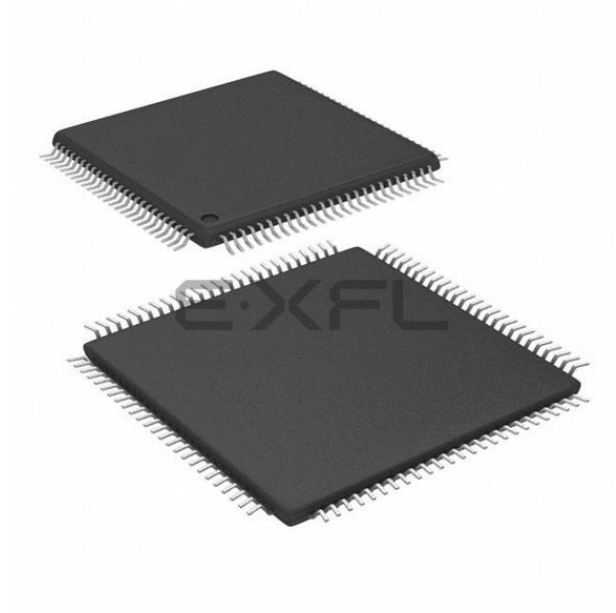
Microchip Technology - PIC32MX360F256L-80V/PT Datasheet



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"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	MIPS32® M4K™
Core Size	32-Bit Single-Core
Speed	80MHz
Connectivity	I²C, IrDA, LINbus, PMP, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, POR, PWM, WDT
Number of I/O	85
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	32K x 8
Voltage - Supply (Vcc/Vdd)	2.3V ~ 3.6V
Data Converters	A/D 16x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	100-TQFP
Supplier Device Package	100-TQFP (12x12)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic32mx360f256l-80v-pt

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	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	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [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) { ... }`

NOTES:

Chapter 1. PIC32 Features

1.1 INTRODUCTION

The PIC32 is a 32-bit family of general purpose microcontrollers from Microchip Technology. It offers 80+ DMIPS performance with a wide variety of on-chip peripherals. It employs industry leading M4K MIPS32 core from MIPS Technologies, Inc. All members in the PIC32 family use programming interface similar to other Microchip PIC® microcontrollers. In addition, PIC32 microcontrollers are pin-to-pin compatible with the PIC24FJ128GA family of 16-bit microcontrollers.

1.2 HIGHLIGHTS

The PIC32 family offers a number of features to enable a wide variety of applications. The following subsections list all the key features grouped in major categories.

Performance:

- Up to 80 MHz, MIPS M4K 32-bit core with 5 stage pipeline
- High-performance hardware multiply/divide unit – 1 multiply per clock
- Programmable user and kernel memory partition for enhanced application stability
- Multiple register sets for reduced interrupt latency
- Hardware assisted single-cycle register bits manipulations
- 128-bit wide Flash memory to shorten individual instruction fetch time
- 256 bytes of high-speed cache memory with instruction and ROM data prefetch buffer
- Available DMA controller with integrated CRC calculation and pattern-based transfer termination
- Includes USB On-The-Go controller for USB device, host, or dual-role applications
- USB controller has own dedicated DMA interface

Power Management:

- 2.3 to 3.6V operation
- Full-speed operation over entire voltage range
- Various low-power modes including RUN, IDLE and SLEEP
- I/O transfers via DMA in IDLE mode
- Programmable peripheral clock
- Individual peripheral ON/OFF control and operation during IDLE mode
- Multiple clock sources

Scalability:

- Industry known MIPS32-compatible M4K CPU core with 5 stage pipeline
- Large family of devices with Flash memory options from 32 KB to 512 KB
- Pin compatible with 64/100 pin PIC24FJXXXGA family of 16-bit microcontrollers

Ease of Use:

- PIC® microcontroller “look and feel” peripherals
- Standard MPLAB® tool-suite – MPLAB IDE, MPLAB C32 C Compiler, MPLAB REAL ICE™, and MPLAB ICD 2.
- Software Peripheral Libraries compatible with those for Microchip 16-bit microcontrollers
- Microchip developed middleware modules such as TCP/IP and 16-bit file system

