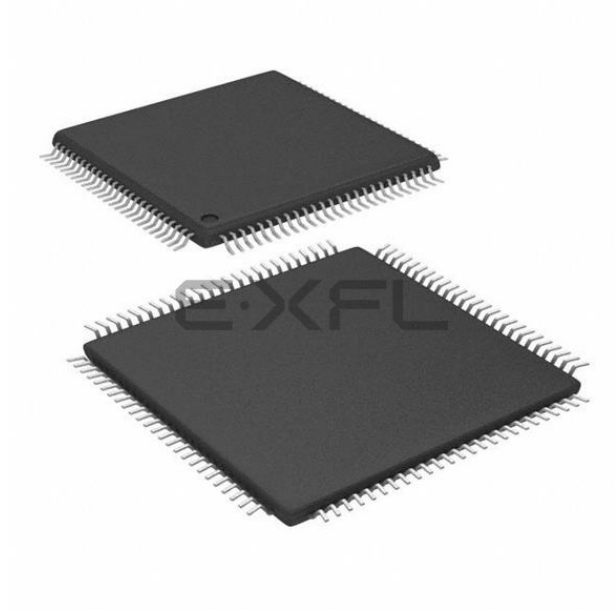
Microchip Technology - PIC32MX360F256L-80I/PT Datasheet



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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 ~ 85°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-80i-pt

Note the following details of the code protection feature on Microchip devices:

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RECOMMENDED READING

This user's guide describes how to use PIC32. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

Readme for the PIC32MX
For the latest information on using PIC32 microcontrollers, read the file (an ASCII text file) at the root level of the CD included in the PIC32 Starter Kit. The file generally contains the most current update information, as well as any issues that may not have been available when this document was published.

Readme Files

For the latest information on using other tools, read the tool-specific readme files in the `Readmes` subdirectory of the PIC32MX Starter Kit installation directory. The files contain update information, as well as any issues that may not have been available when this document was published.

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NOTES:

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

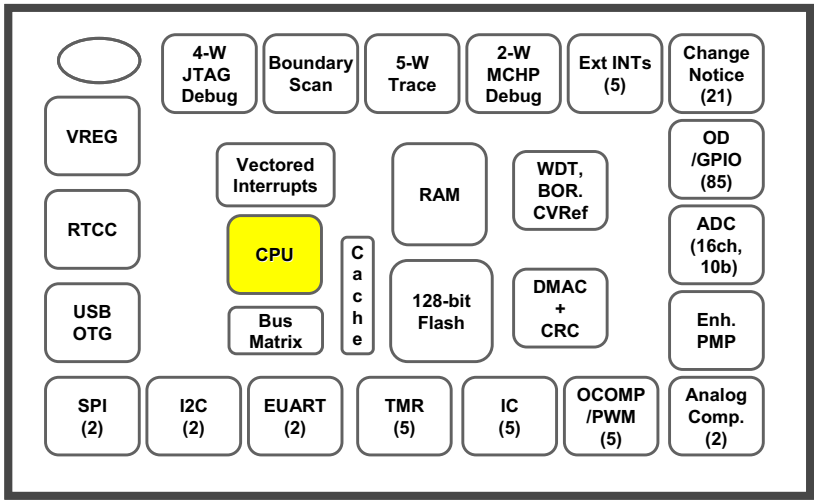
Chapter 2. PIC32 Product Family

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:

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:

TABLE 4-1: PERIPHERAL LIBRARY

Peripheral	Header File	Description
ADC	adc10.h	Library for the Analog-to-Digital converters support
Memory Org	bmx.h	Library for configuring the Bus Matrix internal buses, priorities and memory layout
Analog Comparators	cmp.h	Library for the Comparator modules support
Comparator Voltage Reference	cvref.h	Library for the Comparators Voltage reference support
DMA Controller	dma.h	Library for the DMA Controller and CRC module support
Nonvolatile (Flash) Memory	nvm.h	Library providing access to Flash erase/program functions
I^2C™	i2c.h	Library for I^2C™ module support
Input Capture	incap.h	Library for the Input Capture module suport
Interrupts	int.h	Library for the vectored Interrupt Controller support
Lock	lock.h	Library for the system lock and unlock support
Output Compare	outcompare.h	Library for Output Compare module support
Oscillator	osc.h	Library for Oscillators support
Prefetch Cache	pcache.h	Library for prefetch-cache module support
Power Modes	power.h	Library for Sleep and Idle operationsl power modes support
Parallel Master Port	pmp.h	Library for Parallel Master Port support
GPIO	ports.h	Library for configuring the I/O ports, reading or writing I/O data
Reset	reset.h	Library for Reset control and status
RTCC	rtcc.h	Library for Real-Time Clock and Calendar support
SYSTEM	system.h	Library for system level operations
SPI	spi.h	Library for Serial Peripheral Interface support
Timer	timer.h	Library to support 16 and 32-bit timers
UART	uart.h	Library supporting the enhanced UART module
Watchdog	wdt.h	Library to support the Watchdog Timer module

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.

