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dsPICDEM™ 80-Pin
Starter Development Board
User's Guide

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dsPICDEM™ 80-PIN STARTER DEVELOPMENT BOARD USER'S GUIDE

Table of Contents

dsPICDEM™ 80-Pin Starter Development Board User's Guide

dsPICDEM™ 80-PIN STARTER DEVELOPMENT BOARD USER'S GUIDE

Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This 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" is the document number and "A" is the revision level.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This preface contains general information that will be useful to know before you use the dsPICDEM™ 80-Pin Starter Development Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Warranty Registration
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the dsPICDEM 80-Pin Starter Development Board as a development tool to emulate and debug firmware on a target board. The manual is organized as follows:

- **Chapter 1: Introduction** – This chapter introduces the dsPICDEM 80-Pin Starter Development Board and provides a brief description of the hardware.
- **Chapter 2: Tutorial** – This chapter details the step-by-step process for getting the dsPICDEM 80-Pin Starter Development Board up and running with the MPLAB® In-Circuit Debugger 2 (MPLAB ICD 2).
- **Chapter 3: Demonstration Program Operation** – This chapter describes the operational functionality of the sample code that is preprogrammed into the dsPIC30F device.
- **Chapter 4: dsPICDEM™ Development Board Hardware** – This chapter describes the hardware comprising the dsPICDEM 80-Pin Starter Development Board.
- **Appendix A: Hardware Schematics** – This appendix provides dsPICDEM 80-Pin Starter Development Board hardware layout and schematic diagrams.

CONVENTIONS USED IN THIS GUIDE

This manual uses these documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB$^{®}$ IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier font:		
Plain Courier	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier	A variable argument	`file`.o, where `file` can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options] file [options]`
Curly brackets and pipe character: {	}	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void)` `{ ...` `}`

WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles users to receive new product updates. Interim software releases are available on the Microchip web site (www.microchip.com).

RECOMMENDED READING

This user's guide describes how to use the dsPICDEM 80-Pin Starter Development Board. Other useful Microchip documents that are available and recommended as supplemental reference resources include:

Readme for dsPICDEM 80-Pin Starter Development Board

For the latest information on using dsPICDEM 80-Pin Starter Development Board, read the "`Readme for` dsPICDEM 80-Pin Starter Development Board`.txt`" file (an ASCII text file) in the Readmes subdirectory of the MPLAB IDE installation directory. The Readme file contains update information and known issues that may not be included in this user's guide.

Readme Files

For the latest information on using other tools, read the tool-specific Readme files in the Readmes subdirectory of the MPLAB IDE installation directory. The Readme files contain update information and known issues that may not be included in this user's guide.

dsPIC30F Family Reference Manual (DS70046)

Consult this document for detailed information on dsPIC30F device operation. This reference manual explains the operation of the dsPIC30F Digital Signal Controller (DSC) family architecture and peripheral modules but does not cover the specifics of each device. Refer to the appropriate device data sheet for device-specific information.

dsPIC30F/dsPIC33F Programmer's Reference Manual (DS70157)

This manual is a software developer's reference for the dsPIC30F and dsPIC33F 16-bit DSC family of devices. It describes the instruction set in detail and also provides general information to assist in developing software for these dsPIC® DSC families.

dsPIC33F Family Data Sheet (DS70165)

Consult this document for detailed information on dsPIC33F Digital Signal Controllers. Reference information found in this data sheet includes:

• Device memory map
• Device pinout and packaging details
• Device electrical specifications
• Overview of peripherals included in the device

PIC24H Family Data Sheet (DS70175)

Consult this document for detailed information on the PIC24H 16-bit MCU family. Reference information found in this data sheet includes:

• Device memory map
• Device pinout and packaging details
• Device electrical specifications
• Overview of peripherals included in the device

PIC24FJ128GA Family Device Data Sheet (DS39474)

Consult this document for detailed information on the PIC24FJ128GA 16-bit MCU. Reference information found in this data sheet includes:

• Device memory map
• Device pinout and packaging details
• Device electrical specifications
• Overview of peripherals included in the device

dsPIC30F6011A/6012A/6013A/6014A Data Sheet (DS70143)

Consult this document for detailed information on dsPIC30F6011A, dsPIC30F6012A, dsPIC30F6013A and dsPIC30F6014A Digital Signal Controllers. Reference information found in this data sheet includes:

• Device memory map
• Device pinout and packaging details
• Device electrical specifications
• Overview of peripherals included in the device

MPLAB® ASM30, MPLAB® LINK30 and Utilities User's Guide (DS51317)

This document details Microchip Technology's language tools for dsPIC DSC devices based on GNU technology. The language tools discussed are:

• MPLAB ASM30 Assembler
• MPLAB LINK30 Linker
• MPLAB LIB30 Archiver/Librarian
• Other Utilities

MPLAB® C30 C Compiler User's Guide (DS51284)

This document details the use of Microchip's MPLAB C30 C Compiler for dsPIC DSC devices to develop an application. MPLAB C30 is a GNU-based language tool, based on source code from the Free Software Foundation (FSF). For more information about the FSF, see www.fsf.org.

Other GNU language tools available from Microchip are:

• MPLAB ASM30 Assembler
• MPLAB LINK30 Linker
• MPLAB LIB30 Librarian/Archiver

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

Consult this document for more information pertaining to the installation and implementation of the MPLAB Integrated Development Environment (IDE) Software.

To obtain any of these documents, contact the nearest Microchip sales location (see back page) or visit the Microchip web site at www.microchip.com.

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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To register, access the Microchip web site at www.microchip.com, click on Customer Change Notification and follow the registration instructions.

The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers and other language tools. These include the MPLAB C18 and MPLAB C30 C compilers; MPASM™ and MPLAB ASM30 assemblers; MPLINK™ and MPLAB LINK30 object linkers; and MPLIB™ and MPLAB LIB30 object librarians.
- **Emulators** – The latest information on Microchip in-circuit emulators. This includes the MPLAB ICE 2000 and MPLAB ICE 4000.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 2.
- **MPLAB® IDE** – The latest information on Microchip MPLAB IDE, the Windows® Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB SIM simulator, MPLAB IDE Project Manager and general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include the MPLAB PM3 and PRO MATE® II device programmers and the PICSTART® Plus and PICkit™ 1 development programmers.

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://support.microchip.com

DOCUMENT REVISION HISTORY

Revision A (October 2005)

- Initial Release of this Document.

Revision B (March 2006)

- Updated document to include dsPIC33F Digital Signal Controllers, and PIC24F and PIC24H MCU information.

