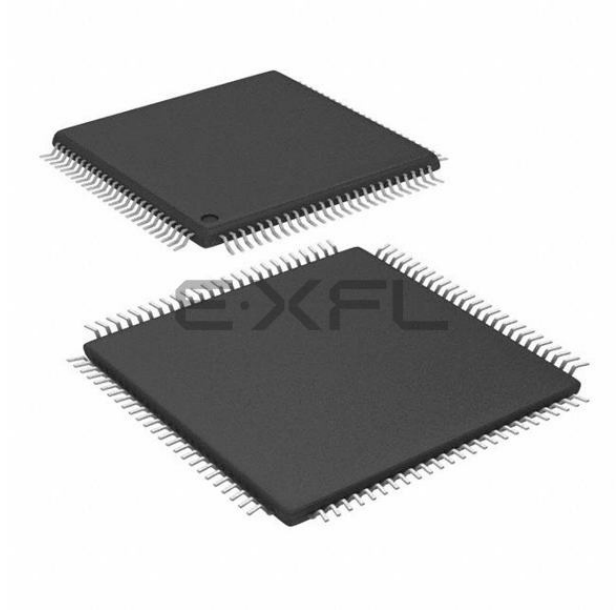
Microchip Technology - PIC32MX360F256LT-80V/PT Datasheet



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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/pic32mx360f256lt-80v-pt

Table of Contents

NOTES:

DOCUMENT LAYOUT

This document is divided into 6 sections. Sections 1 through 4 provide an overview of PIC32 products. Section 5 provides an overview of PIC32 development tools. Section 6 describes the procedure to setup a development environment and debug a sample application. The manual layout is as follows:

- **Chapter 1. PIC32 Features**
- **Chapter 2. PIC32 Product Family**
- **Chapter 3. PIC32 Architecture**
- **Chapter 4. PIC32 Tools**
- **Chapter 5. Step-by-Step Procedures to Setup, Build, and Run a Demo Project**
- **Chapter 6. Technical Support Resources**

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

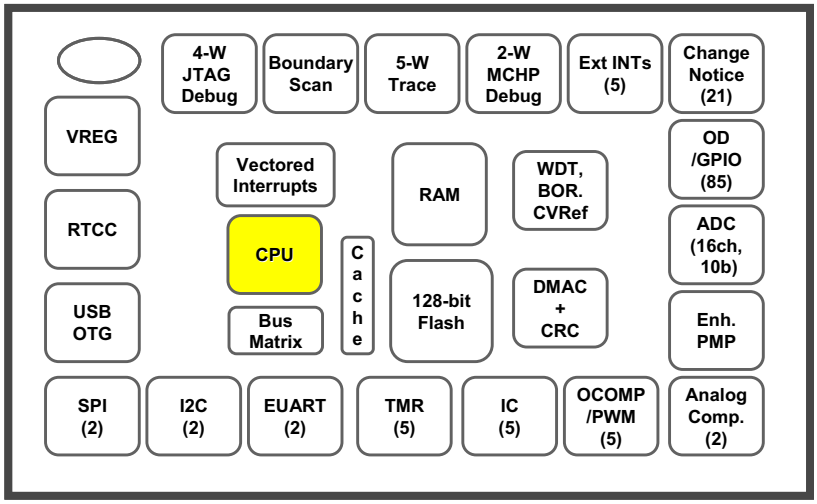
Chapter 2. PIC32 Product Family

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



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

Communication channels:

- USB 2.0 compliant (FS. 12 Mbps), OTG, Host and Device-only capable
- 2 enhanced UART channels with hardware IrDA®
- 2 Master/Slave/Frame mode SPI channels
- 2 Master/Slave I^2C channels, 10/7 bits mode addressing, broadcast capable

Analog-to-Digital Converters:

- Up to 16 Channels, each 10-bit resolution ADCs
- Up to 500+ kilo-samples per second (ksps) conversion speed
- Software selectable Internal or External voltage reference
- Automatic Channel Scan mode
- Selectable conversion trigger source
- 16 word conversion result buffer
- Selectable Buffer Fill modes
- Eight result alignment options
- Operation during CPU Sleep mode

Timers:

- 5 16-bit timer/counter with the ability to form up to (2) 32-bit timer/counters
- Software-selectable internal or external clock source
- Asynchronous timer/counter with built-in oscillator
- Programmable interrupt generation and priority
- Gated external pulse counter
- Software-selectable prescalers.
- Operational during CPU Sleep mode

Core Timer:

- 32 bit timer in CPU for implementing a timer interrupt function.

