmx
```


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Directive case does not matter; `__CONFIG` or `__config` is acceptable. Macro case should match what is in the header.

Example – PIC18 MCUs

```
#include p18f452.inc

;Oscillator switch enabled, RC oscillator with OSC2 as I/O pin.
CONFIG     OSCS=ON, OSC=LP

;Watch Dog Timer enable, Watch Dog Timer PostScaler count - 1:128
CONFIG     WDT=ON, WDTPS=128
```

A.4 C18 TOOLCHAIN

The `#pragma config` directive specifies the device-specific configuration settings (i.e., Configuration bits) to be used by the application:

`#pragma config` *`setting-list`*

where

`setting-list:`	A list of one or more *`setting-name`* = *`value-name`* macro pairs, separated by commas.

Macros are specified in the device header file (`*.h`) that is located in the Windows default directory:

`C:\program files\microchip\mplabc18\v`*`x.xx`*`\.h`

Pragma case does not matter; either `#PRAGMA CONFIG` or `#pragma config` is acceptable. Macro case should match what is in the header.

Example

```
#include <p18cxxx.h>

/*Oscillator switch enabled, RC oscillator with OSC2 as I/O pin.*/
#pragma config OSCS = ON, OSC = LP

/*Watch Dog Timer enable, Watch Dog Timer PostScaler count - 1:128*/
#pragma config WDT = ON, WDTPS = 128
```

A.5 HI-TECH® PICC™ TOOLCHAIN

A macro specified in the `htc.h` header file is used to set device Configuration Words for PIC10/12/16 MCUs:

`__CONFIG(x);`

where

x: Expression representing the value to which the specified Configuration bits will be set. May be literal but usually represented by a macro or macros ANDed together.

Macros are specified in the device header file (`*.h`) that is located in the Windows OS default directory:

`C:\Program Files\HI-TECH Software\PICC\v*x.xx*\include`

where *version* is the version number of the compiler.

For devices that have more than one Configuration Word location, each subsequent invocation of `__CONFIG()` will modify the next Configuration Word in sequence.

Macro case should match what is in the relevant header. For `htc.c`, `__CONFIG()` is correct but `__config()` is not.

PICC Example

```
#include <htc.h>

__CONFIG(WDTDIS & XT & UNPROTECT); // Program config. word 1
__CONFIG(FCMEN);                   // Program config. word 2
```

A.6 HI-TECH® PICC-18™ TOOLCHAIN

A macro specified in the `htc.h` header file is used to set device Configuration Words for PIC18 MCUs:

`__CONFIG(n,x);`

where

n: Configuration register number

x: Expression representing the value to which the specified Configuration bits will be set. May be literal but usually represented by a macro or macros ANDed together.

Macros are specified in the device header file (`*.h`) that is located in the Windows OS default directory:

`C:\Program Files\HI-TECH Software\PICC\v*x.xx*\include`

where *version* is the version number of the compiler.

Macro case should match what is in the relevant header. For `htc.c`, `__CONFIG()` is correct but `__config()` is not.

PICC-18 Example

```
#include <htc.h>

//Oscillator switch enabled, RC oscillator with OSC2 as I/O pin.
__CONFIG(1, LP);

//Watch Dog Timer enable, Watch Dog Timer PostScaler count - 1:128
__CONFIG(2, WDTEN & WDTPS128);
```


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A.7 ASM30 TOOLCHAIN

A macro specified in the device include file is used to set Configuration bits:

```
config __reg, value
```

where

__reg: Configuration register name macro.

value: Expression representing the value to which the specified Configuration bits will be set. May be literal but usually represented by a macro or macros ANDed together.

Macros are specified in the device include file (`*.inc`) that is located in the Windows OS default directory:

```
C:\Program Files\Microchip\MPLAB ASM30 Suite\Support\device\inc
```

where *device* is the abbreviation of the selected 16-bit device, such as PIC24H or dsPIC33F.

Macro case should match what is in the relevant header. For example, `config` is correct but `CONFIG` is not.

MPLAB® Assembler, Linker and Utilities for PIC24 MCUs and dsPIC® DSCs User's Guide

Example

```
.include "p30fxxxx.inc"

;Clock switching off, Fail-safe clock monitoring off,
; Use External Clock
config __FOSC, CSW_FSCM_OFF & XT_PLL16

;Turn off Watchdog Timer
config __FWDT, WDT_OFF
```

A.8 C30 TOOLCHAIN

Two types of compiler macros are used to set device Configuration bits: one type for PIC24F MCUs and one type for dsPIC30F and dsPIC33F/PIC24H devices.

A.8.1 PIC24F Configuration Settings

Macros are provided in device header files to set Configuration bits:

```
_confign(value);
```

where

n: Configuration register number.

value: Expression representing the value to which the specified Configuration bits will be set. May be literal but usually represented by a macro or macros ANDed together.

Macros are specified in the device header file (`*.h`) that is located in the Windows OS default directory:

```
C:\Program Files\Microchip\MPLAB C30\support\PIC24F\h
```

Macro case should match what is in the relevant header. For example, `_CONFIG1` is correct but `_config1` is not.

Example – PIC24F MCUs

```
#include "p24Fxxxx.h"

//JTAG off, Code Protect off, Write Protect off, COE mode off, WDT off
_CONFIG1( JTAGEN_OFF & GCP_OFF & GWRP_OFF & COE_OFF & FWDTEN_OFF )

//Clock switching/monitor off, Oscillator (RC15) on,
// Oscillator in HS mode, Use primary oscillator (no PLL)
_CONFIG2( FCKSM_CSDCMD & OSCIOFNC_ON & POSCMOD_HS & FNOSC_PRI )
```

A.8.2 dsPIC30F/33F/PIC24H Configuration Settings

Macros are provided in device header files to set Configuration bits:

_reg(*value*);

where

_reg: Configuration register name macro.

value: Expression representing the value to which the specified Configuration bits will be set. May be literal but usually represented by a macro or macros ANDed together.

Macros are specified in the device header file (*.h) that is located in the Windows OS default directory:

C:\Program Files\Microchip\MPLAB C30\support*device*\h

where *device* is the abbreviation of the selected 16-bit device, i.e., PIC24H, dsPIC30F, or dsPIC33F.

Macro case should match what is in the relevant header. For example, _FOSC is correct but, _fosc is not.

MPLAB® C Compiler for PIC24 MCUs and dsPIC® DSCs User's Guide

Example – dsPIC30F DSCs

```
#include "p30fxxxx.h"

//Clock switching and failsafe clock monitoring off,
// Oscillator in HS mode
_FOSC(CSW_FSCM_OFF & HS);

//Watchdog timer off
_FWDT(WDT_OFF);

//Brown-out off, Master clear on
_FBORPOR(PBOR_OFF & MCLR_EN);
```

Example – dsPIC33F/PIC24H Devices

```
#include "p33fxxxx.h"

// Use primary oscillator (no PLL)
_FOSCSEL(FNOSC_PRI);

//Oscillator in HS mode
_FOSC(POSCMD_HS);

//Watchdog timer off
_FWDT(FWDTEN_OFF);

//JTAG off
_FICD(JTAGEN_OFF);
```


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A.9 C32 TOOLCHAIN

The `#pragma config` directive specifies the device-specific configuration settings (i.e., Configuration bits) to be used by the application:

`# pragma config` *`setting-list`*

where

`setting-list:`	A list of one or more *`setting-name`* = *`value-name`* macro pairs, separated by commas.

Macros are specified in the device header file (`*.h`) that is located in the Windows OS default directory:

`C:\Program Files\Microchip\MPLAB C32\pic32mx\include\proc`

Pragma case does not matter; either `#PRAGMA CONFIG` or `#pragma config` is acceptable. Macro case should match what is in the header.

MPLAB® C Compiler for PIC32 MCUs User's Guide

Example

```
#include "p32xxxx.h"

//Enables the Watchdog Timer,
// Sets the Watchdog Postscaler to 1:128
#pragma config FWDTEN = ON, WDTPS = PS128