Chapter 1. Introduction

1.1   INTRODUCTION

The dsPICDEM 80-Pin Starter Development Board is a development kit and evaluation tool for dsPIC high-performance DSCs and PIC24 MCUs.

> **Note:** The term dsPIC DSC used throughout this manual refers to both the dsPIC30F and dsPIC33F device families. Unless specified otherwise, these devices can be used interchangeably. Similarly, the term PIC24 MCU refers to both the PIC24F and PIC24H device families.

1.2   HIGHLIGHTS

This chapter discusses:

• dsPICDEM 80-Pin Starter Development Board Kit Contents
• dsPICDEM 80-Pin Starter Development Board Functionality and Features
• dsPICDEM 80-Pin Starter Development Board Demonstration Program
• Reference documents

1.3   dsPICDEM 80-PIN STARTER DEVELOPMENT BOARD KIT CONTENTS

The following items comprise the dsPICDEM 80-Pin Starter Development Board Kit:

• The dsPICDEM 80-Pin Starter Development Board printed circuit board (see Figure 1-1).
• A preprogrammed dsPIC30F6014A device soldered onto an adapter board, which plugs into the Emulation Header on the dsPICDEM 80-Pin Starter Development Board (see Figure 1-2).
• dsPICDEM 80-Pin Starter Development Board CD-ROM containing various demonstration programs provided by Microchip.

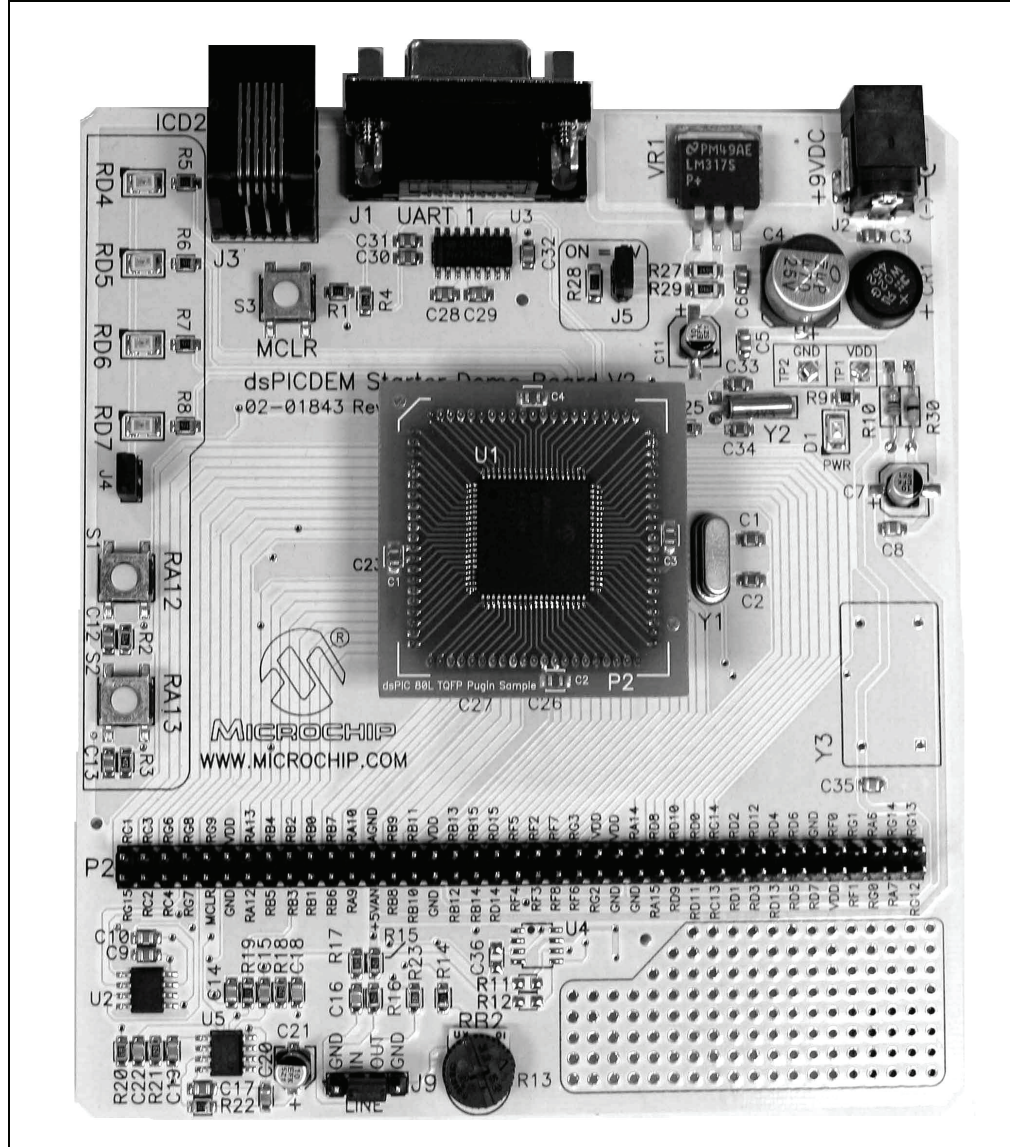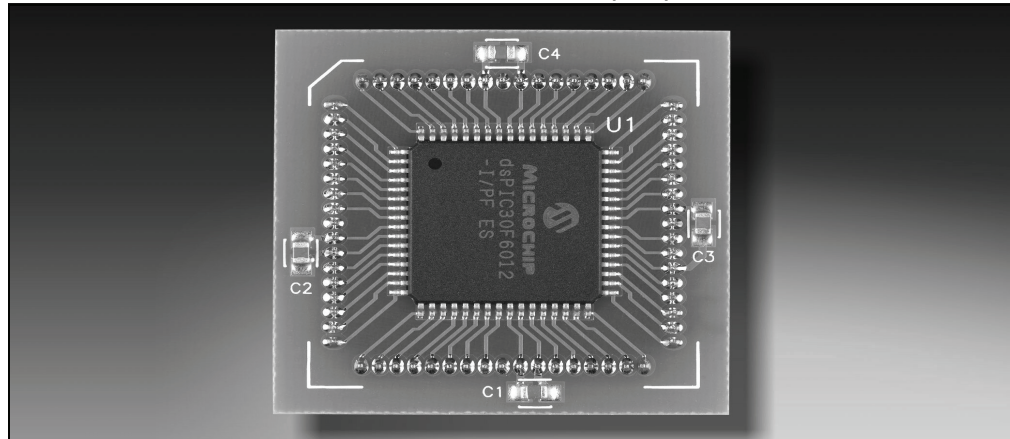**FIGURE 1-1:** **dsPICDEM™ 80-PIN STARTER DEVELOPMENT BOARD**

FIGURE 1-2: **TYPICAL PLUG-IN MODULE (PIM)**

For information on the components used on the dsPICDEM 80-Pin Starter Development Board see **Chapter 4. "dsPICDEM™ Development Board Hardware"**.

