# MPLAB® IDE PROJECT TUTORIALS FOR THIRD PARTY TOOLS

Information contained in this publication regarding device applications and the like is intended by way of suggestion only. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip.

# Table of Contents

## Preface

# Table of Contents

## Chapter 6. MPLAB IDE Project using IAR Tools

# Preface

## Introduction

This first chapter contains general information that will be useful to know before using the tutorials.

## Highlights

The information you will garner from this chapter:

- About this Guide
- Warranty Registration
- Recommended Reading
- Troubleshooting
- The Microchip Technology Internet Web Site
- Development Systems Customer Notification Service
- Customer Support

## About This Guide

### Document Layout

This document describes how to use third party development tools with MPLAB IDE. The manual layout is as follows:

- **Preface** – This section.
- **Chapter 1: Project Overview - Third Party Tools** – Describes in general how to use MPLAB IDE with third party tools.
- **Chapter 2: Project Overview - HI-TECH PICC™ Tools** – Describes specifically how to use MPLAB IDE with HI-TECH PICC tools. Includes setup information.
- **Chapter 3: Single Source File Project using PICC Tools**– Walks you through making an MPLAB IDE project with PICC tools using one source file.
- **Chapter 4: Multiple Source File Project using PICC Tools** – Walks you through making an MPLAB IDE project with PICC tools using several source files.
- **Chapter 5: Project Overview - IAR Tools** – Describes specifically how to use MPLAB IDE with IAR tools. Includes setup information.

- **Chapter 4: MPLAB IDE Project using IAR Tools** – Walks you through making an MPLAB IDE project with IAR tools using either one or several source files.
- **Glossary** – A glossary of Microchip terms.
- **Index** – Cross-reference listing of terms, features, and sections of this document.
- **Worldwide Sales and Service** – A listing of Microchip sales and service locations and telephone numbers worldwide.

## Conventions Used in this Guide

This manual uses the following documentation conventions:

**Table: Documentation Conventions**

| Description | Represents | Examples |
|---|---|---|
| Code (Courier font): | | |
| Plain characters | Sample code<br>Filenames and paths | `#define START`<br>`c:\autoexec.bat` |
| Angle brackets: < > | Variables | `<label>, <exp>` |
| Square brackets [ ] | Optional arguments | `MPASMWIN [main.asm]` |
| Curly brackets and pipe character: { \| } | Choice of mutually exclusive arguments<br>An OR selection | `errorlevel {0\|1}` |
| Lower case characters in quotes | Type of data | `"filename"` |
| Ellipses... | Used to imply (but not show) additional text that is not relevant to the example | `list ["list_option..., "list_option"]` |
| 0xnnn | A hexadecimal number where n is a hexadecimal digit | `0xFFFF, 0x007A` |
| Italic characters | A variable argument; it can be either a type of data (in lower case characters) or a specific example (in uppercase characters). | `char isascii (char,` *`ch`*`);` |
| Interface (Helvetica font): | | |
| Underlined, italic text with right arrow | A menu selection from the menu bar | *File > Save* |
| Bold characters | A window or dialog button to click | **OK**, **Cancel** |
| Characters in angle brackets < > | A key on the keyboard | <Tab>, <Ctrl-C> |

**Table: Documentation Conventions (Continued)**

| Description | Represents | Examples |
|---|---|---|
| Documents (Helvetica font): | | |
| Italic characters | Referenced books | *MPLAB IDE, Simulator, Editor User's Guide* |

## Documentation Updates

All documentation becomes dated, and this tutorial is no exception. Since MPLAB IDE and other Microchip tools are constantly evolving to meet customer needs, some MPLAB IDE dialogs and/or tool descriptions may differ from those in this document. Please refer to our Web site at http://www.microchip.com to obtain the latest documentation available.

## Documentation Numbering Conventions

Documents are numbered with a "DS" number. The 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 | = | The document number. |
| A | = | The revision level of the document. |

# Warranty Registration

Please complete any Warranty Registration Cards and mail them promptly to Microchip Technology or Third Party vendors. Sending in your Microchip Warranty Registration Card entitles you to receive new product updates. Interim software releases are available at the Microchip Web site.

# Recommended Reading

This tutorial describes how to use MPLAB IDE with third party tools. For more information on MPLAB IDE or third party tools, the following is recommended reading.

**README Files**

For the latest information on Microchip tools (MPLAB IDE, MPASM™ assembler, etc.), read the associated README files (ASCII text files) included with the MPLAB IDE software. Third party tools generally have readme files also, with the most up-to-date information available on the tools.

**Help Files**

For the the most up-to-date information on using Microchip tools, consult the associated on-line help files (`mplab.hlp`, `mpasm.hlp`, etc.) available through the Help menu of MPLAB IDE software. The help files contain updated information that may not be included in documentation.

**MPLAB IDE, Simulator, Editor User's Guide (DS51025)**

Comprehensive guide that describes installation and features of Microchip's MPLAB Integrated Development Environment, including the editor and simulator functions in the MPLAB IDE environment.

**Microchip Technology Library CD-ROM (DS00161)**

This CD-ROM contains comprehensive application notes, data sheets, and technical briefs for all of Microchip products. To obtain this CD-ROM, contact the nearest Microchip Sales and Service location (see back page).

**Third Party Documentation**

Third Party tool vendors may have manuals and help files, as well as electronic manuals, available for more information on the use of their tools.

**Microsoft® Windows® Manuals**

This manual assumes that users are familiar with Microsoft Windows operating system. Many excellent references exist for this software program, and should be consulted for general operation of Windows.

# Troubleshooting

If you have difficulty with any of the tutorials, consult MPLAB IDE documentation (*MPLAB IDE, Simulator, Editor User's Guide* (DS51025) or MPLAB Help) and/or Third Party documentation for help.

# The Microchip Internet Web Site

Microchip provides on-line support on the Microchip World Wide Web (WWW) site.

The Web site is used by Microchip as a means to make files and information easily available to customers. To view the site, the user must have access to the Internet and a Web browser, such as Netscape® Communicator or Microsoft® Internet Explorer®. Files are also available for FTP download from our FTP site.

## Connecting to the Microchip Internet Web Site

The Microchip Web site is available by using your favorite Internet browser to attach to:

**http://www.microchip.com**

The file transfer site is available by using an FTP service to connect to:

**ftp://ftp.microchip.com**

The Web site and file transfer site provide a variety of services. Users may download files for the latest Development Tools, Data Sheets, Application Notes, User's Guides, Articles, and Sample Programs. A variety of Microchip specific business information is also available, including listings of Microchip sales offices, distributors and factory representatives. Other data available for consideration is:

- Latest Microchip Press Releases
- Technical Support Section with Frequently Asked Questions
- Design Tips
- Device Errata
- Job Postings
- Microchip Consultant Program Member Listing
- Links to other useful Web sites related to Microchip Products
- Conferences for products, Development Systems, technical information
- Listing of seminars and events

# Development Systems Customer Notification Service

Microchip provides a customer notification service to help our customers keep current on Microchip products with the least amount of effort. Once you subscribe to one of our list servers, you will receive e-mail notification whenever we change, update, revise or have errata related to that product family or development tool. See the Microchip Web site at www.microchip.com.

The Development Systems list names are:

- Compilers
- Emulators
- Programmers
- MPLAB
- Otools (Other Tools)

Once you have determined the names of the lists that you are interested in, you can subscribe by sending a message to:

```
listserv@mail.microchip.com
```

with the following as the body:

```
subscribe <listname> yourname
```

Here is an example:

```
subscribe mplab John Doe
```

To UNSUBSCRIBE from these lists, send a message to:

```
listserv@mail.microchip.com
```

with the following as the body:

```
unsubscribe <listname> yourname
```

Here is an example:

```
unsubscribe mplab John Doe
```

The following sections provide descriptions of the available Development Systems lists.

## Compilers

The latest information on Microchip C compilers, assemblers and linkers. These include MPLAB C17, MPLAB C18, MPASM™ assembler, MPLINK™ linker, and MPLIB™ librarian.

To SUBSCRIBE to this list, send a message to:

```
listserv@mail.microchip.com
```

with the following as the body:

```
subscribe compilers yourname
```

## Emulators

The latest information on Microchip In-Circuit Emulators. These include MPLAB ICE emulators.

To SUBSCRIBE to this list, send a message to:

```
listserv@mail.microchip.com
```

with the following as the body:

```
subscribe emulators yourname
```

## Programmers

The latest information on Microchip PICmicro® microcontroller (MCU) device programmers. These include PRO MATE® II and PICSTART® Plus.

To SUBSCRIBE to this list, send a message to:

```
listserv@mail.microchip.com
```

with the following as the body:

```
subscribe programmers yourname
```

## MPLAB

The latest information on Microchip MPLAB IDE, the Windows Integrated Development Environment for development systems tools. This list is focused on MPLAB IDE, MPLAB SIM, MPLAB IDE Project Manager and general editing and debugging features. For specific information on MPLAB IDE compilers, linkers and assemblers, subscribe to the COMPILERS list. For specific information on MPLAB IDE emulators, subscribe to the EMULATORS list. For specific information on MPLAB IDE device programmers, please subscribe to the PROGRAMMERS list.

To SUBSCRIBE to this list, send a message to:

```
listserv@mail.microchip.com
```

with the following as the body:

```
subscribe mplab yourname
```

## Otools (Other Tools)

The latest information on other development system tools provided by Microchip. For specific information on MPLAB IDE and its integrated tools refer to the other mail lists.

To SUBSCRIBE to this list, send a message to:

```
listserv@mail.microchip.com
```

with the following as the body:

subscribe otools yourname

## Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Corporate Applications Engineer (CAE)
- Hotline

Customers should call their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. See the back cover for a listing of sales offices and locations.

Corporate applications engineers (CAEs) may be contacted at (480) 792-7627.

In addition, there is a Systems Information and Upgrade Line. This line provides system users a listing of the latest versions of all of Microchip's development systems software products. Plus, this line provides information on how customers can receive any currently available upgrade kits.

The Hotline Numbers are:

1-800-755-2345 for U.S. and most of Canada.

1-480-792-7302 for the rest of the world.

# Chapter 1. Project Overview - Third Party Language Tools

## 1.1 Introduction

This chapter gives an overview of using projects in MPLAB IDE with third party language tools.

## 1.2 Highlights

This chapter discusses:

- Overview of Projects
- Preliminary Setup of MPLAB IDE
- Integrating Other Tools into MPLAB IDE

## 1.3 Overview of Projects

Several third party language tools work with MPLAB IDE. These tools may be used as part of an MPLAB IDE Project. A project in MPLAB IDE is a group of files needed to build an application, along with their associations to various build tools. See the *MPLAB IDE, Simulator, Editor User's Guide* (DS51025) for more information on MPLAB IDE and MPLAB IDE Projects.

Figure 1.1 shows a generic MPLAB IDE Project.

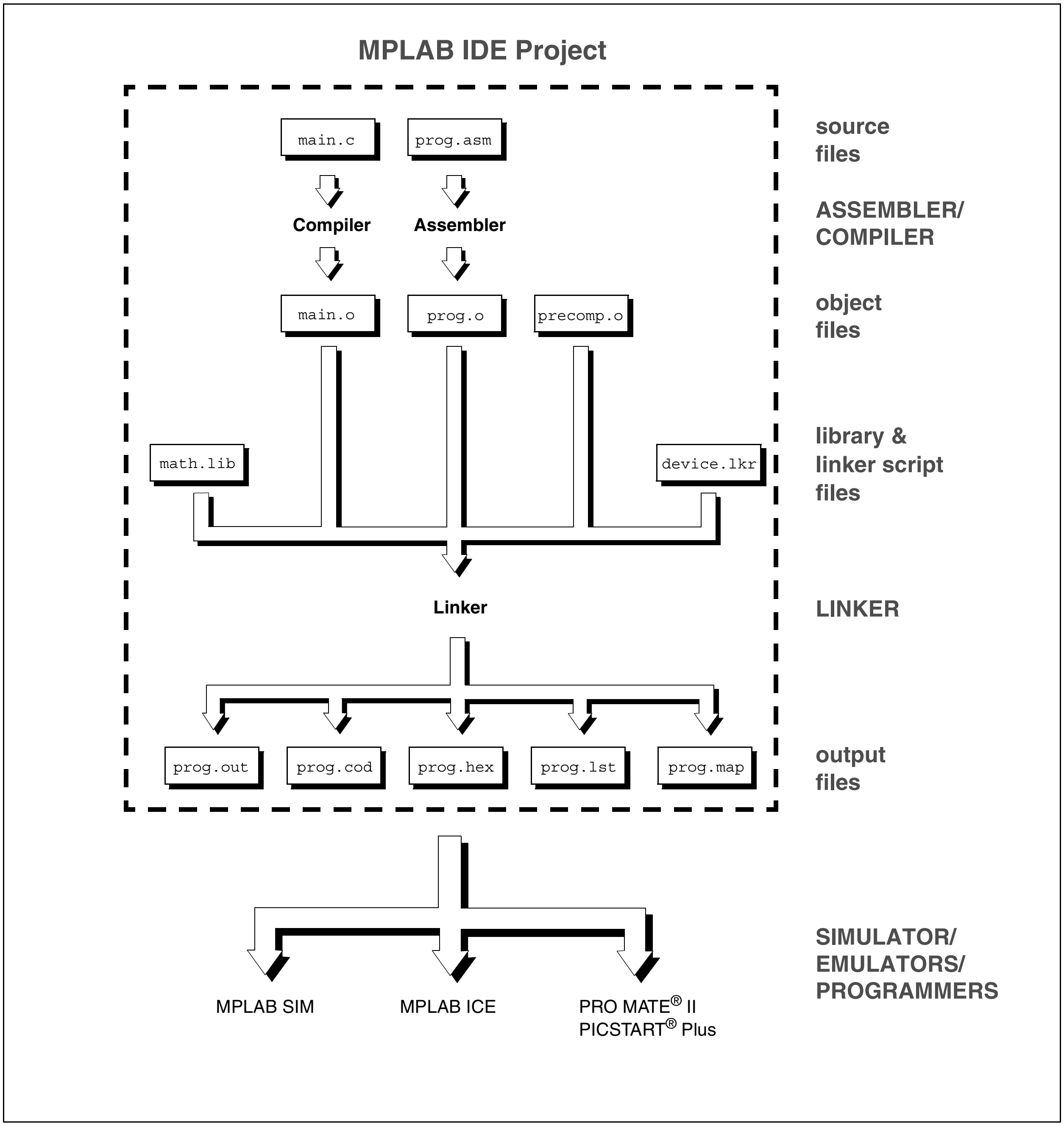


**Figure 1.1: Project Relationships**

In this MPLAB IDE Project, the C source file `main.c` is associated with a compiler. MPLAB IDE will use this information to generate an object file (`main.o`) for input into a linker.

An assembly source file (`prog.asm`) is shown also with its associated assembler. MPLAB IDE will use this information to generate the object file `prog.o` for input into a linker.

In addition, precompiled object files (`precomp.o`) may be included in a project, with no associated tool required. Types of precompiled object files that are generally required in a project are:

- Start up code
- Initialization code
- Interrupt service routines
- Register definitions

Precompiled object files are often device and/or memory model dependent.

Some library files (`math.lib`) may be available with the tools. Others may be built outside the project using a librarian tool.

The object files, along with library files and a linker script file (`device.lkr`) are used to generate the project output files via a linker.

The main output file generated from a linker is the **HEX file** (`prog.hex`), used by simulators (MPLAB SIM), emulators (MPLAB ICE) and programmers (PRO MATE II and PICSTART Plus). The other possible output files are:

- **COFF file (.out).** Intermediate file used to generate Code file, HEX file, and Listing file.
- **Code file (.cod).** Debug file used by MPLAB IDE.
- **Listing file (.lst).** Original source code, side-by-side with final binary code.
- **Map file (.map).** Shows the memory layout after linking. Indicates used and unused memory regions.

For information on available third party tools, please refer to the *Third Party Guide* (DS00104) for more information.

## 1.4 Preliminary Setup of MPLAB IDE

In order to use third party language tools with MPLAB IDE you must:

- Install MPLAB IDE. The latest version of this free software is available at our Web site (http://www.microchip.com) or from any sales office (back cover).
- Install the Third Party Tool. Consult the tool documentation for how to install.

In general, you will need to set up MPLAB IDE first as follows:

- Specific Third Party Setup - You may need to set up environmental variables for the third party tool to operate correctly.
- Install Language Tools - You will need to install the third party tools using the Install Language Tool dialog (*Project > Install Language Tool*) so that MPLAB IDE can use them.

## 1.5 Integrating Other Tools into MPLAB IDE

In order to integrate with MPLAB IDE, third party tool executables should have these properties:

- All input must be received from the command line.
- Do NOT wait on user input.
- Do NOT emit messages to the error stream (`stderr`, `cerr`). MPLAB IDE can find error messages in an error file (`sourcename.err`) or on the standard output stream (`stdout`, `cout`). Make all output go to the DOS™ window or an error file (not in a special error window or screen).

Look at the files with extension `.mtc` in the MPLAB IDE installation directory. These set up the command line switches for the Node Properties dialogs. Then look at the `tlxxxx.ini`. This has the name of the tool group which MPLAB IDE will show in its Project dialog. The last line points to the name of the associated `*.mtc` file(s).

- Support files for HI-TECH's PICC™ products are:
  - `tlhitech.ini`
  - `picc_cmp.mtc`
  - `picc_asm.mtc`
  - `picc_lkr.mtc`
- Support files for HI-TECH's PICC Lite™ products are:
  - `tlpicl.ini`
  - `picl_cmp.mtc`
  - `picl_asm.mtc`
  - `picl_lkr.mtc`
- Support for IAR's products are:
  - `tliar.ini`
  - `iara.mtc`
  - `iarc.mtc`
  - `iarl.mtc`

- Support files for microEngineering Labs PICBASIC™ products, including PICBASIC and PICBASIC PRO™ compilers are:
  - `tlmelabs.ini`
  - `pbp.mtc`
  - `pbc.mtc`
- Support files for CCS (Custom Computer Services) C-language compilers, including PCB, PCH, and PCM are:
  - `tlcss.ini`
  - `ccsc.mtc`
- Support files for Byte Craft's products are
  - `tlbcraft.ini`
  - `mpc.mtc`

NOTES:

# Chapter 2. Project Overview - HI-TECH PICC™ Tools

## 2.1 Introduction

This chapter gives an overview of using projects in MPLAB IDE with the HI-TECH PICC tool. Chapter 3 and Chapter 4 discuss in detail how to make single source file and multiple source file MPLAB IDE projects with PICC tools, respectively.

## 2.2 Highlights

This chapter discusses:

- Overview of Projects with HI-TECH PICC Tools
- Preliminary Setup of MPLAB IDE with PICC Tools

The next two chapters discuss:

- Single Source File Project using PICC Tools
- Multiple Source File Project using PICC Tools

## 2.3 Overview of Projects with HI-TECH PICC Tools

There are several versions of HI-TECH PICC tools:

- PICC tools (`picc.exe`) - Compiler, assembler and linker for PICmicro® MCU code development.
- PICC Lite™ tools (`picl.exe`) - Free demo version of the PICC tools that only support PIC16X8X devices.
- PICC tools demo - Free demo version of the PICC tools that only work with the HI-TECH development environment, **NOT** MPLAB IDE.

PICC tools may be used with MPLAB IDE running under Windows® 3.1x, Windows 95/98 or Windows NT®/2000.

PICC tools are one group of several third party language tools that work with MPLAB IDE. These tools may be used as part of an MPLAB IDE Project. A project in MPLAB IDE is a group of files needed to build an application, along with their associations to various build tools. See the *MPLAB IDE, Simulator, Editor User's Guide* (DS51025) for more information on MPLAB IDE and MPLAB IDE Projects.

Figure 2.1 shows a generic MPLAB IDE Project using PICC tools.

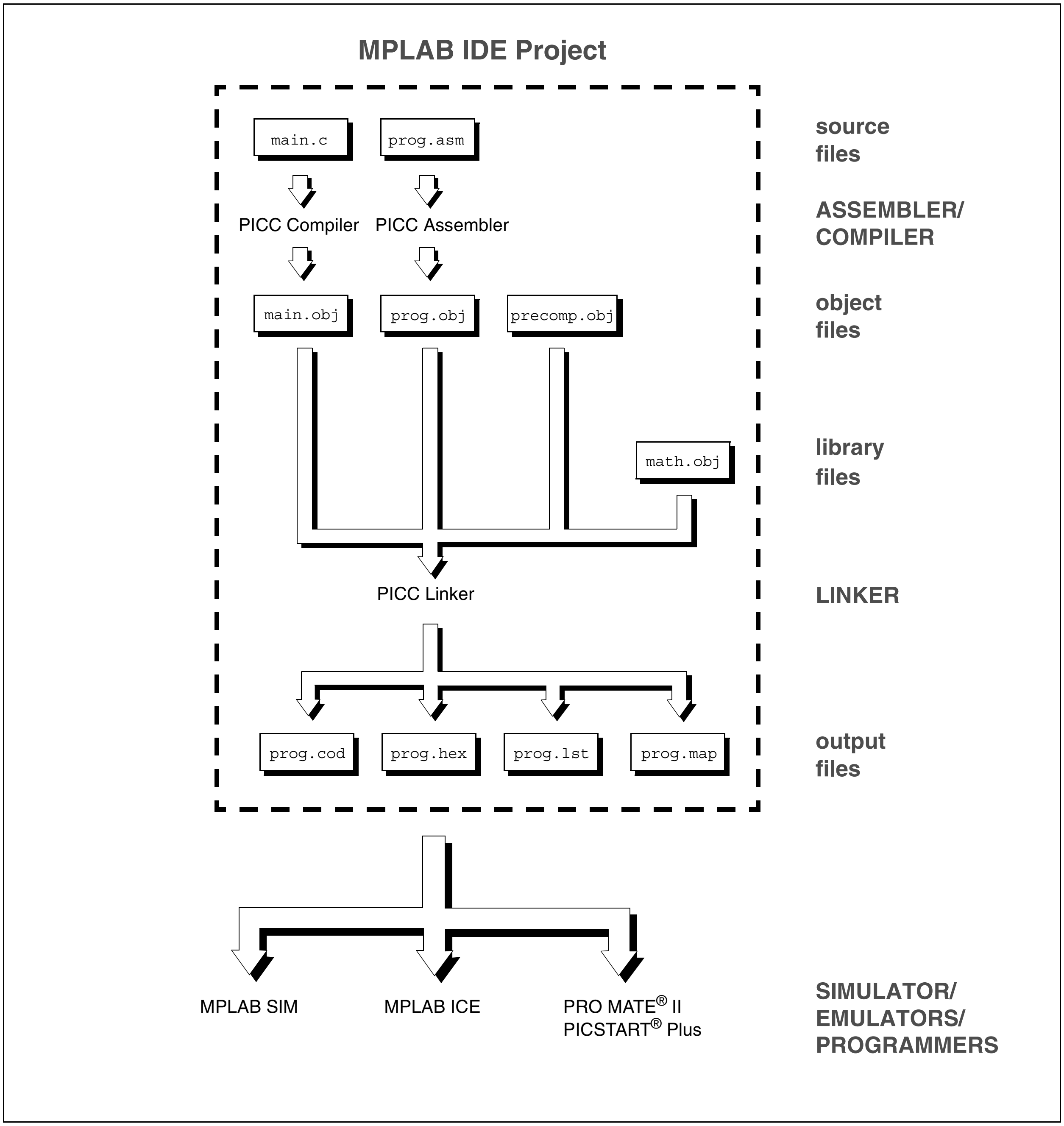


**Figure 2.1: Project Relationships**

In this MPLAB IDE Project, the C source file `main.c` is associated with the PICC Compiler. MPLAB IDE will use this information to generate an object file (`main.obj`) for input into the linker (PICC Linker).

An assembly source file (`prog.asm`) is shown also with its associated assembler (PICC Assembler). MPLAB IDE will use this information to generate the object file `prog.obj` for input into the linker.

In addition, precompiled object files (`precomp.obj`) may be included in a project, with no associated tool required.

Standard library files are available with the compiler. Others (`math.obj`) may be built outside the project using the librarian tool, LIBR (`libr.exe`). See HI-TECH documentation for more information on using the librarian.

The object files, along with library files, are used to generate the project output files via the linker.

The main output file generated by the linker is the **HEX file** (`prog.hex`), used by simulators (MPLAB SIM), emulators (MPLAB ICE) and programmers (PRO MATE II and PICSTART Plus). The other output files are:

- **Code file (.cod).** Debug file used by MPLAB IDE.
- **Listing file (.lst).** Original source code, side-by-side with final binary code.
- **Map file (.map).** Shows the memory layout after linking. Indicates used and unused memory regions.

For more information on using HI-TECH PICC tools, please see the documentation you received with your PICC tools or visit HI-TECH’s Web site (http://www.htsoft.com).

## 2.4 Preliminary Setup of MPLAB IDE with PICC Tools

In order to use PICC tools with MPLAB IDE you must:

- Install MPLAB IDE. The latest version of this free software is available at our Web site (http://www.microchip.com) or from any sales office (back cover).
- Install PICC tools. Consult the HI-TECH documentation on how to do this.

No matter what type of project you choose to use (single file or multiple file), you will need to set up MPLAB IDE first as follows:

- Error/Warning Formatting - Set up error/warning output formatting for Windows 3.1x/95/98, Windows NT 4.0 or Windows 2000.
- Install PICC or PICC Lite Language Tools - Install the HI-TECH tools so that MPLAB IDE can use them. Select either `picc.exe` (all PICmicro® devices) or `picl.exe` (only PIC16X8X devices).

