



**MICROCHIP**

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## Section 32. Development Tools

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### HIGHLIGHTS

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## 32.1 Introduction

Microchip offers a wide range of tightly integrated development tools to ease the application development process. These can be broken down into the core development tools and the supplemental tools.

The core tools are as follows:

- MPLAB Integrated Development Environment, including full featured editor
- Language Products
  - MPASM Assembler
  - MPLAB-C C Compiler
- MPLAB-SIM Software Simulator
- Real-Time In-Circuit Emulators
  - PICMASTER/PICMASTER CE Emulator with Full Featured Trace and Breakpoint debug capabilities
  - ICEPIC Low-Cost Emulator with Breakpoint debug capabilities
- Device Programmers
  - PRO MATE® II Universal Programmer
  - PICSTART® Plus Entry-Level Prototype Programmer

Supplemental Tools:

- Other Software Programming Tools
  - fuzzyTECH®-MP Fuzzy logic development system
  - MP-Driveway Application Code Generator
- Development Boards
  - PICDEM-1 Low-Cost Demonstration Board
  - PICDEM-2 Low-Cost Demonstration Board
  - PICDEM-3 Low-Cost Demonstration Board
  - PICDEM-14A Low-Cost Demonstration Board

The minimum configuration of MPLAB, is the Integrated Development Environment (IDE), the assembler (MPASM), and the software simulator (MPLAB-SIM). Other tools are added to MPLAB as they are installed. This gives a common platform for the design activity, from the writing and assembling of the source code, through the simulation/emulation, to the programming of prototype devices.

<b>Note:</b> The most current version may be downloaded from Microchip's web site or BBS for free.
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In addition to Microchip, there are many third party vendors. Microchip's Third Party Handbook gives an overview of the manufactures and their tools.

## 32.2 The Integrated Development Environment (IDE)

The core set of development tools operate under the IDE umbrella, called MPLAB. This gives a consistent look and feel to all the development tools so that minimal learning of the new tool interface is required. The MPLAB IDE integrates all the following aspects of development:

- Source code editing
- Project management
- Machine code generation (from assembly or “C”)
- Device simulation
- Device emulation
- Device programming

MPLAB is a PC based Windows® 3.x application. It has been extensively tested using Windows 95 and recommended in either of these operating environments.

This comprehensive tool suite allows the complete development of a project without leaving the MPLAB environment.

## 32.2.1 MPLAB

The MPLAB IDE Software brings an ease of software development previously unseen in the 8-bit microcontroller market. MPLAB is a Windows based application that contains:

- A full featured editor
- Three operating modes
  - editor
  - emulator
  - simulator
- A project manager
- Customizable tool bar and key mapping
- A status bar with project information
- Extensive on-line help

MPLAB allows you to:

- Edit your source files. This includes:
  - MPASM assembly language
  - MPLAB-C 'C' language
- One touch assemble (or compile) and download to PIC16/17 tools (automatically updates all project information)
- Debug using:
  - source files
  - absolute listing file
  - program memory
- Run up to four emulators on the same PC
- Run or Single-step
  - program memory
  - source file
  - absolute listing