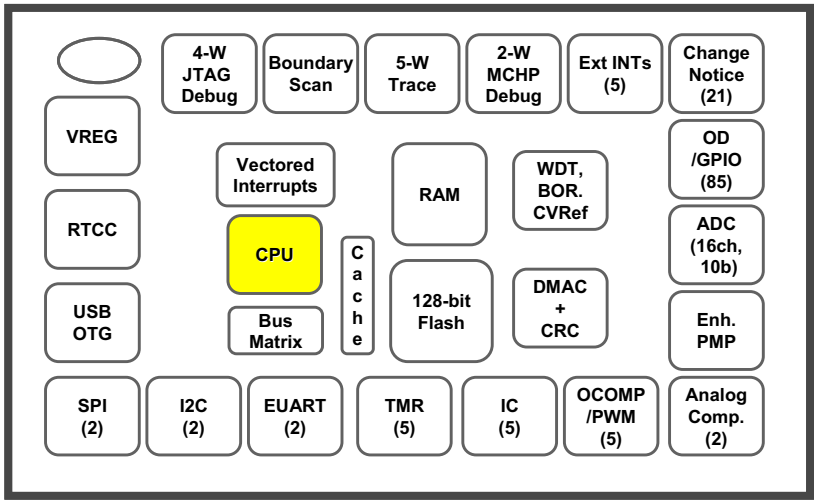
Chapter 2. PIC32 Product Family

2.1 INTRODUCTION

The PIC32 family includes scalable devices ranging from 32KB to 512KB of Flash memory. Also a rich set of peripherals – Five timers, 16 channels of 10-bit A/D Converters and communication interfaces: SPI, I^2C™ and UART.

Please consult the "*PIC32MX Family Data Sheet*" (DS61143) for a complete list of family variants, core and peripheral characteristics.

FIGURE 2-1: PIC32 MCU MODULES



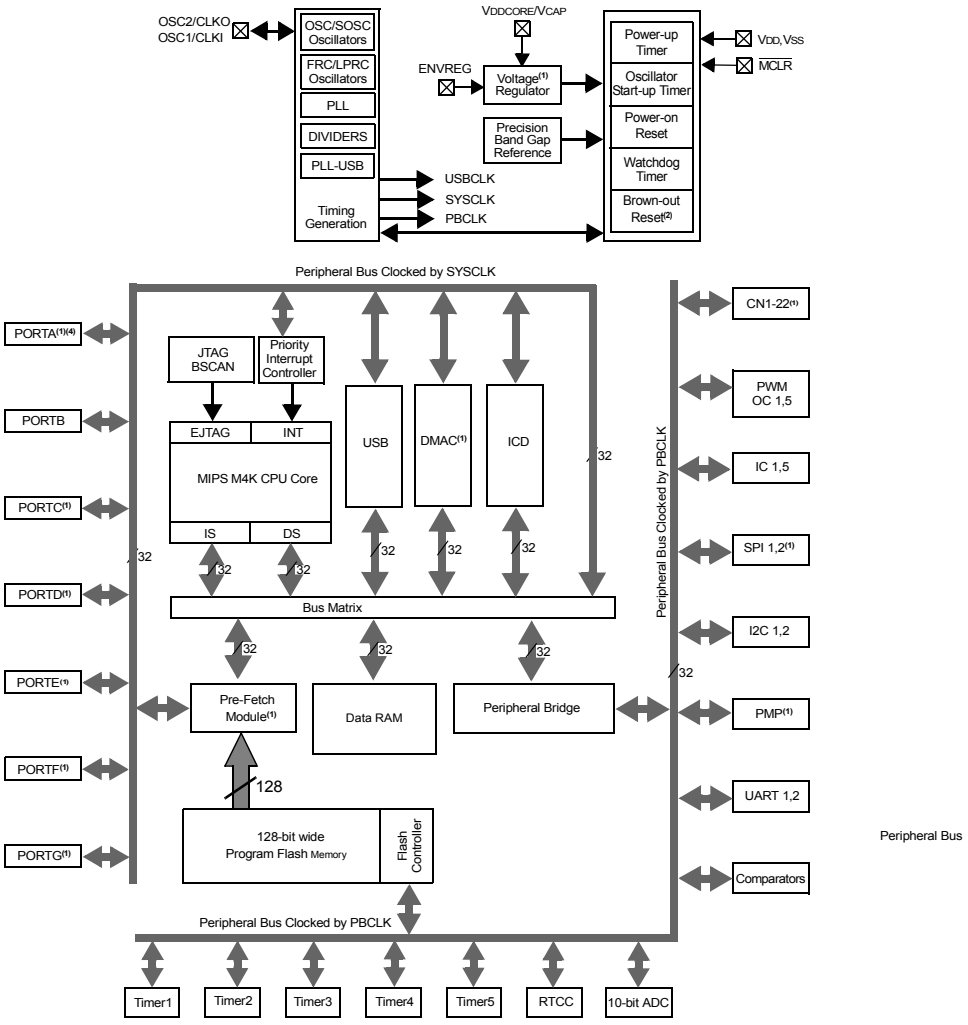
NOTES:

Chapter 3. PIC32 Architecture

3.1 INTRODUCTION

The PIC32 family of MCUs combines the MIPS M4K core together with powerful peripherals and embedded Flash and RAM memory to address a wide range of applications.