### 2.4.1 Error/Warning Formatting - Windows 3.1x/95/98

Place these two statements in the `autoexec.bat` file:

```
SET HTC_ERR_FORMAT=Error[ ] file %%f  %%l : %%s
SET HTC_WARN_FORMAT=Warning[ ] file %%f  %%l : %%s
```

> **Note:** You will have to reboot your PC for these changes to take affect.

### 2.4.2 Error/Warning Formatting - Windows NT 4.0

Right-click on the My Computer icon on your desktop and select Properties from the pop-up menu. The Systems Properties dialog will appear. Click on the Environment tab. To enter a new variable, click in the Variable box and type the name of a new variable. Then click in the Value box and enter the value.

Enter the following two new variables:

1. Variable: `HTC_ERR_FORMAT`

   Value: `Error[000 ] file %f  %l : %s`
2. Variable: `HTC_WARN_FORMAT`

   Value: `Warning[000 ] file %f  %l : %s`

When done, click **OK**.

### 2.4.3 Error/Warning Formatting - Windows 2000

Right-click on the My Computer icon on your desktop and select Properties from the pop-up menu. The Systems Properties dialog will appear. Click on the Advanced tab. Under User Variables, click **New**. The New User Variables dialog appears. To enter a new variable, click in the Variable Name box and type the name of a new variable. Then click in the Variable Value box and enter the value.

Enter the following two new variables:

1. Variable Name: `HTC_ERR_FORMAT`

   Variable Value: `Error[000 ] file %f  %l : %s`
2. Variable Name: `HTC_WARN_FORMAT`

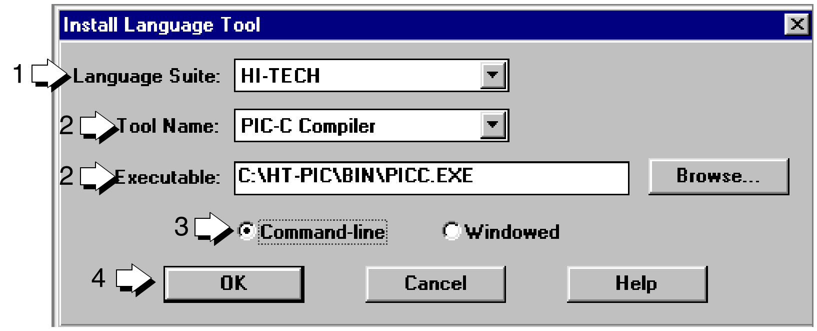
   Variable Value: `Warning[000 ] file %f  %l : %s`

When done, click **OK** in each dialog.

### 2.4.4 Install PICC Language Tools

Start up MPLAB IDE. Select *Project > Install Language Tool*. The Install Language Tool dialog will appear.

1. Select HI-TECH as the Language Suite.
2. Check to see that each Tool Name has an associated Executable. If not, select the Executable `picc.exe` for the assembler, compiler and linker tool as shown in the following figures (your executable path may be different.) Use the **Browse** button to locate `picc.exe` on your system, by default in the `c:\ht-pic\bin` directory.
3. The Command-line option should be selected for all tools.
4. When done, click **OK**.



Install Language Tool

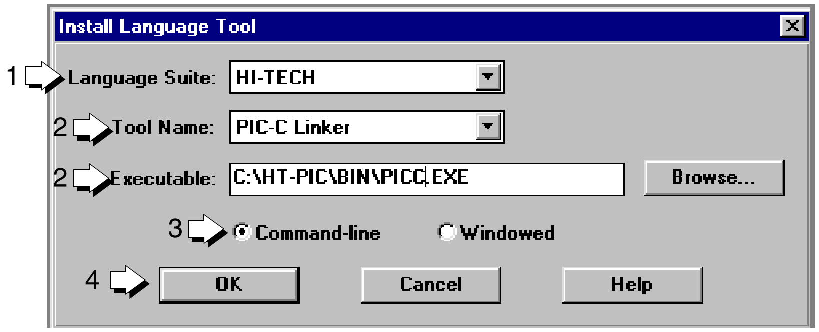
Language Suite: HI-TECH

Tool Name: PIC-C Compiler

Executable: C:\HT-PIC\BIN\PICC.EXE

● Command-line ○ Windowed

**Figure 2.2: Install Language Tool Dialog – PICC Compiler**



Install Language Tool

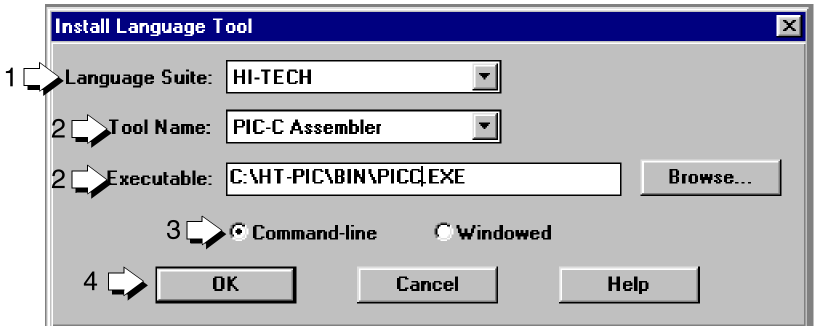
Language Suite: HI-TECH

Tool Name: PIC-C Linker

Executable: C:\HT-PIC\BIN\PICC.EXE

● Command-line ○ Windowed

**Figure 2.3: Install Language Tool Dialog – PICC Linker**



Install Language Tool

1 Language Suite: HI-TECH

2 Tool Name: PIC-C Assembler

2 Executable: C:\HT-PIC\BIN\PICC.EXE

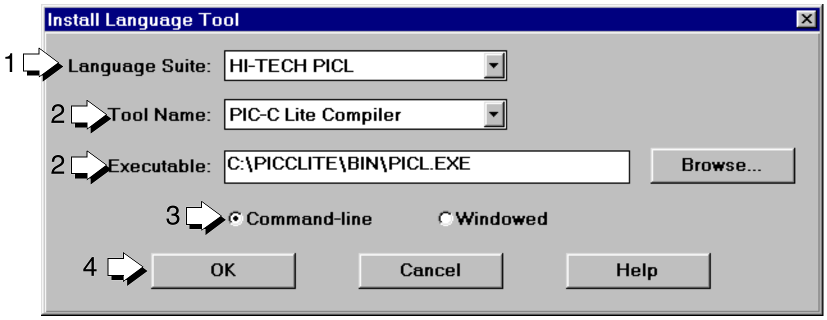
3 ● Command-line ○ Windowed

**Figure 2.4: Install Language Tool Dialog – PICC Assembler**

### 2.4.5 Install PICC Lite Language Tools

Start up MPLAB IDE. Select *Project > Install Language Tool*. The Install Language Tool dialog will appear.

1. Select HI-TECH PICL as the Language Suite.
2. Check to see that each Tool Name has an associated Executable. If not, select the Executable `picl.exe` for the assembler, compiler and linker tool as shown in the following figures (your executable path may be different.) Use the **Browse** button to locate `picl.exe` on your system, by default in the `c:\picclite\bin` directory.
3. The Command-line option should be selected for all tools.
4. When done, click **OK**.



Install Language Tool

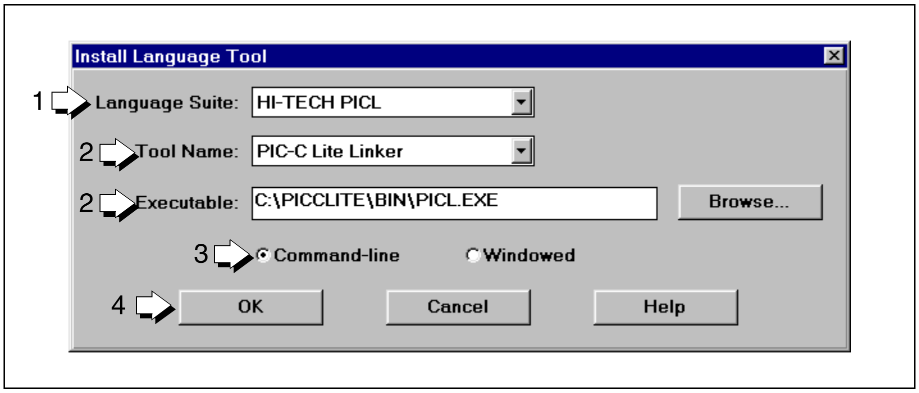
1 Language Suite: HI-TECH PICL

2 Tool Name: PIC-C Lite Compiler

2 Executable: C:\PICCLITE\BIN\PICL.EXE

3 ● Command-line ○ Windowed

**Figure 2.5: Install Language Tool Dialog – PICC Lite Compiler**



1 Language Suite: HI-TECH PICL

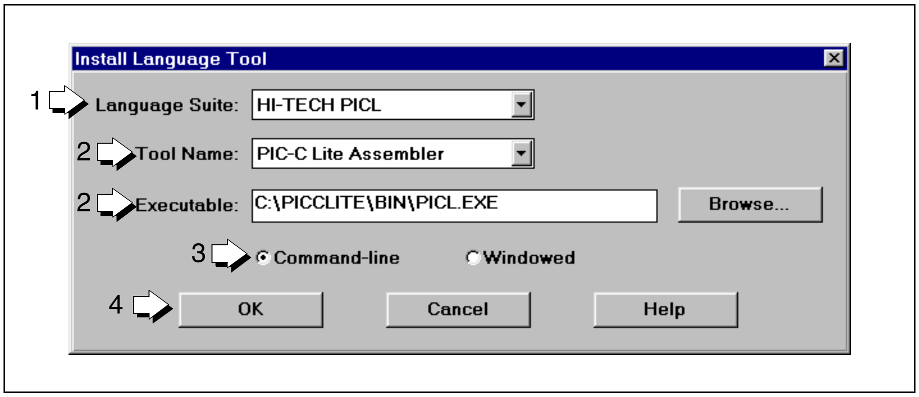
2 Tool Name: PIC-C Lite Linker

2 Executable: C:\PICCLITE\BIN\PICL.EXE

3 ● Command-line ○ Windowed

4 OK

Figure 2.6: Install Language Tool Dialog – PICC Lite Linker



1 Language Suite: HI-TECH PICL

2 Tool Name: PIC-C Lite Assembler

2 Executable: C:\PICCLITE\BIN\PICL.EXE

3 ● Command-line ○ Windowed

4 OK

Figure 2.7: Install Language Tool Dialog – PICC Lite Assembler

NOTES:

# Chapter 3. Single Source File Project using PICC™ Tools

## 3.1 Introduction

This chapter will guide you, step by step, in making an MPLAB IDE Project with one source file using HI-TECH PICC tools.

## 3.2 Highlights

In this tutorial, you will learn how to:

- Create the source file
- Set the MPLAB IDE development mode
- Create a new project
- Set project Node Properties (PICC Compiler)
- Add the source file
- Debug and build the project

## 3.3 Overview of One Source File Project

Figure 3.1 gives a graphical overview of the MPLAB IDE Project using PICC tools. The source file `ex1.c` is associated with the compiler to produce the object file `ex1.obj`. This file is used by the linker to produce the main output file, `ex1.hex`.

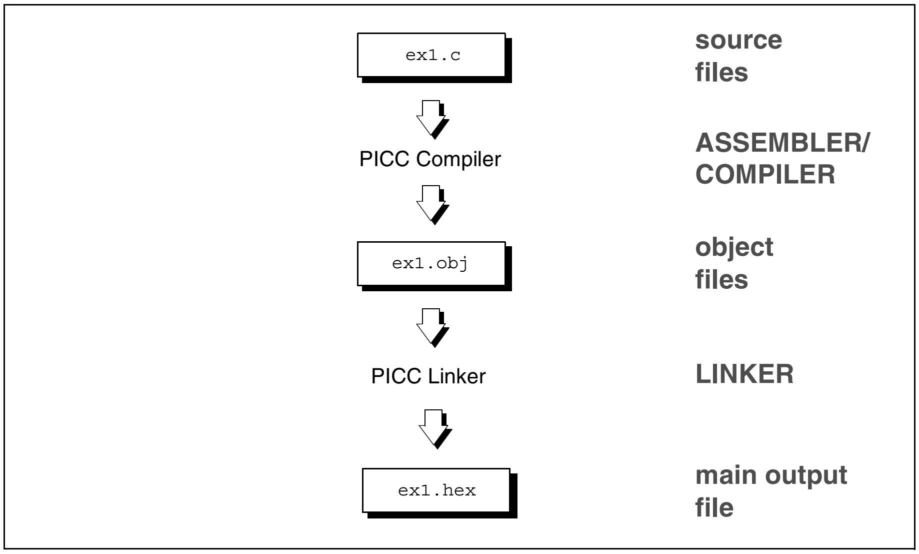


**Figure 3.1: Project Relationships For PICC Source Files**

## 3.4 Create Source File

Select *File > New* to open a blank editor window. The Create Project dialog will open also. Click **No** in the dialog for now.

Type the following into the window and save it as `ex1.c` in a directory called, for example, `c:\proj1` (If you have gone through the multiple source file tutorial first, you should pick a different directory, e.g., `c:\proj2`.) This is a very simple program that adds two numbers.

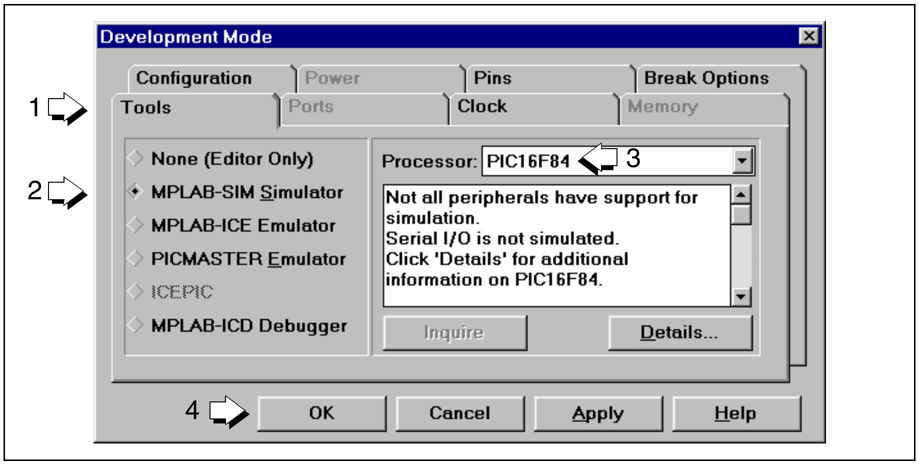
> **Note:** An error is contained in the code. Do not fix it yet.

```
#include <pic1684.h>
void main(void);
unsigned char Add(unsigned char a, unsigned char b);
unsigned char x, y, z;
void main()
{
 x = 2;
 y = 5;
 t = Add(x,y);
}
unsigned char Add(unsigned char a, unsigned char b)
{ return a+b; }
```

## 3.5 Set Development Mode

Select *Options > Development Mode* to open the Development Mode dialog.

1. Click the **Tools** tab.
2. Select MPLAB SIM simulator
3. Select the PIC16F84 PICmicro® MCU for this example.
4. Click **OK**.



○ None (Editor Only)
● MPLAB-SIM Simulator
○ MPLAB-ICE Emulator
○ PICMASTER Emulator
○ ICEPIC
○ MPLAB-ICD Debugger

Processor: PIC16F84

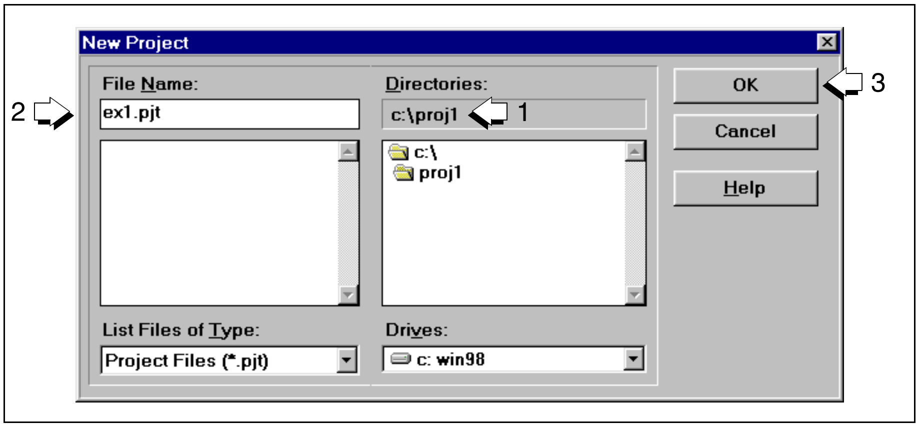
Not all peripherals have support for simulation.
Serial I/O is not simulated.
Click 'Details' for additional information on PIC16F84.

**Figure 3.2: Development Mode Dialog – MPLAB SIM, PIC16F84**

## 3.6 Create New Project

Select *Project > New Project* to open the New Project dialog.

1. Select the directory containing the source file as the directory for a new project.
2. Name the project `ex1.PJT`.
3. Click **OK**.



File Name: ex1.pjt

Directories: c:\proj1

c:\
proj1

List Files of Type: Project Files (*.pjt)

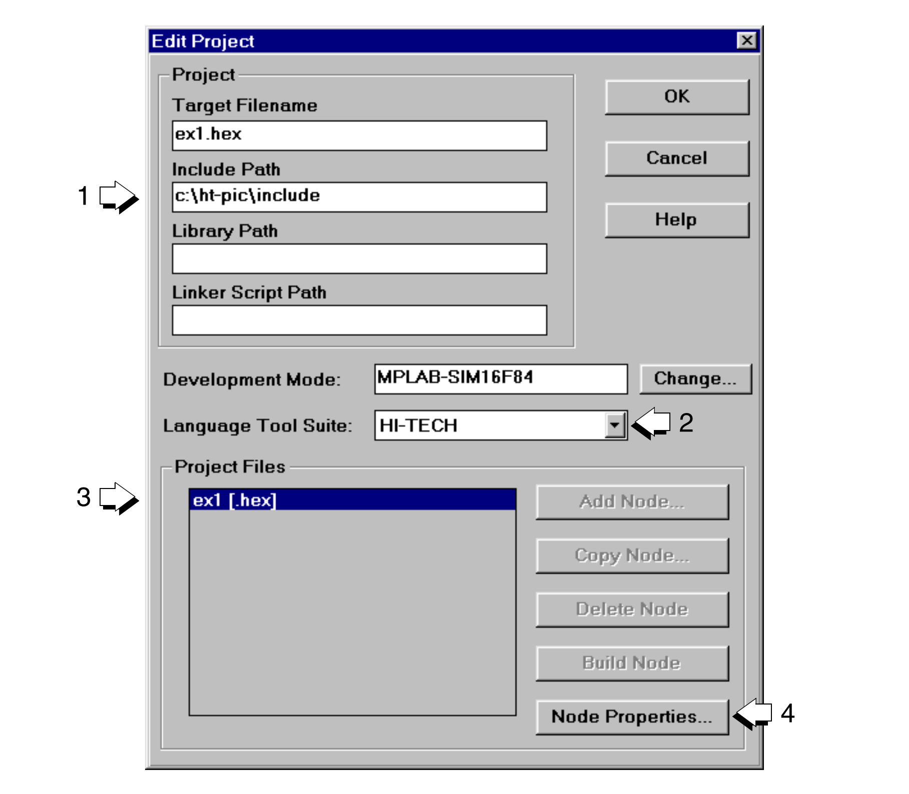
Drives: c: win98

**Figure 3.3: New Project Dialog – ex1.pjt**

## 3.7 Edit Project

The Edit Project dialog has several sections.

1. In the Project section, enter the Include Path, (e.g., `c:\ht-pic\include)`. This information lets MPLAB IDE know where to find the HI-TECH include files, `*.h`.
2. Select HI-TECH as the Language Tool Suite. The Change Suite Warning dialog will open. Click **OK**.
3. In the Project Files section, click on `ex1 [.hex]` to highlight the HEX file name and activate the **Node Properties** button.
4. Click on **Node Properties**.



Target Filename: ex1.hex

Include Path: c:\ht-pic\include

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: HI-TECH

Project Files: ex1 [.hex]

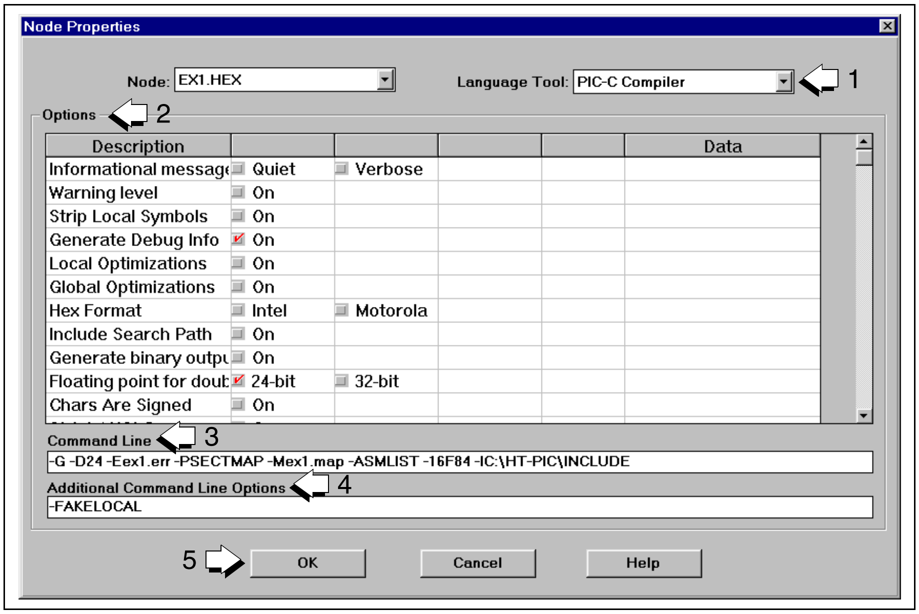
**Figure 3.4: Edit Project Dialog – ex1.hex**

## 3.8 Set Node Properties for Target Node

The Node Properties dialog should now be open.

1. Set the Language Tool to **PICC Compiler**.
2. The command line switches for the selected language tool are shown descriptively in Options. When you first open this dialog, the checked boxes represent the default values for the tool. For more information on each option, consult HI-TECH documentation.

   For this tutorial, several setting needs to be changed, as shown in Figure 3.5 and described below.



Node: EX1.HEX

Language Tool: PIC-C Compiler

Options

| Description | | | | | Data |
|---|---|---|---|---|---|
| Informational messag | ☐ Quiet | ☐ Verbose | | | |
| Warning level | ☐ On | | | | |
| Strip Local Symbols | ☐ On | | | | |
| Generate Debug Info | ☑ On | | | | |
| Local Optimizations | ☐ On | | | | |
| Global Optimizations | ☐ On | | | | |
| Hex Format | ☐ Intel | ☐ Motorola | | | |
| Include Search Path | ☐ On | | | | |
| Generate binary outpu | ☐ On | | | | |
| Floating point for doub | ☑ 24-bit | ☐ 32-bit | | | |
| Chars Are Signed | ☐ On | | | | |

Command Line

```
-G -D24 -Eex1.err -PSECTMAP -Mex1.map -ASMLIST -16F84 -IC:\HT-PIC\INCLUDE
```

Additional Command Line Options

```
-FAKELOCAL
```

**Figure 3.5: Node Properties Dialog – ex1.hex**

Make the following changes in the Options section:

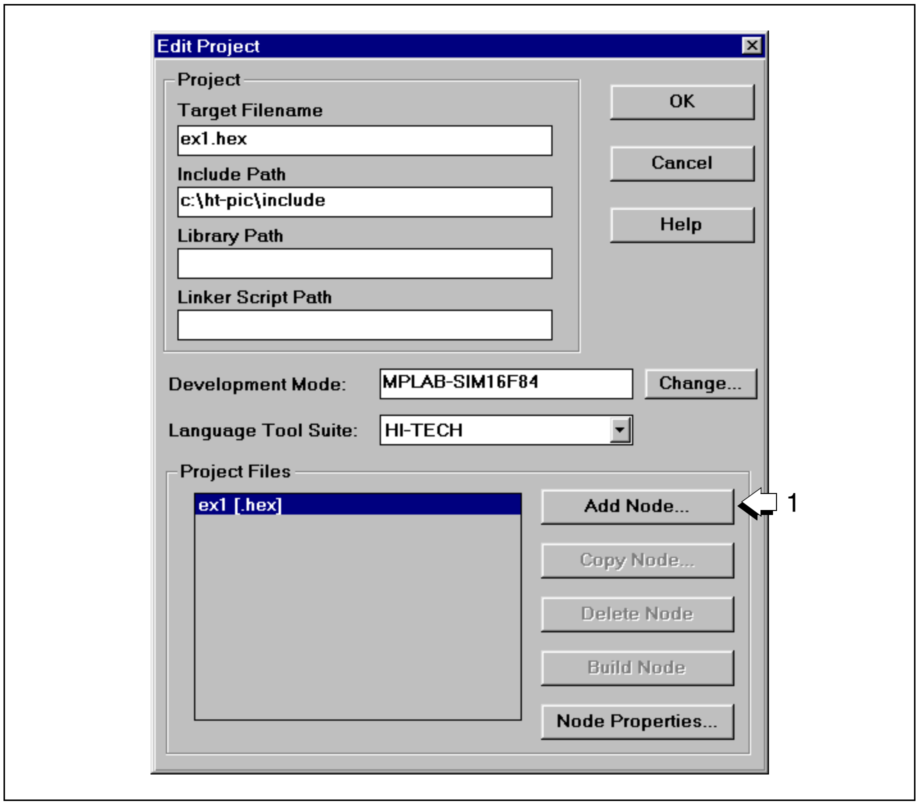
- Select Generate Debug Info
- Select Error File and add an error file name to the Data column, (i.e., `ex1.err`).
- Select Display Memory Usage
- Select Map File and add a map file name to the Data column, (i.e., `ex1.map`).
- Select Assembler List File to generate `ex1.lst`.