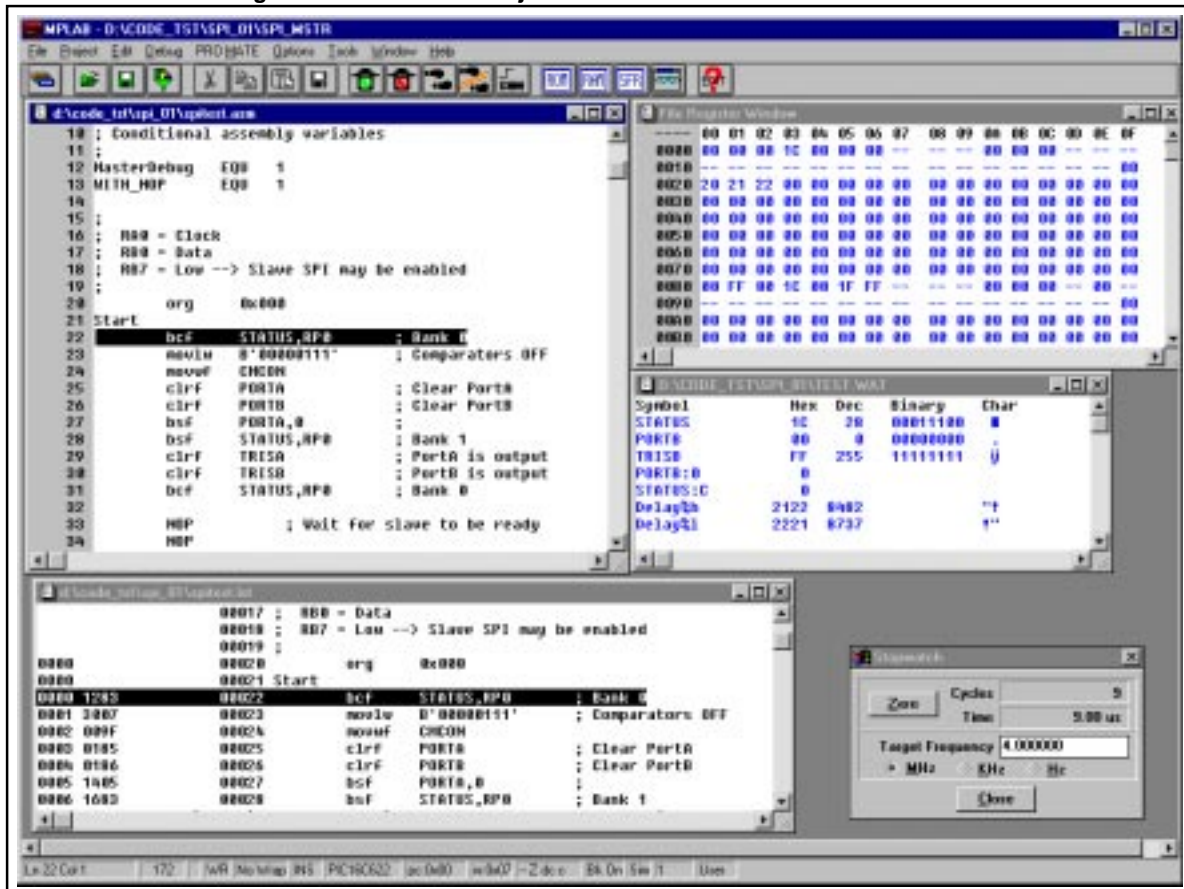
Microchip's simulator, MPLAB-SIM, operates under the same platform as the PICMASTER emulator. This allows the user to learn a single tool set which functions equivalently for both the simulator and the full featured emulator.

# Section 32. Development Tools

Figure 32-1 shows a typical MPLAB desktop in the middle of a project. Some of the highlights are:

- Tool bars, multiple choices and user configurable
- Status, mode information, and button help on footer bar
- Multiple windows, such as
  - Source code
  - Source listing (most useful for 'C' programs)
  - Register file window (RAM)
  - Watch windows (to look at specific register)
  - Stop watch window for time/cycle calculations
- Programmer support (in this case PRO MATE pull down menu)

Figure 32-1: MPLAB Project Window



## 32.3 MPLAB Software Language Support

To make the device operate as desired in the application, a software program needs to be written for the microcontroller. This software program needs to be written in one of the programming languages for the device. Currently MPLAB supports two of Microchip's language products:

- Microchip Assembler (MPASM)
- Microchip 'C' Compiler (MPLAB-C)
- Other language products that support Common Object Description (COD) may also work with MPLAB

### 32.3.1 Assembler (MPASM)

The MPASM Universal Macro Assembler is a PC-hosted symbolic assembler. It supports all Microchip microcontroller families.

MPASM offers full featured Macro capabilities, conditional assembly, and several source and listing formats. It generates various object code formats to support Microchip's development tools as well as third party programmers.

MPASM allow full symbolic debugging from the Microchip Universal Emulator System (PICMASTER).

MPASM has the following features to assist in developing software for specific use applications.

- Provides translation of Assembler source code to object code for all Microchip microcontrollers.
- Macro assembly capability.
- Produces all the files (Object, Listing, Symbol, and special) required for symbolic debug with Microchip's emulator systems.
- Supports Hex (default), Decimal and Octal source and listing formats.

MPASM provides a rich directive language to support programming of the PICmicro. Directives are helpful in making the development of your assemble source code shorter and more maintainable.

### 32.3.2 C Compiler (MPLAB-C)

The MPLAB-C is a complete 'C' compiler for Microchip's PICmicro family of microcontrollers. The compiler provides powerful integration capabilities and ease of use not found with other compilers.

For easier source level debugging, the compiler provides symbol information that is compatible with the MPLAB IDE memory display, Watch windows, and File register windows.