5.6 CREATING THE PROJECT

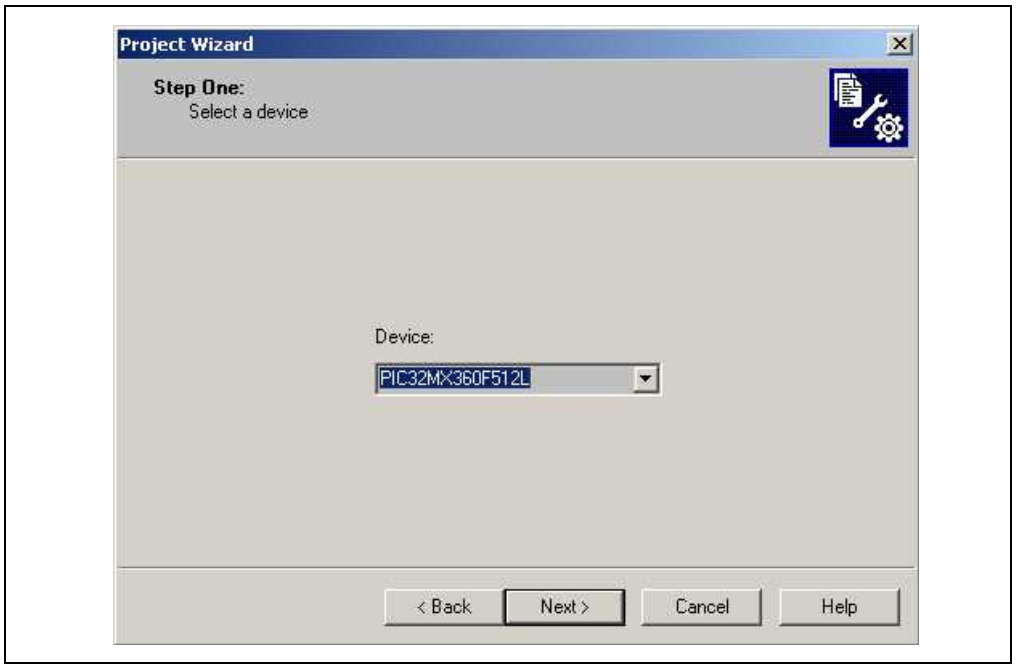
The next step is to create a project using the Project Wizard. A project is the way the files are organized to be compiled, assembled and linked. We will use a single "C" file for this project and a linker script.