3. Command line switches are also shown in Command Line. Refer to the HI-TECH documentation for more information on these switches.
4. Click in the text box for Additional Command Line Options and type `-FAKELOCAL` (supported for PICC tools version 7.84 and above).
5. Click **OK** to return to the Edit Project dialog.

## 3.9 Add Source File

The **Add Node** button on the Edit Project dialog should now be active.

1. Click on it to open the Add Node dialog.



Project

Target Filename: ex1.hex

Include Path: c:\ht-pic\include

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

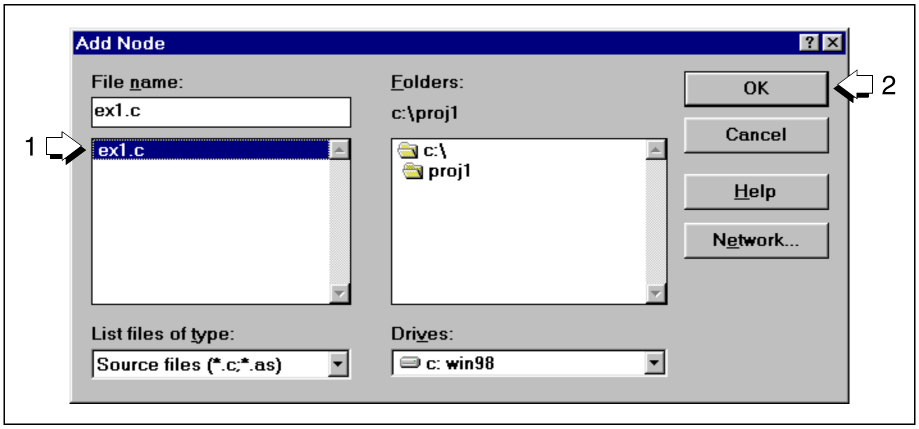
Language Tool Suite: HI-TECH

Project Files: ex1 [.hex]

**Figure 3.6: Edit Project Dialog – Add Node**

In the Add Node dialog (Figure 3.7):

1. Add the source file, `ex1.c` from the source file directory
2. Click **OK** to return to the Edit Project dialog.



File name: ex1.c

ex1.c

Folders: c:\proj1

c:\
proj1

List files of type: Source files (*.c;*.as)

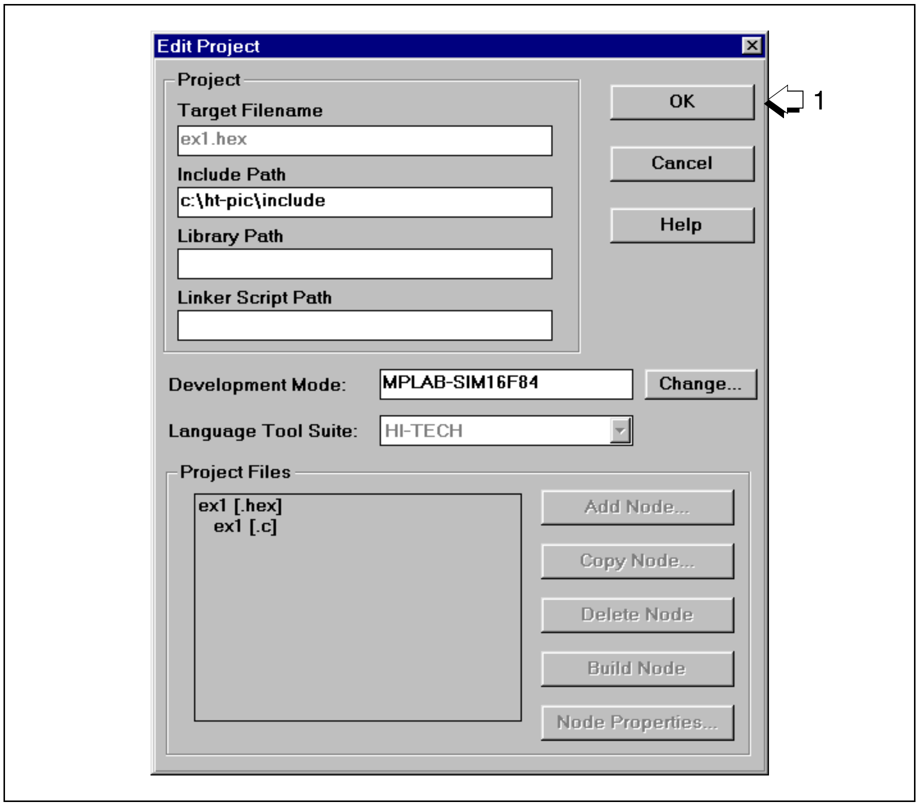
Drives: c: win98

Figure 3.7: Add Node Dialog – ex1.c

## 3.10 Finish Editing Project

To finish editing the project;

1. Click **OK** to close the Edit Project dialog.



Target Filename: ex1.hex

Include Path: c:\ht-pic\include

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: HI-TECH

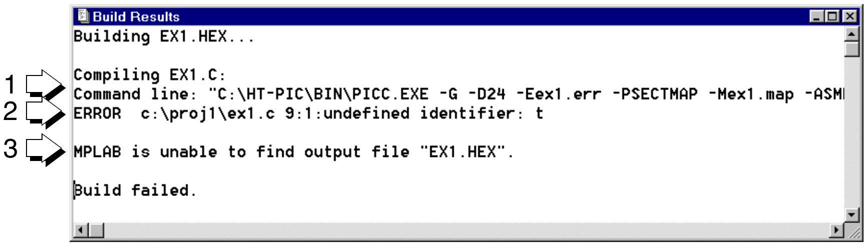
ex1 [.hex]
  ex1 [.c]

Figure 3.8: Edit Project Dialog – Final

## 3.11 Debug and Build Project

Select *Project > Make Project* from the menu to compile the application using the HI-TECH compiler. A Build Results window is created that shows;

1. The command line sent to the compiler, along with other information specified in Node Properties
2. Compilation errors
3. A compiler error will cause the build to fail, meaning a HEX file is not generated, and therefore MPLAB IDE will be unable to find this file.



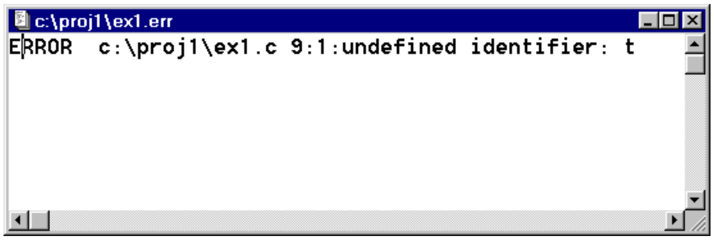
```
Building EX1.HEX...

Compiling EX1.C:
Command line: "C:\HT-PIC\BIN\PICC.EXE -G -D24 -Eex1.err -PSECTMAP -Mex1.map -ASM
ERROR  c:\proj1\ex1.c 9:1:undefined identifier: t

MPLAB is unable to find output file "EX1.HEX".

Build failed.
```

**Figure 3.9: Build Results Window – Build Failed**

If you have a build error, double-click on the error in the Build Results window to send you to the line in the source file that contains that error. If the source code file is not open, MPLAB IDE will open the file and then go to the line containing the error.

Alternatively, you can click on the error in the error file to accomplish the same result. By selecting Error File in the Node Properties dialog, an error file is created with the name given in the Data field.

To open the error file, select *File > Open* and then choose All Files (*.*) from the List of file types. Choose the `.err` file and click **OK**.

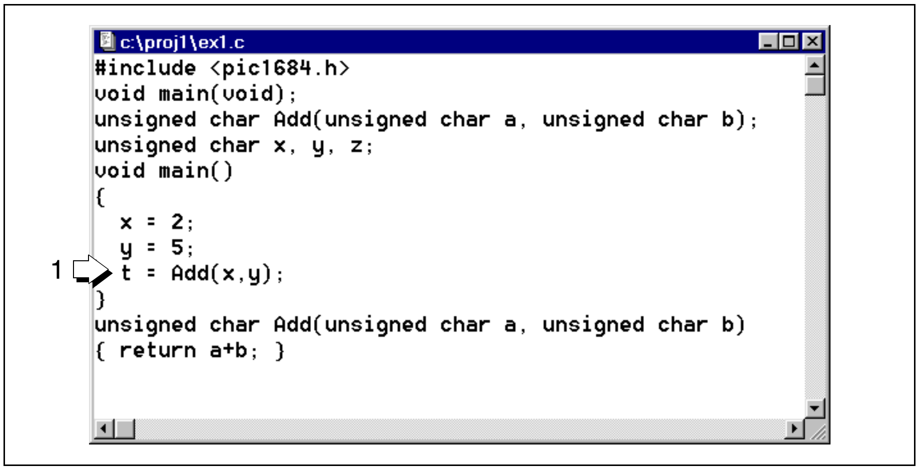


```
ERROR  c:\proj1\ex1.c 9:1:undefined identifier: t
```

**Figure 3.10: Assembler List File Window – ex1.err**

Now you will fix the error in the source code.

1. Change the "t" to a "z"



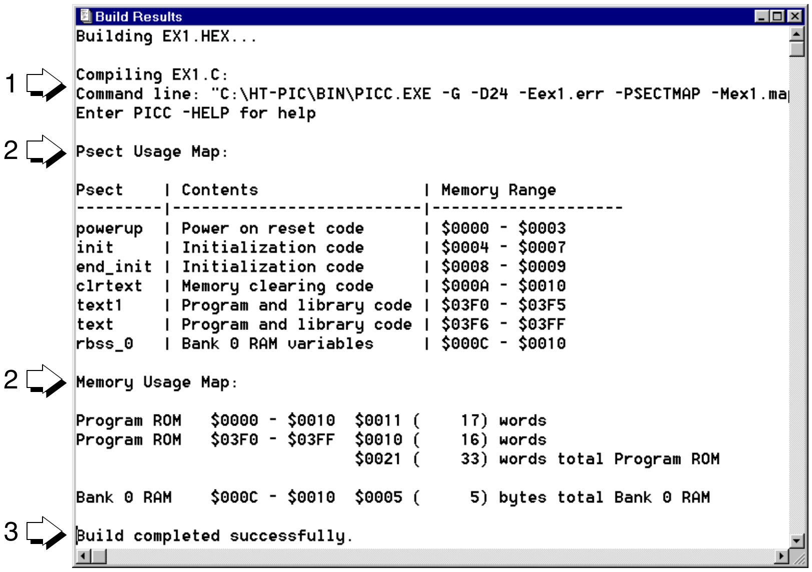
```
#include <pic1684.h>
void main(void);
unsigned char Add(unsigned char a, unsigned char b);
unsigned char x, y, z;
void main()
{
  x = 2;
  y = 5;
  t = Add(x,y);
}
unsigned char Add(unsigned char a, unsigned char b)
{ return a+b; }
```

**Figure 3.11: Source Code with Error**

Select *File > Save* (This step is just good practice, but not necessary, as MPLAB IDE will save the file when doing a build.) Now build the project again by selecting *Project > Make Project*. The Build Results window should now look different.

1. The command line sent to the compiler is still displayed, along with other information specified in Node Properties.
2. By selecting Display Memory Usage in the Node Properties dialog, Psect (Section) Usage Map and the Memory Usage Map are shown in the Build Results window. These usage maps display complete memory segment usage after linking.

   For HI-TECH tools, the linker is called by the compiler automatically, (i.e., you do not need to specify its use in conjunction with a node for single-node projects).
3. Build was successful.



```
Building EX1.HEX...

Compiling EX1.C:
Command line: "C:\HT-PIC\BIN\PICC.EXE -G -D24 -Eex1.err -PSECTMAP -Mex1.ma
Enter PICC -HELP for help

Psect Usage Map:

Psect    | Contents                 | Memory Range
---------|--------------------------|--------------------
powerup  | Power on reset code      | $0000 - $0003
init     | Initialization code      | $0004 - $0007
end_init | Initialization code      | $0008 - $0009
clrtext  | Memory clearing code     | $000A - $0010
text1    | Program and library code | $03F0 - $03F5
text     | Program and library code | $03F6 - $03FF
rbss_0   | Bank 0 RAM variables     | $000C - $0010

Memory Usage Map:

Program ROM   $0000 - $0010  $0011 (    17) words
Program ROM   $03F0 - $03FF  $0010 (    16) words
                             $0021 (    33) words total Program ROM

Bank 0 RAM    $000C - $0010  $0005 (     5) bytes total Bank 0 RAM

Build completed successfully.
```

**Figure 3.12: Build Results Window – Build Successful**

# 3.12 More Project Information

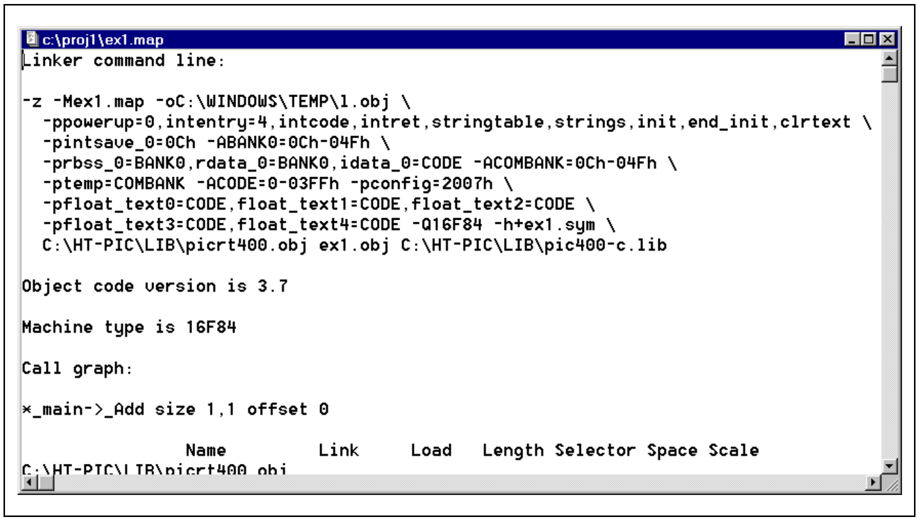
The source code in this tutorial only had one error. However, real untested code would most likely need to be debugged more extensively. This is where the options that you set in Node Properties will help out.

## 3.12.1 Debug Information

By selecting Generate Debug Info in the Node Properties dialog, the MPLAB IDE has information necessary to help you debug your code.

## 3.12.2 Map File

By selecting Map File in the Node Properties dialog, a map file is created with the name given in the Data field. To open the map file, select *Window > Map File* (Figure 3.13). For information on the content of the map file, please refer to HI-TECH documentation.

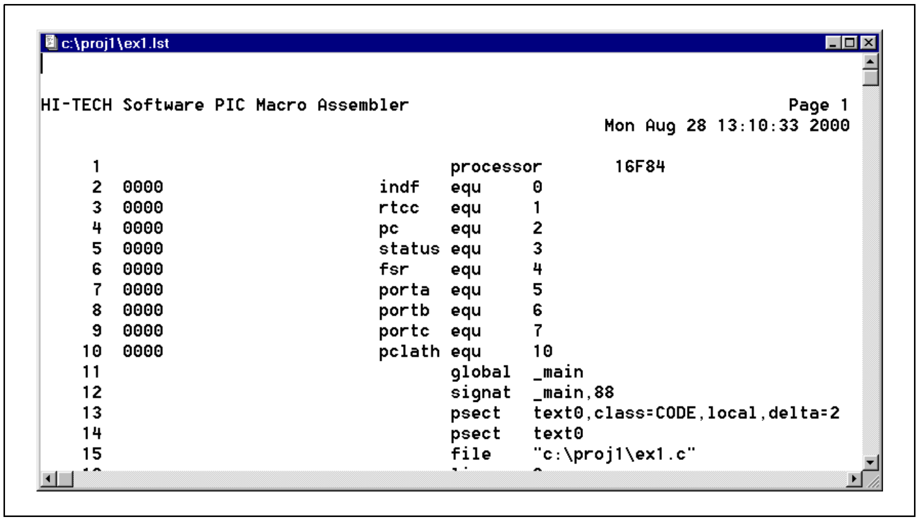


```
Linker command line:

-z -Mex1.map -oC:\WINDOWS\TEMP\l.obj \
  -ppowerup=0,intentry=4,intcode,intret,stringtable,strings,init,end_init,clrtext \
  -pintsave_0=0Ch -ABANK0=0Ch-04Fh \
  -prbss_0=BANK0,rdata_0=BANK0,idata_0=CODE -ACOMBANK=0Ch-04Fh \
  -ptemp=COMBANK -ACODE=0-03FFh -pconfig=2007h \
  -pfloat_text0=CODE,float_text1=CODE,float_text2=CODE \
  -pfloat_text3=CODE,float_text4=CODE -Q16F84 -h+ex1.sym \
  C:\HT-PIC\LIB\picrt400.obj ex1.obj C:\HT-PIC\LIB\pic400-c.lib

Object code version is 3.7

Machine type is 16F84

Call graph:

*_main->_Add size 1,1 offset 0

                Name          Link      Load   Length Selector Space Scale
C:\HT-PIC\LIB\picrt400.obj
```

Figure 3.13: Map File Window – ex1.map

## 3.12.3 Absolute Listing

By selecting Assembler List File in the Node Properties dialog, an absolute listing file is generated. The list file shows both the original C code, the generated assembler code and the corresponding binary code.



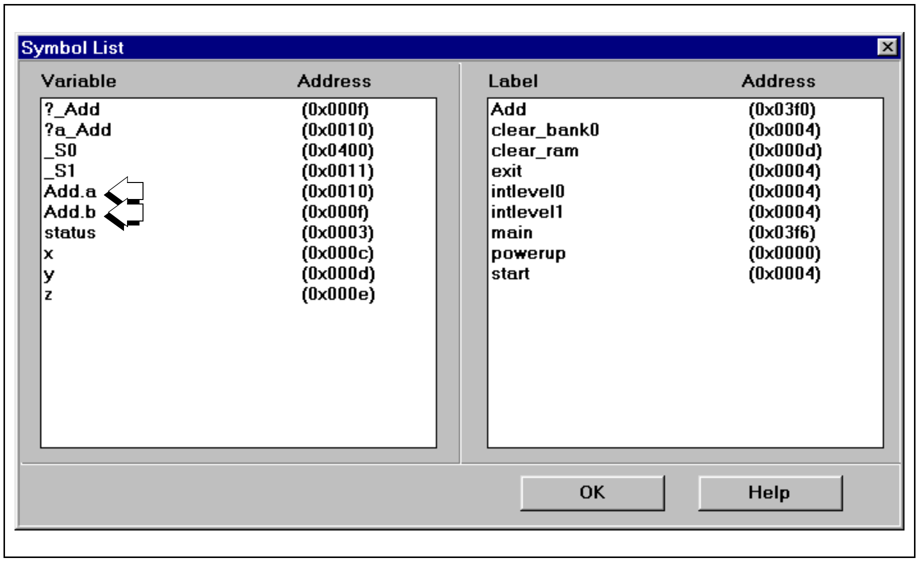
```


HI-TECH Software PIC Macro Assembler                                     Page 1
                                                        Mon Aug 28 13:10:33 2000

     1                                   processor       16F84
     2  0000                      indf   equ     0
     3  0000                      rtcc   equ     1
     4  0000                      pc     equ     2
     5  0000                      status equ     3
     6  0000                      fsr    equ     4
     7  0000                      porta  equ     5
     8  0000                      portb  equ     6
     9  0000                      portc  equ     7
    10  0000                      pclath equ     10
    11                                   global  _main
    12                                   signat  _main,88
    13                                   psect   text0,class=CODE,local,delta=2
    14                                   psect   text0
    15                                   file    "c:\proj1\ex1.c"
```

Figure 3.14: Assembler List File Window – ex1.lst

### 3.12.4 Symbol List

By setting `-FAKELOCAL` under Additional Command Line Options in the Node Properties dialog, local `auto` variables will appear and have a value when single stepping inside the function.

Open the Symbol List by selecting *Window > Show Symbol List*. Scroll through the variable list to make sure any local variables in your code are listed.



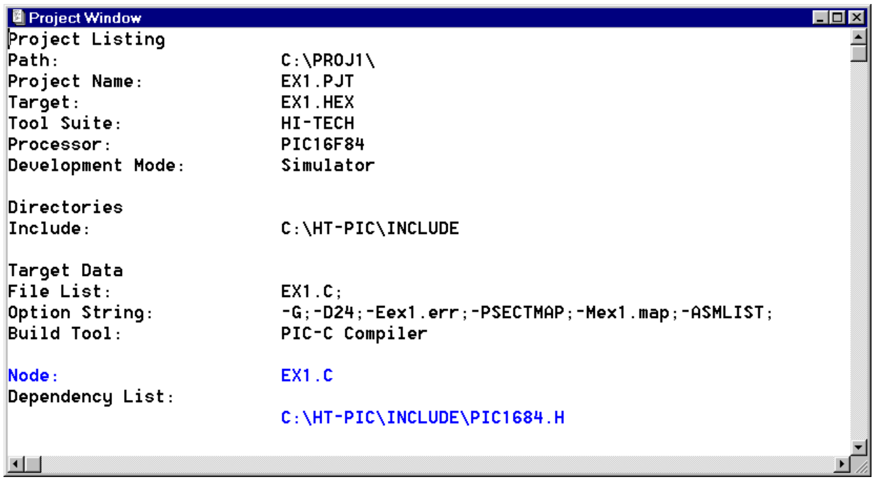
| Variable | Address |
|---|---|
| ?_Add | (0x000f) |
| ?a_Add | (0x0010) |
| _S0 | (0x0400) |
| _S1 | (0x0011) |
| Add.a | (0x0010) |
| Add.b | (0x000f) |
| status | (0x0003) |
| x | (0x000c) |
| y | (0x000d) |
| z | (0x000e) |

| Label | Address |
|---|---|
| Add | (0x03f0) |
| clear_bank0 | (0x0004) |
| clear_ram | (0x000d) |
| exit | (0x0004) |
| intlevel0 | (0x0004) |
| intlevel1 | (0x0004) |
| main | (0x03f6) |
| powerup | (0x0000) |
| start | (0x0004) |

**Figure 3.15: Symbol List Window**

### 3.12.5 Project Window

Open the *Window > Project* window. This displays various project information, which can be useful to review when debugging.



```
Project Listing
Path:                     C:\PROJ1\
Project Name:             EX1.PJT
Target:                   EX1.HEX
Tool Suite:               HI-TECH
Processor:                PIC16F84
Development Mode:         Simulator

Directories
Include:                  C:\HT-PIC\INCLUDE

Target Data
File List:                EX1.C;
Option String:            -G;-D24;-Eex1.err;-PSECTMAP;-Mex1.map;-ASMLIST;
Build Tool:               PIC-C Compiler

Node:                     EX1.C
Dependency List:
                          C:\HT-PIC\INCLUDE\PIC1684.H
```

**Figure 3.16: Project Window – ex1.pjt**

Double-clicking on any of the blue file names, you can open these files in the MPLAB IDE. This is ideal for opening files that are not in the project directory (e.g., header .h files), and therefore would require hunting through directory structures to find otherwise.

## 3.13 Optimization and Other Node Properties

For more information on optimization techniques, (e.g., Local and Global Optimization switches), as well as definitions of other Node Properties switches, please refer to HI-TECH documentation.

NOTES:

# Chapter 4. Multiple Source File Project using PICC™ Tools

## 4.1 Introduction

This chapter will guide you, step by step, in making an MPLAB IDE Project with several source files using HI-TECH PICC tools.

## 4.2 Highlights

In this tutorial, you will learn how to:

- Create the source files
- Set the MPLAB IDE development mode
- Create a new project
- Set project Node Properties (PICC Linker)
- Add the source files and set Node Properties (PICC Compiler)
- Debug and build the project

## 4.3 Overview of Multiple Source File Project

Figure 4.1 gives a graphical overview of the MPLAB IDE Project using PICC tools. The source files `ex1.c` and `add.c` are associated with the compiler to produce the object files `ex1.obj` and `add.obj`. These files are used by the linker to produce the main output file, `ex1.hex`.

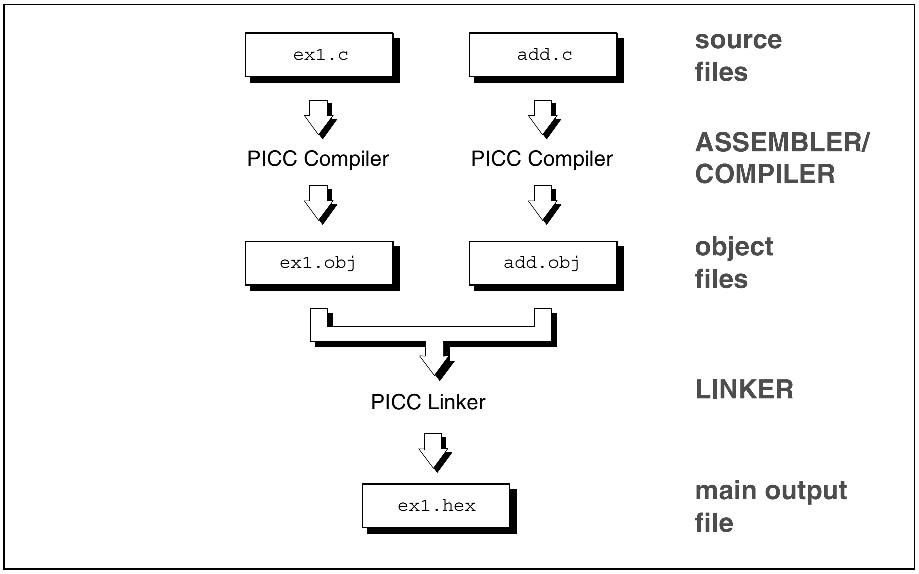


**Figure 4.1: Project Relationships For PICC Source Files**

## 4.4 Create Source Files

Select *File > New* to open a blank editor window. The Create Project dialog will open also. Click **No** in the dialog for now.