## 32.3.3 MPLINK Linker

MPLINK is a linker for the Microchip C compiler, MPLAB-C, and the Microchip relocatable assembler, MPASM. MPLINK is introduced with MPLAB-C v2.00 and can only be used with these or later versions.

MPLINK allows you to produce modular, re-usable code with MPLAB-C and MPASM. Control over the linking process is accomplished through a linker “script” file and with command line options. MPLINK ensures that all symbolic references are resolved and that code and data fit into the available PICmicro device.

MPLINK combines multiple input object modules generated by MPLAB-C or MPASM, into a single executable file. The actual addresses of data and the location of functions will be assigned when MPLINK is executed. This means that you will instruct MPLINK to place code and data somewhere within the named regions of memory, not to specific physical locations.

Once the linker knows about the ROM and RAM memory regions available in the target PICmicro device and it analyzes all the input files, it will try to fit the application's routines into ROM and assign its data variables into available RAM. If there is too much code or too many variables to fit, MPLINK will give an error message.

MPLINK also provides flexibility for specifying that certain blocks of data memory are re-usable, so that different routines (which never call each other and don't depend on this data to be retained between execution) can share limited RAM space.

## 32.3.4 MPLIB Librarian

MPLIB is a librarian for use with COFF object modules created using either MPASM v2.0, MPASMWIN v2.0, or MPLAB-C v2.0 or later.

MPLIB manages the creation and modification of library files. A library file is a collection of object modules that are stored in a single file. There are several reasons for creating library files:

- Libraries make linking easier. Since library files can contain many object files, the name of a library file can be used instead of the names of many separate object when linking.
- Libraries help keep code small. Since a linker only uses the required object files contained in a library, not all object files which are contained in the library necessarily wind up in the linker's output module.
- Libraries make projects more maintainable. If a library is included in a project, the addition or removal of calls to that library will not require a change to the link process.
- Libraries help convey the purpose of a group of object modules. Since libraries can group together several related object modules, the purpose of a library file is usually more understandable than the purpose of its individual object modules. For example, the purpose of a file named “math.lib” is more apparent than the purpose of ‘power.o’, ‘ceiling.o’, and ‘floor.o’.

## 32.4 MPLAB-SIM Simulator Software

The software simulator is a no-cost tool with which to evaluate Microchip's products and designs. The use of the simulator greatly helps debug software, particularly algorithms. Depending on the complexity of a design project a time/cost benefit should be looked at comparing the simulator with an emulator.

For projects that have multiple engineers in the development, the simulator in conjunction with an emulator can keep costs down and will allow speedy debug of the tough problems.

MPLAB-SIM Simulator simulates the PICmicro series microcontrollers on an instruction level. On any given instruction, the user may examine or modify any of the data areas or provide external stimulus to any of the pins. The input/output radix can be set by the user and the execution can be performed in; single step, execute until break, or in a trace mode.

MPLAB-SIM supports symbolic debugging using MPLAB-C, and MPASM. The Software Simulator offers the low cost flexibility to develop and debug code outside of the laboratory environment making it an excellent multi-project software development tool.



## 32.5 MPLAB Emulator Hardware Support

Microchip offers two emulators, a high-end version (PICMASTER) and a low-cost version (ICEPIC). Both versions offer a very good price/feature value, and the selection of which emulator should depend on the feature set that you wish. For people looking at doing several projects with Microchip devices (or using the high-end devices) the use of PICMASTER may offset the additional investment, through time savings achieved with the sophisticated breakpoint and trace capabilities.

### 32.5.1 PICMASTER: High Performance Universal In-Circuit Emulator

The PICMASTER Universal In-Circuit Emulator provides the product development engineer with a complete microcontroller design tool set for all microcontrollers in the Baseline, Mid-Range, and High End families. PICMASTER operates in the MPLAB™ Integrated Development Environment (IDE), which allows editing, “make” and download, and source debugging from a single environment.

Interchangeable target probes allow the system to be easily re-configured for emulation of different processors. The universal architecture of the PICMASTER allows expansion to support all new Microchip microcontrollers.

The PICMASTER Emulator System has been designed as a real-time emulation system with advanced features that are generally found on more expensive development tools.

A CE compliant version of PICMASTER is available for European Union (EU) countries.

### 32.5.2 ICEPIC: Low-Cost PIC16CXXX In-Circuit Emulator

ICEPIC is a low-cost in-circuit emulator solution for the Microchip Base-line and Mid-Range families of 8-bit OTP microcontrollers.