RTCC (Real-Time Clock and Calendar):

- Time with hours, minutes and seconds
- Calendar with weekday, date, month and year
- Leap year detection
- Highly configurable alarm
- Calibration of up to 260 ppm of crystal error

Debug and Programming:

- 6 instructions and 2 data breakpoints
- 2 complex breakpoint logic blocks with qualified/primed breakpoint triggers, Pass counters, and stopwatch timers.
- 4-wire EJTAG and 2-wire Microchip interface
- 2-wire Microchip Interface:
  - 6 real-time read/write capture logic blocks
  - Read/write access to all data RAM and SFRs without stopping CPU
- Instruction Trace Port:
  - 5-Wire, nonintrusive trace port
  - Triggered by complex breakpoint logic block

4.6 SOFTWARE SOLUTIONS

At the time of writing this document, Microchip had not released any drivers. Microchip does intend to develop drivers for key communication peripherals.

4.6.1 Middleware

The following list provides the Microchip middleware components available at the time of writing this document:

- 16-bit file system on SD Memory to support Microsoft MS-DOS file system.
- Two types of TCP/IP stack – 1) Microchip legacy TCP/IP Stack – fully compatible with Microchip 8- and 16-bit Stack, 2) Microchip BSD TCP/IP Stack – A Berkeley socket API stack with many advanced features.
- TCP/IP middleware:
  - FTP server to allow the application running on the target PIC32 machine to be a File Transfer Protocol server.
  - SNMP Agent to monitor PIC32 products using SNMP protocol.
  - Web server to accept HTTP requests from Web browsers clients.
- USB middleware:
  - USB Embedded Host Stack (HID and Mass Storage)
  - USB Device Stack (HID, Mass Storage and CDC class)