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

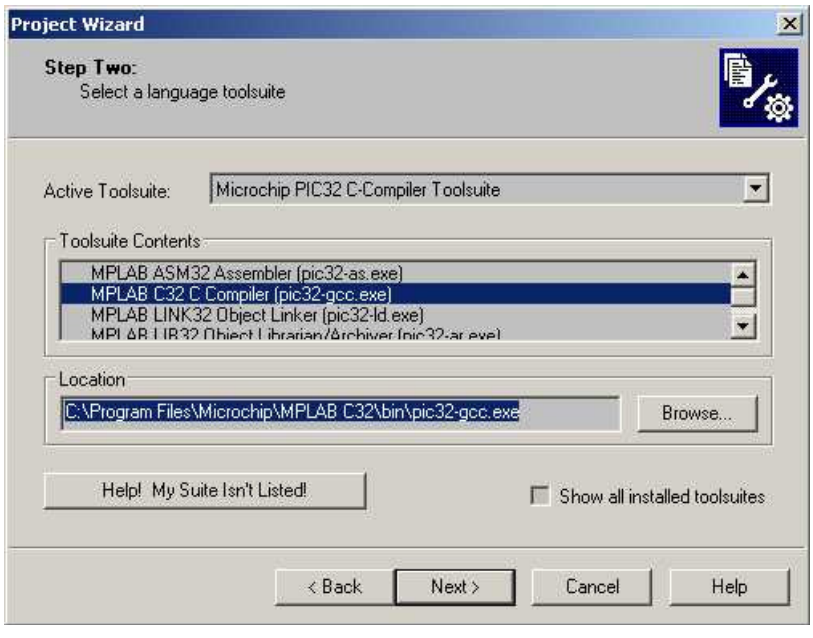
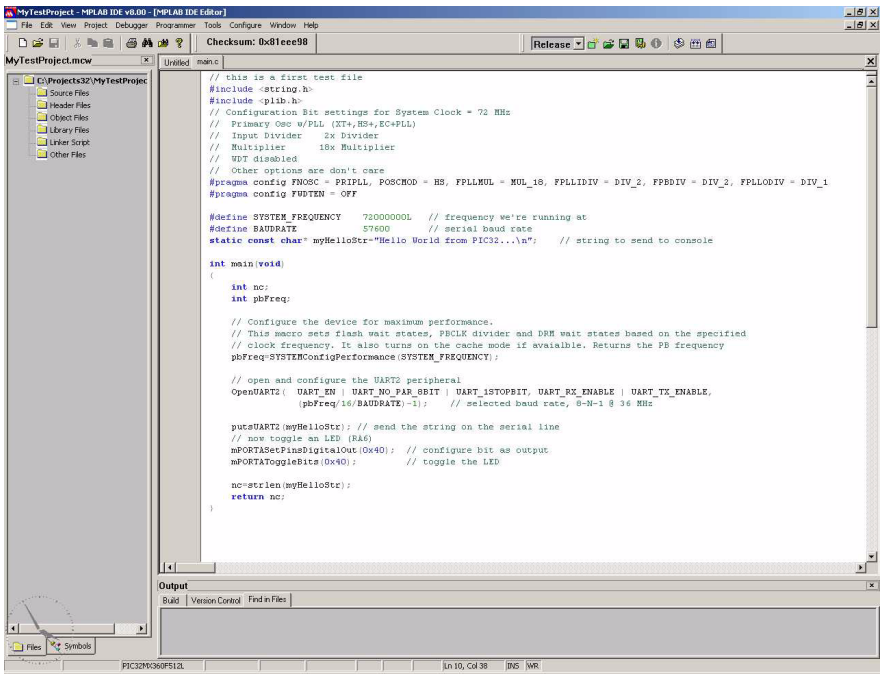


FIGURE 5-9: MPLAB IDE MAIN.C FILE



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.

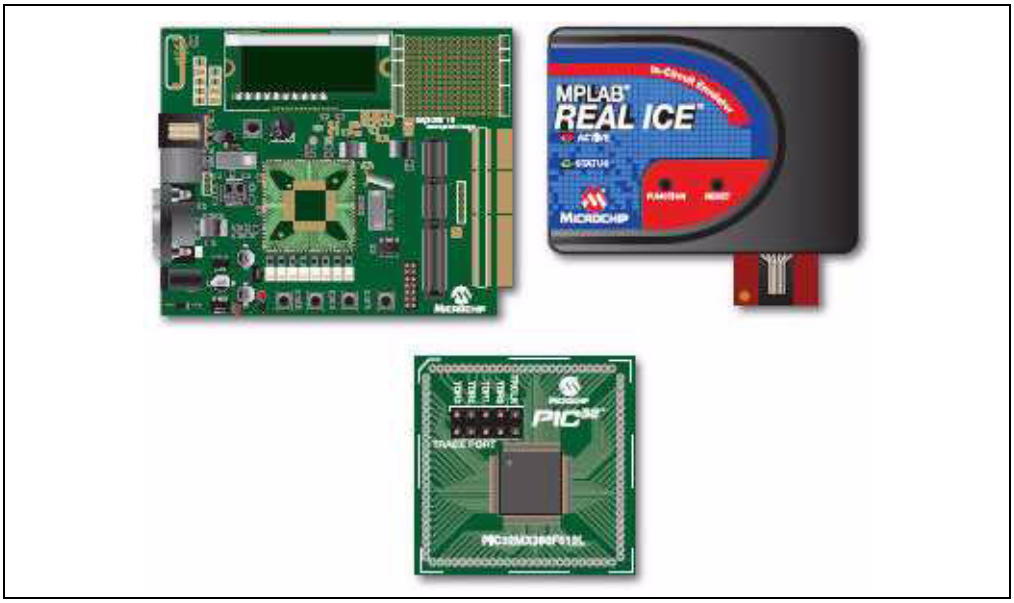
The linker script that's needed for this project is selected automatically by the MPLAB IDE. We don't need to add any other file to our project.

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.