Type the following into the window and save it as `ex1.c` in a directory called, for example, `c:\proj1` (If you have gone through the single source file tutorial first, you should pick a different directory, e.g., `c:\proj2`). This is a very simple program that adds two numbers.

**Note:** An error is contained in the code. Do not fix it yet.

```
#include <pic1684.h>
void main(void);
unsigned char Add(unsigned char a, unsigned char b);
unsigned char x, y, z;
void main()
{
 x = 2;
 y = 5;
 t = Add(x,y);
}
```

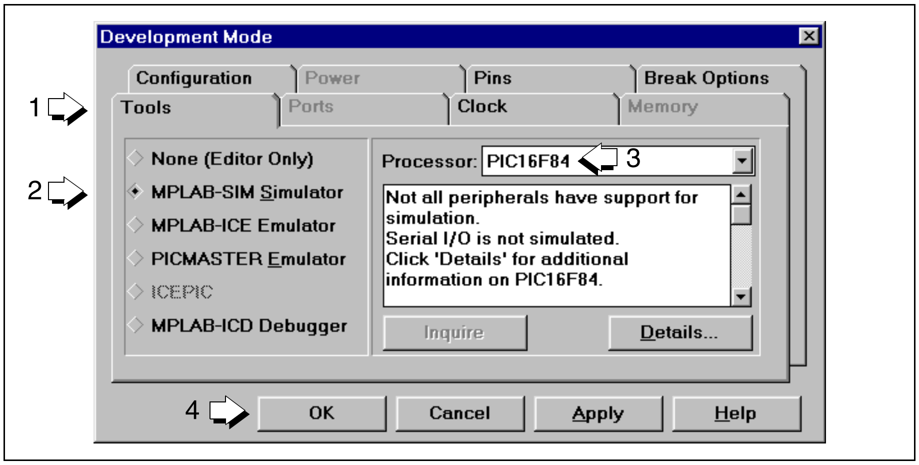
Again select *File > New* to open a blank editor window. Select **No** in the Create Project dialog. Type the following into the window and save it as `add.c` in the same directory as the file above.

```
#include <pic1684.h>
unsigned char Add(unsigned char a, unsigned char b)
{ return a+b; }
```

## 4.5 Set Development Mode

Select *Options > Development Mode* to open the Development Mode dialog.

1. Click the **Tools** tab.
2. Select MPLAB SIM simulator
3. Select the PIC16F84 PICmicro® MCU for this example.
4. Click **OK**.



Development Mode

Tools: ● MPLAB-SIM Simulator

Processor: PIC16F84

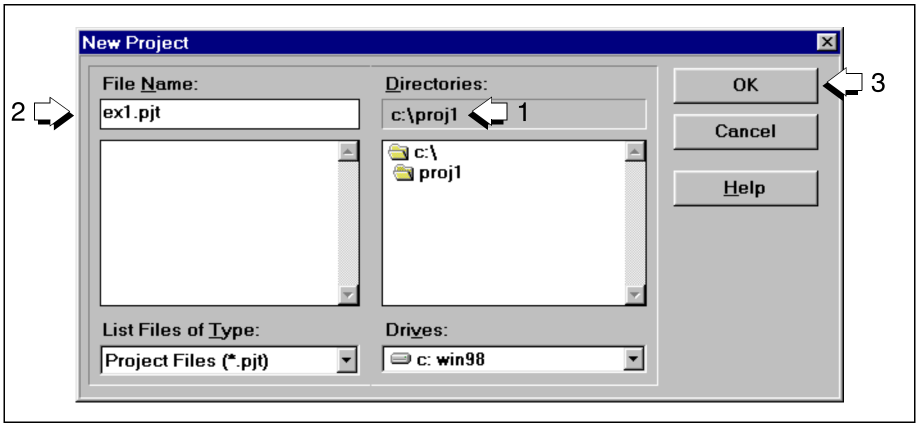
Not all peripherals have support for simulation.
Serial I/O is not simulated.
Click 'Details' for additional information on PIC16F84.

**Figure 4.2: Development Mode Dialog – MPLAB SIM, PIC16F84**

## 4.6 Create New Project

Select *Project > New Project* to open the New Project dialog.

1. Select the directory containing the source files as the directory for a new project.
2. Name the project `ex1.PJT`.
3. Click **OK**.



New Project

File Name: ex1.pjt

Directories: c:\proj1

List Files of Type: Project Files (*.pjt)

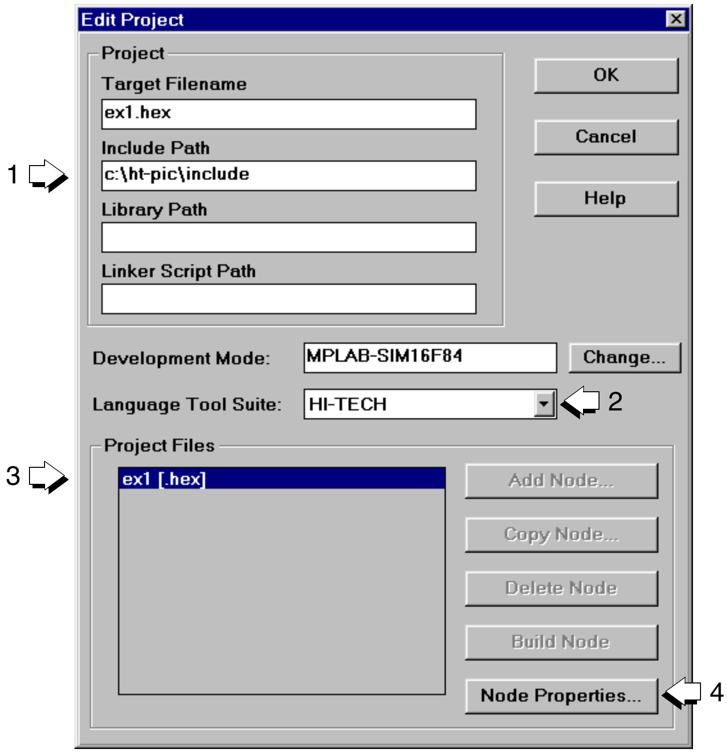
Drives: c: win98

**Figure 4.3: New Project Dialog – ex1.pjt**

## 4.7 Edit Project

The Edit Project dialog has several sections.

1. In the Project section, enter the Include Path, (e.g., `c:\ht-pic\include`). This information lets MPLAB IDE know where to find the HI-TECH include files, `*.h`.
2. Select HI-TECH as the Language Tool Suite. The Change Suite Warning dialog will open. Click **OK**.
3. In the Project Files section, click on `ex1 [.hex]` to highlight the HEX file name and activate the **Node Properties** button.
4. Click on **Node Properties**.



Edit Project

Project

Target Filename: ex1.hex

Include Path: c:\ht-pic\include

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: HI-TECH

Project Files: ex1 [.hex]

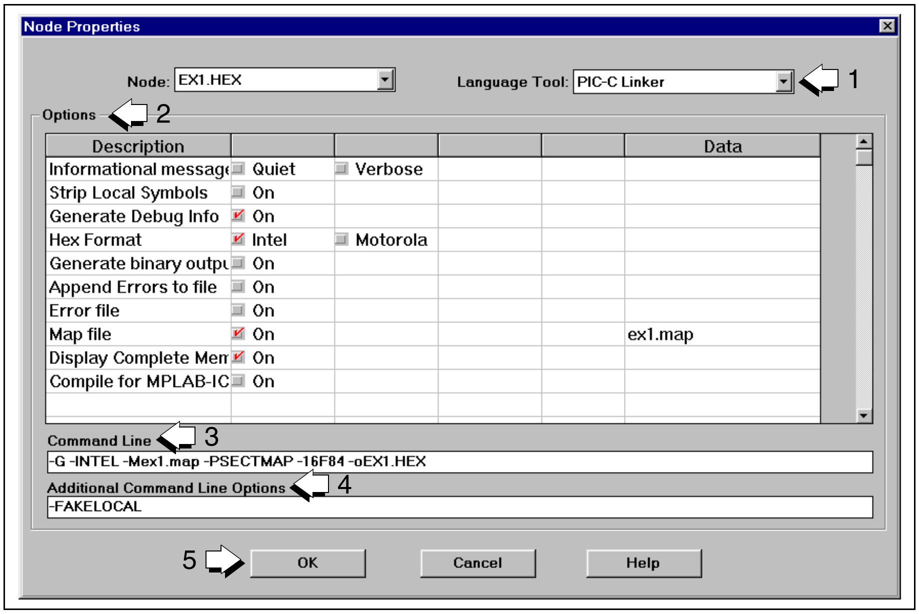
**Figure 4.4: Edit Project Dialog – ex1.hex**

## 4.8 Set Node Properties for Target Node

The Node Properties dialog should now be open.

1. Set the Language Tool to **PICC Linker**.
2. The command line switches for the selected language tool are shown descriptively in Options. When you first open this dialog, the checked boxes represent the default values for the tool. For more information on each option, consult HI-TECH documentation.

   For this tutorial, several setting needs to be changed, as shown in Figure 4.5 and described below.



Node: EX1.HEX

Language Tool: PIC-C Linker

Options

| Description | | | | | Data |
|---|---|---|---|---|---|
| Informational message | ☐ Quiet | ☐ Verbose | | | |
| Strip Local Symbols | ☐ On | | | | |
| Generate Debug Info | ☑ On | | | | |
| Hex Format | ☑ Intel | ☐ Motorola | | | |
| Generate binary outpu | ☐ On | | | | |
| Append Errors to file | ☐ On | | | | |
| Error file | ☐ On | | | | |
| Map file | ☑ On | | | | ex1.map |
| Display Complete Mem | ☑ On | | | | |
| Compile for MPLAB-IC | ☐ On | | | | |

Command Line

-G -INTEL -Mex1.map -PSECTMAP -16F84 -oEX1.HEX

Additional Command Line Options

-FAKELOCAL

**Figure 4.5: Node Properties Dialog – ex1.hex**

Make the following changes in the Options section:

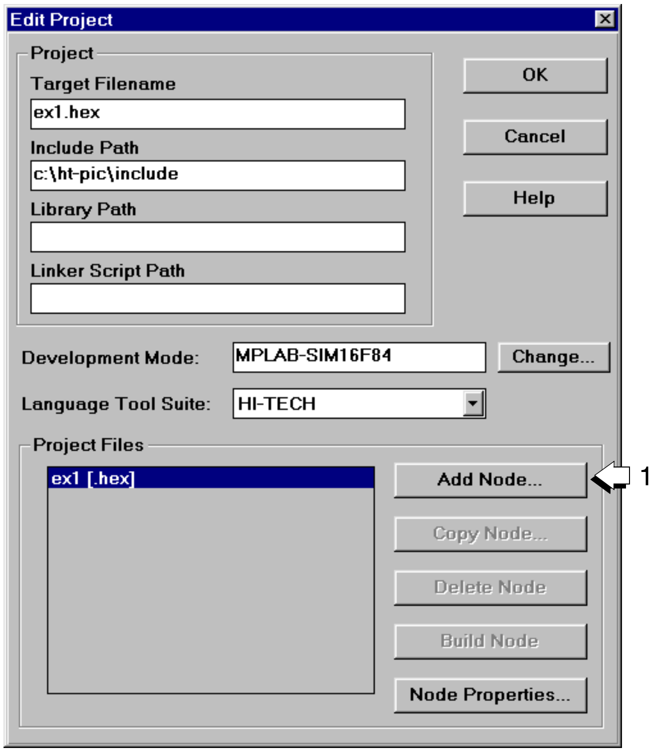
- Select Generate Debug Info
- Select Map File and add a map file name to the Data column, (i.e., `ex1.map`).
- Select Display Complete Memory Usage

3. Command line switches are also shown in Command Line. Refer to the HI-TECH documentation for more information on these switches.
4. Click in the text box for Additional Command Line Options and type `-FAKELOCAL` (supported for PICC tools version 7.84 and above).
5. Click **OK** to return to the Edit Project dialog.

## 4.9 Add First Source File

The **Add Node** button on the Edit Project dialog should now be active.

1. Click on it to open the Add Node dialog.



Target Filename: ex1.hex

Include Path: c:\ht-pic\include

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

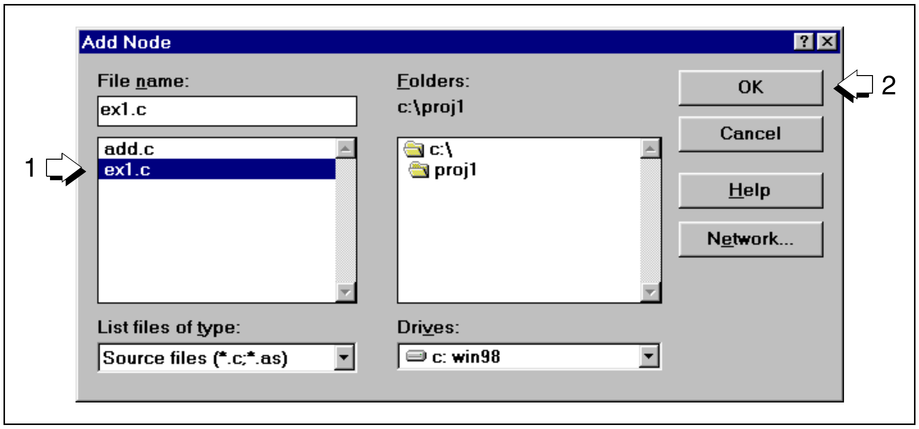
Language Tool Suite: HI-TECH

Project Files: ex1 [.hex]

**Figure 4.6: Edit Project Dialog – Add Node**

In the Add Node dialog (Figure 4.7);

1. Add the source file, `ex1.c` from the source file directory
2. Click **OK** to return to the Edit Project dialog.



Add Node

File name: ex1.c

add.c
ex1.c

Folders: c:\proj1

c:\
proj1

List files of type: Source files (*.c;*.as)

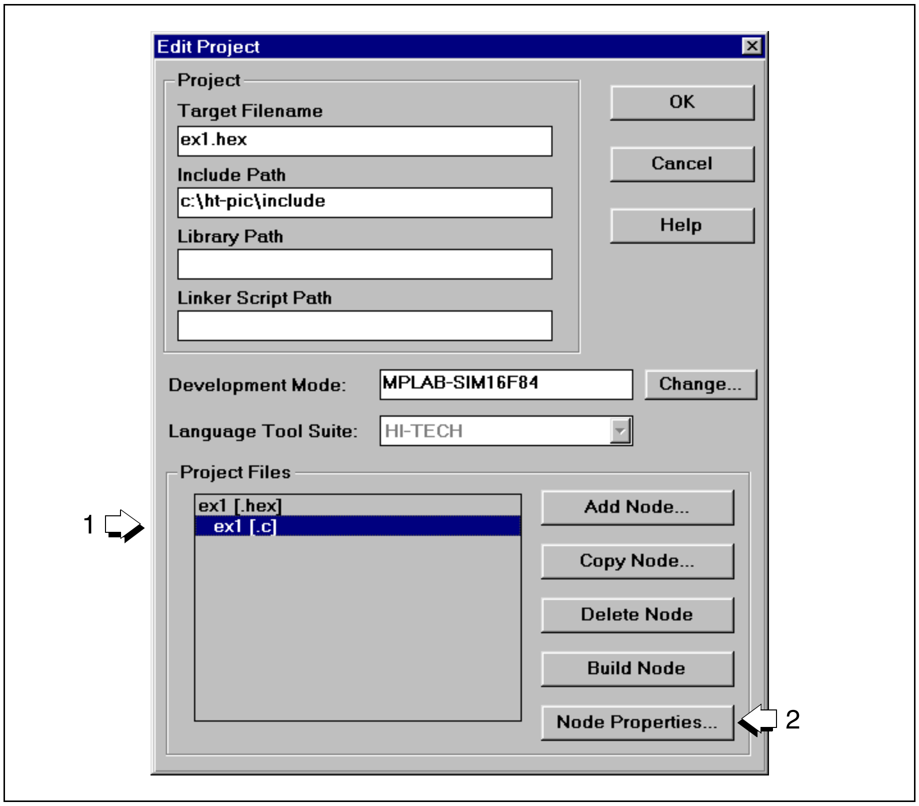
Drives: c: win98

**Figure 4.7: Add Node Dialog – ex1.c**

## 4.10 Set Node Properties for First Source Node

In the Edit Project dialog;

1. Click on the source file
2. Click on **Node Properties**.



Edit Project

Project

Target Filename: ex1.hex

Include Path: c:\ht-pic\include

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: HI-TECH

Project Files

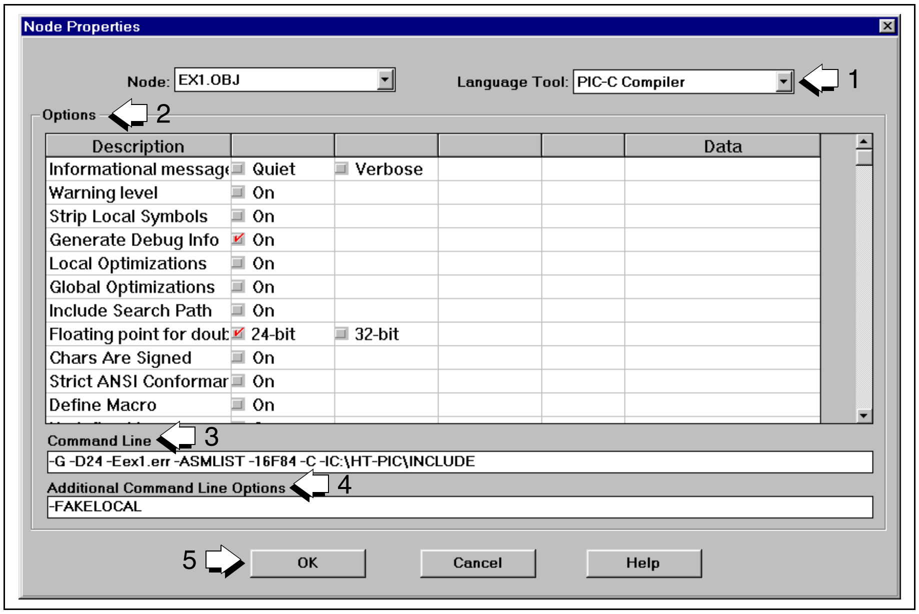
ex1 [.hex]
ex1 [.c]

**Figure 4.8: Edit Project Dialog – ex1.c**

The Node Properties dialog should now be open.

1. Set the Language Tool to **PICC Compiler**.
2. The command line switches for the selected language tool are shown descriptively in Options. When you first open this dialog, the checked boxes represent the default values for the tool.

   For this tutorial, several setting needs to be changed, as shown in Figure 4.5 and described below.



Node: EX1.OBJ

Language Tool: PIC-C Compiler

Options

| Description | | | | | Data |
|---|---|---|---|---|---|
| Informational message | □ Quiet | □ Verbose | | | |
| Warning level | □ On | | | | |
| Strip Local Symbols | □ On | | | | |
| Generate Debug Info | ☑ On | | | | |
| Local Optimizations | □ On | | | | |
| Global Optimizations | □ On | | | | |
| Include Search Path | □ On | | | | |
| Floating point for doub | ☑ 24-bit | □ 32-bit | | | |
| Chars Are Signed | □ On | | | | |
| Strict ANSI Conformar | □ On | | | | |
| Define Macro | □ On | | | | |

Command Line

-G -D24 -Eex1.err -ASMLIST -16F84 -C -IC:\HT-PIC\INCLUDE

Additional Command Line Options

-FAKELOCAL

**Figure 4.9: Node Properties Dialog – ex1.obj**

Make the following changes in the Options section:

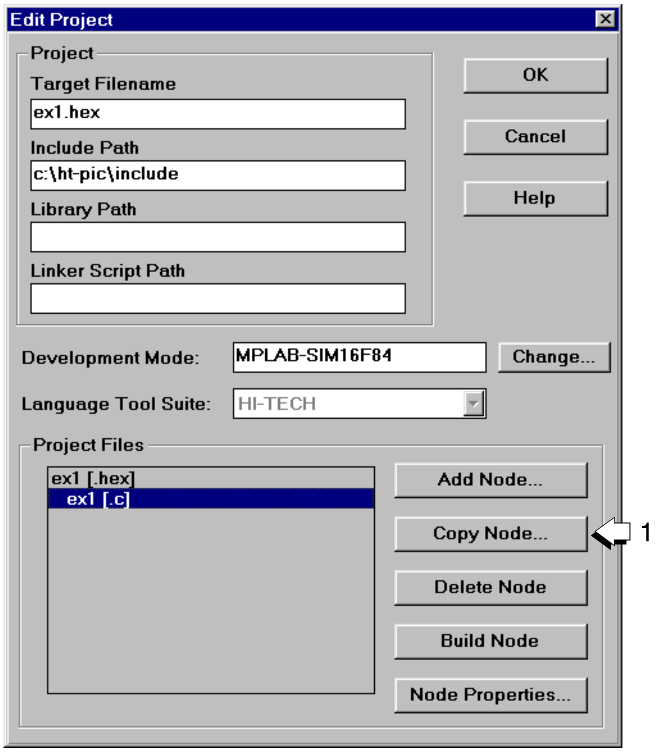
- Select Generate Debug Info
- Select Error File and add an error file name to the Data column, (i.e., `ex1.err).`
- Select Assembler List File to generate `ex1.lst`.

3. Command line switches are also shown in Command Line. Refer to the HI-TECH documentation for more information on these switches.
4. Click in the text box for Additional Command Line Options and type `-FAKELOCAL` (supported for PICC tools version 7.84 and above.)
5. Click **OK** to return to the Edit Project dialog.

## 4.11 Add Second Source File

All node buttons on the Edit Project dialog should be active.

1. Click on **Copy Node** to open the Copy Node dialog.



Edit Project

Project

Target Filename: ex1.hex

Include Path: c:\ht-pic\include

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: HI-TECH

Project Files

ex1 [.hex]
  ex1 [.c]

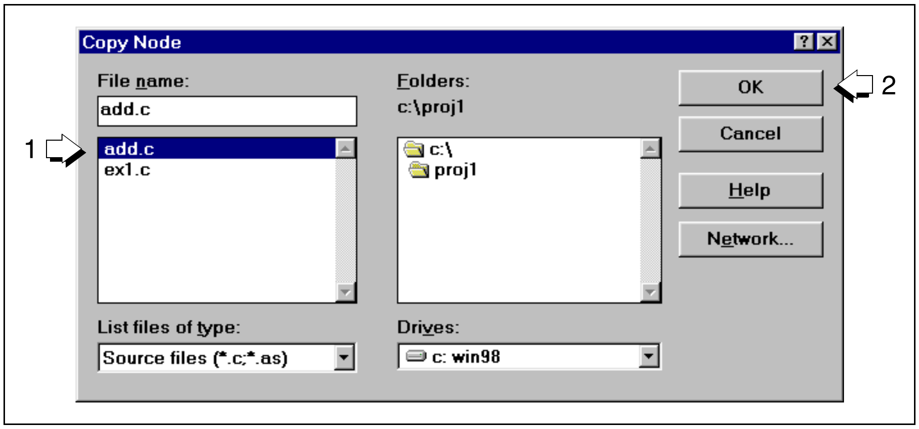
**Figure 4.10: Edit Project Dialog – Copy Node**

In the Copy Node dialog (Figure 4.7);

1. Click on the source file, `add.c` from the source file directory.

   This file will be added to the project, with its Node Properties copied from `ex1.c`.