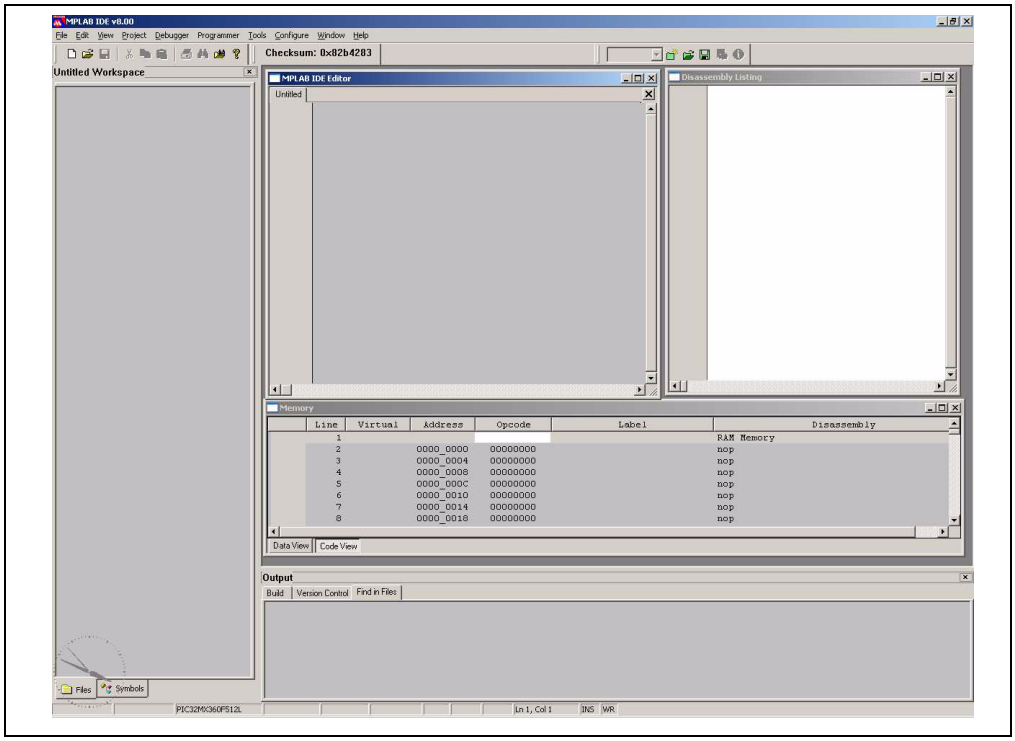
4.6.2 3rd Party Tools

Check the PIC32 home page (www.microchip.com/PIC32) to learn about the list of companies with support for PIC32.

5.3.3 Running MPLAB IDE

To start MPLAB IDE, double click on the icon installed on the desktop after installation or select *Start>Programs>Microchip>MPLAB IDE vx.xx>MPLAB IDE*. A screen will display the MPLAB IDE logo followed by the MPLAB IDE desktop.

FIGURE 5-1: MPLAB IDE START SCREEN



5.4 STEP-BY-STEP GUIDE OVERVIEW

To create code that is executable by the PIC32 MCU, source files need to be part of a project. The code can then be built into executable code using selected language tools (assemblers, compilers, linkers, etc.). In MPLAB IDE, the project manager controls this process and will guide us through most of these steps.

All projects will have these basic steps:

- Select Device

The capabilities of MPLAB IDE vary according to which device is selected. Device selection should be completed before starting a project.

- Create Project

MPLAB IDE Project Wizard will be used to create a project.

- Select Language Tools

In the Project Wizard the language tools will be selected. For this tutorial, the PIC32 tools will be used. For other projects, either other Microchip or third party tools might be selected.

- Add Files in Project

We'll add a template file and a linker script to the project.

- Create Code

Some very simple code will be added to the template file to print a “Hello World…” string to a serial console connected to the evaluation board. We will use the UART Peripheral Library provided by Microchip.

- Build Project

The project will be built – causing the source files to be compiled and linked into machine code that can run on the selected PIC32 MCU.

- Test Code

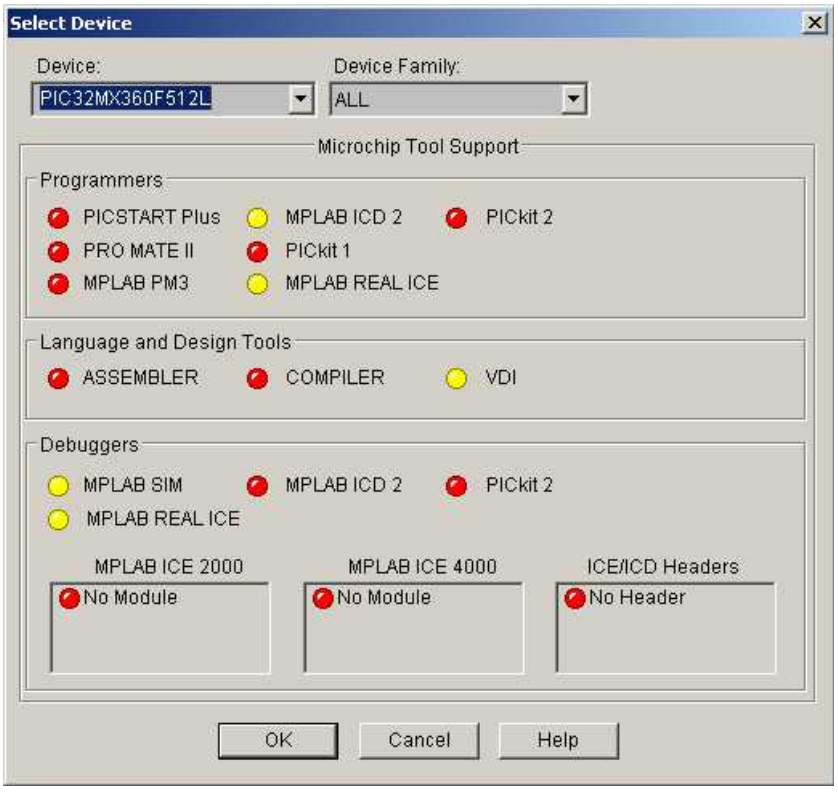
Finally, the code will be tested by running it on the evaluation board.