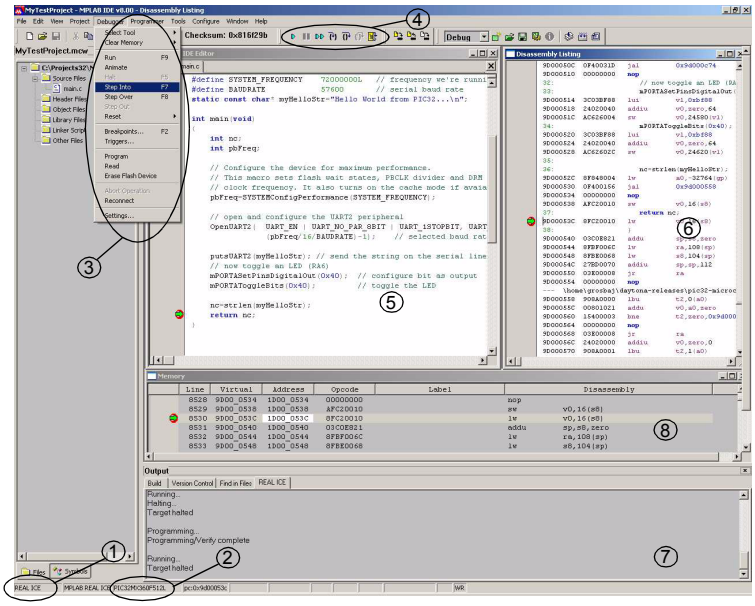
Note: MPLAB IDE may need to download new firmware if this is the first time the MPLAB REAL ICE is being used with a PIC32 device. Allow it to do so.

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.

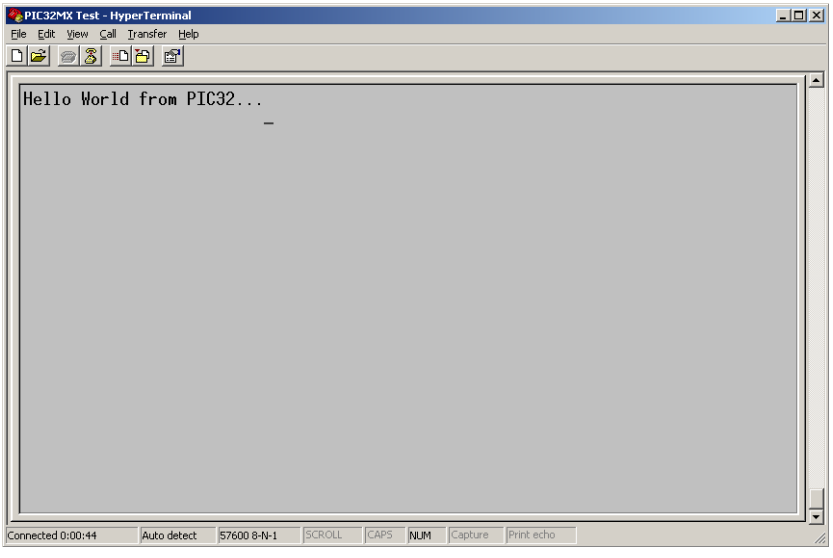
FIGURE 5-14: MPLAB IDE BREAKPOINT REACHED



1. The debugging tool selected to connect to the demo board
2. The device selected on the target board
3. The menus available under the Debugger top menu
4. The Debug toolbar
5. The Source window, with the breakpoint reached
6. The Disassembly window
7. The Output window
8. The Program Memory window

Now, if you take a look to the PC Hyper Terminal window, you should see the output sent by our simple test program to the serial line:

FIGURE 5-15: HYPER TERMINAL RECEIVED CHARACTERS



Also, if you look at the Explorer 16 board, you should see the LED D9 lit on.

This shows that the PIC32 Explorer16 demo board and the MPLAB IDE operate correctly.

We just made our first “Hello World” program for PIC32.

There are many other things that you can do in the MPLAB IDE to debug your program. For example, you can notice in that by hovering the mouse over the variable “nc” we can see its actual value (which should be the number of characters sent to the serial port by the `putsUART2()` function).

Other MPLAB IDE debug features:

- Watch window: you can add variables of peripheral SFRs to the watch window and monitor their values
- Complex Breakpoint manipulation
- All the useful debug commands: step into, step over, etc, using both the C Source window and the disassembly listing window.
- Profile your code execution and calculate delay times between different points in your program.

We presented here the essential steps for getting started with PIC32 using the MPLAB IDE. You are now ready to continue exploring the capabilities of PIC32 and MPLAB IDE. For further information about PIC32 please see the documentation list provided in this document. For more information about the MPLAB IDE please see the “*MPLAB IDE Quick Start Guide*” (DS51281) available on our site at www.microchip.com following the Design link.

NOTES:

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