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**dsPICDEM.net™ 1  
and dsPICDEM.net™ 2  
Connectivity Development Board  
User's Guide**

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# dsPICDEM.net™ 1 AND dsPICDEM.net 2 CONNECTIVITY DEVELOPMENT BOARD USER'S GUIDE

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## Preface

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### INTRODUCTION

This user's guide supports the dsPICDEM.net 1 and dsPICDEM.net 2 connectivity development boards. These boards provide basic platforms that enable the application developer to create and evaluate both connectivity and non-connectivity based solutions. This chapter previews the contents of the manual, tells you how to obtain valuable customer support and recommends useful reference information.

### HIGHLIGHTS

Items discussed in this chapter are:

- About This Guide
- Warranty Registration
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Notification Service
- Customer Support

### ABOUT THIS GUIDE

This user's guide describes how to use the dsPICDEM.net 1 and dsPICDEM.net 2 connectivity development boards. The document is organized as follows:

- **Chapter 1: Introduction** – This chapter introduces the dsPICDEM.net 1 and dsPICDEM.net 2 connectivity development board and provides a brief description of the hardware.
- **Chapter 2: Tutorial** – This chapter presents a step-by-step process for getting your dsPICDEM.net 1 and dsPICDEM.net 2 connectivity development board up and running with the MPLAB® In-Circuit Debugger 2 (MPLAB ICD 2).
- **Chapter 3: Quick Start Program** – This chapter describes the operational functionality of a demonstration program included on the dsPICDEM.net Development Kit Software CD. The demonstration program exercises several capabilities of the dsPIC30F by interacting with peripheral devices on the development board.
- **Chapter 4: HTTP Web Server Demonstration** – This chapter describes the operational functionality of a sample HTTP Web Server based embedded application that is included on the dsPICDEM.net Development Kit Software CD.
- **Chapter 5: FTP Server Demonstration** – This chapter describes the operational functionality of a sample FTP Server based embedded application that is included on the dsPICDEM.net Development Kit Software CD.
- **Chapter 6: V.22bis Soft Modem Demonstration** – This chapter describes the operational functionality of a sample PSTN based application that is preprogrammed into the dsPIC30F6014 device.
- **Chapter 7: dsPICDEM.net™ Development Hardware** – This chapter describes the hardware included on the of the dsPICDEM.net 1 and dsPICDEM.net 2 boards.
- **Appendix A: Hardware Schematics** – This Appendix contains hardware layout and schematic diagrams of the dsPICDEM.net 1 and dsPICDEM.net 2.

## Conventions Used in This Guide

This User's Guide uses the following documentation conventions:

### DOCUMENTATION CONVENTION

Description	Represents	Examples
<b>Code (Courier font):</b>		
Plain characters	Sample code Filenames and paths	#define START c:\autoexec.bat
Angle brackets: < >	Variables	<label>, <exp>
Square brackets [ ]	Optional arguments	pic30-as [main.s]
Curly brackets and pipe character: {   }	Choice of mutually exclusive arguments; 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 upper case characters)	char isascii (char, ch) ;
<b>Interface (Arial font):</b>		
Underlined, italic text with right arrow	A menu selection from the menu bar	<u>File &gt; Save</u>
Bold characters	A window or dialog button to click	<b>OK, Cancel</b>
Characters in angle brackets < >	A key on the keyboard	<Tab>, <Ctrl-C>
<b>Documents (Arial font):</b>		
Italic characters	Referenced books	<i>MPLAB IDE User's Guide</i>

## Documentation Updates

All documentation becomes dated, and this user's guide is no exception. Since Microchip tools are constantly evolving to meet customer needs, some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site 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 the enclosed Warranty Registration Card and mail it promptly. Sending in your Warranty Registration Card entitles you to receive new product updates. Interim software releases are available at the Microchip web site.