Note:	Some aspects of the user interface will change in future product releases and the screen shots in this guide may not exactly match the appearance of the MPLAB IDE desktop in later releases.

5.5 SELECTING THE DEVICE

Choose *Configure>Select Device* from the top IDE menu. In the Device dialog, select the PIC32 variant from the drop-down list.

FIGURE 5-2: MPLAB IDE SELECT DEVICE



The “lights” indicate which MPLAB IDE components support this device.

- A green light indicates full support.
- A yellow light indicates preliminary support for an upcoming part by the particular MPLAB IDE tool component. Components with a yellow light instead of a green light are often intended for early adopters of new parts who need quick support and understand that some operations or functions may not be available.
- A red light indicates no support for this device. Support may be forthcoming or inappropriate for the tool.

5.6 CREATING THE PROJECT

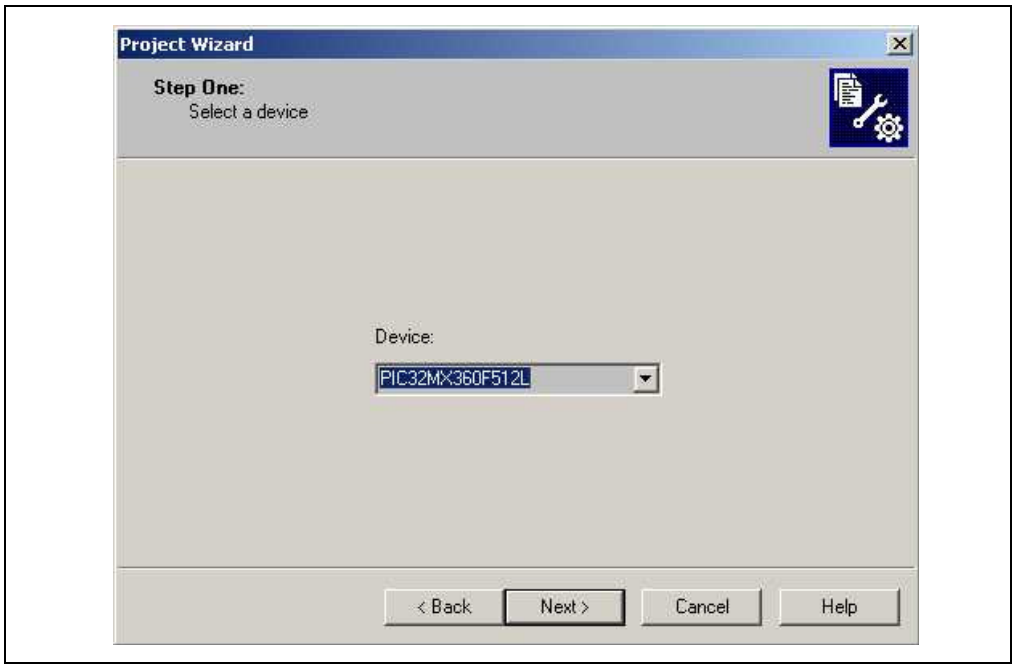
The next step is to create a project using the Project Wizard. A project is the way the files are organized to be compiled, assembled and linked. We will use a single "C" file for this project and a linker script.

Choose *Project>Project Wizard*.

From the Welcome dialog, click on **Next>** to advance.

The Step One dialog allows you to select the device, which we've already done. Make sure that it displays the proper PIC32 variant. If not, select the required PIC32 variant from the drop down menu. Click **Next>**.

FIGURE 5-3: MPLAB IDE WIZARD SELECT DEVICE



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.