//Selects the HS Oscillator for the Primary Oscillator
#pragma config POSCMOD = HS
```

NOTES:

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Appendix B. Working Outside the IDE

B.1 INTRODUCTION

MPLAB X IDE is designed to help you write, debug and release applications for embedded systems. However, your company may have requirements that make code development outside the IDE necessary.

You can build your code outside MPLAB X IDE following the instructions in this chapter. If you need to debug this code, you can import it into an MPLAB X IDE project. See Section 5.3 "Prebuilt Projects" and Section 5.4 "Loadable Projects, Files and Symbols" for more information.

Alternatively, you can compile your code with debug information and use the command-line Microchip Debugger (MDB), which comes with each version of MPLAB X IDE, to debug your code. For more on MDB, see the *Microchip Debugger (MDB) User's Guide* (DS50002102), found in the `<MPLAB X IDE installation>/docs` directory.

- Compiling for Debug Outside of MPLAB X IDE
- Building a Project Outside of MPLAB X IDE
- Creating Makefiles Outside of MPLAB X IDE
- Working with Revision Control Systems

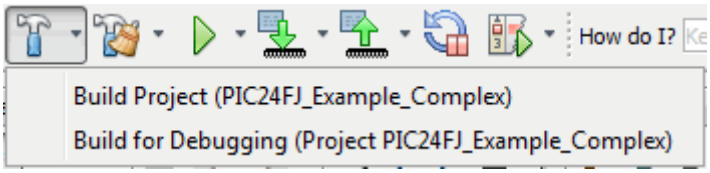
B.2 COMPILING FOR DEBUG OUTSIDE OF MPLAB X IDE

To compile code for debugging outside of MPLAB X IDE, you must ensure you pass the correct parameters to the compiler and/or the linker to reserve the areas required by the specific tool being used. The parameter values depend on the debug tool being used and on the compiler being used. Furthermore, the version of the compiler might determine the specific mechanism used to reserve these areas.

MPLAB X IDE has the knowledge to determine what needs to be passed to the compiler/assembler/linker. So, the best way to find out how to reserve areas for debugging is to create a small project in the IDE using the desired device, debug tool and compiler, remembering that the IDE can support multiple versions of the same compiler. So, while creating the project in the IDE, make sure you select the correct compiler version.

After you have created the small project, build the project for debugging. Save the text in the output window showing the build steps for debugging. Then build the project again (not for debugging) and save the text in the output window showing the build steps for production. Compare the two sets of instructions being passed to the compiler/assembler/linker.

FIGURE B-1: BUILD ICON MENU



Some examples of the differences in the output window are:

- Compiler/assembler/linker being called with the `__DEBUG` macro.
- Compiler/assembler/linker being called with the `__MPLAB_DEBUG` macro.
- Linker being called with `__ICD2_RAM` or `-mreserves`. These two are mutually exclusive, i.e., the linker is called with one of them but not the other.
- Compiler/assembler/linker being called with the name of the debug tool to be used.

This is not an exhaustive list.

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B.3 BUILDING A PROJECT OUTSIDE OF MPLAB X IDE

MPLAB X IDE uses the GNU Make as its build tool. The installation of MPLAB X IDE provides this program. The locations are:

- **Windows 32-Bit OS** – `C:\Program Files\Microchip\MPLABX\vx.xx\gnuBins\GnuWin32\bin`
- **Windows 64-Bit OS** – `C:\Program Files (x86)\Microchip\MPLABX\vx.xx\gnuBins\GnuWin32\bin`
- **Linux 32/64 OS** – `/opt/microchip/mplabx/vx.xx/mplab_ide/bin`
- **Mac OS X** – `/Applications/microchip/mplabx/vx.xx/mplab_ide.app/Contents/Resources/mplab_ide/bin`

MPLAB X IDE automatically adds the directory containing the make to its own path variable. If you want to build outside of the IDE, you must add the directory to the PATH environmental variable.

The `Makefile` in the MPLAB X IDE project directory can be called directly to build the default configuration:

Command – Type on a single line	Description
`$ make clean`	To remove all intermediate objects and final images
`$ make`	To create the production image (Hex file)
`$ make TYPE_IMAGE=DEBUG_RUN`	To create the debug image (COF/ELF file)

If the project has more than one configuration, then:

Command – Type on a single line	Description
`$ make -f Makefile CONF=Configuration clean`	To remove all intermediate objects and final images for configuration `Configuration`
`$ make -f Makefile CONF=Configuration`	To create the production image (Hex file) for configuration `Configuration`
`$ make -f Makefile CONF=Configuration TYPE_IMAGE=DEBUG_RUN`	To create the debug image (COF/ELF file) for configuration `Configuration`

The names of the images by default are (with respect to the MPLAB X IDE directory):

```
dist/$CONF_NAME/production/$PROJ_NAME.production.hex
dist/$CONF_NAME/debug/$PROJ_NAME.debug.cof (or elf)
```

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B.4 CREATING MAKEFILES OUTSIDE OF MPLAB X IDE

MPLAB X IDE uses the GNU Make to build its projects. This document explains how to re-create the Makefiles for an MPLAB X IDE project outside of the IDE and how to customize Makefile behavior (modify what the Makefiles do, like change the processor or add extra options) without having to regenerate the file. This document describes how to run make on the Makefiles from the command line.

> **Note:** The safest way to have the Makefiles match the values of the project in the IDE is to either regenerate them with the IDE itself or to use the `prjMakefilesGenerator` utility, explained later. The IDE will recreate the Makefiles for the main configuration in a project when the project is open. However, you might benefit from some other customization steps which modify the Makefiles' behavior once the Makefiles are already created. This document explains those other steps.

B.4.1 Makefile Creation

Makefiles are created by the MPLAB X IDE as needed when compiler options change or when files are added or removed. In addition, the Makefiles can be created outside of the IDE using the utility `prjMakefilesGenerator`. This utility is a batch file (for Windows) or a shell script (for Linux and MacOSX). This utility allows you to recreate the Makefiles using the same information the IDE uses which is stored in the `$PROJECT_DIR/nbproject/configurations.xml` file for a given MPLAB X IDE project. The first section will explain how to create the Makefiles outside of the IDE. Then the rest of the document will describe how to modify the behavior of the Makefiles without having to regenerate them for further customization. This latter section of the document applies to the Makefiles created by the IDE or by `prjMakefilesGenerator` (which should be identical).

The main Makefile file is called `$PROJECT_DIR/Makefile`. It is created when the IDE creates the project. It can be modified by the user. There are some targets such as `.build-pre`, that can be implemented by the user. **This file is never regenerated.** The rest of the Makefiles are all regenerated by the IDE or `prjMakefilesGenerator`. They are of the format:

```
$PROJECT_DIR/nbproject/Makefile*.mk
```

We recommend that you do not commit these `nbproject/Makefile*` files into revision control. Instead use the IDE or `prjMakefilesGenerator` to reproduce them as needed. See more information, see Section 5.20 "Control Source Code".

B.4.2 prjMakefilesGenerator

The `prjMakefilesGenerator` utility is found at:

- **Windows**:
  `$inst_mplabx\mplab_ide\bin\prjMakefilesGenerator.bat`
- **Linux OS:**
  `$inst_mplabx/mplab_ide/bin/prjMakefilesGenerator.sh`
- **Mac OS X**:
  `$inst_mplabx/mplab_ide.app/Contents/Resources/mplab_ide/bin/prjMakefilesGenerator.sh`

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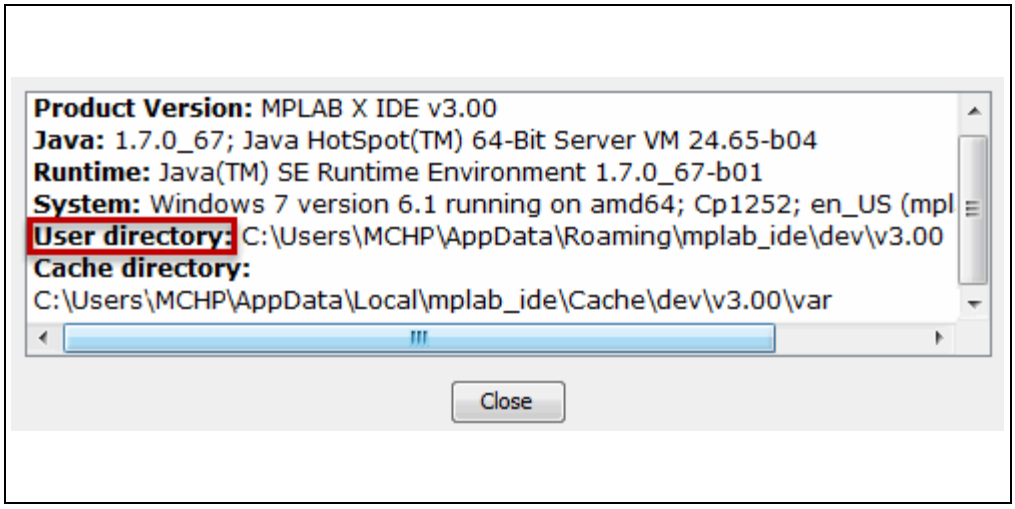
The utility regenerates the `nbproject/Makefile*` files. If you run it with no arguments, it will give you help:

```
$ ./prjMakefilesGenerator.sh
No project has been specified. There should be at least one. Nothing to do.

Invalid arguments. Usage is:
prjMakefilesGenerator [-help] [-v] [-mplabx-userdir=<path>] [project_path[@config_name]*]+
    <project_path>         - path to the MPLAB-X project in the file system
    [config_name]          - (optional) name of a build configuration to generate the makefile for.
                             If missing, the makefiles are generated for all the build configurations.

    -help                  - displays this help screen.
    -v                     - verbose processing.
    -mplabx-userdir=<path> - the MPLAB-X user directory (useful if you run MPLAB-X with --userdir).

    Example: prjMakefilesGenerator /home/usr/prj1@default@custom /home/usr/prj2 /home/usr/prj3@xc16
    The tool will generate the makefiles for:
      1.The configurations named 'default' and 'custom' of the project named 'prj1'
      2.All the configurations of the project named 'prj2' (all because none in particular is specified)
      3.The configuration named 'xc16' of the project named 'prj3'
```

To run the utility pass as an argument the MPLAB X project directories where you want to regenerate the Makefiles. You can also specify which configurations to regenerate. If no configurations are passed (no @confName), then all Makefiles for all configurations will be recreated.

It is recommended that you pass the `-mplabx-userdir=<path>` as a parameter. The `<path>` value is the value shown in the IDE in the ***Help>About*** dialog under userdir.

FIGURE B-2: HELP ABOUT



This will ensure that `prjMakefilesGenerator` will have access to the same list of compilers as the IDE.

B.4.3 Makefiles Description

As mentioned before, the main Makefile lives at `$PROJEC_DIR/Makefile`. This is the Makefile the IDE calls. For each configuration in the project, there is also a `Makefile-local-$conf.mk` and a `Makefile-$conf.mk` where `$conf` is the name of the configuration. The main `$PROJEC_DIR/Makefile` file will call make again on these configuration specific files. The `Makefile-local-$conf.mk` contains macro values that are tied to the host where the Makefile was generated. You have the option of not keeping this file if you want the `Makefile-$conf.mk` to work in another system. In that case you can call make specifying all the values that are normally found in the `Makefile-local-$conf.mk` to match the host where the make is being run. How to do this is explained later on.

If you recreate the files with `prjMakefilesGenerator`, the `Makefile-local-$conf.mk` will be correct at that point and will work on the machine where it was run.

B.4.4 Make Environment

The make process must be run from a command line native to the OS. This is `cmd.exe` in Windows and any shell for Linux/MacOSX. The make to be run is GNU Make. There are two types of images that can be created when running make:

1. A production image
2. A debug image

By default running the make process produces a production image. To have the make process produce a debug image you need to add to the following to the make command line:

```
TYPE_IMAGE=DEBUG_RUN
```

The debug image contains everything MPLAB X IDE needs to run a debug session. This information is tool specific. At this point, there is no way to tell the Makefile which tool to build for. This information is hard coded in the Makefile when it is created based on the values selected in the IDE for each configuration in each project.

B.4.4.1 MAKE ENVIRONMENT IN WINDOWS

We need to use a specific version of make and other GNU tools (such as `rm`).

When you install MPLAB X IDE, the following directory will be created:

```
$InstallDir\gnuBins\GnuWin32\bin
```

where `$InstallDir` is either:

- `C:\Program Files\Microchip\MPLABX\v`*`x.xx`* (32-bit system)
- `C:\Program Files (x86)\Microchip\MPLABX\v`*`x.xx`* (64-bit system)

This directory contains the `gnuWin32` tools. You must use these tools to run the make process. You cannot use Cygwin or any other GNU port.

Make sure the path above is the very first thing in your `%PATH%` environment variable:

```
c:> set PATH=C:\Program Files\Microchip\MPLABX\vx.xx\gnuBins\GnuWin32\
bin;%PATH%
```

before you run the make process.

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B.4.4.2 MAKE ENVIRONMENT IN MAC OSX

An out-of-the-box Mac computer contains all the tools needed except the GNU Make executable. You have two choices:

1. Install MPLAB X IDE. This will create the file:
   `/Applications/microchip/mplabx/v`*`x.xx`*`/mplab_ide.app/Contents/Resources/mplab_ide/bin/make`

   Then, add the directory where Make is to your path before you run the make process:

   ```
   export PATH=/Applications/microchip/mplabx/vx.xx/mplab_ide.app/Contents/Resources/mplab_ide/bin:$PATH
   ```

2. Install the X tools which will install the make in `/usr/bin/make`.

B.4.4.3 MAKE ENVIRONMENT IN LINUX

You have two choices:

1. Install MPLAB X IDE (v2.10 and above). This will create the file:
   `/opt/microchip/mplabx/v`*`x.xx`*`/mplab_ide/bin/make`

   Add `/opt/microchip/mplabx/v`*`x.xx`*`/mplab_ide/bin` to your path.

   > **Note:** Versions of MPLAB X IDE prior to v2.10 did not include make. It was expected that you would install it yourself. After v2.10, make is included with MPLAB X IDE.

2. Use the GNU Make that will probably be present in a typical Linux distro. To test that Make is available:

   ```
   $ which make
   /usr/bin/make
   ```

   If Make is not installed, use the package manager in your system to install it.

   > **Note:** If you are running a 64-bit Linux distro, you MUST have the 32-bit libraries installed, since our compilers are 32-bit applications.

B.4.5 Makefile Interface

To remove all target files for a given configuration

1. Change directory to `$PROJECT_DIR`.
2. `make -f nbproject/Makefile-debugOption.mk SUBPROJECTS= .clean-conf`

This will clean the target files for the `debugOption` configuration.

To remove all target files for all configurations

1. Change directory to `$PROJECT_DIR`.
2. `make clobber`

To run the Makefile for a given configuration

1. Change directory to `$PROJECT_DIR`.
2. Set environment variables to override values in the Make process.
3. `make -f nbproject/Makefile-$CONFIGURATION_NAME.mk SUBPROJECTS= .build-conf`

   where `$CONFIGURATION_NAME` is the name of the configuration Makefile to be run.

For a configuration called default:

```
make -f nbproject/Makefile-default.mk SUBPROJECTS= .build-conf
```

The output for a configuration is one of the debug files `.cof` or `.elf`. The production image will be a `.hex` file.

```
dist/$CONFIGURATION_NAME/production/$PROJECT_NAME.production.hex
dist/$CONFIGURATION_NAME/debug/$PROJECT_NAME.debug.$COF_OR_ELF
```

where `$COF_OR_ELF` is either `cof` or `elf`, and `$PROJECT_NAME` is the name of the project.

B.4.6 Environment Variables to Control the Make Process

There are four ways to set the variables that control the Make process:

- Use environmental variables, and call Make with the `-e` option:

  ```
  $ export MC_CC=/opt/microchip/xc16/v1.21/bin/xc16-gcc
  $ make -e
  ```

- Set the variables in the command line when calling Make. For example:

  ```
  $ make MC_CC=/opt/microchip/xc16/v1.21/bin/xc16-gcc
  ```

- Create a `nbproject/Makefile-local-$conf.mk` for the machine in use. Include the values of the environmental variables in it.
- Let `prjMakefilesGenerator` create a custom `nbproject/Makefile-local-$conf.mk` file for the machine.

Variables that are not overridden will take the values of the macros in the Makefile. The Makefile contains a section that has all of the default values for these macros. So, override whatever you need and the rest will be taken care of by the default values in the Makefile.

When a path is to be supplied in Windows, it must be entered like this:

```
"C:/Program\ Files/Microchip/xc16/bin/xc16-gcc.exe"
```

Use "/" for directory separators, and escape space characters with "\". Finally, when run from the command line, quote the whole thing.

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B.4.6.1 VARIABLES TO CONTROL TOOL NAMES/LOCATIONS

The following variables can be overridden.

MP_CC	Complete path to C compiler executable name
MP_BC	Complete path to Basic compiler executable name
MP_AS	Complete path to assembler executable name
MP_LD	Complete path to linker executable name
MP_AR	Complete path to archiver executable name
MP_CC_DIR	Directory to C compiler executable
MP_BC_DIR	Directory to basic compiler executable
MP_AS_DIR	Directory to assembler compiler executable
MP_LD_DIR	Directory to linker compiler executable
MP_AR_DIR	Directory to archiver compiler executable

```
# Example *nix:
make MP_CC=/opt/microchip/mplabc30/v3.24/bin/pic30-gcc
# Example Windows:
make "C:/Program\ Files/Microchip/xc16/bin/xc16-gcc.exe"
```

B.4.6.2 VARIABLES TO CONTROL PROCESSOR SELECTION

The MP_PROCESSOR_OPTION is the main variable that is used to control the processor name. Be aware that different compilers expect the name of the processor to be different. Some append PIC, some use small “f”, etc. The Makefiles created by MPLAB X IDE have the correct values. When you override these values by using MP_PROCESSOR_OPTION, you must ensure names are correct.

Note: Since MPLAB X IDE v2.00, the generated Makefiles for the most recent versions of the MPLAB XC compilers, MPLAB C Compiler for PIC18 MCUs, and MPASM assembler, cannot be used with different processors by simply changing the value of MP_PROCESSOR_OPTION. This is only for the debug images. You can still produce different hex files for different device by changing the MP_PROCESSOR_OPTION value.

As of MPLAB X IDE v2.00, the debug image is produced by a link line which includes the list of memory regions allocated to the debugger. This list is device dependent. For example, here is the link line to create the debug image on an MPLAB XC16 project:

```
"/opt/microchip/xc16/v1.21/bin/xc16-gcc"   -o
dist/default/debug/Explorer16dsPIC33F_1.X.debug.elf  build/default/debug/main.o
-mcpu=33FJ128GP710        -D__DEBUG -D__MPLAB_DEBUGGER_REAL_ICE=1  -omf=elf
-mreserve=data@0x800:0x81F -mreserve=data@0x820:0x821 -mreserve=data@0x822:0x823
-mreserve=data@0x824:0x825 -mreserve=data@0x826:0x84F
-Wl,,--defsym=__MPLAB_BUILD=1,--defsym=__MPLAB_DEBUG=1,--defsym=__DEBUG=1,--defsym=__M
PLAB_DEBUGGER_REAL_ICE=1,,--script=p33FJ128GP710.gld,--check-sections,--data-init,--pa
ck-data,--handles,--isr,--no-gc-sections,--fill-upper=0,--stackguard=16,--no-force-lin
k,--smart-io,-Map="dist/default/debug/Explorer16dsPIC33F_1.X.debug.map"
```

The reserve areas (shown in **bold** above) may change from device to device. If you want to produce different debug images for different processors, it is preferable to change the processor in the IDE and use prjMakefilesRegenerator to recreate the Makefiles.

These are the versions that support the -mreserve keyword or that pass the list of debug regions by using other means. To generate a debug image with the correct debug ranges passed to the linker, you need to run prjMakefilesRegenerator. You cannot simply change MP_PROCESSOR_OPTION.

Toolchain	First version supported. All versions greater or equal to this version issue -mreserve
MPASMX	5.54
C18	3.47
XC8	1.00
XC16	1.21
XC32	1.30

B.4.6.3 VARIABLES TO CONTROL SPECIAL LINKING NEEDS

Some tools require special handling of the linker files, facilitated by the following macro MP_LINKER_FILE_OPTION.

XC16 and C30/ASM30 toolchains require this option since they need to specify a part name or a file name, depending on whether the project contains a linker script or not.

The MPASM/C18 toolchains require this option to specify the areas where the debug executable is located.

These variables are explained in detail in their corresponding toolchain section in this document (see Section B.4.7 "Special Considerations for Each Language Tool").

B.4.6.4 VARIABLES TO MODIFY COMMAND LINES

The following _PRE and _POST variables are totally optional. They exist simply to allow customization of the command line. You can run a make without defining any of them.