## RECOMMENDED READING

This user's guide describes how to use the dsPICDEM.net 1 and dsPICDEM.net 2 Connectivity Development Board. Other useful documents include:

### **dsPIC30F Family Reference Manual (DS70046)**

Consult this document for detailed information on dsPIC30F device operation. This reference manual explains the operation of the dsPIC30F MCU 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 Data Sheet, Motor Control and Power Conversion Family (DS70082)**

Consult this document for detailed information on the dsPIC30F Motor Control and Power Conversion devices. Reference information found in this data sheet includes:

- Device memory map
- Device pinout and packaging details
- Device electrical specifications
- List of peripherals included on the device

### **dsPIC30F Data Sheet, General Purpose and Sensor Families (DS70083)**

Consult this document for detailed information on the dsPIC30F Sensor and General Purpose devices. Reference information found in this data sheet includes:

- Device memory map
- Device pinout and packaging details
- Device electrical specifications
- List of peripherals included on the device

### **dsPIC30F5011, dsPIC30F5013 Data Sheet, High Performance Digital Signal Controllers (DS70116)**

This data sheet contains specific information for the dsPIC30F5011/5013 Digital Signal Controller (DSC) devices.

### **dsPIC30F6011, dsPIC30F6012, dsPIC30F6013, dsPIC30F6014 Data Sheet, High Performance Digital Signal Controllers (DS70117)**

This data sheet contains specific information for the dsPIC30F6011/6012/6013/6014 Digital Signal Controller (DSC) devices.

### **dsPIC30F Programmer's Reference Manual (DS70030)**

This manual is a software developer's reference for the dsPIC30F 16-bit MCU family of devices. This manual describes the instruction set in detail and also provides general information to assist you in developing software for the dsPIC30F MCU family.

### **dsPIC30F Family Overview (DS70043)**

This document provides an overview of the functionality of the dsPIC<sup>®</sup> product family. It helps determine how the dsPIC30F 16-bit Digital Signal Controller Family fits a specific product application. This document is a supplement to the *dsPIC30F Family Reference Manual*.

### **MPLAB<sup>®</sup> ASM30, MPLAB<sup>®</sup> LINK30 and Utilities User's Guide (DS51317)**

This document helps you use Microchip Technology's language tools for dsPIC 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 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](http://www.fsf.org).

Other GNU language tools available from Microchip are:

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

## **dsPIC™ Language Tools Libraries (DS51456)**

DSP, dsPIC peripheral and standard (including math) libraries for use with dsPIC language tools.

## **GNU HTML Documentation**

This documentation is provided on the language tool CD-ROM. It describes the standard GNU development tools, upon which these tools are based.

## **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, visit the Microchip web site at [www.microchip.com](http://www.microchip.com).

## **THE MICROCHIP WEB SITE**

Microchip provides online 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, you must have access to the Internet and a web browser, such as, Netscape® Navigator or Microsoft® Internet Explorer. The Microchip web site is available at: [www.microchip.com](http://www.microchip.com).

The web site provides 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 information specific to the business of Microchip is also available, including listings of Microchip sales offices, distributors and factory representatives.

### **Technical Support**

- Frequently Asked Questions (FAQ)
- Online Discussion Groups – conferences for products, development systems, technical information and more
- Microchip Consultant Program Member Listing
- Links to other useful web sites related to Microchip products

### **Engineer's Toolbox**

- Design Tips
- Device Errata

### **Other Available Information**

- Latest Microchip Press Releases
- Listing of Seminars and Events
- Job Postings



## DEVELOPMENT SYSTEMS CUSTOMER NOTIFICATION SERVICE

Microchip started the customer notification service to help our customers stay current on Microchip products with the least amount of effort. Once you subscribe, you will receive E-mail notification whenever we change, update, revise or have errata related to your specified product family or development tool of interest.

Go to the Microchip web site at ([www.microchip.com](http://www.microchip.com)) and click on Customer Change Notification. Follow the instructions to register.