FIGURE 3-1: PIC32 BLOCK DIAGRAM



Note 1: Not all pins or features are implemented on all device pinout configurations. See Table 1-4 for I/O port pin descriptions.

2: Some features are not available on certain device variants.

3: BOR functionality is provided when the on-board voltage regulator is enabled.

4: PORTA is not present on 64 pin devices

Processor core:

- MIPS M4K with 5-stage pipeline
- MIPS32-compatible Release 2 Instruction Set
- MIPS16e™ Code Compression to improve code density by up to 40%
- GPR shadow registers to minimize latency for interrupt handlers
- Bit field manipulation instructions
- High-performance Multiply/Divide Unit:
  - Maximum issue rate of one 32x16 multiply per clock
  - Maximum issue rate of one 32x32 multiply every other clock
- Static implementation: minimum operating frequency 0 MHz
- 2.3 to 3.6V operation with full speed over entire range
- Low-power modes including RUN, IDLE, and SLEEP

Memory:

- Unified 4GB virtual memory space
- Fixed Memory Mapping Translation (FMT) mechanism
- Flexible partitioning into kernel and user accessible memory segments for increased application stability

Pre Fetch Cache:

- 16 lines, each 128-bit wide, instruction Prefetch buffer
- Ability to load and lock lines – useful to create SW breakpoints in Flash and minimize interrupt latency

Interrupt Controller:

- Fully programmable interrupt controller with Single or Multi vector mode, supporting up to 95 IRQs.
- Multiple priorities and subpriorities for each vector
- Highest priority interrupt has dedicated register set for reduced interrupt latency

DMA Controller:

- Up to 4 independent channels
- Memory-to-Memory, Memory-to-Peripheral, and Peripheral-to-Memory transfers
- Programmable trigger from any IRQ
- Chainable channels, stop on match detection, Auto-Enable mode
- Data transfers can occur while the core is in IDLE mode
- Integrated programmable CRC engine: calculates on the fly while the data is transferred.

Enhanced Parallel Master Port:

- 8- and 16-bit data interface
- Up to 16-bit address lines, expandable using GPIO lines
- 2 Chip Select lines

Chapter 4. PIC32 Tools

4.1 INTRODUCTION

The PIC32 microcontrollers are supported by the MPLAB Integrated Development Environment and its full range of hardware and software tools.

4.2 HIGHLIGHTS

Items discussed in this chapter are:

- MPLAB IDE
- MPLAB C32 C Compiler
- Peripheral Libraries
- Software Solutions
- Demonstration, Development and Evaluation Boards
- Technical Documentation

4.3 MPLAB IDE

The Microchip MPLAB IDE is a FREE development toolsuite for Microsoft Windows® that contains:

- A single graphical interface to all debugging tools:
  - Simulator
  - Programmers
  - Emulators
  - In-Circuit Debuggers
- A full-featured editor with color-coded context
- A project manager
- Customizable data windows with in-place editable contents
- High-level source code debugging
- Extensive on-line help

The MPLAB IDE provides integrated debugging and programming facilities using any of the following probes connected to the target processor/Development Board:

- MPLAB ICD 2 In-Circuit Debugger: a low-cost, run-time development tool.
- MPLAB REAL ICE In-Circuit Emulator: a high speed in-circuit emulator with hardware and software trace capabilities.
- FS2 JTAG probe: Developed by First Silicon Solutions, this probe uses 4-wire EJTAG interface to debug and program the PIC32 microcontrollers.
- MPLAB PM3 Device Programmer: a Microchip universal device programmer suitable for development and manufacturing purposes.
- MPLAB SIM32 Device Simulator: Accurately simulates many PIC32 peripherals and the CPU in selectable cycle and clock-accurate modes

4.5 PERIPHERAL LIBRARIES

PIC32 MCUs integrate a large number of on-chip high-performance peripherals.

To accelerate the usage of these peripherals, the MPLAB C32 compiler for PIC32 includes software peripheral libraries compatible with the 16-bit Microchip MCUs. The peripheral libraries are distributed in source and object format along with a detailed API description document. Software applications using MPLAB C32 compiler may call peripheral library functions by simply including the appropriate header file in their source files – the MPLAB C32 compiler has built-in knowledge of library header and archive files.