1.4   FUNCTIONALITY AND FEATURES

The dsPICDEM 80-Pin Starter Development Board provides the following capabilities:

Development Board Power

• On-board variable voltage regulator for 3.3V and 5.0V output with direct input from 9V, AC/DC wall adapter
• 9 VDC power source input jack for development board
• Power-on indicator LED

MPLAB ICD 2 and MPLAB ICE 4000 Connections

• MPLAB ICD 2 programming connector
• Emulation header for connection to MPLAB ICE 4000
• Pad location for 80-pin TQFP dsPIC DSC device

Serial Communication Channel

• Single RS-232 communication channel

Analog

• One 10 kΩ Potentiometer (RP2)
• Microchip MCP41010 Digital Potentiometer
• Microchip MCP6022 Operational Amplifier
  - Output configured as low-pass filter for digital potentiometer
  - Input configured as low-pass filter for sampling input signals with the ADC

Device Clocking

• 7.37 MHz crystal (Y1) for dsPIC DSC device

Miscellaneous

• Reset push button switch (S3) for resetting the dsPIC DSC device
• Four red LEDs (RD4-RD7)
• Two push button switches (S1-S2) for external input stimulus
• 80-pin dual-row header with labeled pinouts.
• Prototype area for user hardware
• Supports 100-to-80-pin dsPIC33F and PIC24 Plug-in Modules

1.5   dsPICDEM 80-PIN STARTER DEVELOPMENT BOARD DEMONSTRATION PROGRAM

The dsPICDEM 80-Pin Starter Development Board is supplied with a pre-loaded demonstration program that exercises principal CPU functions and peripheral options that allow interaction with the program as follows:

• Demonstrates interrupt handling by using switches S1 and S2 to blink LEDs RD4 and RD5, respectively.
• Demonstrates digital-to-analog conversion by generating an audio tone on LINE OUT.
• Demonstrates analog-to-digital conversion by adjusting Potentiometer RP2 and transmitting the resulting digital value to the HyperTerminal on a PC.

Refer to **Chapter 3. "Demonstration Program Operation"** for details on the demonstration code operation.

1.6   REFERENCE DOCUMENTS

The following documentation is available to support the use of the dsPICDEM 80-Pin Starter Development Board:

- *"dsPIC30F Family Reference Manual"* (DS70046)
- *"dsPIC30F Family Reference Manual Errata"* (DS80169)
- *"dsPIC30F/33F Programmer's Reference Manual"* (DS70157)
- *"dsPIC30F6011A/6012A/6013A/6014A Data Sheet"* (DS70143)
- *"dsPIC33F Family Data Sheet"* (DS70165)
- *"PIC24H Family Data Sheet"* (DS70175)
- *"PIC24FJ1285A Data Sheet* (DS39747)
- *MPLAB® C30 C Compiler User's Guide"* (DS51284)
- *"MPLAB® ASM30, MPLAB® LINK30 and Utilities User's Guide"* (DS51317)
- *"Using MPLAB® ICD 2"* poster (DS51265)
- *"MPLAB® ICE Emulator User's Guide"* (DS51159)

You can obtain these reference documents from your nearest Microchip sales office (listed in the back of this document) or by downloading them from the Microchip web site (www.microchip.com).

Chapter 2. Tutorial

2.1   INTRODUCTION

This chapter is a self-paced tutorial to get you started using the dsPICDEM 80-Pin Starter Development Board.

2.2   HIGHLIGHTS

Items discussed in this chapter include:

• Tutorial Overview
• Creating the Project
• Building the Code
• Programming the Chip
• Debugging the Code
• Summary

2.3   TUTORIAL OVERVIEW

The tutorial program in `Eg1_BlinkLed.s` is written in assembly code. This program blinks an LED when a key is pressed. The source file is used with a linker script file (`p30f6014a.gld`) and an include file (`p30f6014a.inc`) to form a complete project. This simple project uses a single source code file; however, more complex projects might use multiple assembler and compiler source files as well as library files and precompiled object files.

There are four steps to this tutorial:

1. Creating a project in MPLAB IDE.
2. Assembling and linking the code.
3. Programming the chip with the MPLAB ICD 2.
4. Debugging the code with the MPLAB ICD 2.

> **Note:** The following tutorial instructions assume the use of the dsPIC30F6014A device, which is supplied with the dsPICDEM 80-Pin Starter Development Board. However, this information applies to any of the dsPIC30F, dsPIC33F, PIC24F and PIC24H devices supported by the board.

2.4   CREATING THE PROJECT

The first step is to create a project and a workspace in MPLAB IDE. Typically, there is one project in one workspace.

> **Note:** These instructions presume the use of MPLAB 7.20 or newer.

A project contains the files needed to build an application (source code, linker script files, etc.) along with their associations to various build tools and build options.

A workspace contains one or more projects and information on the selected device, debug tool and/or programmer, open windows and their location and other MPLAB IDE configuration settings.

MPLAB IDE contains a Project Wizard to help create new projects. Before starting, create a folder named Tutorial for the project files for this tutorial (`C:\Tutorial` is assumed in the instructions that follow). From the Example Code\Tutorial Code directory on the Development Kit Software CD-ROM, copy the `Eg1_BlinkLed.s` file into this folder.

2.4.1   Select a Device

1. Start MPLAB IDE.
2. Close any workspace that might be open (*File>Close Workspace*).
3. From the *Project* menu, select *Project Wizard*.
4. From the Welcome screen, click **Next** to display the Project Wizard Step One dialog (see Figure 2-1).