```
MP_EXTRA_CC_PRE      MP_EXTRA_CC_POST
MP_EXTRA_BC_PRE      MP_EXTRA_BC_POST
MP_EXTRA_AS_PRE      MP_EXTRA_AS_POST
MP_EXTRA_AR_PRE      MP_EXTRA_AR_POST
MP_EXTRA_LD_PRE      MP_EXTRA_LD_POST
```

Many compilers (such as gcc-based ones) use their main shell program to call the linker/assembler. These command lines, then, are formed of a first section (where MP_EXTRA_XX_PRE is located), and a second section, which is typically passed to the linker/assembler (where MP_EXTRA_XX_POST is located). That is why two macros per each tool are needed to allow you to modify the behavior of that tool.

An example of a link line in a gcc-based compiler is:

```
${MP_CC}  -omf=elf  ${MP_PROCESSOR_OPTION_LD} ${MP_EXTRA_LD_PRE} -o
dist/${CND_CONF}/${IMAGE_TYPE}/Explorer16PIC24DSC_1.${IMAGE_TYPE}.elf
${OBJECTFILES} -Wl,--defsym=__MPLAB_BUILD=1,--report-mem,
-Tp24FJ128GA010.gld${MP_EXTRA_LD_POST}
```

In this case, the MP_EXTRA_LD_PRE is issued to the shell (before -Wl) and the MP_EXTRA_LD_POST is issued after. You need to pass valid options – see your language tool documentation. For the options to be included before the -Wl, you need a space as a separator:

```
MP_EXTRA_LD_PRE= -D_FOO -D_BAR
```

And for the options to be included after -Wl, you need a comma as a separator:

```
MP_EXTRA_LD_POST=--defsym=_FOO,--defsym=_BAR
```

If the toolchain does not support the use of a driver shell (like gcc), then simply use the _PRE variables.

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B.4.7 Special Considerations for Each Language Tool

Besides variables needed for each toolchain, you need to set:

- The tool locations (MP_CC, MP_AS, etc.)
- The directories where they are installed (MP_CC_DIR, MP_AS_DIR, etc.)

B.4.7.1 MPASM

The required macros for this toolchain are:

- MP_PROCESSOR_OPTION
- MP_LINKER_DEBUG_OPTION

MP_LINKER_DEBUG_OPTION needs to be defined even if the definition is to nothing (MP_LINKER_DEBUG_OPTION=). This macro is only used when building a debug image. When the processor changes, this macro must also change to accommodate the places where the debug exec is stored, and how much data the debug exec uses. You can set this variable to nothing and the linker will build correctly, but any issues where code/data is placed on top of the debug exec will not be caught by the linker. So, it is best to set to the correct values. Correct values can be obtained by creating an MPLAB X IDE project with the correct device and doing a Debug Run, or by creating the Makefile using prjMakefilesGenerator.

The optional macros for this toolchain are:

- MP_EXTRA_AS_PRE
- MP_EXTRA_LD_PRE (for stand alone project)
- MP_EXTRA_AR_PRE (for library project).

B.4.7.2 C18

The required macros for this toolchain are:

- MP_PROCESSOR_OPTION
- MP_CPP
- MP_PROCESSOR_OPTION_LD
- MP_LINKER_DEBUG_OPTION

See Section B.4.7.1 “MPASM” for an explanation of MP_LINKER_DEBUG_OPTION usage.

A different processor option for the linker (MP_PROCESSOR_OPTION_LD) is included, since the linker takes different strings than the mcc18 compiler. The linker likes all small caps.

The optional macros for this toolchain are:

- MP_EXTRA_AS_PRE
- MP_EXTRA_LD_PRE (for stand alone project)
- MP_EXTRA_AR_PRE (for library project)
- MP_EXTRA_CC_PRE

B.4.7.3 XC16, C30, C24, dsPIC

The XC16 toolchain is the upgrade for the C30 toolchain. The C24 and dsPIC toolchains are subsets of the C30.

These compilers are represented by different toolchains. All of them take the same options.

The required macros for these toolchains are:

- `MP_PROCESSOR_OPTION`
- `MP_LINKER_FILE_OPTION`

`MP_LINKER_FILE_OPTION` can be one of the two strings:

1. "`,--script=myScript24FJ256GB106.gld`" – Use this string if the project contains a linker script, in this case named `myScript24FJ256GB106.gld`.
2. "`,-Tp24FJ256GB106.gld`" – Use this string if the project does not contain a linker script. Use the name of the default linker script in the installation; in this case, `p24FJ256GB106.gld`. In Linux, the name of the `.gld` file is case sensitive.

The optional macros for these toolchains are:

- `MP_EXTRA_CC_PRE`
- `MP_EXTRA_AS_PRE`
- `MP_EXTRA_AS_POST`
- `MP_EXTRA_AR_PRE` (for lib project)
- `MP_EXTRA_AR_POST` (for lib project)
- `MP_EXTRA_LD_PRE` (for stand alone project)
- `MP_EXTRA_LD_POST` (for stand alone project)

B.4.7.4 ASM30

The ASM30 toolchain has not been shipped with MPLAB X IDE since version v1.30. Please use the XC16 assembler instead.

The required macros for this toolchain are:

- `MP_PROCESSOR_OPTION`
- `MP_LINKER_FILE_OPTION`

See Section B.4.7.3 "XC16, C30, C24, dsPIC" for an explanation of `MP_LINKER_FILE_OPTION` usage.

The optional macros for this toolchain are:

- `MP_EXTRA_AS_PRE`
- `MP_EXTRA_AR_PRE` (for lib project)
- `MP_EXTRA_LD_PRE` (for stand alone project)

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B.4.7.5 XC32, C32

The XC32 toolchain is the upgrade for the C32 toolchain.

The required macros for these toolchains are:

- `MP_PROCESSOR_OPTION`
- `MP_LINKER_FILE_OPTION`

`MP_LINKER_FILE_OPTION` can be one of the two strings:

1. "`,--script=myScript32X.gld`" – use this string if the project contains a linker script, in this case named `myScript32X.gld`.
2. "" – use the empty string if the project does not contain a linker script.

The optional macros for these toolchains are:

- `MP_EXTRA_CC_PRE`
- `MP_EXTRA_AS_PRE`
- `MP_EXTRA_AS_POST`
- `MP_EXTRA_AR_PRE` (for lib project)
- `MP_EXTRA_AR_POST` (for lib project)
- `MP_EXTRA_LD_PRE` (for stand alone project)
- `MP_EXTRA_LD_POST` (for stand alone project)

B.4.7.6 XC8 AND HI-TECH COMPILERS (PICC, PICC18-STD, PIC18-PRO, DSPIC, PIC32)

The XC8 toolchain is the upgrade for the PICC and PICC18 toolchains.

The required macros for these toolchains are:

- `MP_PROCESSOR_OPTION`

`MP_PROCESSOR_OPTION` will be different for each of these compilers. If you take the “MPLABX” name, you can derive the “compiler” name using the following Java code:

```
public static String getProcessorNameForCompiler(String deviceName) {
    String res = deviceName;
    String lowerCaseDeviceName = deviceName.toLowerCase();
    if (lowerCaseDeviceName.startsWith("pic"))
        res = deviceName.substring(3);
    else if (lowerCaseDeviceName.startsWith("rfpic"))
        res = deviceName.substring(5);
    else if (lowerCaseDeviceName.startsWith("dspic"))
        res = deviceName.substring(5);
    return res;
}
```

Here the `deviceName` is the “MPLABX” name.

The optional macros for these toolchains are:

- `MP_EXTRA_CC_PRE`
- `MP_EXTRA_AS_PRE`
- `MP_EXTRA_LD_PRE` (for stand alone project)

These toolchains do not support library projects.

B.5 WORKING WITH REVISION CONTROL SYSTEMS

When you make changes to files outside of the IDE, conflicts can be created when you try to check these files into a revision control system. To solve these problems, see Section 5.20.2.3 “Resolving Conflicts in Revision Controlled Files”.

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Appendix C. Revision History

Revision A (November 2011)

- Initial release of this document.

Revision B (October 2012)

- JRE installation now automatic with Windows and Linux operating systems. Mac operating system instructions provided. Discussed in Chapter 2. "Before You Begin", 2.2 "Install JRE and MPLAB X IDE".
- Corrected information on device driver names and paths in Chapter 2.
- Added description of meaning of the two lights next to a debug tool in Chapter 3. "Tutorial" and Chapter 4. "Basic Tasks".
- Updated Icon definitions in Chapter 3. "Tutorial" and Chapter 4. "Basic Tasks".
- Added a list of language toolchain abbreviations in Chapter 4. "Basic Tasks", 4.3 "Create a New Project", 4.3.5 "Step 5: Select Compiler".
- Multiple dialogs updated to show projects using the new MPLAB XC C compiler.
- Added information on the Libraries category in the Project Properties dialog in Chapter 4. "Basic Tasks", 4.12 "Add and Setup Library and Object Files".
- Added information on normalizing a hex file under Chapter 4. "Basic Tasks", 4.14 "Set Build Properties".
- Added information on how to add a literal value to a Watches window in Chapter 4. "Basic Tasks", 4.20 "Watch Symbol Values Changes".
- Updated several sections for recent support of C++ (currently for the MPLAB XC32++ Compiler).
- Added section on loadable projects in Chapter 5. "Additional Tasks", 5.5 "Loadable Projects and Files".
- Discussed how to import embedded projects from other applications into MPLAB X IDE in Chapter 5. "Additional Tasks", 5.7 "Other Embedded Projects".
- Added information on working with samples projects in Chapter 5. "Additional Tasks", 5.8 "Sample Projects".
- Described how to work with other files, like XML, in Chapter 5. "Additional Tasks", 5.9 "Work with Other Types of Files".
- Added information on how to work with log files in Chapter 6. Advanced Tasks", 6.4 "Log Data".
- Described how to add functions to a toolbar in Chapter 6. Advanced Tasks", 6.5 "Customize Toolbars".
- Added Chapter 7 Editor, that discusses MPLAB X IDE Editor usage, options and features.
- Described an error message you might receive if you modify or move the default linker script, and how to avoid this. See Chapter 8. "Troubleshooting", 8.4 "MPLAB X IDE Issues".
- Combined "Major Differences" and "Feature Differences" into Chapter 9. "MPLAB X IDE vs. MPLAB IDE v8", 9.2 "Major Differences". Explained NetBeans platform is open source, but MPLAB X IDE is proprietary.

- In Chapter 9. "MPLAB X IDE vs. MPLAB IDE v8", updated 9.3 "Menu Differences" to reflect new functions in MPLAB X IDE and 9.4 "Tool Support Differences" to reflect new plug-in support.
- In Chapter 10. "Desktop Reference", updated 10.2 "Menus" to reflect new functions in MPLAB X IDE.
- Split "Windows and Dialogs" into Chapter 11. "MPLAB X IDE Windows and Dialogs" and Chapter 12. "NetBeans Windows and Dialogs" to better delineate the different windows. Updated window menus.
- Updated project file structure in Chapter 13. "Project Files and Folders", 13.2 "Files Window View". Added information on Makefiles.
- Updated discussion of MPLAB XC C compiler configuration bits to reference the common C interface (CCI) in Chapter 14. "Configuration Settings Summary", 14.8 "XC Toolchains".

Revision C (March 2014)

- Overall Changes: Removed references to old tools. Added information on Windows 8. Updated screens and text to match the latest GUI.
- Chapter 1. "What is MPLAB X IDE?": Updated figure references. Mentioned stand-alone tool help and the Microchip wiki as resources.
- Chapter 2. "Before You Begin": Updated information in 2.3.2 "USB Driver Installation for Windows® XP/7/8 Operating Systems". Added compiler licensing information under 2.5 "Install the Language Tools". Added 2.7.1 "Setting Up Hardware Tools to Work with Multiple Instances".
- Chapter 4. "Basic Tasks": Removed 4.1 "Introduction". Added 4.6.1 "Add or Change a Toolchain" and 4.6.2 "About Toolchain Paths". Added how to exclude file/folders from build under 4.12 "Set File and Folder Properties". Expanded Table 4-3 into sections under 4.13 "Set Build Properties". Added 4.15.2 "Run Considerations". Added 4.16.2 "Debug Macros Generated" and 4.16.3 "Debug Considerations". Added symbol information in 4.19 "Watch Symbol Values Change". Updated 4.21.2 "Change Device Memory". Added 4.23.1 "Set Project Programming Properties".
- Chapter 5. "Additional Tasks": Removed 5.1 "Introduction". Updates 5.4 "Loadable Projects and Files" and created a new section, 5.5 "Loadable Projects and Files – Bootloaders". Added 5.12 "Modify Project Folders and Encoding" and 5.13 "Speed Up Build Times". Updated text to match new display options in 5.17 "View the Dashboard Display". Fixed using version control steps and updated project files that need to be saved into a repository under 5.19 "Control Source Code". Updated options for 5.20 "Collaborate on Code Development and Error Tracking". Reordered sections under 5.21 "Add Plug-In Tools" and added 5.21.4 "Plug-In Code Location".
- Chapter 6. Advanced Tasks: Added 6.1 "Speed Up MPLAB X IDE" and 6.5 "Create User MakeFile Projects". Added information about working without setting an active project and grouping projects under 6.3 "Work with Multiple Projects". Removed statement that debug configuration needed (it is not) from 6.4 "Work with Multiple Configurations". Log file requirements update under 6.6 "Log File".
- Chapter 7. "Editor": "Editor Features of Note" moved to 7.2.4 under 7.2 "Editor Usage". Also added 7.2.1. "Desktop Controls", 7.2.2 "Hyperlinks in C Code" and 7.2.3 "Hyperlinks in ASM Code". Macros definition expanded in Table 7-6 "Macros Tab". Rearranged 7.4 "Code Folding" into 7.4.1 "Code Folding Usage" (includes MPLAB C18 and assembly folding issue) and 7.4.2. "Custom Code Folding".

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- Chapter 8. “Project Files and Folders”: This chapter moved from Chapter 13. Added 8.4 “Favorites Window View”, 8.5 “Classes Window View”, 8.6 “Viewing User Configuration Data” and 8.9 “Deleting a Project”. Changed “Moving a Project” to 8.8 “Moving, Copying or Renaming a Project”. Moved “Building a Project Outside of MPLAB X IDE” to Appendix B. “Working Outside the IDE”.
- Chapter 9. “Troubleshooting”: Added information to 9.6 “Errors”.
- Chapter 10. “MPLAB X IDE vs. MPLAB IDE v8”: Clarified under 10.2 “Major Differences”, item 3. “MPLAB X IDE allows multiple tool selection” and item 9. “MPLAB X IDE uses configuration bits set in code”. Other minor updates for MPLAB X IDE additional selections.
- Chapter 11. “Desktop Reference”: 11.2.10 “Tools Menu” updated for plug-ins and compiler licensing. Other minor updates for MPLAB X IDE additional selections.
- Chapter 12. “MPLAB X IDE Windows and Dialogs”: Added 12.2 “MPLAB X IDE Windows Management”. In 12.3 “MPLAB X IDE Windows with Related Menus and Dialogs”, added new windows to table and moved windows subsections to their own sections. Added 12.4 “Breakpoints Window” and 12.6 “Licenses Window”. Extensive updates to add descriptions of different memory windows under 12.8 “Memory Windows”. 12.11 “Projects Window” menus updates. 12.12 “Tools Options Embedded Window” options update, including the addition of 12.12.5 “Diagnostics Tab”. 12.14 “Watches Window” content broken up into three sections.
- Appendix A: “Configuration Settings”: Change from Chapter 14 to an appendix. Added information about the Configuration Memory window.
- Appendix B: “Working Outside the IDE”: B.1 “Building a Project Outside of MPLAB X IDE” from Chapter 8 “Project Files and Folders”. Added B.2 “Compiling for Debug Outside of MPLAB X IDE”.
- Appendix C: “Revision History”: This chapter updated for major changes from version B to C.

Revision D (September 2015)

- Updated images for MPLAB X IDE v3.00 (NetBeans 8.1 platform)
- Added information about the MPLAB X Store for the tab, icon and Help menu item.
- Added information about *Help>Tool Help Contents*, individual help files.
- Chapter 2: 2.6 Access Information from the Start Page: Updated information.
- Chapter 2: 2.9 Launch Multiple Versions of the IDE: Clarifies version execution.
- Chapter 4: 4.13 Build Properties: Added “Change project Configuration type”.
- Chapter 4: 4.2.2 Step 2: Select Device: Added info on LF devices.
- Chapter 5: 5.6 Library Projects: Added link to section “Change project Configuration type”.
- Chapter 6: Changed name to “Advanced Tasks & Concepts”. Added section groupings. Added sections “Work with Third-Party Hardware Tools” and “Configurations”. Updated section “Create User Makefile Projects” content and added examples
- Chapter 9: 9.6 Errors: Added “HEXMATE Conflict Report Address Error” and “Programming Errors”.
- Chapter 12: 12.4 Watches Window: Swapped location of Watches Display and Watches Menu sections. Added more content to menu section. Added section “Fractional Integer Properties Dialog”.
- Chapter 12: 12.7.5 EE Data Memory Window: Updated text for read during debug or after end of debug session. Updated start address table.

- Chapter 12: 12.10 Message Center added.
- Appendix B: Reordered existing sections and added the section "Creating Make-files Outside of MPLAB X IDE".

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Support

INTRODUCTION

Please refer to the items discussed here for support issues.

- Warranty Registration
- myMicrochip Personalized Notification Service
- The Microchip Web Site
- Microchip Forums
- Customer Support
- Contact Microchip Technology

WARRANTY REGISTRATION

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Please visit myMicrochip to begin the registration process and select your preferences to receive personalized notifications. A FAQ and registration details are available on the page, which can be opened by selecting the link above.

When you are selecting your preferences, choosing "Development Systems" will populate the list with available development tools. The main categories of tools are listed below:

- **Compilers** – The latest information on Microchip C compilers, assemblers, linkers and other language tools. These include all MPLAB XC compilers (MPLAB XC8, MPLAB XC16, and MPLAB XC32) and older MPLAB C compilers, as well as MPASM™ assembler, MPLINK™ object linker, and MPLIB™ object librarian.
- **Emulators** – The latest information on Microchip in-circuit emulators. This includes the MPLAB REAL ICE™ in-circuit emulator.
- **In-Circuit Debuggers** – The latest information on Microchip in-circuit debuggers. These include the PICkit™ 3 and MPLAB ICD 3 in-circuit debuggers.
- **MPLAB® X IDE** – The latest information on Microchip MPLAB X IDE, the Integrated Development Environment for development systems tools. This list is focused on MPLAB X IDE, MPLAB X IDE Projects, MPLAB X Editor and MPLAB X Simulator, as well as general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include the device (production) programmers MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger, and MPLAB PM3, and the development (non-production) programmer PICkit 3.
- **Starter/Demo Boards** – These include MPLAB Starter Kit boards, PICDEM demo boards, and various other evaluation boards.

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Glossary

A

Absolute Section

A GCC compiler section with a fixed (absolute) address that cannot be changed by the linker.

Absolute Variable/Function

A variable or function placed at an absolute address using the OCG compiler's `@ address` syntax.

Access Memory

PIC18 Only – Special registers on PIC18 devices that allow access regardless of the setting of the Bank Select Register (BSR).

Access Entry Points

Access entry points provide a way to transfer control across segments to a function which may not be defined at link time. They support the separate linking of boot and secure application segments.

Address

Value that identifies a location in memory.

Alphabetic Character

Alphabetic characters are those characters that are letters of the Roman alphabet (a, b, …, z, A, B, …, Z).

Alphanumeric

Alphanumeric characters are comprised of alphabetic characters and decimal digits (0,1, …, 9).

ANDed Breakpoints

Set up an ANDed condition for breaking, i.e., breakpoint 1 AND breakpoint 2 must occur at the same time before a program halt. This can only be accomplished if a data breakpoint and a program memory breakpoint occur at the same time.

Anonymous Structure

16-bit C Compiler **–** An unnamed structure.

PIC18 C Compiler **–** An unnamed structure that is a member of a C union. The members of an anonymous structure may be accessed as if they were members of the enclosing union. For example, in the following code, `hi` and `lo` are members of an anonymous structure inside the union `caster`.