The Development Systems product group categories are:

- Compilers
- Emulators
- In-Circuit Debuggers
- MPLAB
- Programmers

Here is a description of these categories:

**Compilers** – The latest information on Microchip C compilers and other language tools. These include the MPLAB C17, MPLAB C18 and MPLAB C30 C compilers; MPASM™ and MPLAB ASM30 assemblers; MPLINK™ and MPLAB LINK30 object linkers; 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 Microchip in-circuit debuggers. These include the MPLAB ICD and MPLAB ICD 2.

**MPLAB** – 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 and MPLAB SIM30 simulators, MPLAB IDE Project Manager and general editing and debugging features.

**Programmers** – The latest information on Microchip device programmers. These include the PRO MATE® II device programmer and PICSTART® Plus development programmer.

## 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 sales offices and locations listed on the back of this publication.

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.

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## Chapter 1. Introduction

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### 1.1 INTRODUCTION

This chapter introduces several connectivity capabilities that can easily be implemented with the use of the dsPICDEM.net Connectivity Development Board.

### 1.2 HIGHLIGHTS

This chapter discusses:

- Overview
- dsPICDEM.net Package Contents
- dsPICDEM.net Board Functionality
- dsPICDEM.net Demonstration Programs
- Reference Documents

### 1.3 OVERVIEW

The dsPICDEM.net 1 and dsPICDEM.net 2 connectivity development boards are tools designed to help the application developer create and evaluate both connectivity and non-connectivity based solutions using dsPIC30F High Performance Digital Signal Controllers. The dsPICDEM.net 1 board supports the Federal Communications Commission (FCC) and Japan Approval Institute for Telecommunications Equipment (JATE) country specific Public Switched Telephone Network (PSTN). The dsPICDEM.net 2 board supports the Common Technical Regulation 21 (CTR-21) PSTN. Both boards support the Realtek 10-base T Ethernet Network Interface Controller (NIC).

Every country has telecommunication laws that prohibit the connection of unapproved telecommunication devices, including modems, to the phone line. Approval by a country's telecommunications regulatory agency may entail hardware/firmware modifications to your end-system modem in order to comply with their telecommunication laws relative to radio-frequency interference, pulse dial make/break ratios, redial capabilities, etc.

The words "approved or compliant for use in country XYZ" mean that the modem has been modified to comply with the telecommunication laws of that country. Thus, a modem approved by the FCC to work in the USA, for example, is not automatically approved by the BZT to work in Germany.

<p><b>Note:</b> For the sample applications described in this manual, connect to an analog line only. You could damage the modem if you use a non-analog line (e.g., digital or PBX multiline).</p>
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The boards come with an ITU-T compliant V.22bis/V.22 modem module and demonstration code pre-programmed on the installed dsPIC30F6014 device. This sample application lets you to connect and transfer data between the dsPIC30F Soft Modem and an ITU-T compliant reference modem. Application source code is included on the supplied development kit software CD.

The Development Kit Software CD also includes additional sample applications, a tutorial module and complete product documentation. The additional sample applications will familiarize you with the CMX-MicroNet HTTP Web and FTP Servers, which demonstrate two TCP/IP protocol based applications over the 10-Base T Ethernet Datalink layer. Product tutorials provide hands-on experience in debugging with the MPLAB ICD 2.

## 1.4 dsPICDEM.net PACKAGE CONTENTS

The following items comprise the dsPICDEM.net Connectivity Development Board package:

- The dsPICDEM.net 1 or dsPICDEM.net 2 Printed Circuit Board (supports both embedded internet and ethernet connections).
- A pre-programmed dsPIC30F6014 device on an adapter board that plugs into the main development board
- A CAT5 “crossover” network cable (RJ45 connectors) for networking the board.
- 9 VDC Power Supply
- RS-232 Interface Cable
- dsPICDEM.net Development Kit Software CD containing demonstration connectivity solutions from Microchip and it's partners along with a product tutorial and complete documentation.