FIGURE 2-1:   PROJECT WIZARD, STEP 1, SELECT A DEVICE
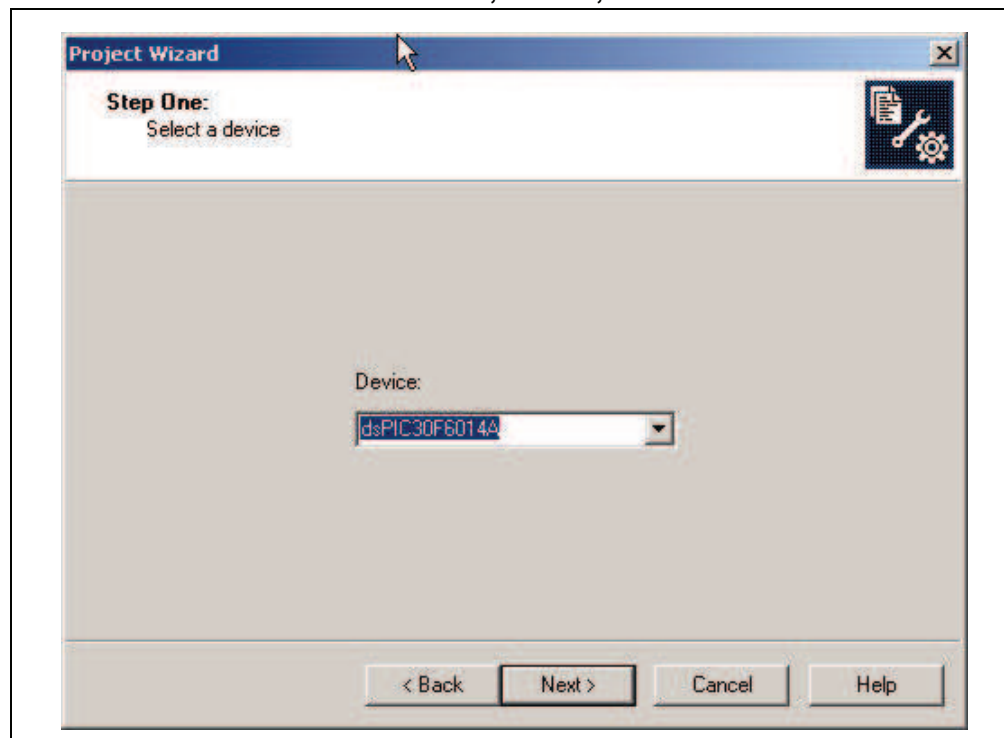
5. From the **Device:** pull-down list, select `dsPIC30F6014A` and click **Next >**. The Project Wizard Step Two dialog displays as shown in Figure 2-2.

FIGURE 2-2: PROJECT WIZARD, STEP 2, SELECT LANGUAGE
TOOLSUITE
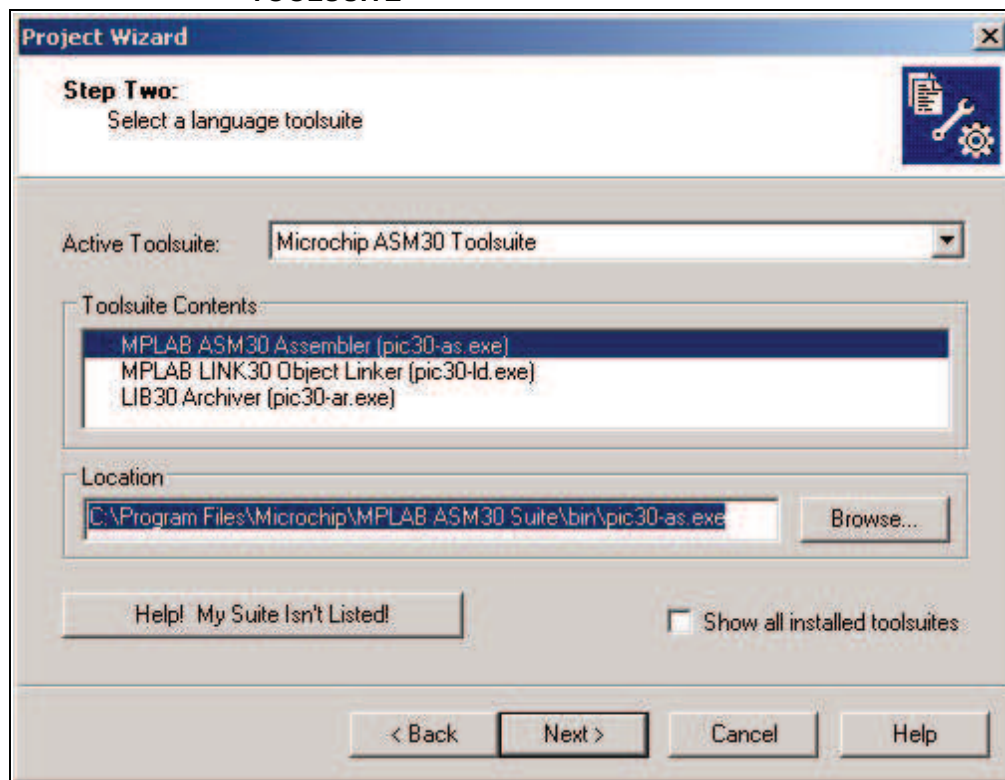
2.4.2   Select Language Toolsuite

1. From the **Active Toolsuite** pull-down menu, select Microchip ASM30 Toolsuite.
    This toolsuite includes the assembler and linker that will be used (the C compiler
    is not used).
2. In the **Toolsuite Contents** block, select MPLAB ASM 30 Assembler
    (pic30-as.exe).
3. In the **Location** block, click **Browse...** and navigate to:
    `C:\Program Files\Microchip\MPLAB ASM30 Suite\Bin\pic30-as.exe`
4. With MPLAB LINK 30 Object Linker (pic30-Id.exe) selected in Toolsuite
    Contents, click **Browse...** and navigate to:
    `C:\Program Files\Microchip\MPLAB ASM30 Suite\Bin\pic30-ld.exe`

> **Note:**   If you have the MPLAB C30 Toolsuite installed, browse to the
>   `C:\program files\microchip\MPLAB C30\bin\` location.