```
union castaway
 int intval;
 struct {
  char lo; //accessible as caster.lo
  char hi; //accessible as caster.hi
 };
} caster;
```

ANSI

American National Standards Institute is an organization responsible for formulating and approving standards in the United States.

Application

A set of software and hardware that may be controlled by a PIC® microcontroller.

Archive/Archiver

An archive/library is a collection of relocatable object modules. It is created by assembling multiple source files to object files, and then using the archiver/librarian to combine the object files into one archive/library file. An archive/library can be linked with object modules and other archives/libraries to create executable code.

ASCII

American Standard Code for Information Interchange is a character set encoding that uses 7 binary digits to represent each character. It includes upper and lower case letters, digits, symbols and control characters.

Assembly/Assembler

Assembly is a programming language that describes binary machine code in a symbolic form. An assembler is a language tool that translates assembly language source code into machine code.

Assigned Section

A GCC compiler section which has been assigned to a target memory block in the linker command file.

Asynchronously

Multiple events that do not occur at the same time. This is generally used to refer to interrupts that may occur at any time during processor execution.

Asynchronous Stimulus

Data generated to simulate external inputs to a simulator device.

Attribute

GCC Characteristics of variables or functions in a C program which are used to describe machine-specific properties.

Attribute, Section

GCC Characteristics of sections, such as "executable", "readonly", or "data" that can be specified as flags in the assembler `.section` directive.

B

Binary

The base two numbering system that uses the digits 0-1. The rightmost digit counts ones, the next counts multiples of 2, then $2^2 = 4$, etc.

Bookmarks

Use bookmarks to easily locate specific lines in a file.

Select Toggle Bookmarks on the Editor toolbar to add/remove bookmarks. Click other icons on this toolbar to move to the next or previous bookmark.

Breakpoint

Hardware Breakpoint: An event whose execution will cause a halt.

Software Breakpoint: An address where execution of the firmware will halt. Usually achieved by a special break instruction.

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Build

Compile and link all the source files for an application.

C

C\C++

C is a general-purpose programming language which features economy of expression, modern control flow and data structures, and a rich set of operators. C++ is the object-oriented version of C.

Calibration Memory

A special function register or registers used to hold values for calibration of a PIC microcontroller on-board RC oscillator or other device peripherals.

Central Processing Unit

The part of a device that is responsible for fetching the correct instruction for execution, decoding that instruction, and then executing that instruction. When necessary, it works in conjunction with the arithmetic logic unit (ALU) to complete the execution of the instruction. It controls the program memory address bus, the data memory address bus, and accesses to the stack.

Clean

Clean removes all intermediary project files, such as object, hex and debug files, for the active project. These files are recreated from other files when a project is built.

COFF

Common Object File Format. An object file of this format contains machine code, debugging and other information.

Command Line Interface

A means of communication between a program and its user based solely on textual input and output.

Compiled Stack

A region of memory managed by the compiler in which variables are statically allocated space. It replaces a software or hardware stack when such mechanisms cannot be efficiently implemented on the target device.

Compiler

A program that translates a source file written in a high-level language into machine code.

Conditional Assembly

Assembly language code that is included or omitted based on the assembly-time value of a specified expression.

Conditional Compilation

The act of compiling a program fragment only if a certain constant expression, specified by a preprocessor directive, is true.

Configuration Bits

Special-purpose bits programmed to set PIC microcontroller modes of operation. A Configuration bit may or may not be preprogrammed.

Control Directives

Directives in assembly language code that cause code to be included or omitted based on the assembly-time value of a specified expression.

CPU

See Central Processing Unit.

Cross Reference File

A file that references a table of symbols and a list of files that references the symbol. If the symbol is defined, the first file listed is the location of the definition. The remaining files contain references to the symbol.

D

Data Directives

Data directives are those that control the assembler's allocation of program or data memory and provide a way to refer to data items symbolically; that is, by meaningful names.

Data Memory

On Microchip MCU and DSC devices, data memory (RAM) is comprised of General Purpose Registers (GPRs) and Special Function Registers (SFRs). Some devices also have EEPROM data memory.

Data Monitor and Control Interface (DMCI)

The Data Monitor and Control Interface, or DMCI, is a tool in MPLAB X IDE. The interface provides dynamic input control of application variables in projects. Application-generated data can be viewed graphically using any of 4 dynamically-assignable graph windows.

Debug/Debugger

See ICE/ICD.

Debugging Information

Compiler and assembler options that, when selected, provide varying degrees of information used to debug application code. See compiler or assembler documentation for details on selecting debug options.

Deprecated Features

Features that are still supported for legacy reasons, but will eventually be phased out and no longer used.

Device Programmer

A tool used to program electrically programmable semiconductor devices such as microcontrollers.

Digital Signal Controller

A digital signal controller (DSC) is a microcontroller device with digital signal processing capability, i.e., Microchip dsPIC DSC devices.

Digital Signal Processing\Digital Signal Processor

Digital signal processing (DSP) is the computer manipulation of digital signals, commonly analog signals (sound or image) which have been converted to digital form (sampled). A digital signal processor is a microprocessor that is designed for use in digital signal processing.

Directives

Statements in source code that provide control of the language tool's operation.

Download

Download is the process of sending data from a host to another device, such as an emulator, programmer or target board.

DWARF

Debug With Arbitrary Record Format. DWARF is a debug information format for ELF files.

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E

EEPROM

Electrically Erasable Programmable Read Only Memory. A special type of PROM that can be erased electrically. Data is written or erased one byte at a time. EEPROM retains its contents even when power is turned off.

ELF

Executable and Linking Format. An object file of this format contains machine code. Debugging and other information is specified in with DWARF. ELF/DWARF provide better debugging of optimized code than COFF.

Emulation/Emulator

See ICE/ICD.

Endianness

The ordering of bytes in a multi-byte object.

Environment

MPLAB PM3 **–** A folder containing files on how to program a device. This folder can be transferred to a SD/MMC card.

Epilogue

A portion of compiler-generated code that is responsible for deallocating stack space, restoring registers and performing any other machine-specific requirement specified in the runtime model. This code executes after any user code for a given function, immediately prior to the function return.

EPROM

Erasable Programmable Read Only Memory. A programmable read-only memory that can be erased usually by exposure to ultraviolet radiation.

Error/Error File

An error reports a problem that makes it impossible to continue processing your program. When possible, an error identifies the source file name and line number where the problem is apparent. An error file contains error messages and diagnostics generated by a language tool.

Event

A description of a bus cycle which may include address, data, pass count, external input, cycle type (fetch, R/W), and time stamp. Events are used to describe triggers, breakpoints and interrupts.

Executable Code

Software that is ready to be loaded for execution.

Export

Send data out of the MPLAB IDE/MPLAB X IDE in a standardized format.

Expressions

Combinations of constants and/or symbols separated by arithmetic or logical operators.

Extended Microcontroller Mode

In extended microcontroller mode, on-chip program memory as well as external memory is available. Execution automatically switches to external if the program memory address is greater than the internal memory space of the PIC18 device.

Extended Mode (PIC18 MCUs)

In Extended mode, the compiler will utilize the extended instructions (i.e., `ADDFSR`, `ADDULNK`, `CALLW`, `MOVSF`, `MOVSS`, `PUSHL`, `SUBFSR` and `SUBULNK`) and the indexed with literal offset addressing.

External Label

A label that has external linkage.

External Linkage

A function or variable has external linkage if it can be referenced from outside the module in which it is defined.

External Symbol

A symbol for an identifier which has external linkage. This may be a reference or a definition.

External Symbol Resolution

A process performed by the linker in which external symbol definitions from all input modules are collected in an attempt to resolve all external symbol references. Any external symbol references which do not have a corresponding definition cause a linker error to be reported.

External Input Line

An external input signal logic probe line (TRIGIN) for setting an event based upon external signals.

External RAM

Off-chip Read/Write memory.

F

Fatal Error

An error that will halt compilation immediately. No further messages will be produced.

File Registers

On-chip data memory, including General Purpose Registers (GPRs) and Special Function Registers (SFRs).

Filter

Determine by selection what data is included/excluded in a trace display or data file.

Fixup

The process of replacing object file symbolic references with absolute addresses after relocation by the linker.

Flash

A type of EEPROM where data is written or erased in blocks instead of bytes.

FNOP

Forced No Operation. A forced NOP cycle is the second cycle of a two-cycle instruction. Since the PIC microcontroller architecture is pipelined, it prefetches the next instruction in the physical address space while it is executing the current instruction. However, if the current instruction changes the program counter, this prefetched instruction is explicitly ignored, causing a forced NOP cycle.

Frame Pointer

A pointer that references the location on the stack that separates the stack-based arguments from the stack-based local variables. Provides a convenient base from which to access local variables and other values for the current function.

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Free-Standing

An implementation that accepts any strictly conforming program that does not use complex types and in which the use of the features specified in the library clause (ANSI '89 standard clause 7) is confined to the contents of the standard headers `<float.h>`, `<iso646.h>`, `<limits.h>`, `<stdarg.h>`, `<stdbool.h>`, `<stddef.h>` and `<stdint.h>`.

G

GPR

General Purpose Register. The portion of device data memory (RAM) available for general use.

H

Halt

A stop of program execution. Executing Halt is the same as stopping at a breakpoint.

Heap

An area of memory used for dynamic memory allocation where blocks of memory are allocated and freed in an arbitrary order determined at runtime.

Hex Code\Hex File

Hex code is executable instructions stored in a hexadecimal format code. Hex code is contained in a hex file.

Hexadecimal

The base 16 numbering system that uses the digits 0-9 plus the letters A-F (or a-f). The digits A-F represent hexadecimal digits with values of (decimal) 10 to 15. The rightmost digit counts ones, the next counts multiples of 16, then 16^2 = 256, etc.

High Level Language

A language for writing programs that is further removed from the processor than assembly.

I

ICE/ICD

In-Circuit Emulator/In-Circuit Debugger: A hardware tool that debugs and programs a target device. An emulator has more features than an debugger, such as trace.

In-Circuit Emulation/In-Circuit Debug: The act of emulating or debugging with an in-circuit emulator or debugger.

-ICE/-ICD: A device (MCU or DSC) with on-board in-circuit emulation or debug circuitry. This device is always mounted on a header board and used to debug with an in-circuit emulator or debugger.

ICSP

In-Circuit Serial Programming. A method of programming Microchip embedded devices using serial communication and a minimum number of device pins.

IDE

Integrated Development Environment, as in MPLAB IDE/MPLAB X IDE.

Identifier

A function or variable name.

IEEE

Institute of Electrical and Electronics Engineers.

Import

Bring data into the MPLAB IDE/MPLAB X IDE from an outside source, such as from a hex file.

Initialized Data

Data which is defined with an initial value. In C,