## 1.5 dsPICDEM.net BOARD FUNCTIONALITY

The dsPICDEM.net Development Board (Figure 1-1) provides a basic platform for developing and evaluating solutions that use dsPIC30F6014 16-bit Digital Signal Controllers. The dsPICDEM.net Development Board includes the following capabilities:

### Power Supply

- Single on-board +5V regulator for VDD and AVDD 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 ICE 4000 Connections

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

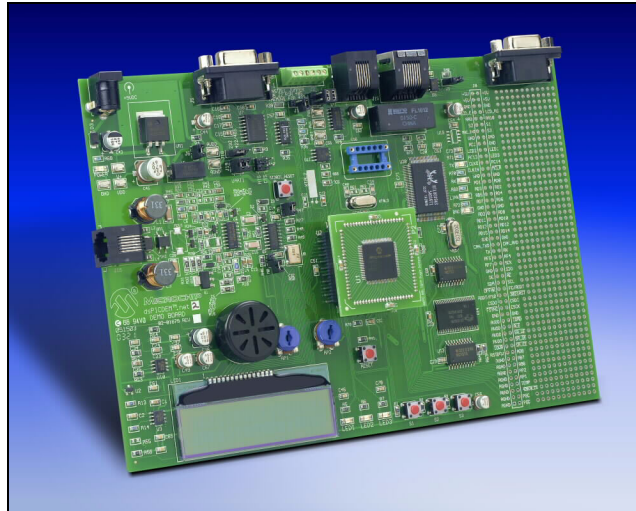
### Serial Communication Channels

- Single RS-232 communication channel
- 6-pin terminal block and configuration jumper for RS-485 and RS-422 communication on UART1 from the dsPIC device
- Single CAN communication channel

## Public-Switched Telephone Network (PSTN)

- Silicon Laboratories Si3035 DAA/AFE chipset (dsPICDEM.net 1 board)
- Silicon Laboratories Si3034 DAA/AFE chipset (dsPICDEM.net 2 board)
- Speaker for monitoring call progress
- Si3021 reset push button switch

**FIGURE 1-1: dsPICDEM.net DEVELOPMENT BOARD**



## 10-BaseT Ethernet

- Realtek RTL8019AS 10-Base T single-chip Network Interface Controller and transceiver
- Four link status LEDs
- RJ-45 (10-Base T) modular connector

## Analog

- Two 5 k $\Omega$  Potentiometers (RP1 and RP2)
- Microchip MCP42050 Digital Potentiometer (dual-channel output)
- Microchip TC1047A Thermal Sensor (U2)
- Microchip MCP602 op amp configured as low-pass filter for thermal sensor (U12)

## Device Clocking

- 7.3728 MHz crystal, X3, for dsPIC device
- Socket U16, clock oscillator for dsPIC device (alternate clock source, X3 removed)
- Pad for 32.768 kHz crystal (XTAL2) and load caps

## Miscellaneous

- Reset push button switch
- Three red LEDs (LED1-LED3)
- Three push button switches (S1-S3) for external input stimulus
- 64k x 16 External SRAM
- Microchip 24LC515 Serial EE memory device
- 2 x 16 character LCD
- 2 x 50 prototyping header for user hardware expansion (header not installed)
- Prototype area for user hardware

## 1.6 dsPICDEM.net DEMONSTRATION PROGRAMS

The dsPICDEM.net Development Board is supplied with several sample application programs for the dsPIC30F6014 to help you jump-start your own solutions. You will need the MPLAB C30 Compiler to program these applications into the dsPIC30F device. You can download a full-featured 60-day trial version of MPLAB C30 from the Microchip web site ([www.microchip.com](http://www.microchip.com)). Follow the download links under *Products/Development Tools/Software*.