The peripheral include files are located in `C:\Program Files\Microchip\MPLAB C32\pic32mx\include\peripheral` and the full source code is located in `C:\Program Files\Microchip\MPLAB C32\pic32-libs\peripheral` location in corresponding peripheral sub-directory.

The Peripheral Library contains following include files:

Chapter 5. Step-by-Step Procedures to Setup, Build, and Run a Demo Project

5.1 INTRODUCTION

In this step-by-step procedure, the basic concepts of the MPLAB Project Manager, Editor and Debugger will be presented. You will create a simple project and understand the debug capabilities of MPLAB IDE.

No previous MPLAB IDE knowledge is assumed. For complete features set and comprehensive technical details of MPLAB IDE and its components, please visit our web site (www.microchip.com/ide).

5.2 HIGHLIGHTS

Items discussed in this chapter are:

- MPLAB IDE Setup
- Step-by-Step Guide Overview
- Selecting the Device
- Creating the Project
- Setting Up Language Tools
- Naming the Project
- Adding Files to the Project
- Attaching the Debugger
- Building the Project
- Testing the Code

5.3 MPLAB IDE SETUP

5.3.1 Install MPLAB IDE

To install the MPLAB on your system, you could either use the supplied installation CD or download the latest MPLAB IDE from the Microchip web site.

- To install from a CD-ROM, just place the disk into a CD drive and follow the on-screen prompts (you could use Windows Explorer to find and execute the CD-ROM menu, `menu.exe`).
- If the MPLAB IDE was downloaded from the Microchip web site, unzip the file and execute the resulting file to install.

Note: Administrative access will be required to install the MPLAB on a PC.

5.3.2 To uninstall MPLAB IDE

- Select *Start>Settings>Control Panel* to open the control panel.
- Double click on Add/Remove Programs. Find MPLAB IDE and select it.
- Click Change/Remove to remove the program from your system.

Note: Administrative access might be required in order to uninstall the MPLAB.

5.7 SETTING UP LANGUAGE TOOLS

Step Two of the Project Wizard sets up the language tools that are used with this project. Make sure the “Show all installed toolsuites” checkbox is checked. Select Microchip PIC32 C Compiler Toolsuite in the Active Toolsuite list box.

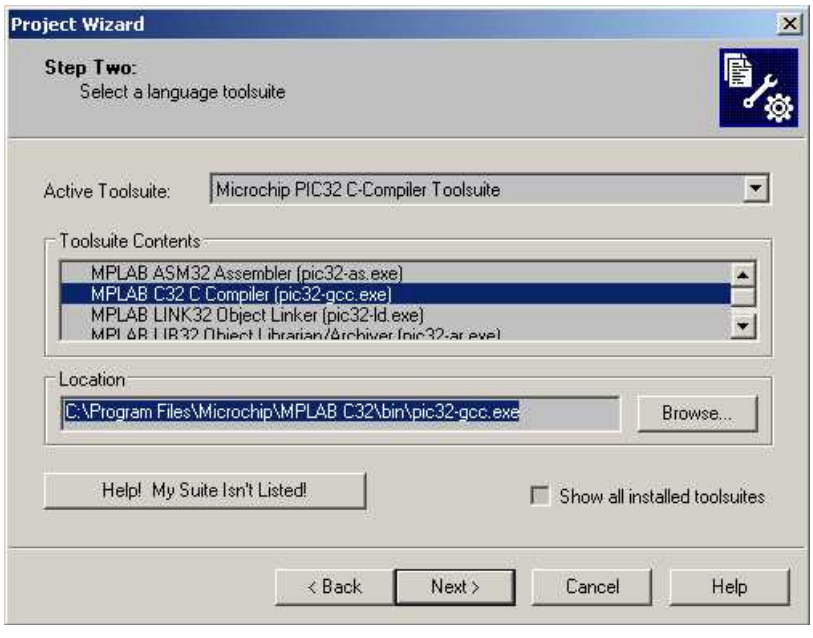
Then “MPLAB PIC32 Assembler (PIC32-as.exe)”, “MPLAB PIC32 C Compiler (PIC32-gcc.exe)”, “MPLAB PIC32 Object Linker (PIC32-ld.exe)”, and “MPLAB PIC32 Archiver (PIC32-ar.exe)”, should be visible in the Toolsuite Contents box. Click on each one to see its location. If MPLAB IDE was installed into the default directory, the paths for these files will be:

- for the MPLAB PIC32 assembler:
  - `C:\Program Files\Microchip\MPLAB IDE\ MPLAB C32\bin\PIC32-as.exe`
- for the MPLAB PIC32 compiler:
  - `C:\Program Files\Microchip\MPLAB IDE\ MPLAB C32\bin\ PIC32-gcc.exe`
- for the MPLAB PIC32 Object Linker:
  - `C:\Program Files\Microchip\MPLAB IDE\ MPLAB C32\bin\PIC32-ld.exe`
- for the MPLAB PIC32 Archiver:
  - `C:\Program Files\Microchip\MPLAB IDE\ MPLAB C32\bin\PIC32-ar.exe`

If these paths do not show up correctly, use the **Browse** button to set them to the proper files in the MPLAB IDE subfolders.

When you are finished, click **Next>**.

FIGURE 5-4: MPLAB IDE SELECT LANGUAGE TOOLSUITE

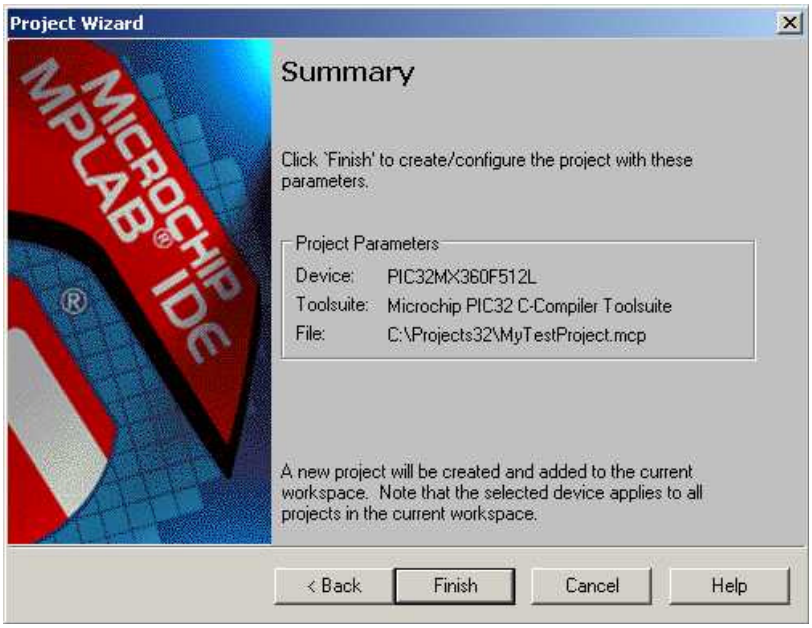


5.9 ADDING FILES TO THE PROJECT

Step Four of the Project Wizard allows file selection for the project. This is where we can add existing files to our project. In the current example we don't have a previously created file but we'll create one once we're done with the new project setting.

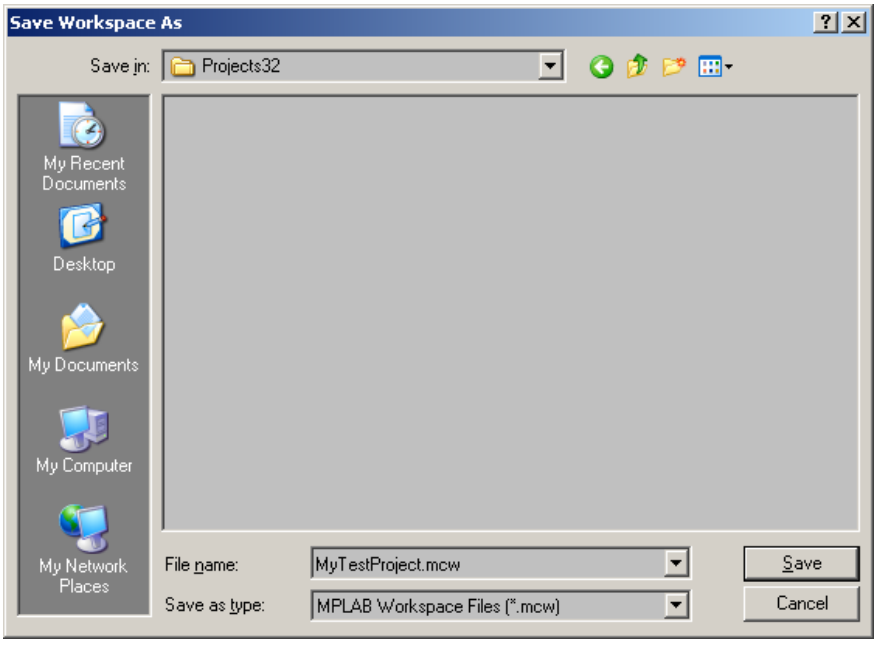
Just press **Next>** and the following Summary Screen will show up:

FIGURE 5-6: MPLAB IDE SUMMARY SCREEN



Press **Finish** and the workspace dialog shows up:

FIGURE 5-7: MPLAB IDE SAVE WORKSPACE

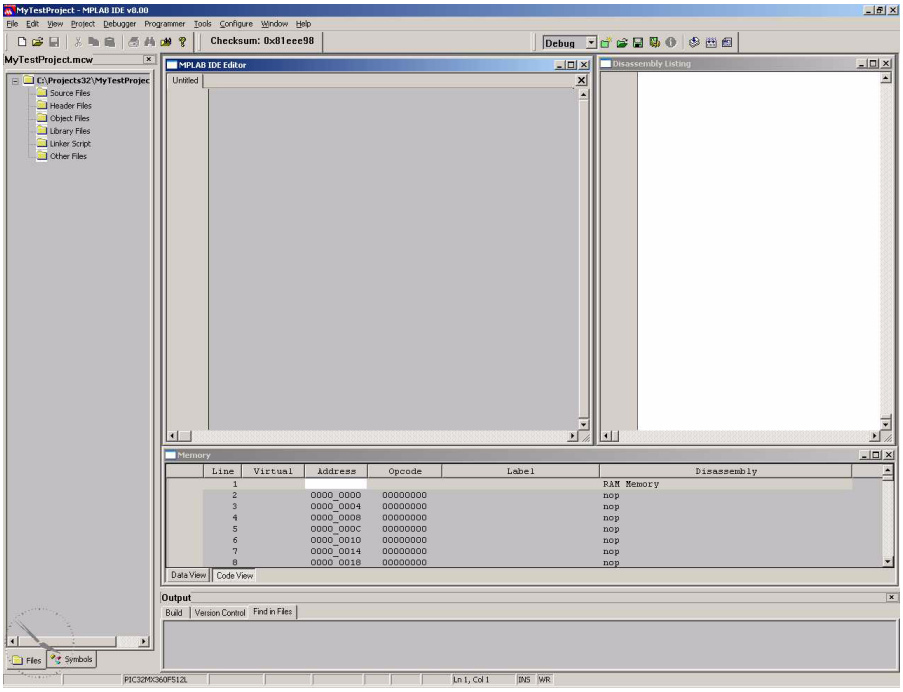


Be sure to save the workspace in the Projects32 directory and name this workspace using the same name as for the project: MyTestProject.

Click **Save**.

The project space is now completely created and it should look like that:

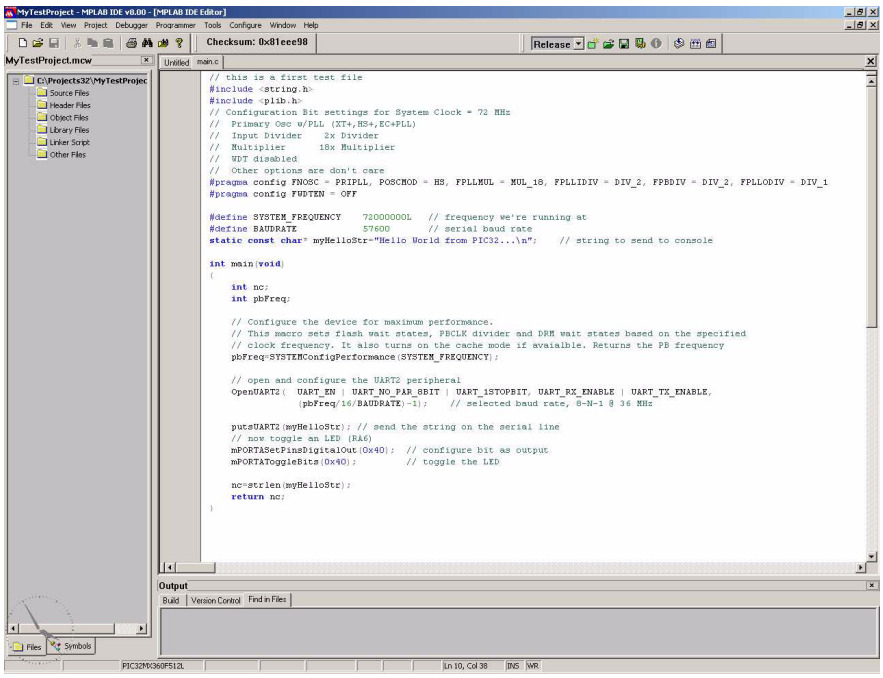
FIGURE 5-8: MPLAB IDE PROJECT SAVE



Now we'll create our C source file. If the MPLAB IDE Editor window is not open, click *File->New* from the top menu or the New File menu shortcut on the standard toolbar. The Editor window will show up.