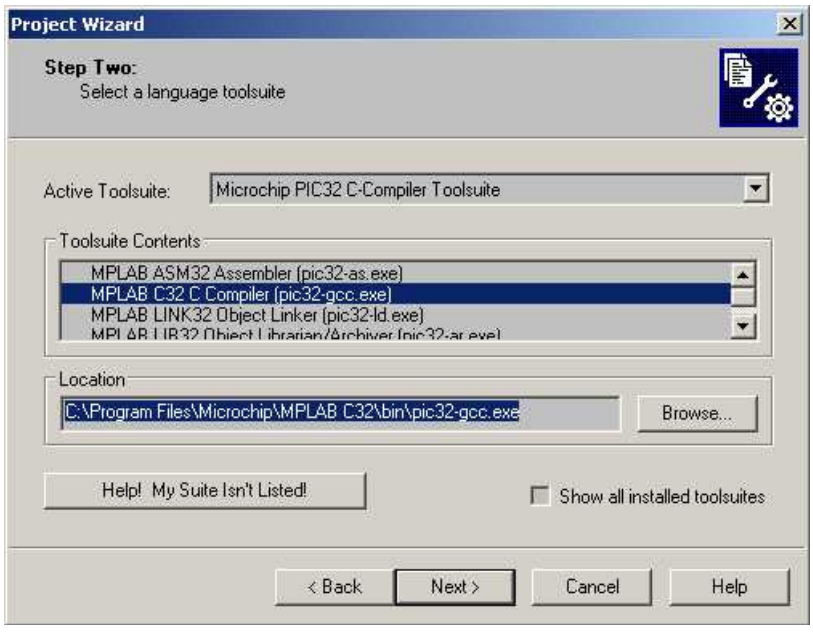
Then “MPLAB PIC32 Assembler (PIC32-as.exe)”, “MPLAB PIC32 C Compiler (PIC32-gcc.exe)”, “MPLAB PIC32 Object Linker (PIC32-ld.exe)”, and “MPLAB PIC32 Archiver (PIC32-ar.exe)”, should be visible in the Toolsuite Contents box. Click on each one to see its location. If MPLAB IDE was installed into the default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

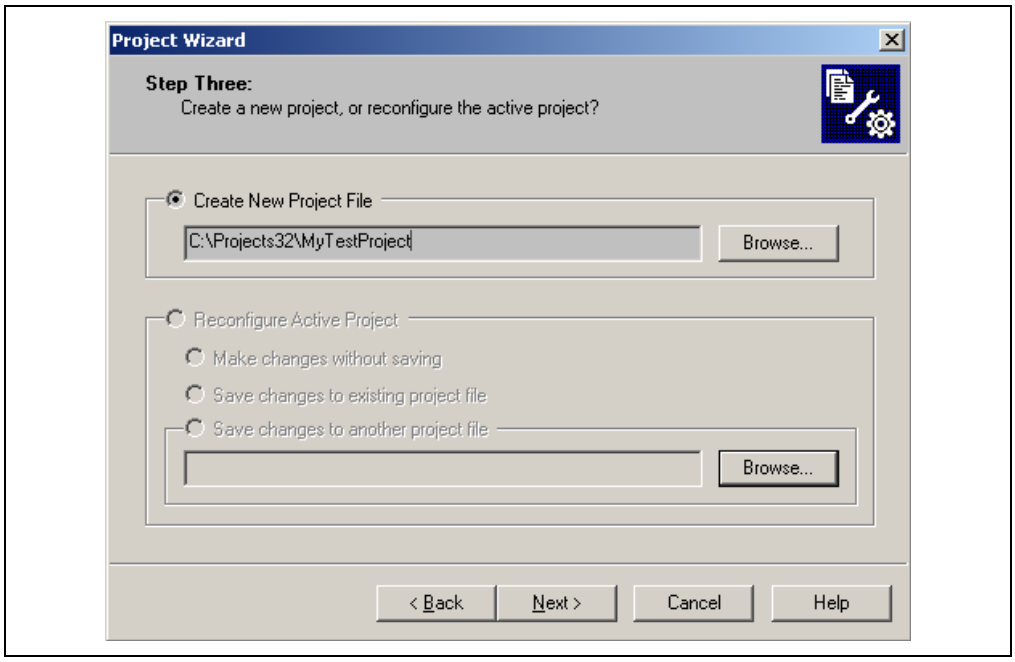
FIGURE 5-4: MPLAB IDE SELECT LANGUAGE TOOLSUITE



5.8 NAMING THE PROJECT

Step Three of the wizard allows you to name the project and put it into a folder. This sample project will be called MyTestProject. Using the **Browse** button, place the project in a folder named Projects32. Click **Next>**.