ICEPIC user interface operates on PC-compatible machines ranging from 286-AT® through Pentium™ based machines under Windows 3.x environment. ICEPIC features real-time emulation. ICEPIC is available under the MPLAB environment.

ICEPIC is designed by Neosoft Inc. and is manufactured under license by RF Solutions. Other emulator solutions may be available directly from RF solutions.

## 32.6 MPLAB Programmer Support

Microchip offers two levels of device programmer support. For most bench setups the PICSTART Plus is sufficient. When true system qualification is done, the PRO MATE II should be the minimum used, due to the validation of program memory at VDD min and VDD max for maximum reliability.

### 32.6.1 PRO MATE® II: Universal Device Programmer

The PRO MATE II Universal Programmer is a full-featured programmer capable of operating in stand-alone mode as well as PC-hosted mode. PRO MATE II operates under MPLAB or as a DOS command driven program.

The PRO MATE II has programmable VDD and VPP supplies which allows it to verify programmed memory at VDD min and VDD max for maximum reliability. It has an LCD display for error messages, keys to enter commands and a modular detachable socket assembly to support various package types. In stand-alone mode the PRO MATE II can read, verify or program Baseline, Mid-Range, and High End devices. It can also set configuration and code-protect bits in this mode. The PRO MATE II programmer also supports Microchip's Serial EEPROM and KEELOQ® Security devices.

A separate In-Circuit Serial Programming (ICSP) module is available for volume programming in a manufacturing environment. See the Programming module documentation for specific application requirements.

### 32.6.2 PICSTART® Plus Low-Cost Development Kit

The PICSTART Plus programmer is an easy-to-use, low-cost prototype programmer. It connects to the PC via one of the COM (RS-232) ports. MPLAB Integrated Development Environment software makes using the programmer simple and efficient. PICSTART Plus is not recommended for production programming, since it does not do program memory verification at VDDMIN and VDDMAX.

PICSTART Plus supports all Baseline, Mid-Range, and High End devices. For devices with up more than 40 pins an adapter socket is required. DIP packages are the form factor that are directly supported. Other package types may be supported with adapter sockets.

## 32.7 Supplemental Tools

Microchip endeavors to provide a broad range of solutions to our customers. Some of these products may fall outside the realm of the classic development tools and include more advanced topics such as high level languages, fuzzy logic, or visual programming aids. These tools are considered supplemental tools and may be available directly from Microchip or from another vendor. A comprehensive listing of alternate tool providers is contained in the Third Party Guide.

### 32.7.1 *fuzzyTECH*-MP Fuzzy Logic Development System

The *fuzzyTECH*-MP fuzzy logic development tool is available in two versions - a low cost introductory version, MP Explorer, for designers to gain a comprehensive working knowledge of fuzzy logic system design, and a full-featured version, *fuzzyTECH*-MP, for implementing more complex systems.

Both versions include Microchip's *fuzzyLAB*™ demonstration board for hands-on experience with fuzzy logic systems implementation.

### 32.7.2 *MP-DriveWay*™ – Application Code Generator

*MP-DriveWay* is an easy-to-use Windows-based Application Code Generator. With *MP-DriveWay* you can visually configure all the peripherals in a PIC16/17 device and, with a click of the mouse, generate all the initialization and many functional code modules in C language. The output is fully compatible with Microchip's MPLAB-C C compiler. The code produced is highly modular and allows easy integration of your own code.

### 32.7.3 Third Party Guide

Looking for something else? Microchip strongly encourages and supports its Third Parties. Microchip publishes the "Third Party Guide". It is an extensive volume that provides:

- Company
- Product
- Contact Information
- Consultants

For over 100 companies and 200 products. These products include Emulators, Device Programmers, Gang Programmers, Language Products, and other tool solutions.

## 32.8 Development Boards

Development boards give a quick start on a circuit that demonstrates the capabilities of a particular device. The device program can then be modified for your own evaluation of the device functionality and operation.

### 32.8.1 PICDEM-1 Low-Cost PIC16/17 Demonstration Board

The PICDEM-1 is a simple board which demonstrates the capabilities of several of Microchip's microcontrollers. The microcontrollers supported are: PIC16C5X (PIC16C54 to PIC16C58A), PIC16C61, PIC16C62X, PIC16C71, PIC16C710, PIC16C711, PIC16C8X, PIC17C42A, PIC17C43 and PIC17C44. All necessary hardware and software is included to run basic demo programs. The users can program the sample microcontrollers provided with the PICDEM-1 board, on a PRO MATE II or PICSTART-Plus programmer, and easily test firmware. The user can also connect the PICDEM-1 board to the PICMASTER emulator and download the firmware to the emulator for testing. Additional prototype area is available to build additional hardware. Some of the features include an RS-232 interface, a potentiometer for simulated analog input, push-button switches and eight LEDs connected to PORTB.