Let's type in a very simple Hello World program in the Editor window and save it in Projects32 directory as `main.c`. We'll use the UART Peripheral Library provided by Microchip:

FIGURE 5-9: MPLAB IDE MAIN.C FILE



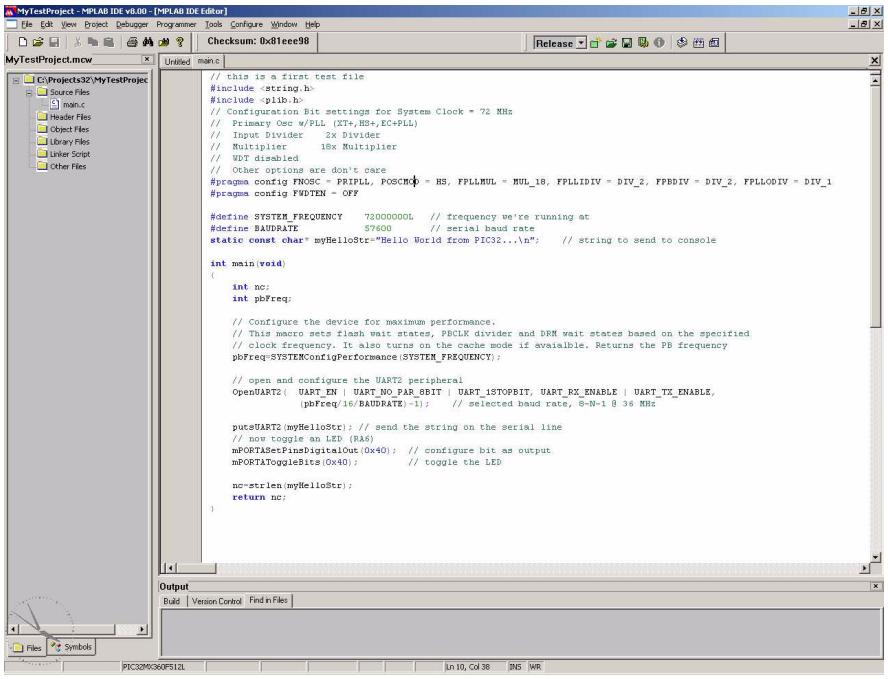
To add the newly created `main.c` file to our project just right click on the Source Files folder in the MPLAB IDE MyTestProject.mcp window and select Add File. Browse and select `main.c` file from the Projects32 directory.

Note: If the Project window is not open, select View->Project from the top IDE menu.

The linker script that's needed for this project is selected automatically by the MPLAB IDE. We don't need to add any other file to our project.

Right click on MyTestProject.mcp window and select **Save**. The test project should be saved. The MyTestProject.mcp should look like:

FIGURE 5-10: MPLAB IDE PROJECT SAVED



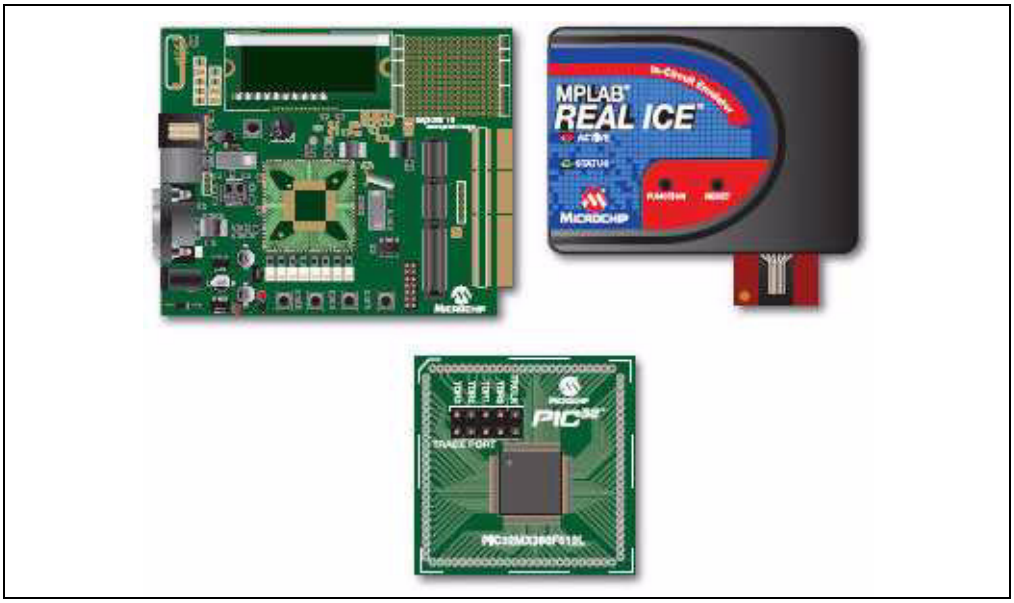
TIP: Files can be added and projects saved by using the right mouse button in the project window. In case of error, files can be manually deleted by selecting them and using the right mouse click menu.