Source code is provided on the Development Kit Software CD for all these demonstration programs:

- **Tutorial** – The tutorial introduces the new user to the basic skills needed to work with the dsPIC30F. It provides step-by-step instructions for programming the dsPIC30F chip with the MPLAB IDE and MPLAB C30 and debugging the program with the MPLAB ICD 2. See **Chapter 2. “Tutorial”**.
- **dsPIC30F Quick Start** – Building on the tutorial, the dsPIC30F demonstration uses a sample application to illustrate functionality of the dsPIC30F and its peripherals interacting with components on the dsPICDEM.net board. This application is described fully in **Chapter 3. “Quick Start Program”**.
- **HTTP Web Server Demonstration** – This sample application illustrates an embedded web server that supports remote monitoring and control over a 10-Base T Ethernet connection. This demonstration program uses the CMX-MicroNet TCP/IP Stack configured for HTTP Web Server protocol. This sample application is described fully in **Chapter 4. “HTTP Web Server Demonstration”**.
- **FTP Server Demonstration** – This demonstration illustrates an embedded FTP server application that provides remote monitoring and control over a 10-Base T Ethernet connection. This sample application uses the CMX-MicroNet TCP/IP Stack configured for FTP Server protocol. This demonstration is described fully in **Chapter 5. “FTP Server Demonstration”**.
- **V.22bis Soft Modem Demonstration** – The dsPIC30F6014 plug-in device is pre-programmed with an ITU-T compliant V.22bis/V.22 modem demonstration that lets you to connect and transfer data between the dsPIC30F Soft Modem and an ITU-T compliant reference modem. This demonstration is described fully in **Chapter 6. “V.22bis Soft Modem Demonstration”**.

## 1.7 REFERENCE DOCUMENTS

The following documentation is available to support your use of the dsPICDEM.net Development Board:

- *dsPIC30F Family Reference Manual* (DS70046)
- *dsPIC30F Data Sheet, Motor Control and Power Conversion Family* (DS70082)
- *dsPIC30F Data Sheet, General Purpose and Sensor Families* (DS70083)
- *dsPIC30F5011, dsPIC30F5013 Data Sheet, High Performance Digital Signal Controllers* (DS70116)
- *dsPIC30F6011, dsPIC30F6012, dsPIC30F6013, dsPIC30F6014 Data Sheet, High Performance Digital Signal Controllers* (DS70117)
- *dsPIC30F Programmer's Reference Manual* (DS70030)
- *dsPIC High Performance 16-bit Digital Signal Controller Family Overview* (DS70043)
- *MPLAB C30 C Compiler User's Guide* (DS51284)
- *MPLAB ASM30, MPLAB LINK30 and Utilities User's Guide* (DS51317)
- *MPLAB ICD 2 In-Circuit Debugger Quick Start Guide* (DS51268)
- *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](http://www.microchip.com)).

NOTES:



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## Chapter 2. Tutorial

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### 2.1 INTRODUCTION

This chapter is a self-paced tutorial intended to get you started using the dsPICDEM.net Development Board. The tutorial demonstrates basic techniques for using the dsPIC30F development tools with the connectivity board.

### 2.2 HIGHLIGHTS

This chapter discusses:

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

### 2.3 TUTORIAL OVERVIEW

This tutorial combines step-by-step instructions for using the dsPIC development tools with files provided on the Development Kit Software CD to exercise key features of the MPLAB IDE, MPLAB ICD 2 and MPLAB C30 for programming and debugging the dsPIC30F chip.

There are three or four steps to this tutorial, depending on the debug tool being used.