5. Click **Next >** to continue. The Project Wizard Step Three dialog displays (see
    Figure 2-3).

FIGURE 2-3: **PROJECT WIZARD, STEP 3, NAME YOUR PROJECT**
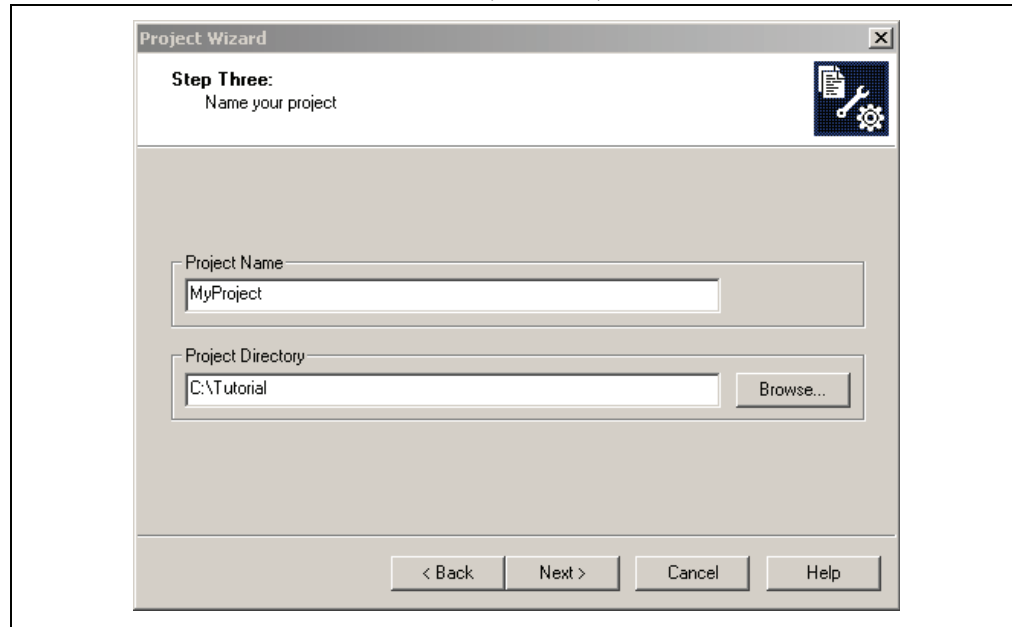
2.4.3 Name Your Project

1. In the Project Name text box, type **MyProject.**
2. Click **Browse...** and navigate to **C:\Tutorial** to place your project in the Tutorial folder.
3. Click **Next >** to continue. The Project Wizard Step Four dialog displays (see Figure 2-4).

**FIGURE 2-4:** **PROJECT WIZARD, STEP 4, ADD FILES TO PROJECT**
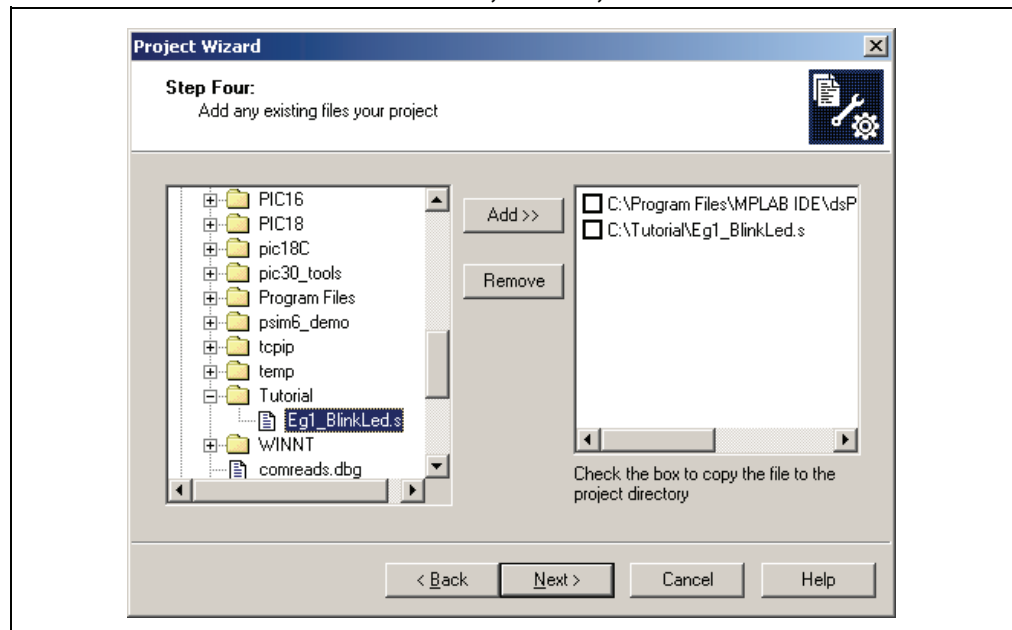
2.4.4 Add Files to Project

1. From the list of folders on the PC, locate the C:\Tutorial folder and select the `Eg1_BlinkLed.s` file.
2. Click **Add>>** to include the file in the project.
3. Expand the `C:\Program Files\Microchip\MPLAB ASM30 Suite\Support\gld` folder and select the `p30f6014a.gld` file.
4. Click **Add>>** to include this file in the project. There should now be two files in the project.
5. Click **Next >** to continue.
6. When the summary screen displays, click **Finish.**

After the project wizard completes, the MPLAB project window shows the `Eg1_BlinkLed.s` file in the Source Files folder and the `p30f6014a.gld` file in the Linker Scripts folder (see Figure 2-5).

FIGURE 2-5: **PROJECT WINDOW**
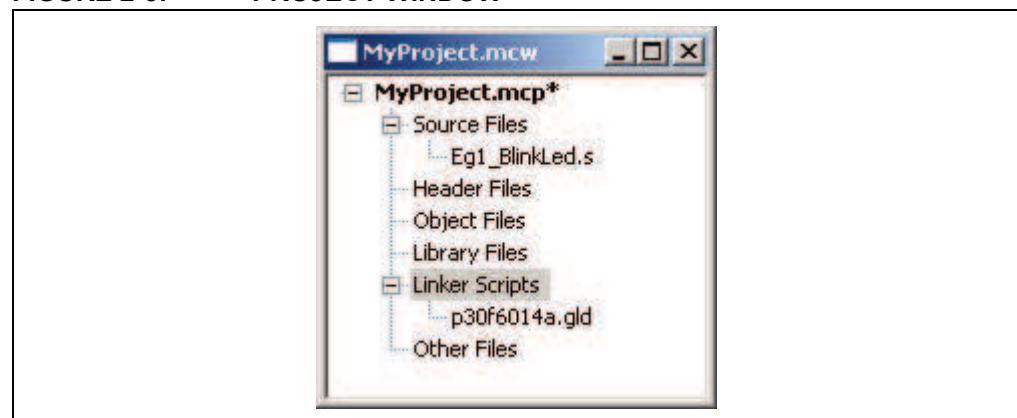
A project and workspace has now been created in MPLAB IDE. `MyProject.mcw` is the workspace file and `MyProject.mcp` is the project file. Double click the `Eg1_BlinkLed.s` file in the project window to open the file. MPLAB IDE should now look similar to Figure 2-6.