2. Click **OK** to return to the Edit Project dialog.



File name: add.c

add.c
ex1.c

Folders: c:\proj1

c:\
proj1

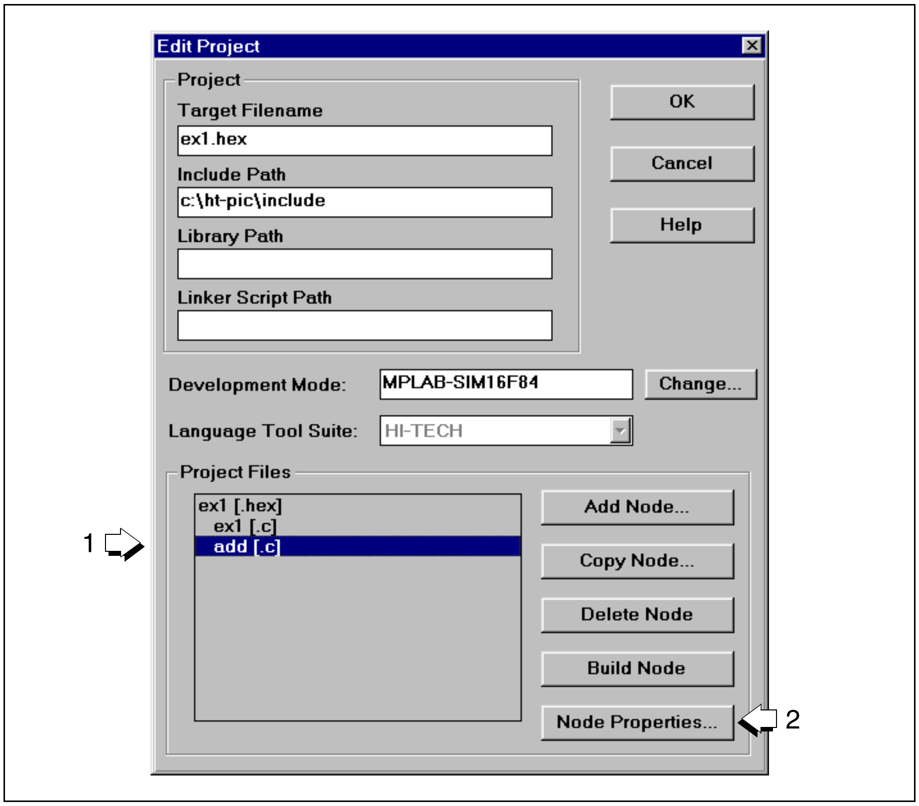
List files of type: Source files (*.c;*.as)

Drives: c: win98

Figure 4.11: Copy Node Dialog – add.c

In the Edit Project dialog;

1. Click on `add [.c]`.
2. Click **Node Properties** to edit the copied properties from `ex1 [.c]`.



Target Filename: ex1.hex

Include Path: c:\ht-pic\include

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: HI-TECH

ex1 [.hex]
ex1 [.c]
add [.c]

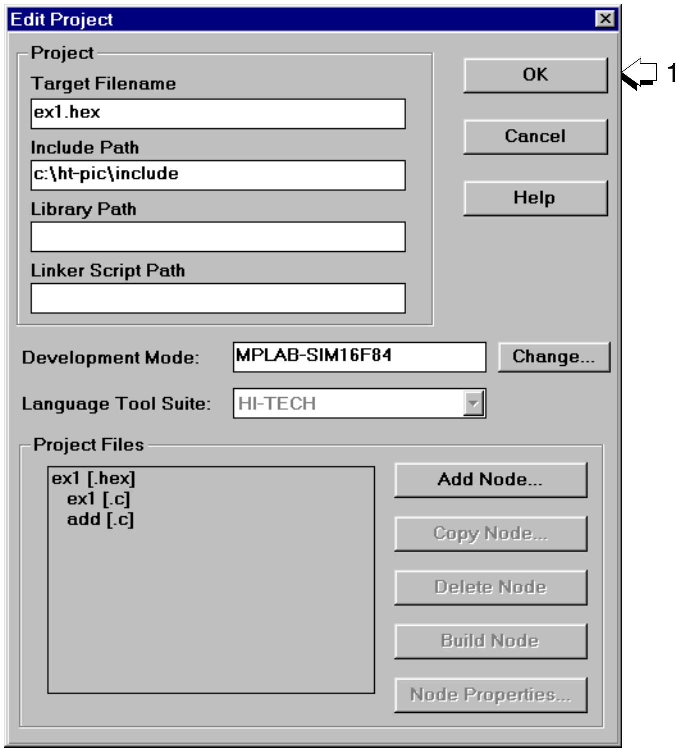
Figure 4.12: Edit Project Dialog – add.c

In the Node Properties dialog under Options, change the Error File name in the Date column to `add.err`. Click **OK** when done.

## 4.12 Finish Editing Project

To finish editing the project;

1. Click **OK** to close the Edit Project dialog.



Edit Project

Project

Target Filename: ex1.hex

Include Path: c:\ht-pic\include

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: HI-TECH

Project Files

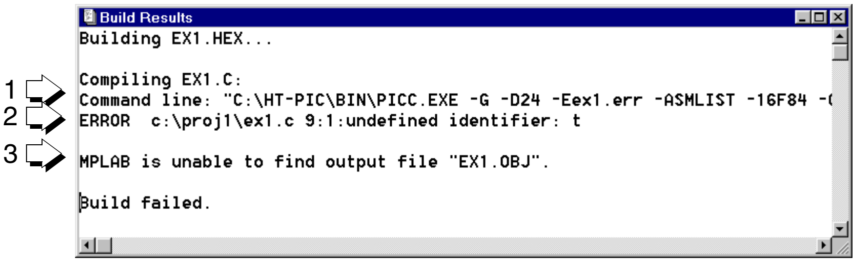
```
ex1 [.hex]
  ex1 [.c]
  add [.c]
```

**Figure 4.13: Edit Project Dialog – Final**

## 4.13 Debug and Build Project

Select *Project > Make Project* from the menu to compile the application using the HI-TECH compiler. A Build Results window is created that shows;

1. The command line sent to the compiler, along with other information specified in Node Properties
2. Compilation errors
3. A compiler error will cause the build to fail, meaning an object file is not generated, and therefore MPLAB IDE will be unable to find this file.



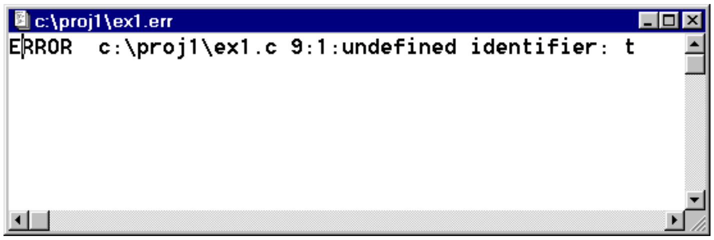
```
Building EX1.HEX...

Compiling EX1.C:
Command line: "C:\HT-PIC\BIN\PICC.EXE -G -D24 -Eex1.err -ASMLIST -16F84 -(
ERROR  c:\proj1\ex1.c 9:1:undefined identifier: t

MPLAB is unable to find output file "EX1.OBJ".

Build failed.
```

**Figure 4.14: Build Results Window – Build Failed**

If you have a build error, double-click on the error in the Build Results window to send you to the line in the source file that contains that error. If the source code file is not open, MPLAB IDE will open the file and then go to the line containing the error.

Alternatively, you can click on the error in the error file to accomplish the same result. By selecting Error File in the Node Properties dialog, an error file is created with the name given in the Data field.

To open the error file, select *File > Open* and then choose All Files (*.*) from the List of file types. Choose the `.err` file and click **OK**.

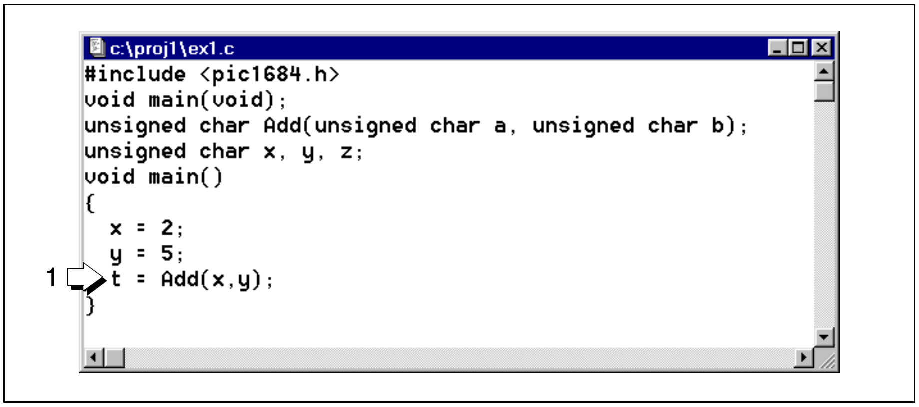


```
ERROR  c:\proj1\ex1.c 9:1:undefined identifier: t
```

**Figure 4.15: Assembler List File Window – ex1.err**

Now you will fix the error in the source code.

1. Change the "t" to a "z"

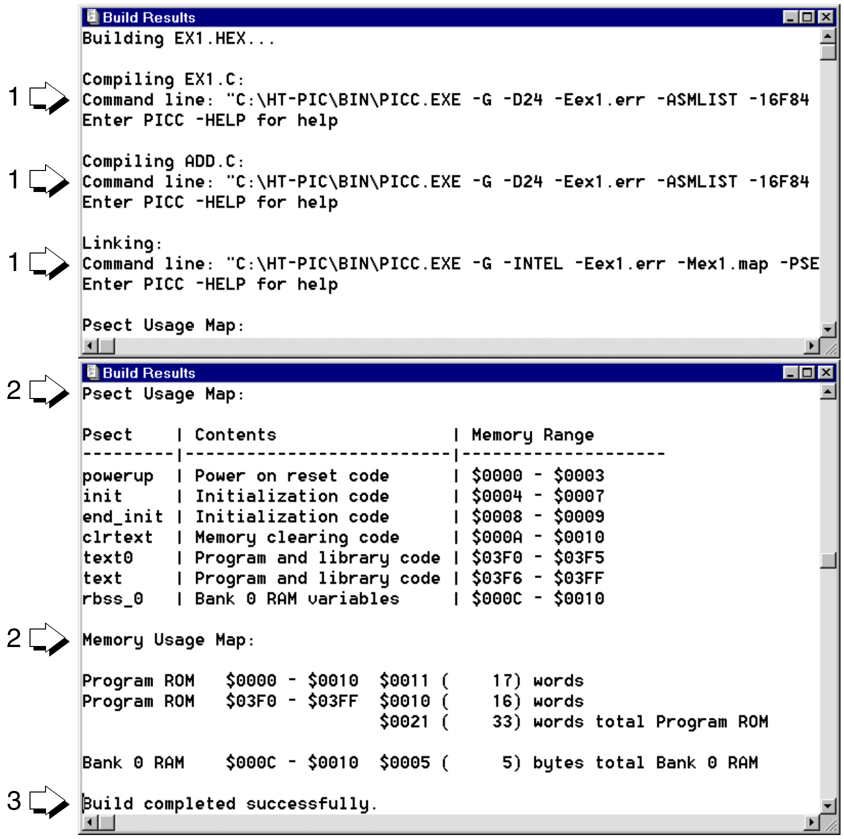


```
#include <pic1684.h>
void main(void);
unsigned char Add(unsigned char a, unsigned char b);
unsigned char x, y, z;
void main()
{
  x = 2;
  y = 5;
  t = Add(x,y);
}
```

**Figure 4.16: Source Code with Error**

Select *File > Save* (This step is just good practice, but not necessary, as MPLAB IDE will save the file when doing a build.) Now build the project again by selecting *Project > Make Project*. The Build Results window should now look different.

1. The command line sent to each tool displayed, along with other information specified in Node Properties.
2. By selecting Display Complete Memory Usage in the target Node Properties dialog, Psect (Section) Usage Map and the Memory Usage Map are shown in the Build Results window. These usage maps display complete memory segment usage after linking.
3. Build was successful.



```
Building EX1.HEX...

Compiling EX1.C:
Command line: "C:\HT-PIC\BIN\PICC.EXE -G -D24 -Eex1.err -ASMLIST -16F84
Enter PICC -HELP for help

Compiling ADD.C:
Command line: "C:\HT-PIC\BIN\PICC.EXE -G -D24 -Eex1.err -ASMLIST -16F84
Enter PICC -HELP for help

Linking:
Command line: "C:\HT-PIC\BIN\PICC.EXE -G -INTEL -Eex1.err -Mex1.map -PSE
Enter PICC -HELP for help

Psect Usage Map:
```

```
Psect Usage Map:

Psect    | Contents                 | Memory Range
---------|--------------------------|--------------------
powerup  | Power on reset code      | $0000 - $0003
init     | Initialization code      | $0004 - $0007
end_init | Initialization code      | $0008 - $0009
clrtext  | Memory clearing code     | $000A - $0010
text0    | Program and library code | $03F0 - $03F5
text     | Program and library code | $03F6 - $03FF
rbss_0   | Bank 0 RAM variables     | $000C - $0010

Memory Usage Map:

Program ROM   $0000 - $0010  $0011 (    17) words
Program ROM   $03F0 - $03FF  $0010 (    16) words
                             $0021 (    33) words total Program ROM

Bank 0 RAM    $000C - $0010  $0005 (     5) bytes total Bank 0 RAM

Build completed successfully.
```

**Figure 4.17: Build Results Window – Build Successful (2 Views)**

# 4.14 More Project Information

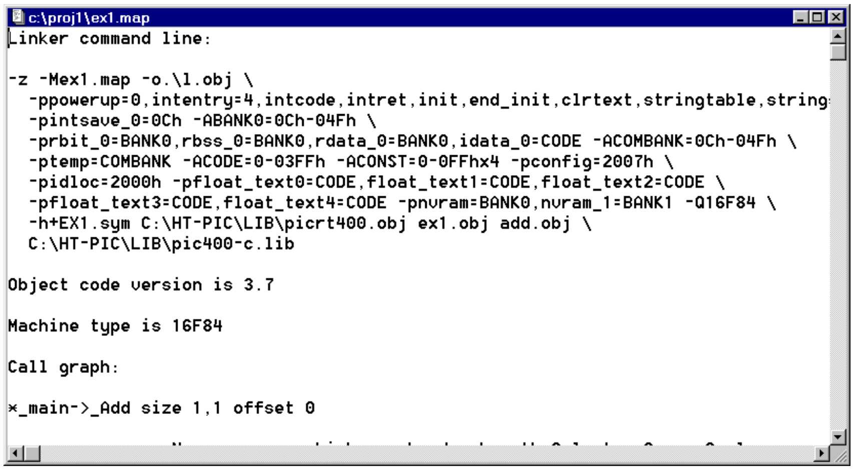
The source code in this tutorial only had one error. However, real untested code would most likely need to be debugged more extensively. This is where the options that you set in Node Properties will help out.

## 4.14.1 Debug Information

By selecting Generate Debug Info in the Node Properties dialog, the MPLAB IDE has information necessary to help you debug your code.

## 4.14.2 Map File

By selecting Map File in the Node Properties dialog, a map file is created with the name given in the Data field. To open the map file, select *Window > Map File* (Figure 4.18). For information on the content of the map file, please refer to HI-TECH documentation.

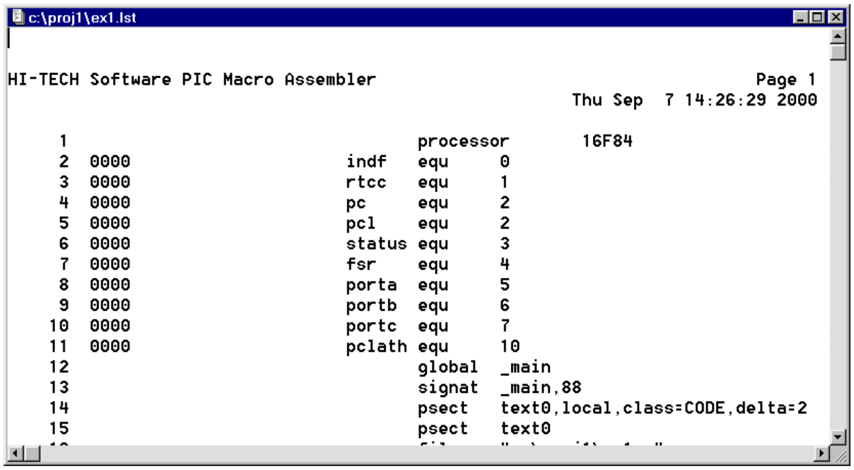


```
Linker command line:

-z -Mex1.map -o.\l.obj \
  -ppowerup=0,intentry=4,intcode,intret,init,end_init,clrtext,stringtable,string
  -pintsave_0=0Ch -ABANK0=0Ch-04Fh \
  -prbit_0=BANK0,rbss_0=BANK0,rdata_0=BANK0,idata_0=CODE -ACOMBANK=0Ch-04Fh \
  -ptemp=COMBANK -ACODE=0-03FFh -ACONST=0-0FFhx4 -pconfig=2007h \
  -pidloc=2000h -pfloat_text0=CODE,float_text1=CODE,float_text2=CODE \
  -pfloat_text3=CODE,float_text4=CODE -pnvram=BANK0,nvram_1=BANK1 -Q16F84 \
  -h+EX1.sym C:\HT-PIC\LIB\picrt400.obj ex1.obj add.obj \
  C:\HT-PIC\LIB\pic400-c.lib

Object code version is 3.7

Machine type is 16F84

Call graph:

*_main->_Add size 1,1 offset 0
```

**Figure 4.18: Map File Window – ex1.map**

## 4.14.3 Absolute Listing

By selecting Assembler List File in the Node Properties dialog, an absolute listing file is generated. The list file shows both the original C code, the generated assembler code and the corresponding binary code.



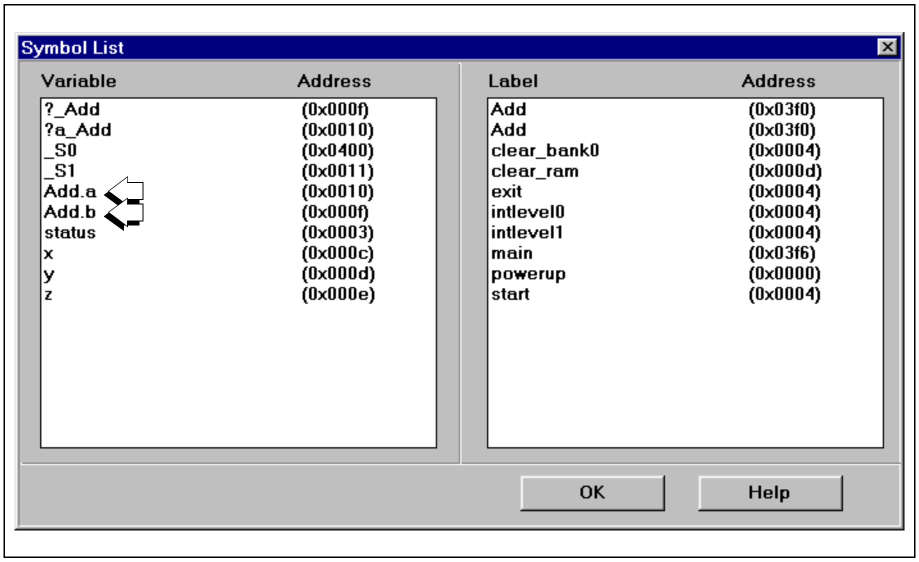
```
HI-TECH Software PIC Macro Assembler                               Page 1
                                                      Thu Sep  7 14:26:29 2000

                                   processor       16F84
        0000                indf   equ     0
        0000                rtcc   equ     1
        0000                pc     equ     2
        0000                pcl    equ     2
        0000                status equ     3
        0000                fsr    equ     4
        0000                porta  equ     5
        0000                portb  equ     6
        0000                portc  equ     7
        0000                pclath equ     10
                                   global  _main
                                   signat  _main,88
                                   psect   text0,local,class=CODE,delta=2
                                   psect   text0
```

**Figure 4.19: Assembler List File Window – ex1.lst**

### 4.14.4 Symbol List

By setting `-FAKELOCAL` under Additional Command Line Options in the Node Properties dialog, local `auto` variables will appear and have a value when single stepping inside the function.

Open the Symbol List by selecting *Window > Show Symbol List*. Scroll through the variable list to make sure any local variables in your code are listed.



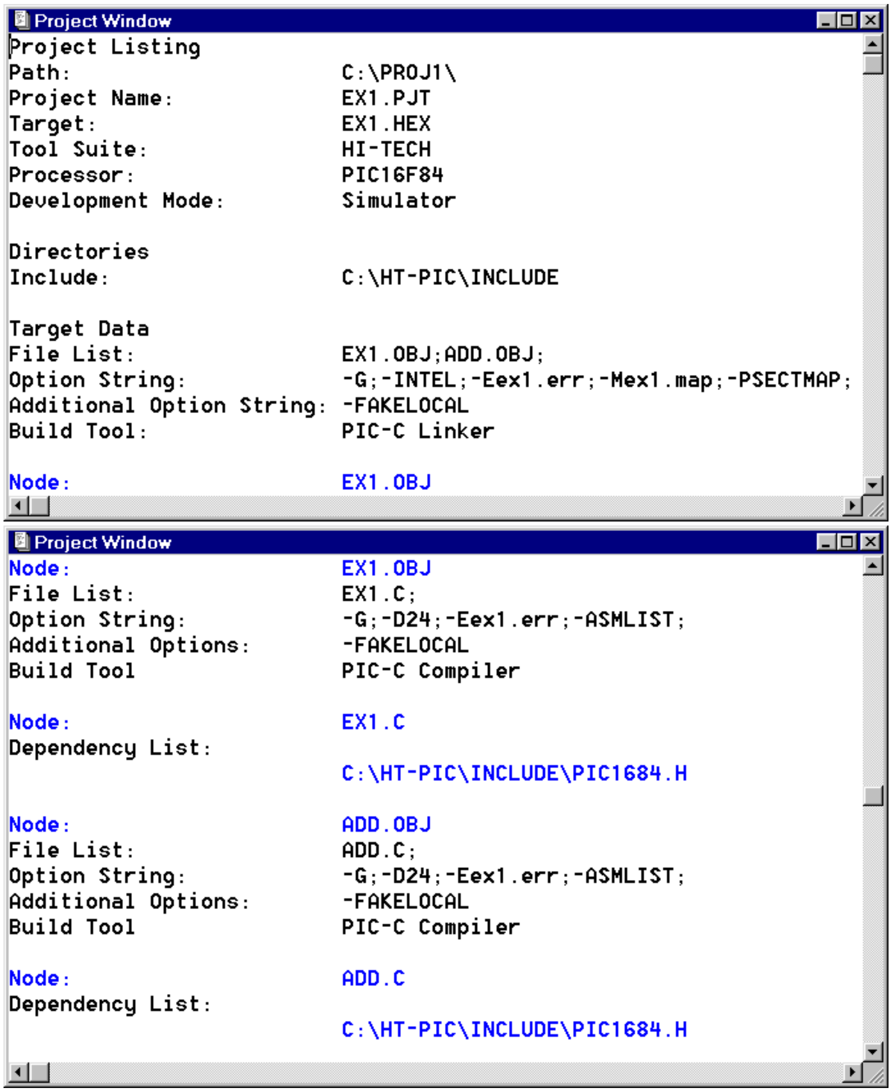
| Variable | Address |
|---|---|
| ?_Add | (0x000f) |
| ?a_Add | (0x0010) |
| _S0 | (0x0400) |
| _S1 | (0x0011) |
| Add.a | (0x0010) |
| Add.b | (0x000f) |
| status | (0x0003) |
| x | (0x000c) |
| y | (0x000d) |
| z | (0x000e) |

| Label | Address |
|---|---|
| Add | (0x03f0) |
| Add | (0x03f0) |
| clear_bank0 | (0x0004) |
| clear_ram | (0x000d) |
| exit | (0x0004) |
| intlevel0 | (0x0004) |
| intlevel1 | (0x0004) |
| main | (0x03f6) |
| powerup | (0x0000) |
| start | (0x0004) |

**Figure 4.20: Symbol List Window**

### 4.14.5 Project Window

Open the *Window > Project* window. This displays various project information, which can be useful to review when debugging.



```
Project Listing
Path:                        C:\PROJ1\
Project Name:                EX1.PJT
Target:                      EX1.HEX
Tool Suite:                  HI-TECH
Processor:                   PIC16F84
Development Mode:            Simulator

Directories
Include:                     C:\HT-PIC\INCLUDE

Target Data
File List:                   EX1.OBJ;ADD.OBJ;
Option String:               -G;-INTEL;-Eex1.err;-Mex1.map;-PSECTMAP;
Additional Option String:    -FAKELOCAL
Build Tool:                  PIC-C Linker

Node:                        EX1.OBJ
```

```
Node:                        EX1.OBJ
File List:                   EX1.C;
Option String:               -G;-D24;-Eex1.err;-ASMLIST;
Additional Options:          -FAKELOCAL
Build Tool                   PIC-C Compiler

Node:                        EX1.C
Dependency List:
                             C:\HT-PIC\INCLUDE\PIC1684.H

Node:                        ADD.OBJ
File List:                   ADD.C;
Option String:               -G;-D24;-Eex1.err;-ASMLIST;
Additional Options:          -FAKELOCAL
Build Tool                   PIC-C Compiler

Node:                        ADD.C
Dependency List:
                             C:\HT-PIC\INCLUDE\PIC1684.H
```

**Figure 4.21: Project Window – ex1.pjt (2 Views)**

Double-clicking on any of the blue file names, you can open these files in the MPLAB IDE. This is ideal for opening files that are not in the project directory (e.g., header .h files), and therefore would require hunting through directory structures to find otherwise.

## 4.15 Optimization and Other Node Properties

For more information on optimization techniques, (e.g., Local and Global Optimization switches, as well as definitions of other Node Properties switches), please refer to HI-TECH documentation.

# Chapter 5. Project Overview - IAR Tools

## 5.1 Introduction

This chapter gives an overview of using projects in MPLAB IDE with the IAR tools. Chapter 6 discusses in detail how to make single source file or multiple source file MPLAB IDE project with IAR tools.

## 5.2 Highlights

This chapter discusses:

- Overview of Projects with IAR Tools
- Preliminary Setup of MPLAB IDE with IAR Tools

The next chapter discusses:

- MPLAB IDE Project using IAR Tools

## 5.3 Overview of Projects with IAR Tools

IAR tools may be used with MPLAB IDE running under Windows® 95/98 or Windows NT® 3.51 or greater. Executables that provide an interface between the IAR tools and the MPLAB IDE are `iari.exe` (compiler), `iarl.exe` (linker), and `iara.exe` (assembler). The relationship between the "wrapper" executables and actual tool executables are shown below.

| Tool Name | Tool Executable | Wrapper Executable |
|---|---|---|
| PICmicro® C Compiler | `iccpic.exe` | `iari.exe` |
| PICmicro® Assembler | `apic.exe` | `iara.exe` |
| IAR Linker | `xlink.exe` | `iarl.exe` |

IAR tools are one group of several third party language tools that work with MPLAB IDE. These tools may be used as part of an MPLAB IDE Project. A project in MPLAB IDE is a group of files needed to build an application, along with their associations to various build tools. See the *MPLAB IDE, Simulator, Editer User's Guide* (DS51025) for more information on MPLAB IDE and MPLAB IDE Projects.