```
int myVar=5;
```

defines a variable which will reside in an initialized data section.

Instruction Set

The collection of machine language instructions that a particular processor understands.

Instructions

A sequence of bits that tells a central processing unit to perform a particular operation and can contain data to be used in the operation.

Internal Linkage

A function or variable has internal linkage if it can not be accessed from outside the module in which it is defined.

International Organization for Standardization

An organization that sets standards in many businesses and technologies, including computing and communications. Also known as ISO.

Interrupt

A signal to the CPU that suspends the execution of a running application and transfers control to an Interrupt Service Routine (ISR) so that the event may be processed. Upon completion of the ISR, normal execution of the application resumes.

Interrupt Handler

A routine that processes special code when an interrupt occurs.

Interrupt Service Request (IRQ)

An event which causes the processor to temporarily suspend normal instruction execution and to start executing an interrupt handler routine. Some processors have several interrupt request events allowing different priority interrupts.

Interrupt Service Routine (ISR)

Language tools – A function that handles an interrupt.

MPLAB IDE/MPLAB X IDE – User-generated code that is entered when an interrupt occurs. The location of the code in program memory will usually depend on the type of interrupt that has occurred.

Interrupt Vector

Address of an interrupt service routine or interrupt handler.

L

L-value

An expression that refers to an object that can be examined and/or modified. An l-value expression is used on the left-hand side of an assignment.

Latency

The time between an event and its response.

Library/Librarian

See Archive/Archiver.

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Linker

A language tool that combines object files and libraries to create executable code, resolving references from one module to another.

Linker Script Files

Linker script files are the command files of a linker. They define linker options and describe available memory on the target platform.

Listing Directives

Listing directives are those directives that control the assembler listing file format. They allow the specification of titles, pagination and other listing control.

Listing File

A listing file is an ASCII text file that shows the machine code generated for each C source statement, assembly instruction, assembler directive, or macro encountered in a source file.

Little Endian

A data ordering scheme for multibyte data whereby the least significant byte is stored at the lower addresses.

Local Label

A local label is one that is defined inside a macro with the LOCAL directive. These labels are particular to a given instance of a macro's instantiation. In other words, the symbols and labels that are declared as local are no longer accessible after the ENDM macro is encountered.

Logic Probes

Up to 14 logic probes can be connected to some Microchip emulators. The logic probes provide external trace inputs, trigger output signal, +5V, and a common ground.

Loop-Back Test Board

Used to test the functionality of the MPLAB REAL ICE in-circuit emulator.

LVDS

Low Voltage Differential Signaling. A low noise, low-power, low amplitude method for high-speed (gigabits per second) data transmission over copper wire.

With standard I/0 signaling, data storage is contingent upon the actual voltage level. Voltage level can be affected by wire length (longer wires increase resistance, which lowers voltage). But with LVDS, data storage is distinguished only by positive and negative voltage values, not the voltage level. Therefore, data can travel over greater lengths of wire while maintaining a clear and consistent data stream.

Source: http://www.webopedia.com/TERM/L/LVDS.html

M

Machine Code

The representation of a computer program that is actually read and interpreted by the processor. A program in binary machine code consists of a sequence of machine instructions (possibly interspersed with data). The collection of all possible instructions for a particular processor is known as its "instruction set".

Machine Language

A set of instructions for a specific central processing unit, designed to be usable by a processor without being translated.

Macro

Macro instruction. An instruction that represents a sequence of instructions in abbreviated form.

Macro Directives

Directives that control the execution and data allocation within macro body definitions.

Makefile

Export to a file the instructions to Make the project. Use this file to Make your project outside of MPLAB IDE/MPLAB X IDE, i.e., with a `make`.

Make Project

A command that rebuilds an application, recompiling only those source files that have changed since the last complete compilation.

MCU

Microcontroller Unit. An abbreviation for microcontroller. Also uC.

Memory Model

For C compilers, a representation of the memory available to the application. For the PIC18 C compiler, a description that specifies the size of pointers that point to program memory.

Message

Text displayed to alert you to potential problems in language tool operation. A message will not stop operation.

Microcontroller

A highly integrated chip that contains a CPU, RAM, program memory, I/O ports and timers.

Microcontroller Mode

One of the possible program memory configurations of PIC18 microcontrollers. In microcontroller mode, only internal execution is allowed. Thus, only the on-chip program memory is available in microcontroller mode.

Microprocessor Mode

One of the possible program memory configurations of PIC18 microcontrollers. In microprocessor mode, the on-chip program memory is not used. The entire program memory is mapped externally.

Mnemonics

Text instructions that can be translated directly into machine code. Also referred to as opcodes.

Module

The preprocessed output of a source file after preprocessor directives have been executed. Also known as a translation unit.

MPASM™ Assembler

Microchip Technology's relocatable macro assembler for PIC microcontroller devices, KeeLoq® devices and Microchip memory devices.

MPLAB *Language Tool* for *Device*

Microchip's C compilers, assemblers and linkers for specified devices. Select the type of language tool based on the device you will be using for your application, e.g., if you will be creating C code on a PIC18 MCU, select the MPLAB C Compiler for PIC18 MCUs.

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MPLAB ICD

Microchip in-circuit debugger that works with MPLAB IDE/MPLAB X IDE. *See* ICE/ICD.

MPLAB IDE/MPLAB X IDE

Microchip's Integrated Development Environment. MPLAB IDE/MPLAB X IDE comes with an editor, project manager and simulator.

MPLAB PM3

A device programmer from Microchip. Programs PIC18 microcontrollers and dsPIC digital signal controllers. Can be used with MPLAB IDE/MPLAB X IDE or stand-alone. Replaces PRO MATE II.

MPLAB REAL ICE™ In-Circuit Emulator

Microchip's next-generation in-circuit emulator that works with MPLAB IDE/MPLAB X IDE. *See* ICE/ICD.

MPLAB SIM

Microchip's simulator that works with MPLAB IDE/MPLAB X IDE in support of PIC MCU and dsPIC DSC devices.

MPLIB™ Object Librarian

Microchip's librarian that can work with MPLAB IDE/MPLAB X IDE. MPLIB librarian is an object librarian for use with COFF object modules created using either MPASM assembler (mpasm or mpasmwin v2.0) or MPLAB C18 C Compiler.

MPLINK™ Object Linker

MPLINK linker is an object linker for the Microchip MPASM assembler and the Microchip C18 C compiler. MPLINK linker also may be used with the Microchip MPLIB librarian. MPLINK linker is designed to be used with MPLAB IDE/MPLAB X IDE, though it does not have to be.

MRU

Most Recently Used. Refers to files and windows available to be selected from MPLAB IDE/MPLAB X IDE main pull down menus.

N

Native Data Size

For Native trace, the size of the variable used in a Watch window must be of the same size as the selected device's data memory: bytes for PIC18 devices and words for 16-bit devices.

Nesting Depth

The maximum level to which macros can include other macros.

Node

MPLAB IDE/MPLAB X IDE project component.

Non-Extended Mode (PIC18 MCUs)

In Non-Extended mode, the compiler will not utilize the extended instructions nor the indexed with literal offset addressing.

Non Real Time

Refers to the processor at a breakpoint or executing single-step instructions or MPLAB IDE/MPLAB X IDE being run in simulator mode.

Non-Volatile Storage

A storage device whose contents are preserved when its power is off.

NOP

No Operation. An instruction that has no effect when executed except to advance the program counter.

O

Object Code/Object File

Object code is the machine code generated by an assembler or compiler. An object file is a file containing machine code and possibly debug information. It may be immediately executable or it may be relocatable, requiring linking with other object files, e.g., libraries, to produce a complete executable program.

Object File Directives

Directives that are used only when creating an object file.

Octal

The base 8 number system that only uses the digits 0-7. The rightmost digit counts ones, the next digit counts multiples of 8, then $8^2 = 64$, etc.

Off-Chip Memory

Off-chip memory refers to the memory selection option for the PIC18 device where memory may reside on the target board, or where all program memory may be supplied by the emulator. The **Memory** tab accessed from *Options>Development Mode* provides the Off-Chip Memory selection dialog box.

Opcodes

Operational Codes. *See* Mnemonics.

Operators

Symbols, like the plus sign '+' and the minus sign '-', that are used when forming well-defined expressions. Each operator has an assigned precedence that is used to determine order of evaluation.

OTP

One Time Programmable. EPROM devices that are not in windowed packages. Since EPROM needs ultraviolet light to erase its memory, only windowed devices are erasable.

P

Pass Counter

A counter that decrements each time an event (such as the execution of an instruction at a particular address) occurs. When the pass count value reaches zero, the event is satisfied. You can assign the Pass Counter to break and trace logic, and to any sequential event in the complex trigger dialog.

PC

Personal Computer or Program Counter.

PC Host

Any PC running a supported Windows operating system.

Persistent Data

Data that is never cleared or initialized. Its intended use is so that an application can preserve data across a device Reset.

Phantom Byte

An unimplemented byte in the dsPIC architecture that is used when treating the 24-bit instruction word as if it were a 32-bit instruction word. Phantom bytes appear in dsPIC hex files.

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PIC MCUs

PIC microcontrollers (MCUs) refers to all Microchip microcontroller families.

PICkit 2 and 3

Microchip's developmental device programmers with debug capability through Debug Express. See the Readme files for each tool to see which devices are supported.

Plug-ins

The MPLAB IDE/MPLAB X IDE has both built-in components and plug-in modules to configure the system for a variety of software and hardware tools. Several plug-in tools may be found under the Tools menu.

Pod

The enclosure for an in-circuit emulator or debugger. Other names are "Puck", if the enclosure is round, and "Probe", not be confused with logic probes.

Power-on-Reset Emulation

A software randomization process that writes random values in data RAM areas to simulate uninitialized values in RAM upon initial power application.

Pragma

A directive that has meaning to a specific compiler. Often a pragma is used to convey implementation-defined information to the compiler. MPLAB C30 uses attributes to convey this information.

Precedence

Rules that define the order of evaluation in expressions.

Production Programmer

A production programmer is a programming tool that has resources designed in to program devices rapidly. It has the capability to program at various voltage levels and completely adheres to the programming specification. Programming a device as fast as possible is of prime importance in a production environment where time is of the essence as the application circuit moves through the assembly line.

Profile

For MPLAB SIM simulator, a summary listing of executed stimulus by register.

Program Counter

The location that contains the address of the instruction that is currently executing.

Program Counter Unit

16-bit assembler – A conceptual representation of the layout of program memory. The program counter increments by 2 for each instruction word. In an executable section, 2 program counter units are equivalent to 3 bytes. In a read-only section, 2 program counter units are equivalent to 2 bytes.

Program Memory

MPLAB IDE/MPLAB X IDE – The memory area in a device where instructions are stored. Also, the memory in the emulator or simulator containing the downloaded target application firmware.

16-bit assembler/compiler – The memory area in a device where instructions are stored.

Project

A project contains the files needed to build an application (source code, linker script files, etc.) along with their associations to various build tools and build options.

Prologue

A portion of compiler-generated code that is responsible for allocating stack space, preserving registers and performing any other machine-specific requirement specified in the runtime model. This code executes before any user code for a given function.

Prototype System

A term referring to a user's target application, or target board.

Psect

The OCG equivalent of a GCC section, short for program section. A block of code or data which is treated as a whole by the linker.

PWM Signals

Pulse Width Modulation Signals. Certain PIC MCU devices have a PWM peripheral.

Q

Qualifier

An address or an address range used by the Pass Counter or as an event before another operation in a complex trigger.

R

Radix

The number base, hex, or decimal, used in specifying an address.

RAM

Random Access Memory (Data Memory). Memory in which information can be accessed in any order.

Raw Data

The binary representation of code or data associated with a section.

Read Only Memory

Memory hardware that allows fast access to permanently stored data but prevents addition to or modification of the data.

Real Time

When an in-circuit emulator or debugger is released from the halt state, the processor runs in Real Time mode and behaves exactly as the normal chip would behave. In Real Time mode, the real time trace buffer of an emulator is enabled and constantly captures all selected cycles, and all break logic is enabled. In an in-circuit emulator or debugger, the processor executes in real time until a valid breakpoint causes a halt, or until the user halts the execution.

In the simulator, real time simply means execution of the microcontroller instructions as fast as they can be simulated by the host CPU.

Recursive Calls

A function that calls itself, either directly or indirectly.

Recursion

The concept that a function or macro, having been defined, can call itself. Great care should be taken when writing recursive macros; it is easy to get caught in an infinite loop where there will be no exit from the recursion.

Reentrant

A function that may have multiple, simultaneously active instances. This may happen due to either direct or indirect recursion or through execution during interrupt processing.

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Relaxation

The process of converting an instruction to an identical, but smaller instruction. This is useful for saving on code size. MPLAB XC16 currently knows how to `relax` a `CALL` instruction into an `RCALL` instruction. This is done when the symbol that is being called is within +/- 32k instruction words from the current instruction.

Relocatable

An object whose address has not been assigned to a fixed location in memory.

Relocatable Section

16-bit assembler – A section whose address is not fixed (absolute). The linker assigns addresses to relocatable sections through a process called relocation.

Relocation

A process performed by the linker in which absolute addresses are assigned to relocatable sections and all symbols in the relocatable sections are updated to their new addresses.

ROM

Read Only Memory (Program Memory). Memory that cannot be modified.

Run

The command that releases the emulator from halt, allowing it to run the application code and change or respond to I/O in real time.

Run-time Model

Describes the use of target architecture resources.

Runtime Watch

A Watch window where the variables change in as the application is run. See individual tool documentation to determine how to set up a runtime watch. Not all tools support runtime watches.

S

Scenario

For MPLAB SIM simulator, a particular setup for stimulus control.

Section

The GCC equivalent of an OCG psect. A block of code or data which is treated as a whole by the linker.

Section Attribute

A GCC characteristic ascribed to a section (e.g., an `access` section).

Sequenced Breakpoints

Breakpoints that occur in a sequence. Sequence execution of breakpoints is bottom-up; the last breakpoint in the sequence occurs first.

Serialized Quick Turn Programming

Serialization allows you to program a serial number into each microcontroller device that the Device Programmer programs. This number can be used as an entry code, password or ID number.

Shell

The MPASM assembler shell is a prompted input interface to the macro assembler. There are two MPASM assembler shells: one for the DOS version and one for the Windows operating system version.

Simulator

A software program that models the operation of devices.

Single Step

This command steps through code, one instruction at a time. After each instruction, MPLAB IDE/MPLAB X IDE updates register windows, watch variables, and status displays so you can analyze and debug instruction execution. You can also single step C compiler source code, but instead of executing single instructions, MPLAB IDE/MPLAB X IDE will execute all assembly level instructions generated by the line of the high level C statement.

Skew

The information associated with the execution of an instruction appears on the processor bus at different times. For example, the executed opcodes appears on the bus as a fetch during the execution of the previous instruction, the source data address and value and the destination data address appear when the opcodes is actually executed, and the destination data value appears when the next instruction is executed. The trace buffer captures the information that is on the bus at one instance. Therefore, one trace buffer entry will contain execution information for three instructions. The number of captured cycles from one piece of information to another for a single instruction execution is referred to as the skew.

Skid

When a hardware breakpoint is used to halt the processor, one or more additional instructions may be executed before the processor halts. The number of extra instructions executed after the intended breakpoint is referred to as the skid.

Source Code

The form in which a computer program is written by the programmer. Source code is written in a formal programming language which can be translated into machine code or executed by an interpreter.

Source File

An ASCII text file containing source code.

Special Function Registers (SFRs)

The portion of data memory (RAM) dedicated to registers that control I/O processor functions, I/O status, timers or other modes or peripherals.

SQTP

See Serialized Quick Turn Programming.

Stack, Hardware

Locations in PIC microcontroller where the return address is stored when a function call is made.

Stack, Software

Memory used by an application for storing return addresses, function parameters, and local variables. This memory is dynamically allocated at runtime by instructions in the program. It allows for reentrant function calls.

Stack, Compiled

A region of memory managed and allocated by the compiler in which variables are statically assigned space. It replaces a software stack when such mechanisms cannot be efficiently implemented on the target device. It precludes reentrancy.

MPLAB Starter Kit for *Device*

Microchip's starter kits contains everything needed to begin exploring the specified device. View a working application and then debug and program your own changes.

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Static RAM or SRAM

Static Random Access Memory. Program memory you can read/write on the target board that does not need refreshing frequently.

Status Bar

The Status Bar is located on the bottom of the MPLAB IDE/MPLAB X IDE window and indicates such current information as cursor position, development mode and device, and active tool bar.

Step Into

This command is the same as Single Step. Step Into (as opposed to Step Over) follows a CALL instruction into a subroutine.

Step Over

Step Over allows you to debug code without stepping into subroutines. When stepping over a `CALL` instruction, the next breakpoint will be set at the instruction after the `CALL`. If for some reason the subroutine gets into an endless loop or does not return properly, the next breakpoint will never be reached. The Step Over command is the same as Single Step except for its handling of `CALL` instructions.

Step Out

Step Out allows you to step out of a subroutine which you are currently stepping through. This command executes the rest of the code in the subroutine and then stops execution at the return address to the subroutine.

Stimulus

Input to the simulator, i.e., data generated to exercise the response of simulation to external signals. Often the data is put into the form of a list of actions in a text file. Stimulus may be asynchronous, synchronous (pin), clocked and register.

Stopwatch

A counter for measuring execution cycles.

Storage Class

Determines the lifetime of the memory associated with the identified object.

Storage Qualifier

Indicates special properties of the objects being declared (e.g., `const`).

Symbol

A symbol is a general purpose mechanism for describing the various pieces which comprise a program. These pieces include function names, variable names, section names, file names, struct/enum/union tag names, etc. Symbols in MPLAB IDE/MPLAB X IDE refer mainly to variable names, function names and assembly labels. The value of a symbol after linking is its value in memory.

Symbol, Absolute

Represents an immediate value such as a definition through the assembly `.equ` directive.

System Window Control

The system window control is located in the upper left corner of windows and some dialogs. Clicking on this control usually pops up a menu that has the items “Minimize,” “Maximize,” and “Close.”

T

Target

Refers to user hardware.

Target Application

Software residing on the target board.

Target Board

The circuitry and programmable device that makes up the target application.

Target Processor

The microcontroller device on the target application board.

Template

Lines of text that you build for inserting into your files at a later time. The MPLAB Editor stores templates in template files.

Tool Bar

A row or column of icons that you can click on to execute MPLAB IDE/MPLAB X IDE functions.

Trace

An emulator or simulator function that logs program execution. The emulator logs program execution into its trace buffer which is uploaded to MPLAB IDE/MPLAB X IDE's trace window.

Trace Memory

Trace memory contained within the emulator. Trace memory is sometimes called the trace buffer.

Trace Macro

A macro that will provide trace information from emulator data. Since this is a software trace, the macro must be added to code, the code must be recompiled or reassembled, and the target device must be programmed with this code before trace will work.

Trigger Output

Trigger output refers to an emulator output signal that can be generated at any address or address range, and is independent of the trace and breakpoint settings. Any number of trigger output points can be set.

Trigraphs

Three-character sequences, all starting with ??, that are defined by ISO C as replacements for single characters.

U

Unassigned Section

A section which has not been assigned to a specific target memory block in the linker command file. The linker must find a target memory block in which to allocate an unassigned section.

Uninitialized Data

Data which is defined without an initial value. In C,