FIGURE 5-5: MPLAB IDE NAMING THE PROJECT

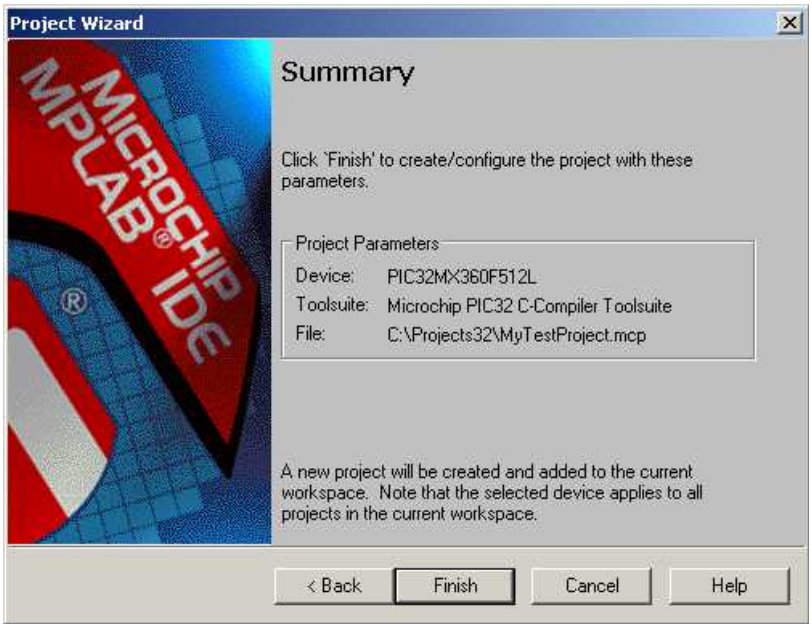


5.9 ADDING FILES TO THE PROJECT

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

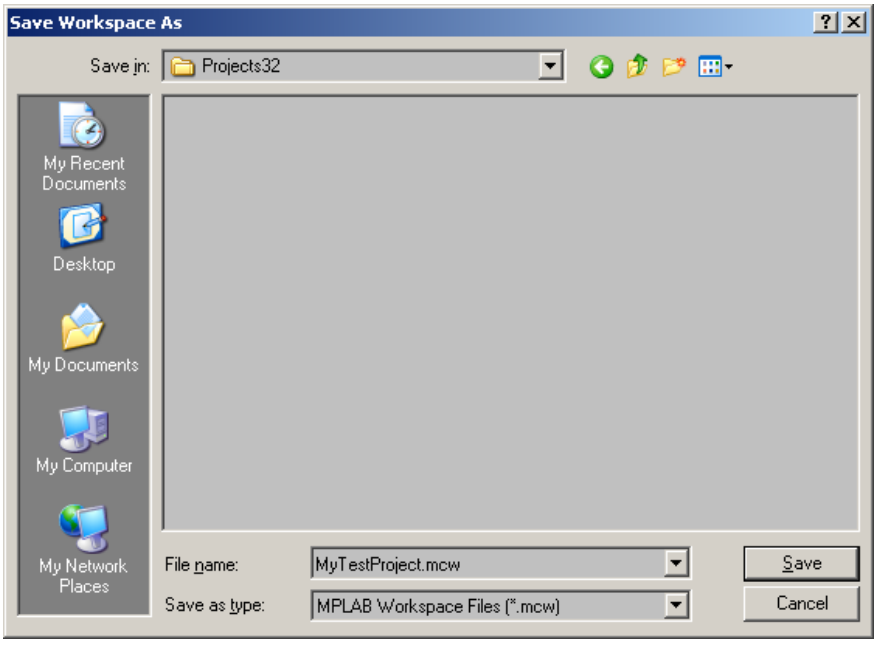
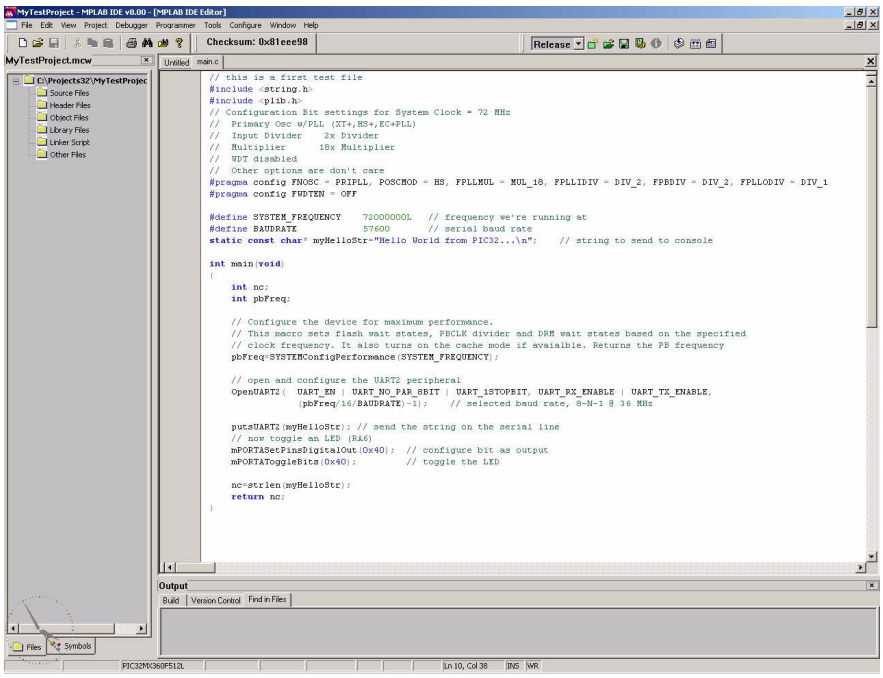