Figure 5.1 shows a generic MPLAB IDE Project using the IAR tools.

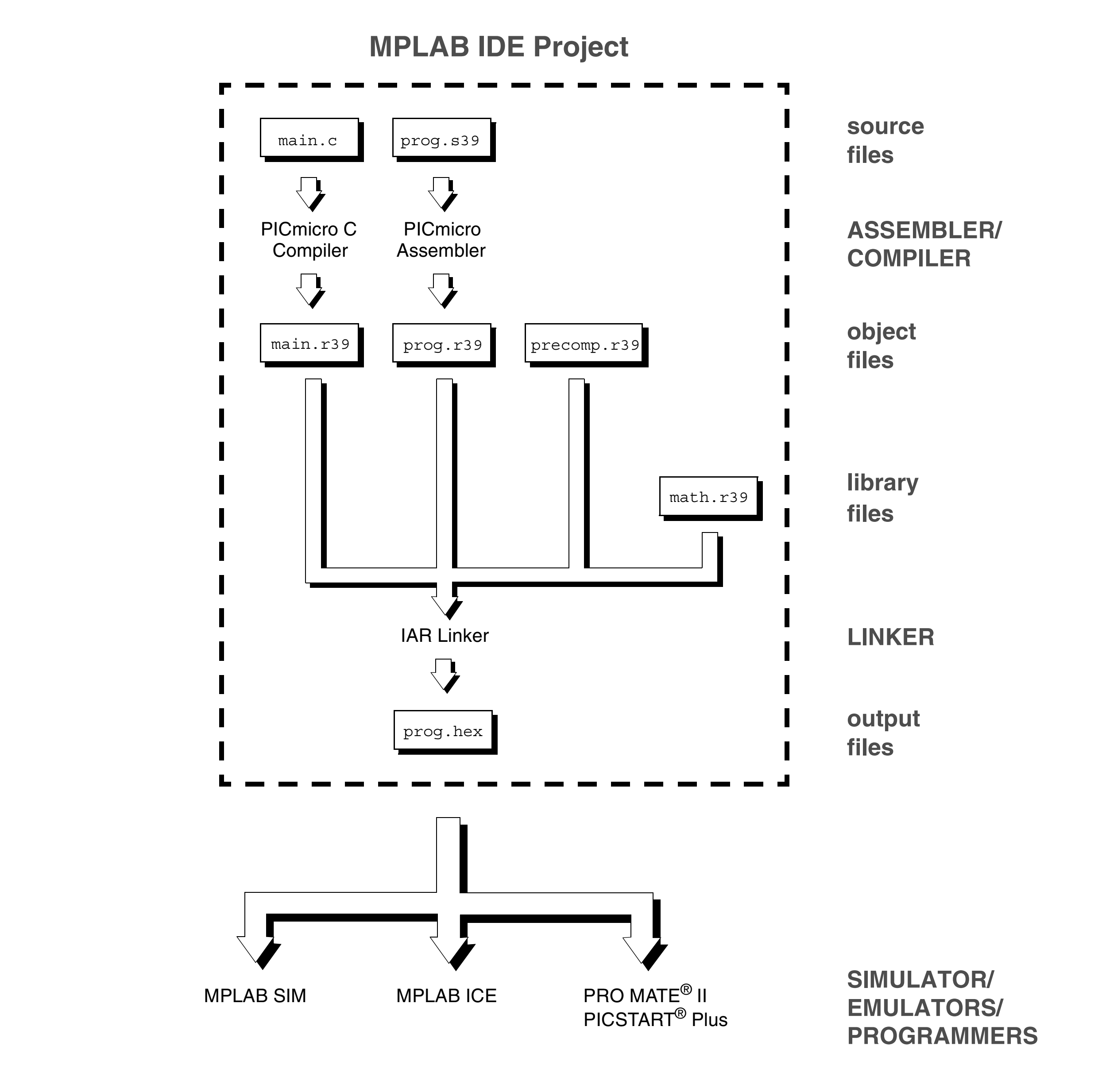


**Figure 5.1: Project Relationships**

In this MPLAB IDE Project, the C source file `main.c` is associated with the PICmicro C Compiler. MPLAB IDE will use this information to generate an object file (`main.r39`) for input into the linker (IAR Linker).

An assembly source file (`prog.s39`) is shown also with its associated assembler (PICmicro Assembler). MPLAB IDE will use this information to generate the object file `prog.r39` for input into the linker.

In addition, precompiled object files (`precomp.r39`) may be included in a project, with no associated tool required.

Standard library files are available with the compiler, located in the `lib` subdirectory. Others (`math.r39`) may be built outside the project using the librarian tool, XLIB (`xlib.exe`). See IAR documentation for more information on using the librarian.

The object files, along with library files, are used to generate the project output files via the linker.

The main output file generated by the linker is the **HEX file** (`prog.hex`), used by simulators (MPLAB SIM), emulators (MPLAB ICE) and programmers (PRO MATE II and PICSTART Plus).

For more information on using IAR tools, please see the documentation you received with your tools or visit IAR's website (http://www.iar.com).

## 5.4 Preliminary Setup of MPLAB IDE with IAR Tools

In order to use IAR tools with MPLAB IDE you must:

- Install MPLAB IDE. The latest version of this free software is available at our Web site (http://www.microchip.com) or from any sales office (back cover).
- Install IAR tools. Consult the IAR documentation on how to install these tools. Once you have installed the software, you may also need to install a hardware dongle for the tools to operate. Again, consult IAR documentation for more details.

No matter what type of project you choose to use (single file or multiple file), you will need to set up MPLAB IDE first as follows:

- Setup Path - Show path to setup directory for Windows 95/98/NT 3.51, Windows NT 4.0 or Windows 2000. This directory contains processor definition files `*.i39`.
- Install IAR Language Tools - Install the IAR tools so that MPLAB IDE can use them.

### 5.4.1 Setup Path - Windows 95/98/NT 3.51

In your `autoexec.bat` file, set the environment variable `QPICINFO` to point to the setup directory of the IAR installation. By default this would be:

```
SET QPICINFO=C:\IAR\EW23\PICMICRO\SETUP\
```

where the ending backslash is required.

> **Note:** You will have to reboot your PC for this change to take affect.

### 5.4.2 Setup Path - Windows NT 4.0

Right-click on the My Computer icon on your desktop and select Properties from the pop-up menu. The Systems Properties dialog will appear. Click on the Environment tab. To enter a new variable, click in the Variable box and type the name of a new variable. Then click in the Value box and enter the value.

Enter the following new variable:

1. Variable: `QPICINFO`

   Value: `C:\IAR\EW23\PICMICRO\SETUP\`

   where Value is the setup path and the ending backslash is required.

When done, click **OK**.

### 5.4.3 Setup Path - Windows 2000

Right-click on the My Computer icon on your desktop and select Properties from the pop-up menu. The Systems Properties dialog will appear. Click on the Advanced tab. Under User Variables, click **New**. The New User Variables dialog appears. To enter a new variable, click in the Variable Name box and type the name of a new variable. Then click in the Variable Value box and enter the value.

Enter the following new variable:

1. Variable Name: `QPICINFO`

   Variable Value: `C:\IAR\EW23\PICMICRO\SETUP\`

   where Variable Value is the setup path and the ending backslash is required.

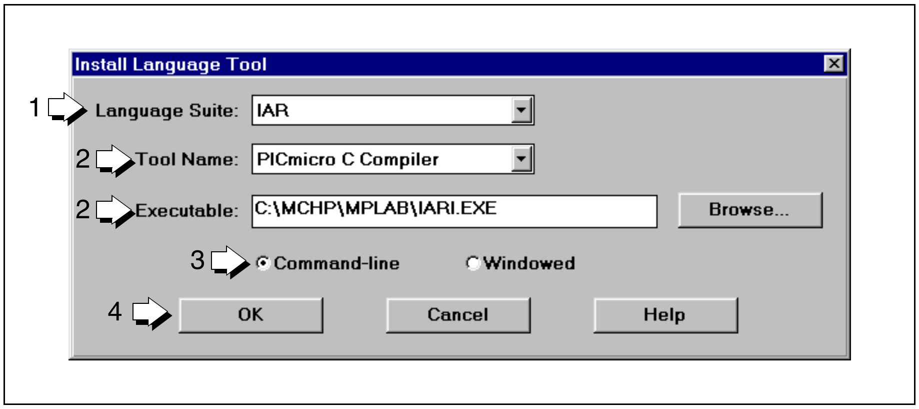
When done, click **OK** in each dialog.

### 5.4.4 Install IAR Language Tools

Start up MPLAB IDE. Select *Project > Install Language Tool*. The Install Language Tool dialog will appear.

1. Select IAR as the Language Suite.
2. Check to see that each Tool Name has an associated Executable. If not, select the Executable for the compiler, linker and assembler tool as shown in the following figures (your executable path may be different.)

   Currently, the executables `iari.exe`, `iarl.exe` and `iara.exe` may be found in the MPLAB IDE install directory. They should soon be in the default IAR install subdirectory of `c:\iar\Ew23\PICmicro\bin`. Use the **Browse** button to locate each executable on your system.
3. The Command-line option should be selected for all tools.
4. When done, click **OK**.



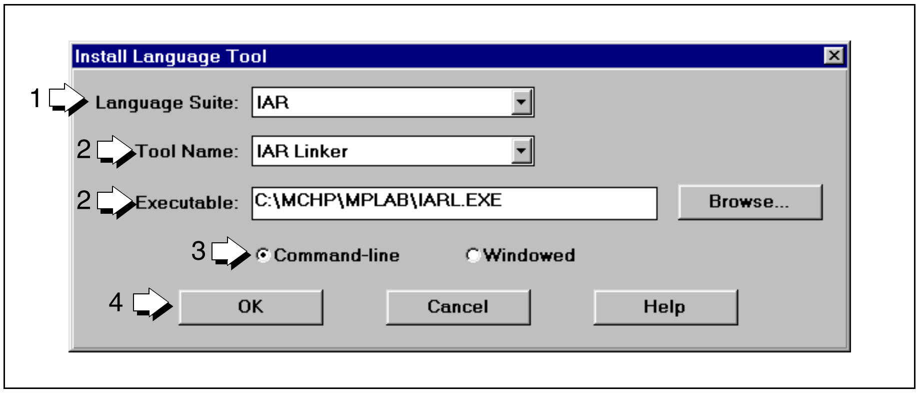
Language Suite: IAR

Tool Name: PICmicro C Compiler

Executable: C:\MCHP\MPLAB\IARI.EXE

● Command-line ○ Windowed

**Figure 5.2: Install Language Tool Dialog – PICmicro C Compiler**



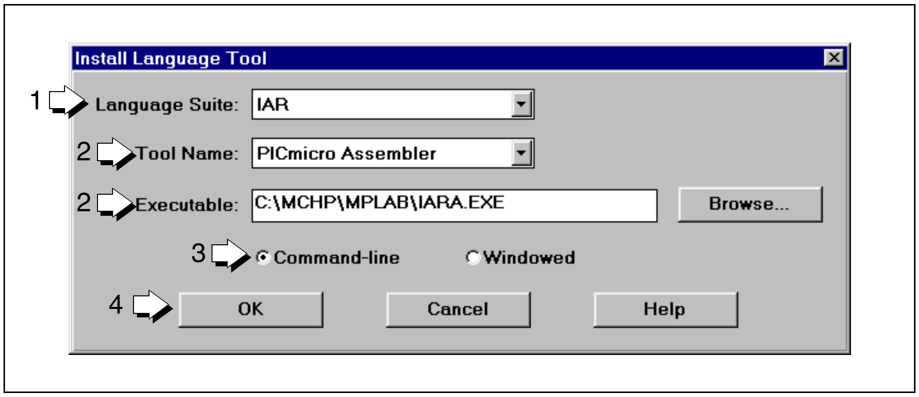
Language Suite: IAR

Tool Name: IAR Linker

Executable: C:\MCHP\MPLAB\IARL.EXE

● Command-line ○ Windowed

**Figure 5.3: Install Language Tool Dialog – IAR Linker**



Install Language Tool

1 Language Suite: IAR

2 Tool Name: PICmicro Assembler

2 Executable: C:\MCHP\MPLAB\IARA.EXE

3 ● Command-line ○ Windowed

**Figure 5.4: Install Language Tool Dialog – PICmicro Assembler**

# Chapter 6. MPLAB IDE Project using IAR Tools

## 6.1 Introduction

This chapter will guide you, step by step, in making an MPLAB IDE Project with several source files using IAR tools. A single source file project is created in much the same way, only using one source file instead of the two shown here.

## 6.2 Highlights

In this tutorial, you will learn how to:

- Create the source files
- Set the MPLAB IDE development mode
- Create a new project
- Set project Node Properties
- Add the source files and set Node Properties
- Debug and build the project

## 6.3 Overview of MPLAB IDE Project

Figure 6.1 gives a graphical overview of the MPLAB IDE Project using IAR. The source files `ex1.c` and `add.c` are associated with the compiler to produce the object files `ex1.r39` and `add.r39`. These files are used by the linker to produce the main output file, `ex1.hex`.

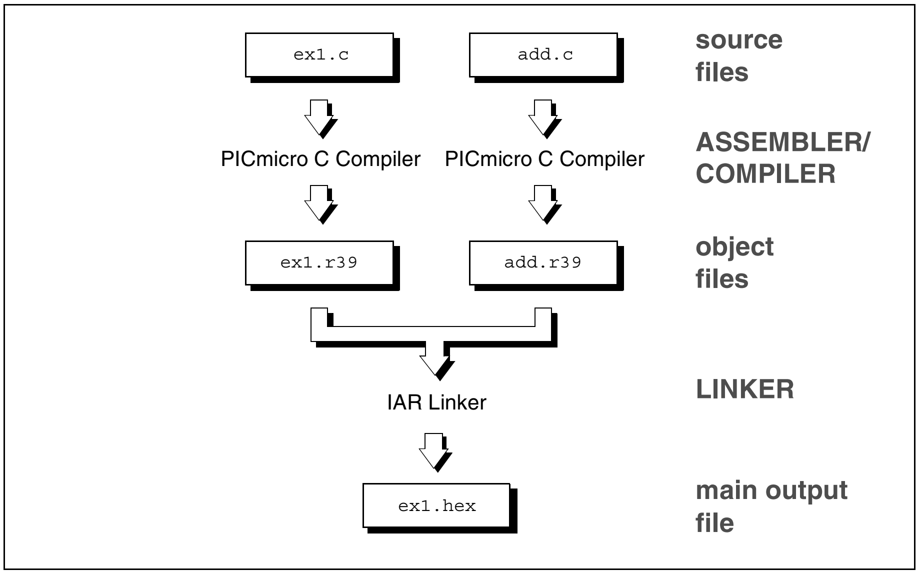


**Figure 6.1: Project Relationships For IAR Source Files**

## 6.4 Create Source Files

Select *File > New* to open a blank editor window. The Create Project dialog will open also. Click **No** in the dialog for now.

Type the following into the window and save it as `ex1.c` in a directory called, for example, `c:\proj1`. This is a very simple program that adds two numbers.

> **Note:** An error is contained in the code. Do not fix it yet.

```
#include <io16f84.h>
void main(void);
unsigned char Add(unsigned char a, unsigned char b);
unsigned char x, y, z;
void main()
{
 x = 2;
 y = 5;
 t = Add(x,y);
}
```

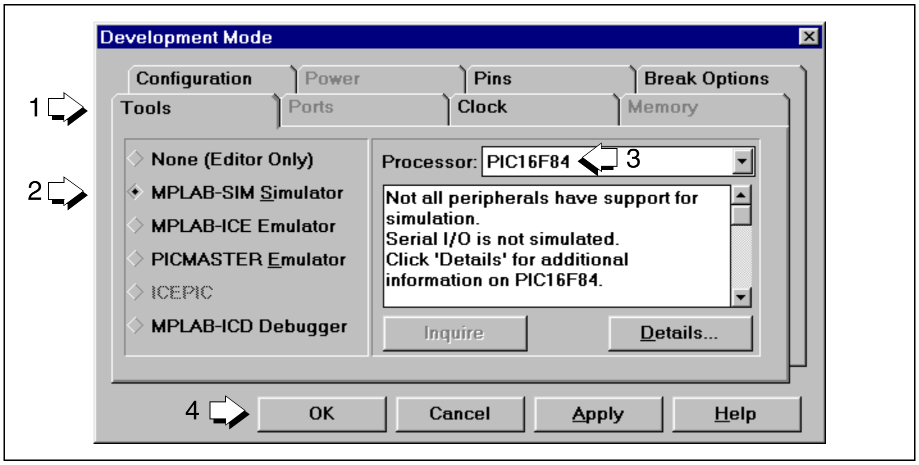
Again select *File > New* to open a blank editor window. Select **No** in the Create Project dialog. Type the following into the window and save it as `add.c` in the same directory as the file above.

```
#include <io16f84.h>
unsigned char Add(unsigned char a, unsigned char b)
{ return a+b; }
```

## 6.5 Set Development Mode

Select *Options > Development Mode* to open the Development Mode dialog.

1. Click the **Tools** tab.
2. Select MPLAB SIM simulator
3. Select the PIC16F84 PICmicro® MCU for this example.
4. Click **OK**.



Processor: PIC16F84

Not all peripherals have support for simulation.
Serial I/O is not simulated.
Click 'Details' for additional information on PIC16F84.

**Figure 6.2: Development Mode Dialog – MPLAB SIM, PIC16F84**

## 6.6 Create New Project

Select *Project > New Project* to open the New Project dialog.

1. Select `c:\proj1` as the directory for a new project.
2. Name the project `ex1.PJT`.
3. Click **OK**.

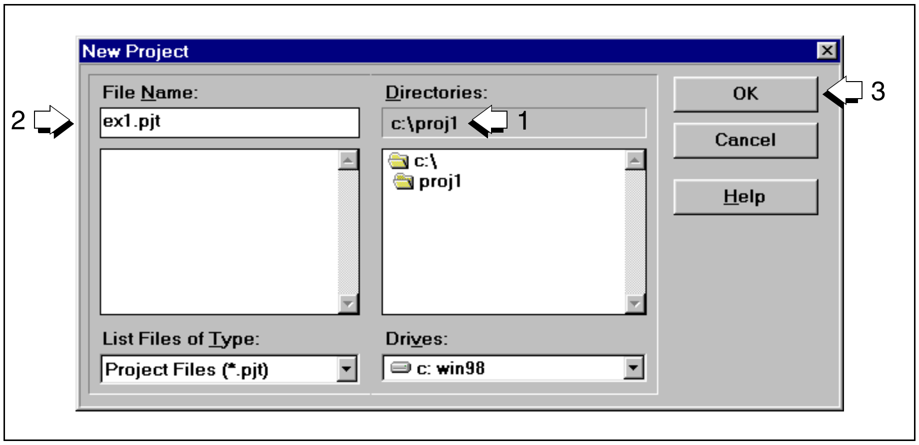
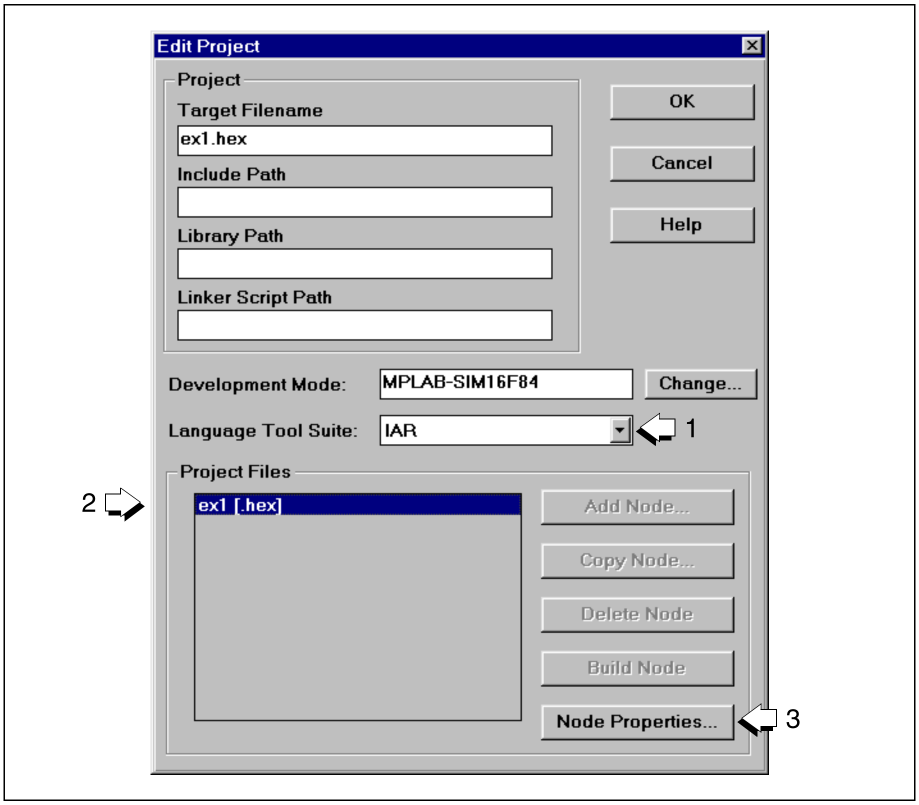


**Figure 6.3: New Project Dialog – ex1.pjt**

## 6.7 Edit Project

The Edit Project dialog is shown in Figure 6.4.

1. Select IAR as the Language Tool Suite. The Change Suite Warning dialog will open. Click **OK**.
2. In the Project Files section, click on `ex1 [.hex]` to highlight the HEX file name and activate the **Node Properties** button.
3. Click on **Node Properties**.



Target Filename: ex1.hex

Include Path:

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: IAR

Project Files: ex1 [.hex]

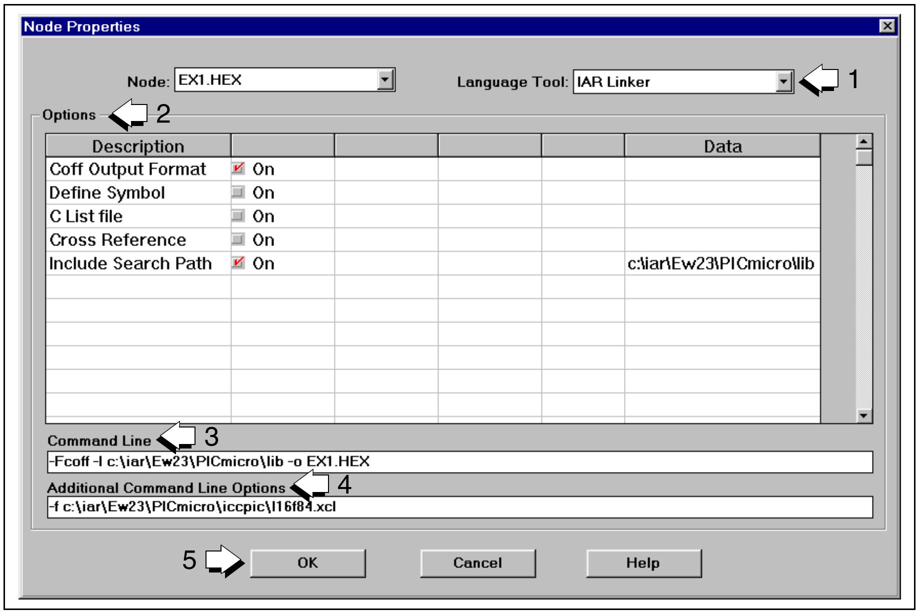
**Figure 6.4: Edit Project Dialog – ex1.hex**

## 6.8 Set Node Properties for Target Node

The Node Properties dialog should now be open.

1. Set the Language Tool to **IAR Linker**.
2. The command line switches for the selected language tool are shown descriptively in Options. When you first open this dialog, the checked boxes represent the default values for the tool. For more information on each option, consult IAR documentation.

   For this tutorial, several settings need to be changed, as shown in Figure 6.5 and described below.