FIGURE 2-6: **MPLAB® IDE WORKSPACE**
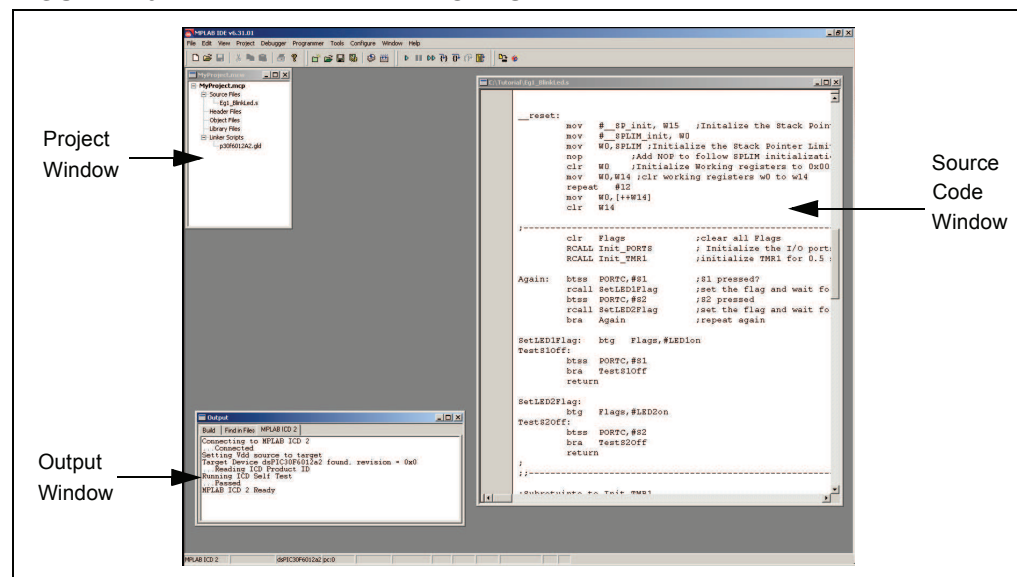
2.5   BUILDING THE CODE

In this project, building the code consists of assembling the `Eg1_BlinkLed.s` file to create an object file `Eg1_BlinkLed.o` and then linking the object file to create the `Eg1_BlinkLed.hex` and `Eg1_BlinkLed.cof` output files. The HEX file contains the data necessary to program the device, and the `.cof` file contains additional information that lets you debug the code at the source code level.

Before building, there are settings required to tell MPLAB IDE where to find the include files and to reserve space for the extra debug code when the MPLAB ICD 2 is used.

The following line is near the top of the `Eg1_BlinkLed.s` file:

```
.include "p30f6014a.inc"
```

This line causes a standard include file to be used. Microchip provides these files with all the Special Function Register (SFR) labels already defined for convenience.

To build the code, select _Build Options>Project_ from the _Project_ menu. The Build Options dialog displays (see Figure 2-7).
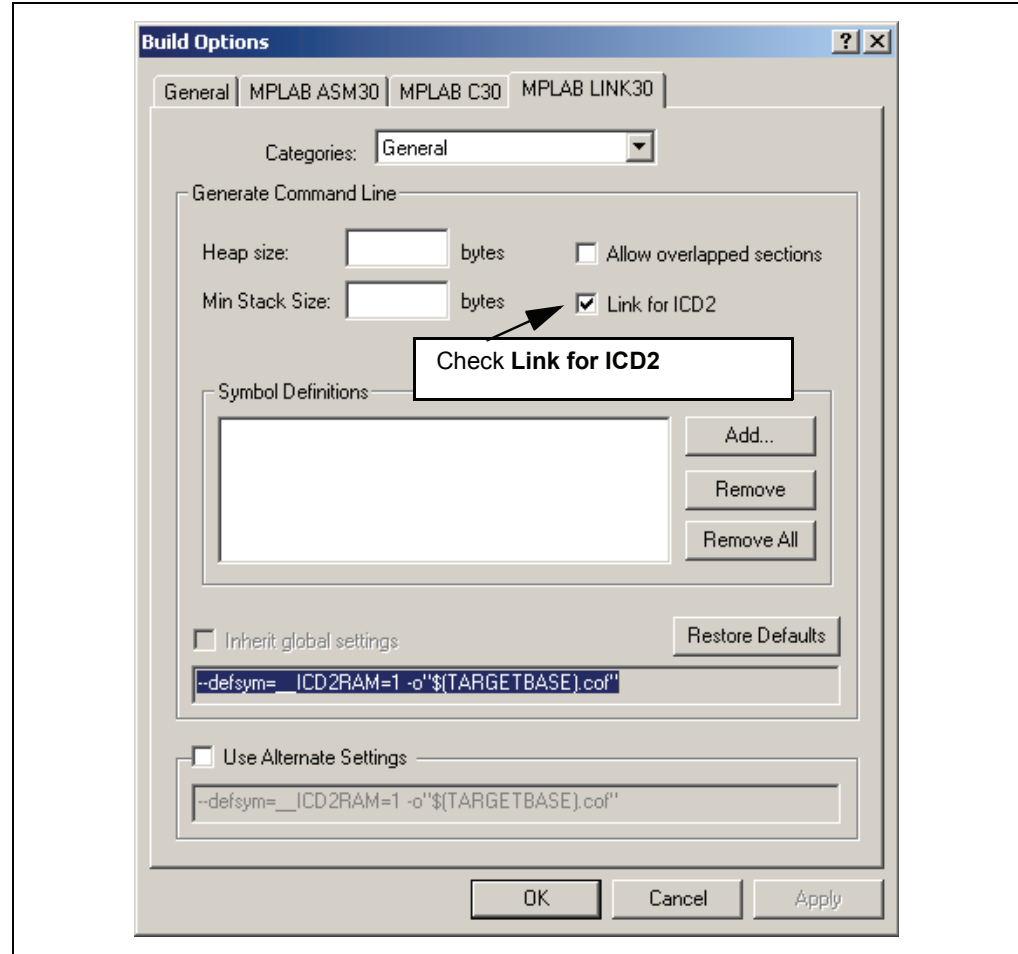
FIGURE 2-7:   BUILD OPTIONS
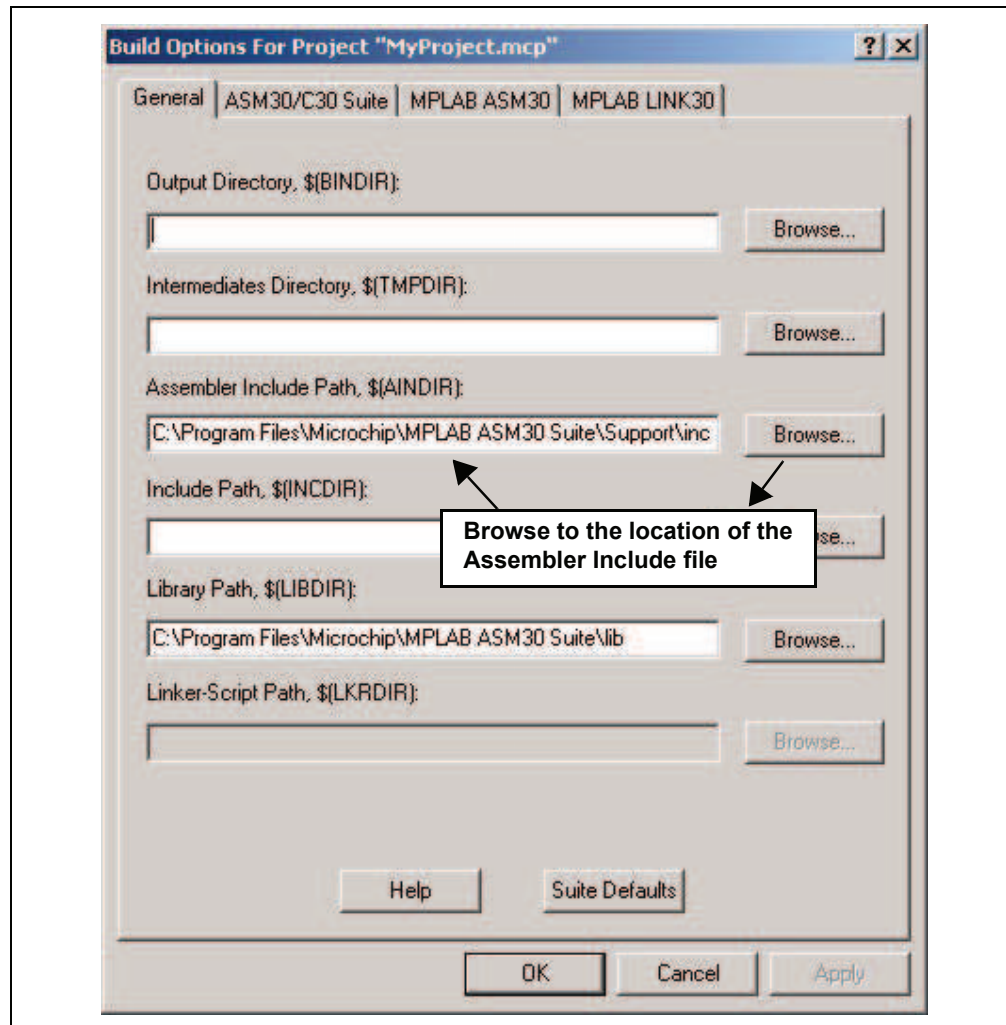
2.5.1 Identify Assembler Include Path