FIGURE 5-9: MPLAB IDE MAIN.C FILE



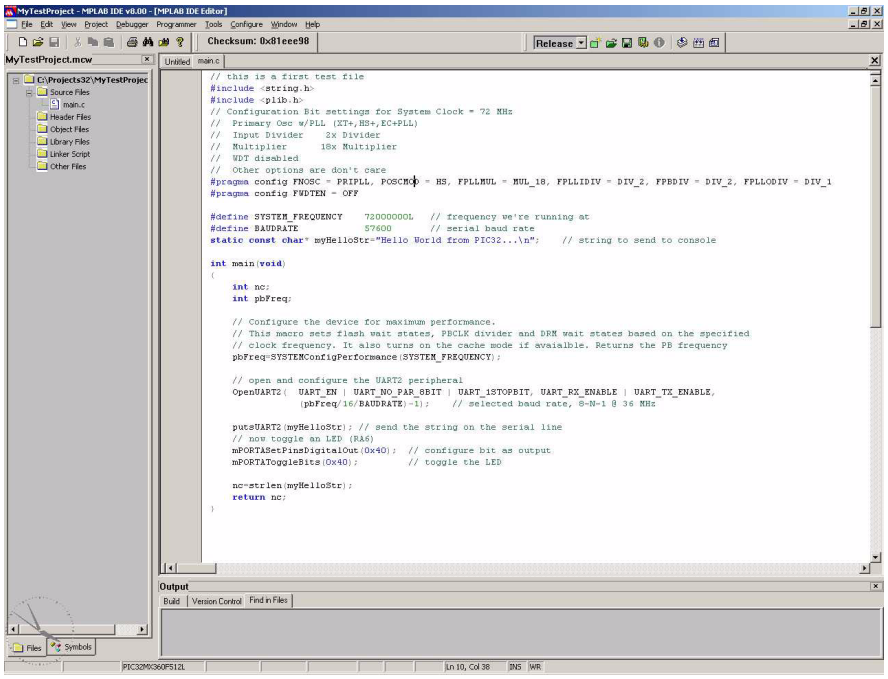
To add the newly created `main.c` file to our project just right click on the Source Files folder in the MPLAB IDE MyTestProject.mcp window and select Add File. Browse and select `main.c` file from the Projects32 directory.

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.

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