Node: EX1.HEX

Language Tool: IAR Linker

Options

| Description | | | | | Data |
|---|---|---|---|---|---|
| Coff Output Format | ☑ On | | | | |
| Define Symbol | □ On | | | | |
| C List file | □ On | | | | |
| Cross Reference | □ On | | | | |
| Include Search Path | ☑ On | | | | c:\iar\Ew23\PICmicro\lib |

Command Line

-Fcoff -I c:\iar\Ew23\PICmicro\lib -o EX1.HEX

Additional Command Line Options

-f c:\iar\Ew23\PICmicro\iccpic\l16f84.xcl

**Figure 6.5: Node Properties Dialog – ex1.hex**

Make the following changes in the Options section:

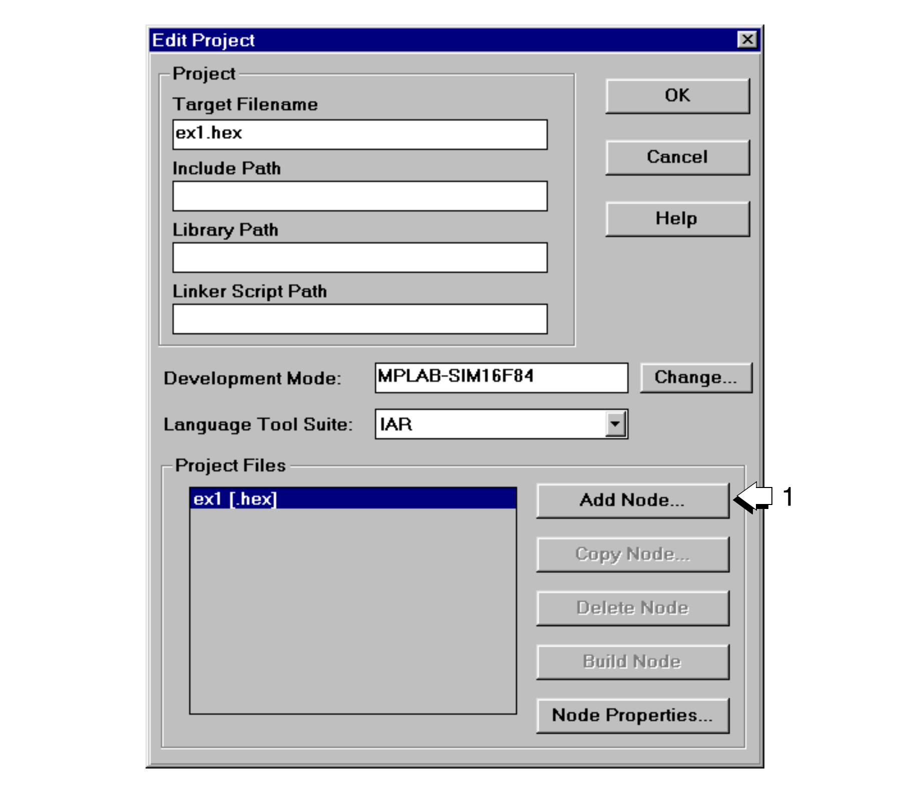
- Select COFF Output Format
- Select Include Search Path and add the following path to the Data column: `c:\iar\Ew23\PICmicro\lib`.

3. Command line switches are also shown in Command Line. Refer to the IAR documentation for more information on these switches.
4. Click in the text box for Additional Command Line Options and type `-f c:\iar\Ew23\PICmicro\iccpic\l16f84.xcl`.
5. Click **OK** to return to the Edit Project dialog.

## 6.9 Add First Source File

The **Add Node** button on the Edit Project dialog should now be active.

1. Click on it to open the Add Node dialog.



Edit Project

Project

Target Filename: ex1.hex

Include Path:

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

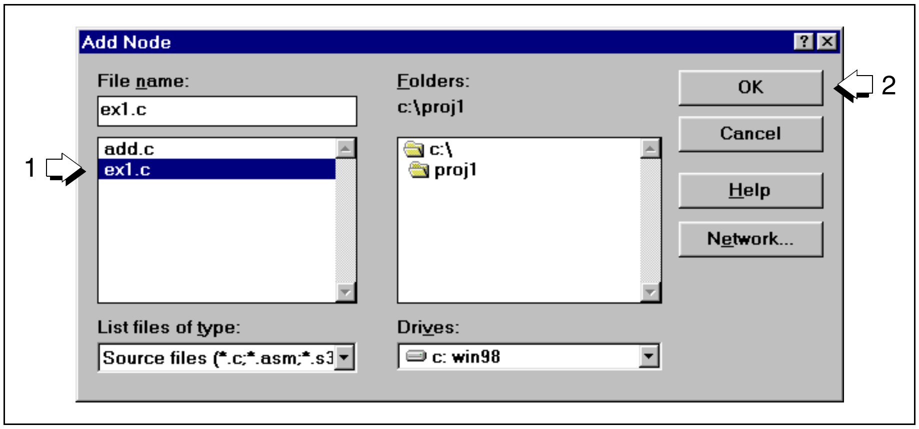
Language Tool Suite: IAR

Project Files: ex1 [.hex]

**Figure 6.6: Edit Project Dialog – Add Node**

In the Add Node dialog (Figure 6.7);

1. Add the source file, `ex1.c` from the `c:\proj1` directory
2. Click **OK** to return to the Edit Project dialog.



Add Node

File name: ex1.c

add.c
ex1.c

Folders: c:\proj1

c:\
proj1

List files of type: Source files (*.c;*.asm;*.s3

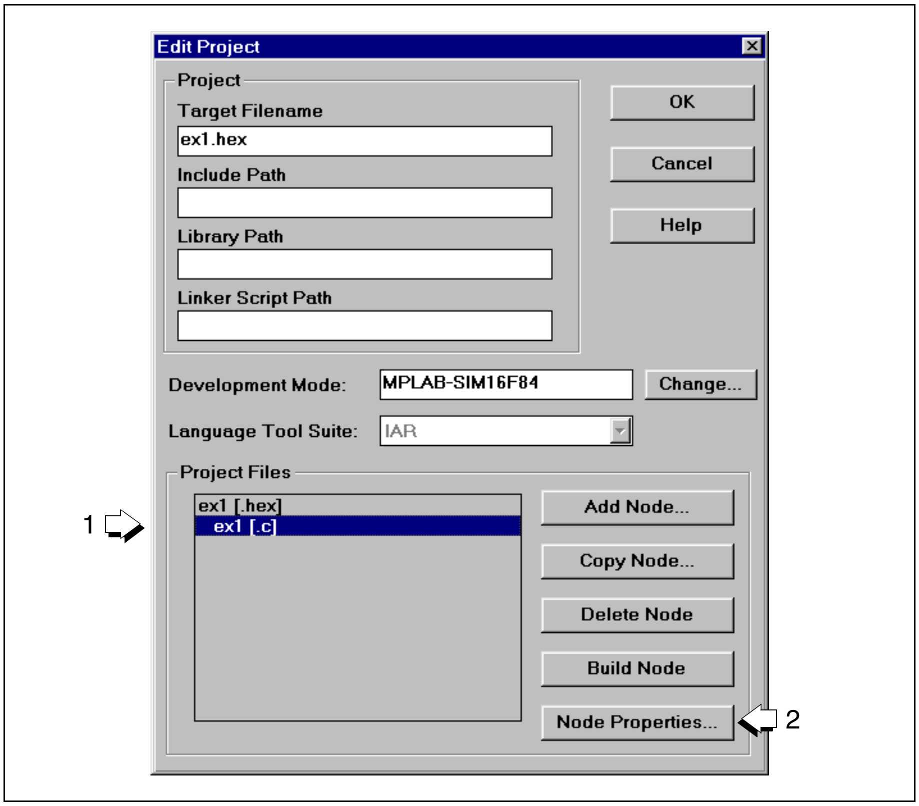
Drives: c: win98

**Figure 6.7: Add Node Dialog – ex1.c**

## 6.10 Set Node Properties for First Source Node

In the Edit Project dialog;

1. Click on the source file
2. Click on **Node Properties**.



Edit Project

Project

Target Filename: ex1.hex

Include Path:

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: IAR

Project Files

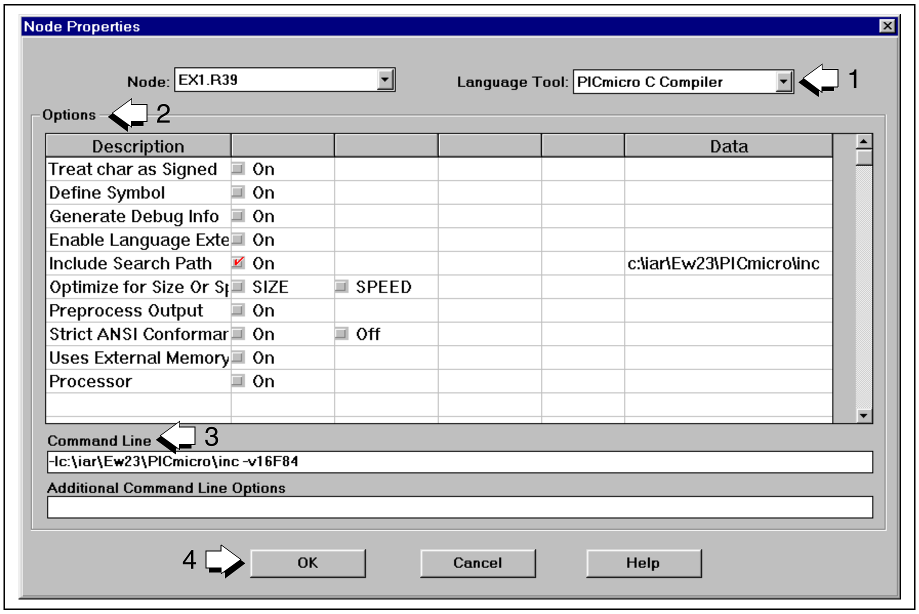
ex1 [.hex]
ex1 [.c]

**Figure 6.8: Edit Project Dialog – ex1.c**

The Node Properties dialog should now be open.

1. Set the Language Tool to **PICmicro C Compiler**.
2. The command line switches for the selected language tool are shown descriptively in Options. When you first open this dialog, the checked boxes represent the default values for the tool.

   For this tutorial, several settings need to be changed, as shown in Figure 6.5 and described below.



Node: EX1.R39

Language Tool: PICmicro C Compiler

Options

| Description | | | | | Data |
|---|---|---|---|---|---|
| Treat char as Signed | ☐ On | | | | |
| Define Symbol | ☐ On | | | | |
| Generate Debug Info | ☐ On | | | | |
| Enable Language Exte | ☐ On | | | | |
| Include Search Path | ☑ On | | | | c:\iar\Ew23\PICmicro\inc |
| Optimize for Size Or Sp | ☐ SIZE | ☐ SPEED | | | |
| Preprocess Output | ☐ On | | | | |
| Strict ANSI Conformar | ☐ On | ☐ Off | | | |
| Uses External Memory | ☐ On | | | | |
| Processor | ☐ On | | | | |

Command Line

-Ic:\iar\Ew23\PICmicro\inc -v16F84

Additional Command Line Options

**Figure 6.9: Node Properties Dialog – ex1.obj**

Make the following changes in the Options section:

- Select Include Search Path and add the following path to the Data column:

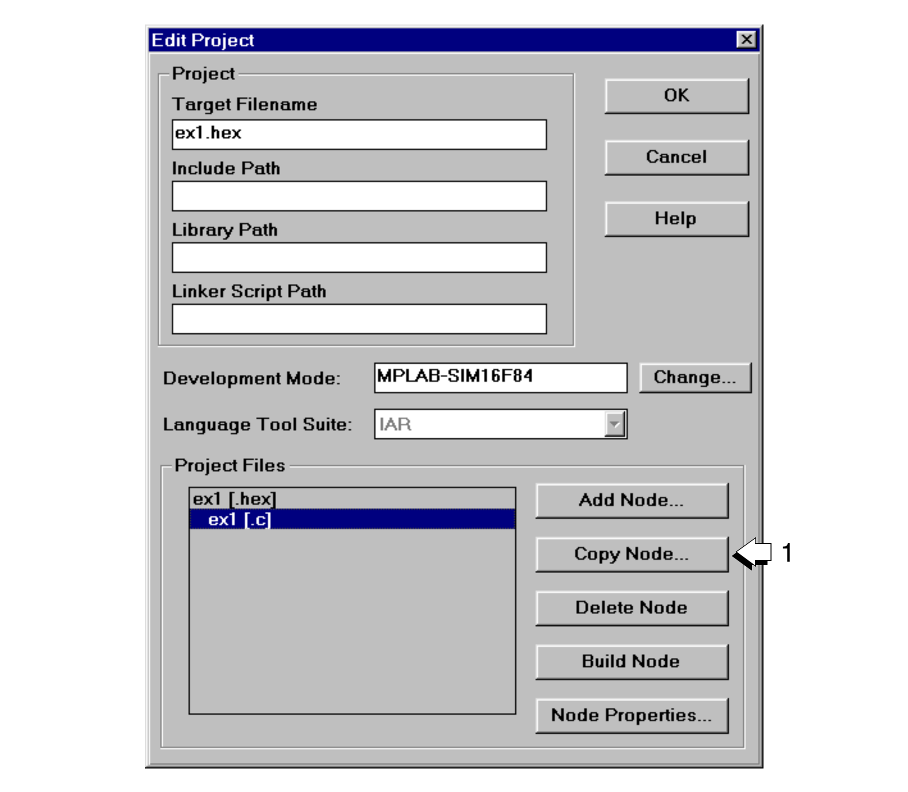
  `c:\iar\Ew23\PICmicro\inc`

3. Command line switches are also shown in Command Line. Refer to the IAR documentation for more information on these switches.
4. Click **OK** to return to the Edit Project dialog.

## 6.11 Add Second Source File

All node buttons on the Edit Project dialog should be active.

1. Click on **Copy Node** to open the Copy Node dialog.



Edit Project

Project

Target Filename: ex1.hex

Include Path:

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: IAR

Project Files

ex1 [.hex]
  ex1 [.c]

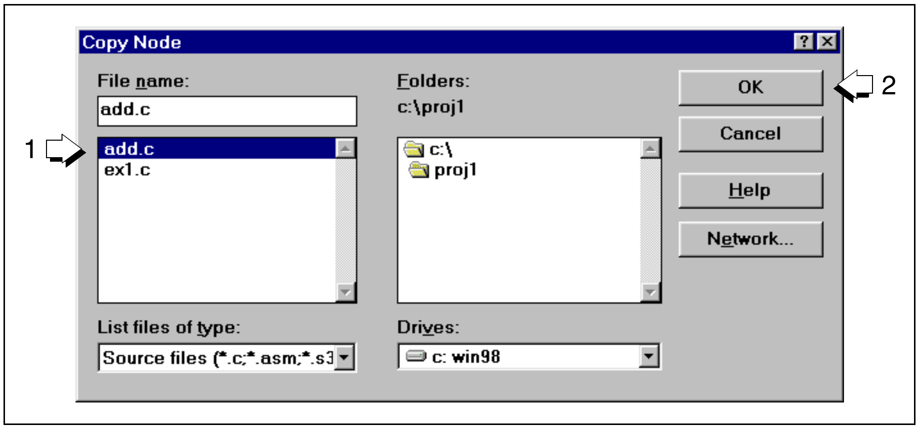
**Figure 6.10: Edit Project Dialog – Copy Node**

In the Copy Node dialog (Figure 6.7);

1. Click on the source file, `add.c` from the `c:\proj1` directory.

   This file will be added to the project, with its Node Properties copied from `ex1.c`.

2. Click **OK** to return to the Edit Project dialog.



Copy Node

File name: add.c

add.c
ex1.c

Folders: c:\proj1

c:\
proj1

List files of type: Source files (*.c;*.asm;*.s3

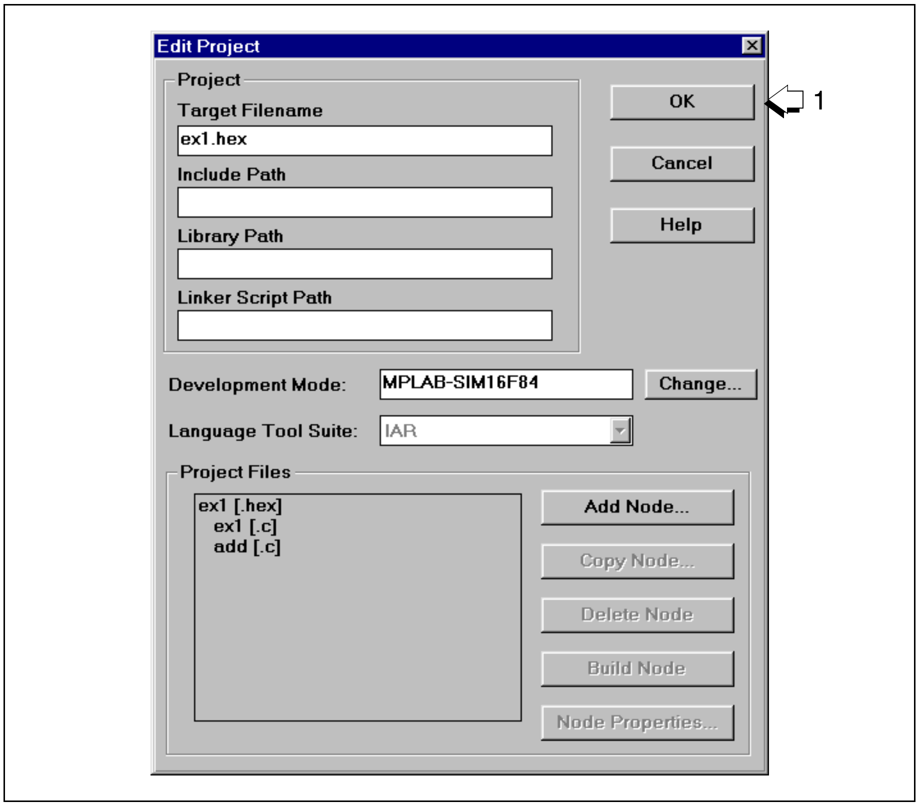
Drives: c: win98

Figure 6.11: Copy Node Dialog – add.c

## 6.12 Finish Editing Project

To finish editing the project;

1. Click **OK** to close the Edit Project dialog.



Edit Project

Project

Target Filename: ex1.hex

Include Path:

Library Path:

Linker Script Path:

Development Mode: MPLAB-SIM16F84

Language Tool Suite: IAR

Project Files

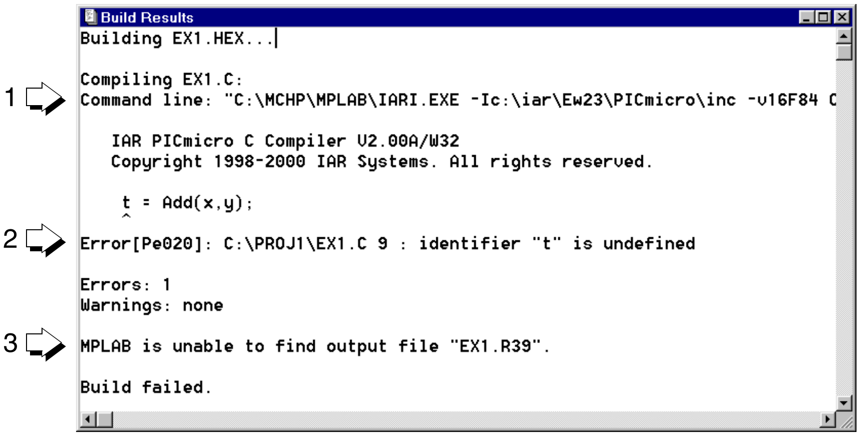
ex1 [.hex]
  ex1 [.c]
  add [.c]

Figure 6.12: Edit Project Dialog – Final

## 6.13 Debug and Build Project

Select *Project > Make Project* from the menu to compile the application using the IAR compiler. A Build Results window is created that shows;

1. The command line sent to the compiler, along with other information specified in Node Properties
2. Compilation errors
3. A compiler error will cause the build to fail, meaning an object file is not generated, and therefore MPLAB IDE will be unable to find this file.



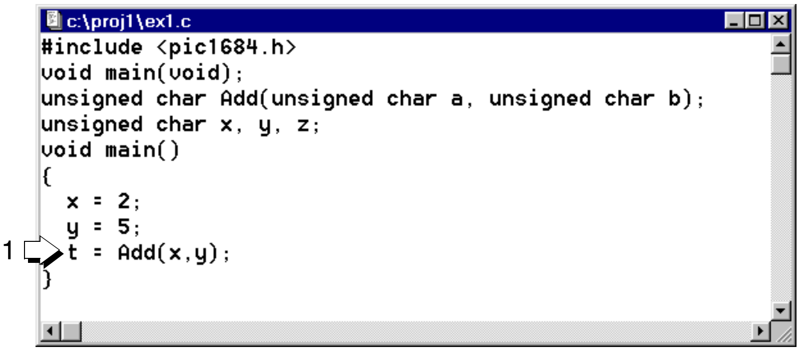
```
Building EX1.HEX...

Compiling EX1.C:
Command line: "C:\MCHP\MPLAB\IARI.EXE -Ic:\iar\Ew23\PICmicro\inc -v16F84 C

   IAR PICmicro C Compiler V2.00A/W32
   Copyright 1998-2000 IAR Systems. All rights reserved.

    t = Add(x,y);
    ^

Error[Pe020]: C:\PROJ1\EX1.C 9 : identifier "t" is undefined

Errors: 1
Warnings: none

MPLAB is unable to find output file "EX1.R39".

Build failed.
```

**Figure 6.13: Build Results Window – Build Failed**

If you have a build error, double-click on the error in the Build Results window to send you to the line in the source file that contains that error. If the source code file is not open, MPLAB IDE will open the file and then go to the line containing the error.

Now you will fix the error in the source code.

1. Change the "t" to a "z"

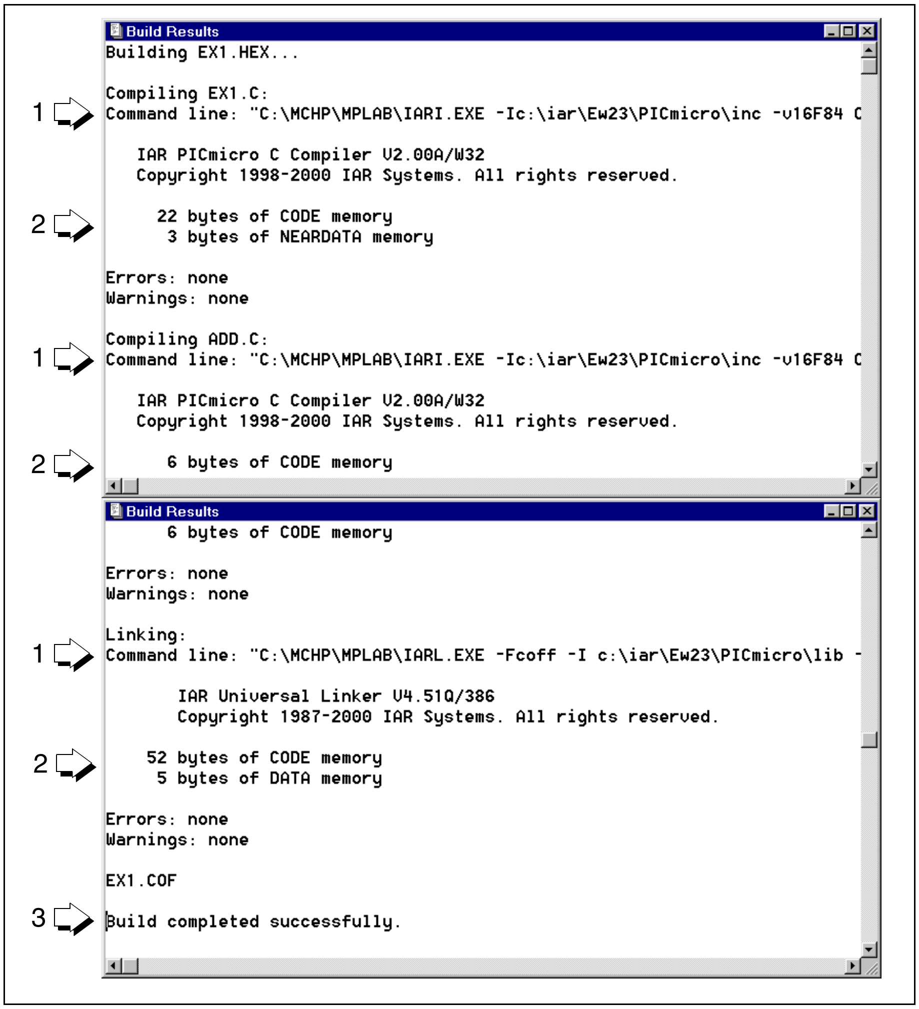


```
#include <pic1684.h>
void main(void);
unsigned char Add(unsigned char a, unsigned char b);
unsigned char x, y, z;
void main()
{
  x = 2;
  y = 5;
  t = Add(x,y);
}
```

**Figure 6.14: Source Code with Error**

Select *File > Save* (This step is just good practice, but not necessary, as MPLAB IDE will save the file when doing a build.) Now build the project again by selecting *Project > Make Project*. The Build Results window should now look different.