### 32.8.2 PICDEM-2 Low-Cost PIC16CXXX Demonstration Board

The PICDEM-2 is a simple demonstration board that supports the PIC16C62, PIC16C63, PIC16C64, PIC16C65, PIC16C72, PIC16C73 and PIC16C74 microcontrollers. All the necessary hardware and software is included to run the basic demonstration programs. The user can program the sample microcontrollers provided with the PICDEM-2 board, on a PRO MATE II programmer or PICSTART-Plus, and easily test firmware. The PICMASTER emulator may also be used with the PICDEM-2 board to test firmware. Additional prototype area has been provided for additional hardware. Some of the features include a RS-232 interface, push-button switches, a potentiometer for simulated analog input, a Serial EEPROM to demonstrate usage of the I<sup>2</sup>C bus and separate headers for connection to an LCD module and a keypad.

## 32.8.3 PICDEM-3 Low-Cost PIC16CXXX Demonstration Board

The PICDEM-3 is a simple demonstration board that supports the PIC16C923 and PIC16C924 in the PLCC package. It will also support future 44-pin PLCC microcontrollers that have an LCD Module. All the necessary hardware and software is included to run the basic demonstration programs. The user can program the sample microcontrollers, provided with the PICDEM-3 board, on a PRO MATE II programmer or PICSTART Plus with an adapter socket, and easily test firmware. The PICMASTER emulator may also be used with the PICDEM-3 board to test firmware. Additional prototype area has been provided for adding hardware. Some of the features include an RS-232 interface, push-button switches, a potentiometer for simulated analog input, a thermistor and separate headers for connection to an external LCD module and a keypad. Also provided on the PICDEM-3 board is an LCD panel, with 4 commons and 12 segments, that is capable of displaying time, temperature and day of the week. The PICDEM-3 provides an additional RS-232 interface and Windows 3.1 software for showing the de-multiplexed LCD signals on a PC. A simple serial interface allows the user to construct a hardware de-multiplexer for the LCD signals.

## 32.8.4 PICDEM-14A Low-Cost PIC14C000 Demonstration Board

The PICDEM-14A demo board is a general purpose platform which is provided to help evaluate the PIC14C000 mixed signal microcontroller. The board runs a PIC14C000 measuring the voltage of a potentiometer and the on-chip temperature sensor. The voltages are then calibrated to the internal bandgap voltage reference. The voltage and temperature data are then transmitted to the RS-232 port. This data can be displayed using a terminal emulation program, such as Windows Terminal. This demo board also includes peripherals that allow users to display data on an LCD panel, read from and write to a serial EEPROM, and prototype custom circuitry to interface to the microcontroller.

## **32.9 Development Tools for Other Microchip Products**

### **32.9.1 SEEVAL<sup>®</sup> Evaluation and Programming System**

The SEEVAL Serial EEPROM Designer's Kit supports all Microchip 2-wire and 3-wire Serial EEPROMs. The kit includes everything necessary to read, write, erase or program special features of any Microchip SEEPROM product including Smart Serials<sup>™</sup> and secure serials. The Total Endurance<sup>™</sup> Disk is included to aid in trade-off analysis and reliability calculations. The total endurance kit can significantly reduce time-to-market and results in a more optimized system.

### **32.9.2 KEELOQ<sup>®</sup> Evaluation and Programming Tools**

KEELOQ evaluation and programming tools supports Microchip's HCS Secure Data Products. The HCS evaluation kit includes an LCD display to show changing codes, a decoder to decode transmissions, and a programming interface to program test transmitters.

# Section 32. Development Tools

## 32.10 Related Application Notes

This section lists application notes that are related to this section of the manual. These application notes may not be written specifically for the Mid-Range MCU family (that is they may be written for the Base-Line, or the High-End), but the concepts are pertinent, and could be used (with modification and possible limitations). The current application notes related to Microchip's development tools are:

Title	Application Note #
Air Flow using Fuzzy Logic	AN600

# PICmicro MID-RANGE MCU FAMILY

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## 32.11 Revision History

### Revision A

This is the initial released revision of Microchip's development tools description.