5.10 ATTACHING THE DEBUGGER

In order to test the code using the PIC32 Starter Kit, please refer to the PIC32MX Starter Kit User's Guide (DS61144) for a sample project and a step-by-step getting started info.

For the purpose of testing our code in this document we will use an Explorer 16 Development board (DM240001), a MPLAB REAL ICE In-Circuit Debugger (DV244005) and a PIC32MX360F512L PIM (MA320001) together with a 9V universal power supply, a serial cable and a USB cable for connecting the REAL ICE to the development board.

FIGURE 5-11: EXPLORER 16, MPLAB® REAL ICE™ AND PIC32MX360F512L PIM



Take the following steps to ensure proper connection of the REAL ICE to the Explorer 16 development board:

1. Connect the MPLAB REAL ICE module to the PC with the USB cable.
2. Connect the MPLAB REAL ICE to the Explorer 16 Development Board with the short RJ-11 cable.
3. Apply power to the Explorer 16 board.
4. From the Debugger menu, click *Select Tool > MPLAB REAL ICE* to set the MPLAB REAL ICE as the debug tool in MPLAB IDE.
5. From the Debugger menu, select Connect to connect the debugger to the device. MPLAB IDE should report in the Output window that it found the PIC32MX360F512L device.

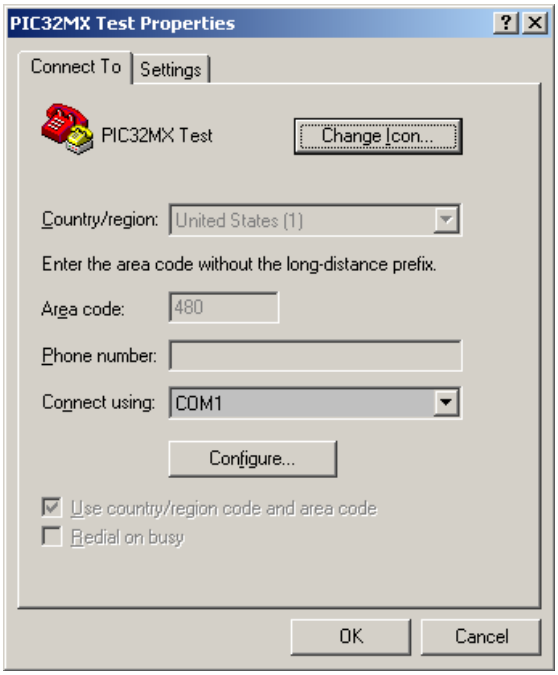
Note: MPLAB IDE may need to download new firmware if this is the first time the MPLAB REAL ICE is being used with a PIC32 device. Allow it to do so.

Once you have performed these steps, go to the MPLAB IDE window and from the *Debugger->Select Tool* menu select the debugging tool you're using to connect to the board (i.e., MPLAB REAL ICE should be within the available choices).

Once you have selected the tool, the "Debug Toolbar" should be present just below the main menu bar, together with other toolbars that may be selected.

Note: Be sure to select Debug from the MPLAB IDE Build Configuration drop down list.

FIGURE 5-13: HYPER TERMINAL CONNECTION SCREEN



Click **OK** and, on the next screen, select the following communication settings:

- Bits Per Second: 57600
- Data Bits: 8
- Parity: None
- Stop Bits: 1
- Flow Control: None

Click **OK** and the Hyper Terminal session should be connected to the serial port on the development board.

Now return to the MPLAB IDE and double click on the line:

return nc;

in the MPLAB IDE Editor window, the `main.c` program, to set a breakpoint on that line, just after the call to `strlen()`.

Click Debugger->Run from the main menu, or Run from the Debug toolbar. The program should start running and it will reach the set breakpoint. The MPLAB IDE window will look very similar to this one:

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