1. The command line sent to each tool displayed, along with other information specified in Node Properties.
2. Memory usage information is provided for each tool.
3. Build was successful.



```
Building EX1.HEX...

Compiling EX1.C:
Command line: "C:\MCHP\MPLAB\IARI.EXE -Ic:\iar\Ew23\PICmicro\inc -v16F84 C

   IAR PICmicro C Compiler V2.00A/W32
   Copyright 1998-2000 IAR Systems. All rights reserved.

     22 bytes of CODE memory
      3 bytes of NEARDATA memory

Errors: none
Warnings: none

Compiling ADD.C:
Command line: "C:\MCHP\MPLAB\IARI.EXE -Ic:\iar\Ew23\PICmicro\inc -v16F84 C

   IAR PICmicro C Compiler V2.00A/W32
   Copyright 1998-2000 IAR Systems. All rights reserved.

      6 bytes of CODE memory
```

```
      6 bytes of CODE memory

Errors: none
Warnings: none

Linking:
Command line: "C:\MCHP\MPLAB\IARL.EXE -Fcoff -I c:\iar\Ew23\PICmicro\lib -

       IAR Universal Linker V4.51Q/386
       Copyright 1987-2000 IAR Systems. All rights reserved.

    52 bytes of CODE memory
     5 bytes of DATA memory

Errors: none
Warnings: none

EX1.COF

Build completed successfully.
```

**Figure 6.15: Build Results Window – Build Successful (2 Views)**

# 6.14 More Project Information

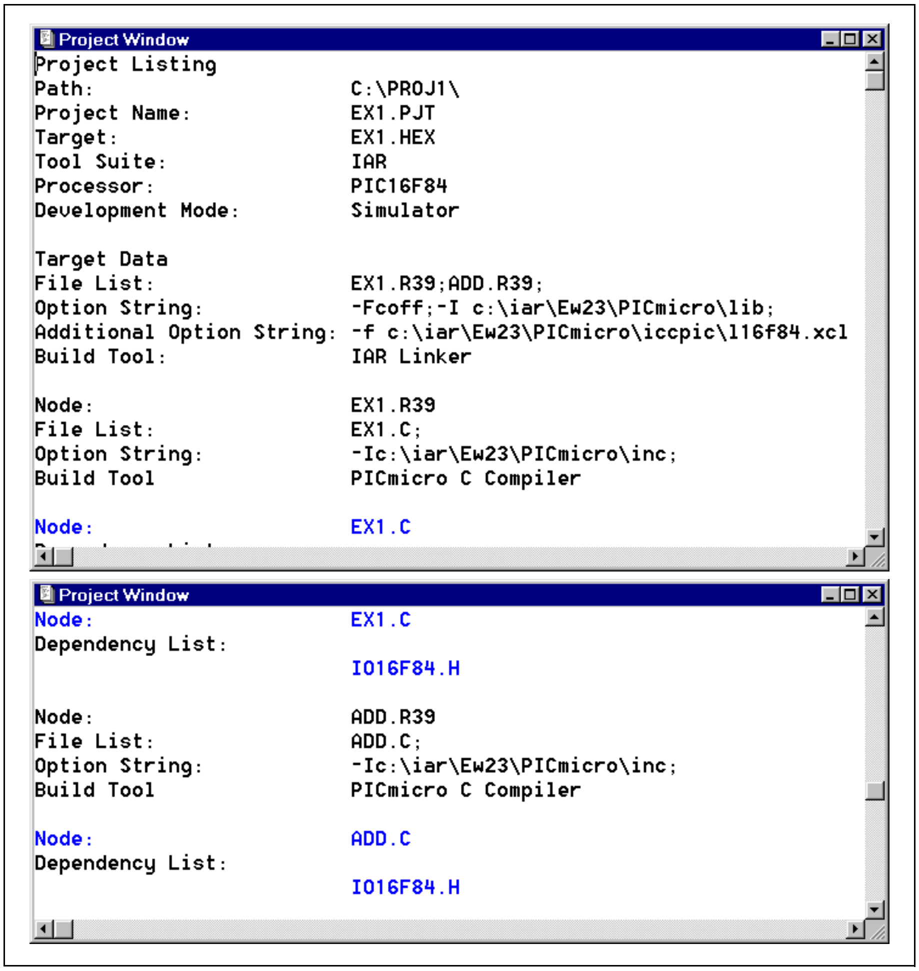
The source code in this tutorial only had one error. However, real untested code would most likely need to be debugged more extensively.

## 6.14.1 Debug Information

By selecting COFF Output Format in the Node Properties dialog, the MPLAB IDE has information necessary to help you debug your code.

## 6.14.2 Project Window

Open the *Window > Project* window. This displays various project information, which can be useful to review when debugging.



```
Project Listing
Path:                      C:\PROJ1\
Project Name:              EX1.PJT
Target:                    EX1.HEX
Tool Suite:                IAR
Processor:                 PIC16F84
Development Mode:          Simulator

Target Data
File List:                 EX1.R39;ADD.R39;
Option String:             -Fcoff;-I c:\iar\Ew23\PICmicro\lib;
Additional Option String:  -f c:\iar\Ew23\PICmicro\iccpic\l16f84.xcl
Build Tool:                IAR Linker

Node:                      EX1.R39
File List:                 EX1.C;
Option String:             -Ic:\iar\Ew23\PICmicro\inc;
Build Tool                 PICmicro C Compiler

Node:                      EX1.C
```

```
Node:                      EX1.C
Dependency List:
                           IO16F84.H

Node:                      ADD.R39
File List:                 ADD.C;
Option String:             -Ic:\iar\Ew23\PICmicro\inc;
Build Tool                 PICmicro C Compiler

Node:                      ADD.C
Dependency List:
                           IO16F84.H
```

**Figure 6.16: Project Window – ex1.pjt (2 Views)**

Double-clicking on any of the blue file names, you can open these files in the MPLAB IDE. This is ideal for opening files that are not in the project directory (e.g., header .h files), and therefore would require hunting through directory structures to find otherwise.

## 6.15 Optimization and Other Node Properties

For more information on optimization techniques, (e.g., Speed or Size Optimization switches, as well as definitions of other Node Properties switches), please refer to IAR documentation.

NOTES:

# Glossary

## Introduction

To provide a common frame of reference, this glossary defines the terms for several Microchip tools.

## Highlights

This glossary contains terms and definitions for the following tools:

- MPLAB IDE, MPLAB SIM, MPLAB Editor
- MPASM™ assembler, MPLINK™ linker, MPLIB™ librarian
- MPLAB CXX C compilers
- MPLAB ICE emulators
- MPLAB ICD debugger
- PICSTART® Plus, PRO MATE® II programmers

## Terms

**Absolute Section**

A section with a fixed (absolute) address that can not be changed by the linker.

**Access RAM (PIC18CXXX Devices Only)**

Special general purpose registers on PIC18CXXX devices that allow access regardless of the setting of the bank select bit (BSR).

**Alpha Character**

Alpha characters are those characters, regardless of case, that are letters of the alphabet: (a, b, …, z, A, B, …, Z).

**Alphanumeric**

Alphanumeric characters include alpha characters and numbers: (0,1, …, 9).

**Application**

A set of software and hardware developed by the user, usually designed to be a product controlled by a PICmicro® microcontroller.

**Assemble**

The process of translating assembly source code into an executable program. This operation is performed by an assembler.

**Assembler**

A language tool that translates a user's assembly source code (`.asm`) into machine code. MPASM assembler is Microchip Technology's assembler tool.

**Assembly**

A programming language that is once removed from machine language. Machine languages consist entirely of numbers and are almost impossible for humans to read and write. Assembly languages have the same structure and set of commands as machine languages, but they enable a programmer to use names (mnemonics) instead of numbers.

**Assigned Section**

A section which has been assigned to a target memory block in the linker command file. The linker allocates an assigned section into its specified target memory block.

**Breakpoint – Hardware**

An event whose execution will cause a halt.

**Breakpoint – Software**

An address where execution of the firmware will halt. Usually achieved by a special break opcode.

**Build**

A function that recompiles all the source files for an application.

**C**

A high level programming language that may be used to generate code for PICmicro microcontrollers, especially high-end device families.

**Calibration Memory**

A special function register or registers used to hold values for calibration of a PICmicro microcontroller on-board RC oscillator or other device peripherals.

**COFF**

Common Object File Format. An intermediate file format generated by MPLINK object linker that contains machine code and debugging information.

**Command Line Interface**

Command line interface refers to executing a program on the DOS™ command line with options.

Executing MPASM assembler with any command line options or just the file name will invoke the assembler. In the absence of any command line options, a prompted input interface (shell) will be executed.

**Compile**

The process of translating C source code into machine code. This operation is performed by a compiler.

### Compiler

A language tool that translates a user’s C source code into machine code. MPLAB C17 and MPLAB C18 are Microchip Technology’s C compilers for PIC17CXXX and PIC18CXXX devices, respectively.

### Configuration Bits

Unique bits programmed to set PICmicro microcontroller modes of operation. A configuration bit may or may not be preprogrammed. These bits are set in the *Options > Development Mode* dialog for simulators or emulators and in the _ _ CONFIG MPASM directive for programmers.

### Control Directives

Control directives in MPASM assembler permit code to be conditionally assembled.

### Data Directives

Data directives are those that control MPASM assembler’s allocation of memory and provide a way to refer to data items symbolically; that is, by meaningful names.

### Data Memory

General purpose file registers (GPRs) from RAM on the PICmicro device being emulated. The File Register window displays data memory.

### Daughter Board

The ICEPIC™ In-Circuit Emulator (Third Party product) uses interchangeable daughter boards to support the different subsets of the PIC16C5X and PIC16CXXX family of PICmicro microcontrollers. The daughter board is a circuit board that connects to the motherboard.

### Directives

Directives provide control of the assembler’s operation by telling MPASM assembler how to treat mnemonics, define data, and format the listing file. Directives make coding easier and provide custom output according to specific needs.

### Download

Download is the process of sending data from the PC host to another device, such as an emulator, programmer or target board.

### EPROM

Erasable Programmable Read Only Memory. A programmable read-only memory that can be erased usually by exposure to ultraviolet radiation.

### 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.

**Emulation**

The process of executing software loaded into emulation memory as if the firmware resided on the microcontroller device under development.

**Emulation Memory**

Program memory contained within the emulator.

**Emulator**

Hardware that performs emulation.

**Emulator System**

The MPLAB ICE emulator system includes the pod, processor module, device adapter, cables, and MPLAB IDE Software. The ICEPIC In-Circuit Emulator (Third Party product) is another emulator system.

**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 and breakpoints.

**Executable Code**

See HEX Code.

**Export**

Send data out of the MPLAB IDE in a standardized format.

**Expressions**

Expressions are used in the operand field of MPASM assembler's source line and may contain constants, symbols, or any combination of constants and symbols separated by arithmetic operators. Each constant or symbol may be preceded by a plus or minus to indicate a positive or negative expression.

**Note:** MPASM assembler expressions are evaluated in 32-bit integer math. (Floating point is not currently supported.)

**Extended Microcontroller Mode**
**(PIC17CXXX and PIC18CXXX Devices Only)**

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 PIC17CXXX or PIC18CXXX device.

**External Input Line (MPLAB ICE only)**

An external input signal logic probe line (TRIGIN) for setting an event based upon external signals.

**External Linkage**

A function or variable has external linkage if it can be accessed from outside the module in which it is defined.

**External RAM (PIC17CXXX and PIC18CXXX Devices Only)**

Off-chip Read/Write memory.

**External Symbol**

A symbol for an identifier which has external linkage.

**External Symbol Definition**

A symbol for a function or variable defined in the current module.

**External Symbol Reference**

A symbol which references a function or variable defined outside the current module.

**External Symbol Resolution**

A process performed by the linker in which external symbol definitions from all input modules are collected in an attempt to update all external symbol references. Any external symbol references which do not have a corresponding definition, cause a linker error to be reported.

**File Registers**

On-chip general purpose and special function registers.

**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 PICmicro 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.

**GPR**

General Purpose Register. GPR’s may be one section of a file register.

**Halt**

A function that stops the emulator. Executing Halt is the same as stopping at a breakpoint. The program counter stops, and the user can inspect and change register values, and single step through code.

**HEX Code**

Executable instructions assembled or compiled from source code into standard hexadecimal format code. Also called executable or machine code. HEX code is contained in a HEX file.

**HEX File**

An ASCII file containing hexadecimal addresses and values (hex code) suitable for programming a device. This format is readable by a device programmer.

**High Level Language**

A language for writing programs that is of a higher level of abstraction from the processor than assembler code. High level languages (such as C) employ a compiler to translate statements into machine instructions that the target processor can execute.

**ICD**

In-Circuit Debugger. MPLAB ICD is Microchip Technology's in-circuit debugger for PIC16F87X devices. MPLAB ICD works with MPLAB IDE.

**ICE**

In-Circuit Emulator. MPLAB ICE is Microchip Technology's in-circuit emulator that works with MPLAB IDE. ICEPIC (Third Party product) is another ICE device.

**IDE**

Integrated Development Environment. An application that has multiple functions for firmware development. The MPLAB IDE integrates a compiler, an assembler, a project manager, an editor, a debugger, a simulator, and an assortment of other tools within one Windows application. A user developing an application can write code, compile, debug, and test an application without leaving the MPLAB IDE desktop.

**Identifier**

A function or variable name.

**Import**

Bring data into the MPLAB 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.

**Internal Linkage**

A function or variable has internal linkage if it can not be accessed from outside the module in which it is defined.

**Librarian**

A language tool that creates and manipulates libraries. MPLIB librarian is Microchip Technology's librarian tool.

**Library**

A library is a collection of relocatable object modules. It is created by assembling multiple source files to object files, and then using the librarian to combine the object files into one library file. A library can be linked with object modules and other libraries to create executable code.

### Link

The process of combining object files and libraries to create executable code. This operation is performed by a linker.

### Linker

A language tool that combines object files and libraries to create executable code. Linking is performed by Microchip's MPLINK linker.

### Linker Script Files

Linker script files (`.lkr`) are the command files of MPLINK linker. They define linker options and describe available memory on the target platform.

### Listing Directives

Listing directives are those directives that control the MPASM 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, MPASM assembler directive, or macro encountered in a source file.

### 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.

### Machine Code

Either object or executable code.

### Macro

A collection of assembler instructions that are included in the assembly code when the macro name is encountered in the source code. Macros must be defined before they are used; forward references to macros are not allowed.

All statements following a `MACRO` directive and prior to an `ENDM` directive are part of the macro definition. Labels used within the macro must be local to the macro so the macro can be called repetitively.

### Macro Directives

Directives that control the execution and data allocation within macro body definitions.

### Make Project

A command that rebuilds an application, re-compiling only those source files that have changed since the last complete compilation.

### MCU

Microcontroller Unit. An abbreviation for microcontroller. Also µC.

### Memory Models

Versions of libraries and/or precompiled object files based on a device's memory (RAM/ROM) size and structure.

### Microcontroller

A highly integrated chip that contains all the components comprising a controller. Typically this includes a CPU, RAM, some form of ROM, I/O ports, and timers. Unlike a general-purpose computer, which also includes all of these components, a microcontroller is designed for a very specific task – to control a particular system. As a result, the parts can be simplified and reduced, which cuts down on production costs.

### Microcontroller Mode (PIC17CXXX and PIC18CXXX Devices Only)

One of the possible program memory configurations of the PIC17CXXX and PIC18CXXX families of microcontrollers. In microcontroller mode, only internal execution is allowed. Thus, only the on-chip program memory is available in microcontroller mode.

### Microprocessor Mode (PIC17CXXX and PIC18CXXX Devices Only)

One of the possible program memory configurations of the PIC17CXXX and PIC18CXXX families of microcontrollers. In microprocessor mode, the on-chip program memory is not used. The entire program memory is mapped externally.

### Mnemonics

Instructions that are translated directly into machine code. Mnemonics are used to perform arithmetic and logical operations on data residing in program or data memory of a microcontroller. They can also move data in and out of registers and memory as well as change the flow of program execution. Also referred to as Opcodes.

### MPASM Assembler

Microchip Technology's relocatable macro assembler. MPASM assembler is a DOS or Windows-based PC application that provides a platform for developing assembly language code for Microchip's PICmicro microcontroller families. Generically, MPASM assember will refer to the entire development platform including the macro assembler and utility functions.

MPASM assembler will translate source code into either object or executable code. The object code created by the assembler may be turned into executable code through the use of the MPLINK linker.

### MPLAB CXX

Refers to both the MPLAB C17 and MPLAB C18 C compilers.

### MPLAB ICD

Microchip Technology's in-circuit debugger for PIC16F87X devices. MPLAB ICD works with MPLAB IDE. The main component of MPLAB ICD is the module.  A complete system consists of a module, header, demo board, cables, and MPLAB IDE Software.

### MPLAB ICE

Microchip Technology's in-circuit emulator that works with MPLAB IDE.

### MPLAB IDE

The name of the main executable program that supports the IDE with a built-in project manager, editor and simulator (MPLAB SIM) and support for an emulator or debugger. The MPLAB IDE software resides on the PC host. The executable file name is `mplab.exe`. `mplab.exe` calls many other files.

### MPLAB SIM

Microchip Technology's simulator that works with MPLAB IDE.

### MPLIB Librarian

MPLIB librarian is an object librarian for use with COFF object modules (`filename.o`) created using either MPASM assembler (mpasm or mpasmwin v2.0) or MPLAB CXX C compilers.

MPLIB librarian will combine multiple object files into one library file. Then the librarian can be used to manipulate the object files within the created library.

### MPLINK Linker

MPLINK linker is an object linker for the Microchip MPASM assembler and the Microchip MPLAB C17 or C18 C compilers. MPLINK linker also may be used with the Microchip MPLIB librarian. MPLINK linker is designed to be used with MPLAB IDE, though it does not have to be.

MPLINK linker will combine object files and libraries to create a single executable file.

### MPSIM™ Simulator

The DOS version of Microchip's simulator. MPLAB SIM is the newest simulator from Microchip.

### MRU

Most Recently Used. Refers to files and windows available to be selected from MPLAB IDE main pull down menus.

### Nesting Depth

The maximum level to which macros can include other macros.

### Non Real-Time

Refers to the processor at a breakpoint or executing single step instructions or MPLAB IDE being run in simulator mode.

### Node

MPLAB IDE project component.

**`NOP`**

No Operation. An instruction that has no effect when executed except to advance the program counter.

**Object Code**

The intermediate code that is produced from the source code after it is processed by an assembler or compiler. Relocatable code is code produced by MPASM assembler or MPLAB C17/C18 C compilers that can be run through MPLINK linker to create executable code. Object code is contained in an object file.

**Object File**

A module which may contain relocatable code or data and references to external code or data. Typically, multiple object modules are linked to form a single executable output. Special directives are required in the source code when generating an object file. The object file contains object code.

**Object File Directives**

Directives that are used only when creating an object file.

**Off-Chip Memory (PIC17CXXX and PIC18CXXX Devices Only)**

Off-chip memory refers to the memory selection option for the PIC17CXXX or PIC18CXXX 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**

Arithmetic symbols, like the plus sign ‘+’ and the minus sign ‘-’, that are used when forming well-defined expressions. Each operator has an assigned precedence.

**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.

**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 IBM® or compatible Personal Computer running Windows 3.1x or Windows 95/98, Windows NT, or Windows 2000.

### PICmicro® MCUs

PICmicro microcontrollers (MCUs) refers to all Microchip microcontroller families.

### PICSTART® Plus Programmer

A device programmer from Microchip. Programs 8, 14, 28, and 40 pin PICmicro microcontrollers. Must be used with MPLAB IDE Software.

### Pod

The external emulator box that contains emulation memory, trace memory, event and cycle timers, and trace/breakpoint logic.

### 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.

### Precedence

The concept that some elements of an expression are evaluated before others; (i.e., * and / before + and -). In MPASM assembler, operators of the same precedence are evaluated from left to right. Use parentheses to alter the order of evaluation.

### Program Counter

A register that specifies the current execution address.

### Program Memory

The memory area in a PICmicro microcontroller where instructions are stored. Memory in the emulator or simulator containing the downloaded target application firmware.

### Programmer

A device used to program electrically programmable semiconductor devices such as microcontrollers.

### Project

A set of source files and instructions to build the object and executable code for an application.

### PRO MATE® II Programmer

A device programmer from Microchip. Programs all PICmicro microcontrollers and most memory and KEELOQ® devices. Can be used with MPLAB IDE or stand-alone.

### Prototype System

A term referring to a user’s target application, or target board.

**PWM Signals**

Pulse Width Modulation Signals. Certain PICmicro devices have a PWM peripheral.

**Qualifier**

An address or an address range used by the Pass Counter or as an event before another operation in a complex trigger.

**Radix**

The number base, hex, or decimal, used in specifying an address and for entering data in the *Window > Modify* command.

**RAM**

Random Access Memory (Data Memory).

**Raw Data**

The binary representation of code or data associated with a section.

**Real-Time**

When released from the halt state in the emulator or MPLAB ICD mode, 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 MPLAB ICE is enabled and constantly captures all selected cycles, and all break logic is enabled. In the emulator or MPLAB ICD, the processor executes in real-time until a valid breakpoint causes a halt, or until the user halts the emulator.

In the simulator real-time simply means execution of the microcontroller instructions as fast as they can be simulated by the host CPU.

**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.

**Relocatable Section**

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 identifier symbol definitions within the relocatable sections are updated to their new addresses.

**ROM**

Read Only Memory (Program Memory).

**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.

**Section**

An portion of code or data which has a name, size, and address.

**SFR**

Special Function Register. SFR’s may be one section of a file register.

**Shared Section**

A section which resides in a shared (non-banked) region of data RAM.

**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 version.

**Simulator**

A software program that models the operation of PICmicro microcontrollers.

**Single Step**

This command steps through code, one instruction at a time. After each instruction, MPLAB 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 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 - Assembly**

Source code consists of PICmicro MCU instructions and MPASM assembler directives and macros that will be translated into machine code by an assembler.

### Source Code - C

A program written in the high-level language called “C” which will be converted into PICmicro MCU machine code by a compiler. Machine code is suitable for use by a PICmicro MCU or Microchip development system product like MPLAB IDE.

### Source File - Assembly

The ASCII text file of PICmicro MCU instructions and MPASM assembler directives and macros (source code) that will be translated into machine code by an assembler. It is an ASCII file that can be created using any ASCII text editor.

### Source File - C

The ASCII text file containing C source code that will be translated into machine code by a compiler. It is an ASCII file that can be created using any ASCII text editor.

### Special Function Registers

Registers that control I/O processor functions, I/O status, timers, or other modes or peripherals.

### Stack - Hardware

An area in PICmicro MCU memory where function arguments, return values, local variables, and return addresses are stored; (i.e., a “Push-Down” list of calling routines). Each time a PICmicro MCU executes a `CALL` or responds to an interrupt, the software pushes the return address to the stack. A return command pops the address from the stack and puts it in the program counter.

The PIC18CXXX family also has a hardware stack to store register values for “fast” interrupts.

### Stack - Software

The compiler uses a software stack for storing local variables and for passing arguments to and returning values from functions.

### 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 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.

### 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.

### 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 refer mainly to variable names, function names and assembly labels.

### System Button

The system button is another name for the system window control. Clicking on the system button pops up the system menu.

### 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.” In some MPLAB IDE windows, additional modes or functions can be found.

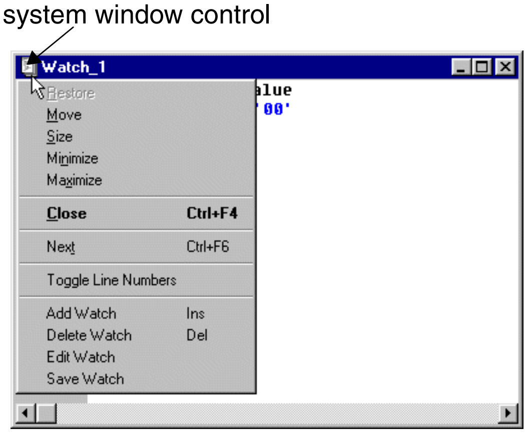

system window control

**Figure G1: System Window Control Menu - Watch Window**

### Target

Refers to user hardware.

### Target Application

Firmware 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 that is being emulated.

### 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 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’s trace window.

### Trace Memory

Trace memory contained within the emulator. Trace memory is sometimes called the trace buffer.

### 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.

### 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.

### Warning

An alert that is provided to warn you of a situation that would cause physical damage to a device, software file, or equipment.

### WatchDog Timer (WDT)

A timer on a PICmicro microcontroller that resets the processor after a selectable length of time. The WDT is enabled or disabled and set up using configuration bits.

### Watch Variable

A variable that you may monitor during a debugging session in a watch window.

### Watch Window

Watch windows contain a list of watch variables that are updated at each breakpoint.

NOTES:

# Index

# Index

MICROCHIP®

# WORLDWIDE SALES AND SERVICE

## AMERICAS

### Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200 Fax: 480-792-7277
Technical Support: 480-792-7627
Web Address: http://www.microchip.com

### Rocky Mountain
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

### Atlanta
500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

### Boston
2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

### Chicago
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

### Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

### Dayton
Two Prestige Place, Suite 130
Miamisburg, OH 45342
Tel: 937-291-1654 Fax: 937-291-9175

### Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

### Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

### New York
150 Motor Parkway, Suite 202
Hauppauge, NY 11788
Tel: 631-273-5305 Fax: 631-273-5335

### San Jose
Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

### Toronto
6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

## ASIA/PACIFIC

### China - Beijing
Microchip Technology Beijing Office
Unit 915
New China Hong Kong Manhattan Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

### China - Shanghai
Microchip Technology Shanghai Office
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200051
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

### Hong Kong
Microchip Asia Pacific
RM 2101, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

### India
Microchip Technology Inc.
India Liaison Office
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaugnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

### Japan
Microchip Technology Intl. Inc.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471- 6166 Fax: 81-45-471-6122

### Korea
Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea
Tel: 82-2-554-7200 Fax: 82-2-558-5934

## ASIA/PACIFIC (continued)

### Singapore
Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-334-8870 Fax: 65-334-8850

### Taiwan
Microchip Technology Taiwan
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

## EUROPE

### Denmark
Microchip Technology Denmark ApS
Regus Business Centre
Lautrup hoj 1-3
Ballerup DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

### France
Arizona Microchip Technology SARL
Parc d'Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - ler Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

### Germany
Arizona Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

### Italy
Arizona Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

### United Kingdom
Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820

10/01/00

DNV Certification, Inc.
USA

ANSI★RAB
QMS
ACCREDITED

DNV MSC
The Netherlands
Accredited by the RvA

DNV

ISO 9001 / QS-9000
REGISTERED FIRM

*Microchip received QS-9000 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona in July 1999. The Company's quality system processes and procedures are QS-9000 compliant for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs and microperipheral products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001 certified.*

Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, except as maybe explicitly expressed herein, under any intellectual property rights. The Microchip logo and name are registered trademarks of Microchip Technology Inc. in the U.S.A. and other countries. All rights reserved. All other trademarks mentioned herein are the property of their respective companies.