1. Select the **General** tab.
2. At the Assembler Include Path, $(AINDIR):box, click **Browse...** and navigate to:

   `C:\Program Files\Microchip\MPLAB ASM30 Suite\Support\inc`

   This path tells MPLAB IDE where to find the include files.
3. Select the **MPLAB LINK30** tab to view the linker settings (see Figure 2-8).

FIGURE 2-8: MPLAB® LINK30 BUILD OPTIONS

2.5.2 Link for MPLAB ICD 2

1. Check **Link for ICD 2**.
2. Click **OK**. The text box closes while the linker reserves space for the debug code used by the MPLAB ICD 2.
3. Click **OK** again to save these changes. The project is now ready to build.

2.5.3 Build the Project

1. From the *Project* menu, select *Make*. The Build Output window displays.
2. Observe the progress of the build.
3. When the BUILD SUCCEEDED message displays (see Figure 2-9), you are ready to program the device.

FIGURE 2-9: BUILD OUTPUT
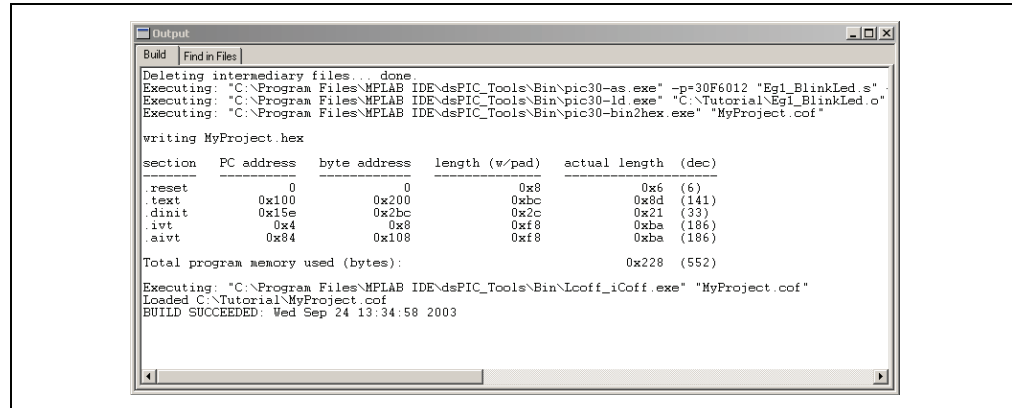
2.6   PROGRAMMING THE CHIP

The MPLAB ICD 2 In-Circuit Debugger is used to program and debug the dsPIC30F6014A device in-circuit on the dsPICDEM 80-Pin Starter Development Board.

> **Note:** Before proceeding, make sure that the USB driver for the MPLAB ICD 2 has been installed on the PC (see the "*MPLAB® ICD 2 In-Circuit Debugger User's Guide*" (DS51331) for more details regarding the installation of the MPLAB ICD 2).

Use the procedures in the following section to program the dsPIC30F6014A device.

2.6.1   Set Up The Device Configuration

1. Use the *Configure>Configuration Bits* menu to display the configuration settings.
2. Set up the configuration bits, as shown in Figure 2-10.

    The settings that will most likely need to change are:

Oscillator	XT w/PLL 4x
Watchdog Timer	Disabled

FIGURE 2-10:   CONFIGURATION SETTINGS

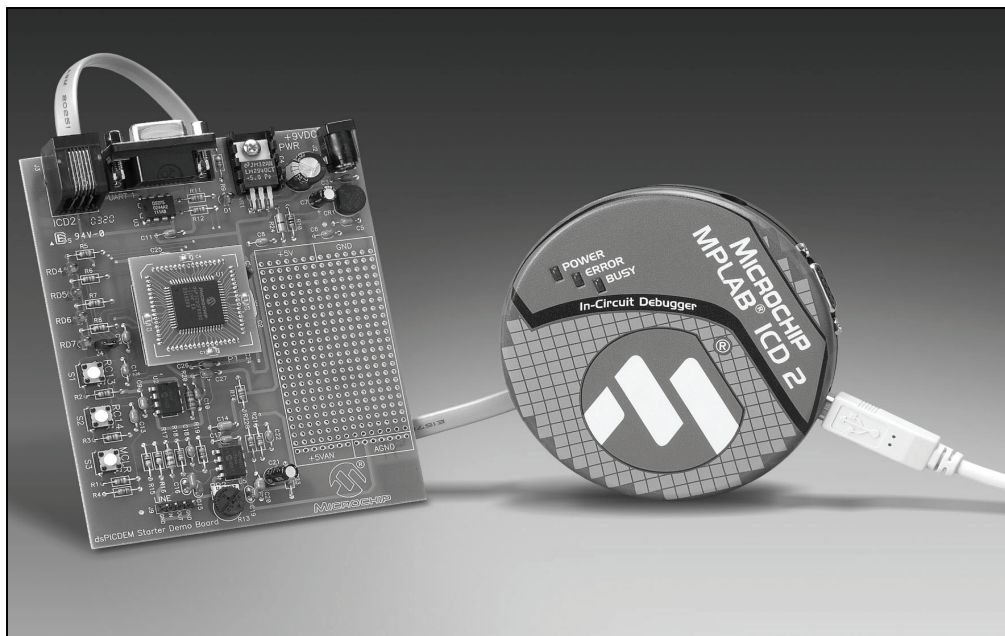### 2.6.2   Connect the MPLAB ICD 2 In-Circuit Debugger

1. Connect the MPLAB ICD 2 to the PC with the USB cable (see Figure 2-11).
2. Connect the MPLAB ICD 2 to the dsPICDEM 80-Pin Starter Development Board with the short RJ-11 (telephone) cable.

> ## CAUTION
>
> **Before you apply power to the board, observe these voltage precautions:**
> **If a dsPIC33F device is being used, J5 should be OPEN or OFF to enable 3.3V to the VDD or supply voltage. Operating a dsPIC33F device at 5.0V will cause a catastrophic failure of the device.**
> **If a dsPIC30F device is being used, J5 can be open or closed. You will get 3.3V or 5.0V voltage to the VDD pin.**

3. Apply power to the board.

FIGURE 2-11: **TYPICAL dsPIC® DSC DEVELOPMENT BOARD CONNECTED TO MPLAB® ICD 2**


2.6.3 Enable MPLAB ICD 2 Connection

1. From the *Debugger* menu, click *Select Tool>MPLAB ICD 2* to set the MPLAB ICD 2 as the debug tool in MPLAB IDE.

2. From the *Debugger* menu, select *Connect* to connect the debugger to the device. MPLAB IDE should report that it found the dsPIC30F6014A device, as shown in Figure 2-12.

> **Note:** MPLAB IDE may need to download new firmware if this is the first time the MPLAB ICD 2 is being used with a dsPIC30F device. Allow it to do so. If any errors are shown, double click the error message to get more information.
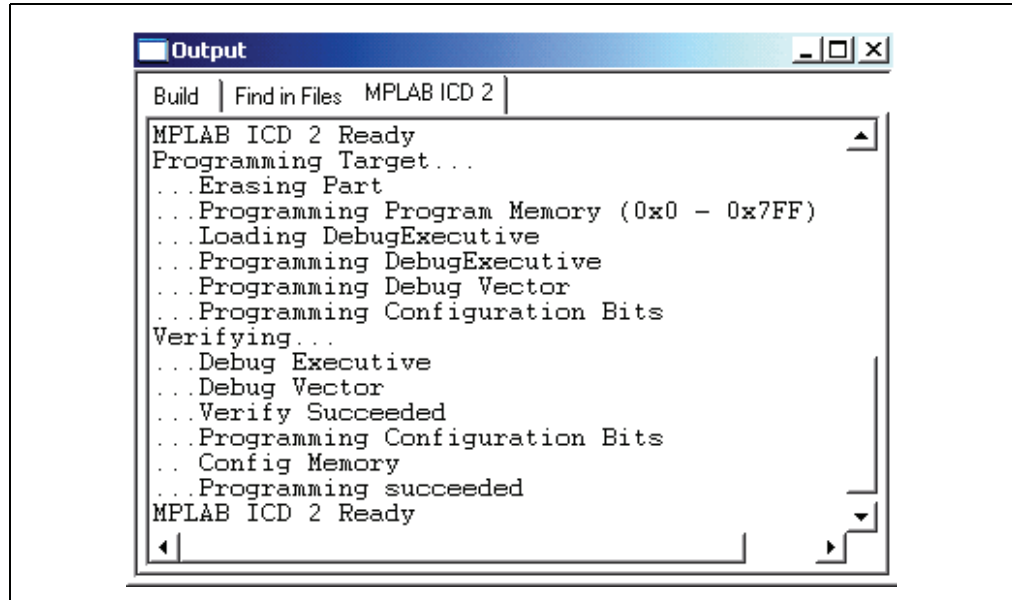
FIGURE 2-12: **ENABLING MPLAB® ICD 2**
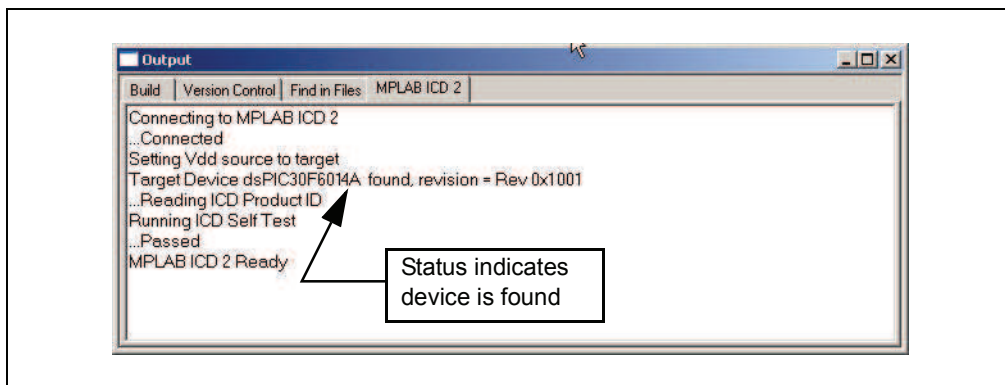
2.6.4   Program the dsPIC30F6014A Device

1. From the *Debugger* menu, select *Program* to program the part. The output window (Figure 2-13) displays the program steps as they occur.
2. Observe the results of the programming. When "MPLAB ICD 2 Ready" displays, the device is programmed and ready to run.

FIGURE 2-13:   PROGRAMMING THE dsPIC® DSC DEVICE

3. Use the *Debugger>Run* menu to run the code. LED1 should start blinking when S1 is pressed.