```
int myVar;
```

defines a variable which will reside in an uninitialized data section.

Upload

The Upload function transfers data from a tool, such as an emulator or programmer, to the host PC or from the target board to the emulator.

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USB

Universal Serial Bus. An external peripheral interface standard for communication between a computer and external peripherals over a cable using bi-serial transmission. USB 1.0/1.1 supports data transfer rates of 12 Mbps. Also referred to as high-speed USB, USB 2.0 supports data rates up to 480 Mbps.

V

Vector

The memory locations that an application will jump to when either a Reset or interrupt occurs.

Volatile

A variable qualifier which prevents the compiler applying optimizations that affect how the variable is accessed in memory.

W

Warning

MPLAB IDE/MPLAB X IDE – An alert that is provided to warn you of a situation that would cause physical damage to a device, software file, or equipment.

16-bit assembler/compiler – Warnings report conditions that may indicate a problem, but do not halt processing. In MPLAB C30, warning messages report the source file name and line number, but include the text '`warning`:' to distinguish them from error messages.

Watch Variable

A variable that you may monitor during a debugging session in a Watch window.

Watches Window

Watches windows contain a list of watch variables that are updated at each breakpoint.

Watchdog Timer (WDT)

A timer on a PIC microcontroller that resets the processor after a selectable length of time. The WDT is enabled or disabled and set up using Configuration bits.

Workbook

For MPLAB SIM stimulator, a setup for generation of SCL stimulus.

NOTES:

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Index

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