1. Create a project in MPLAB
2. Assemble and link the code
3. Program the chip if the MPLAB ICD 2 is being used
4. Debug the code with the MPLAB ICD 2

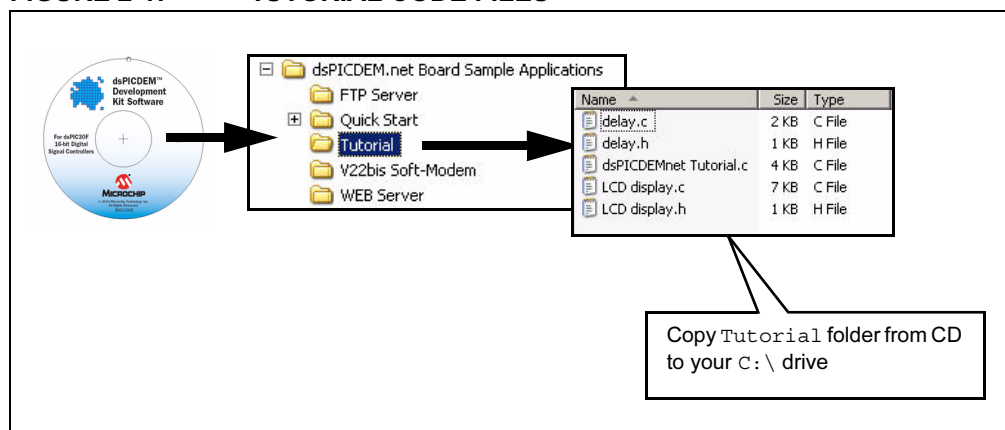
The MPLAB ICD 2 is used in the tutorial to illustrate debugging.

### 2.4 CREATING THE PROJECT

The first step is to create a project and a workspace in MPLAB. Usually, you will have one project in one workspace. 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 IDE configuration settings. MPLAB IDE contains a Project Wizard to help create new projects.

Before starting, copy the Tutorial files from the dsPICDEM.net Sample Applications folder on the dsPICDEM.net Development Kit Software CD to your c:\ drive (see Figure 2-1).

FIGURE 2-1: TUTORIAL CODE FILES



Your c:\Tutorial folder should now contain these files:

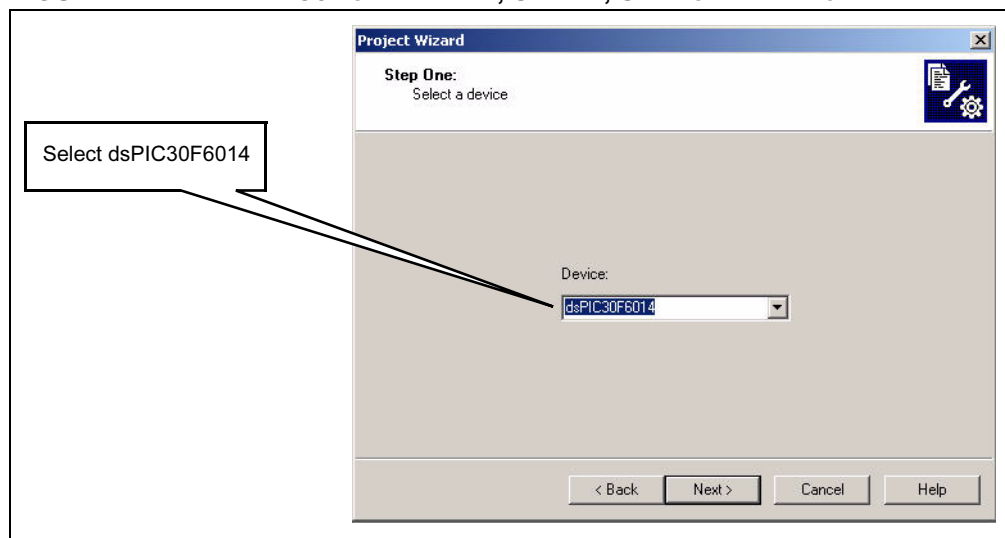
- delay.c
- delay.h
- dsPICDEM net Tutorial.c
- LCD Display.c
- LCD Display.h

**Note:** Files copied from the CD are read only; you will need to change the attributes of files that need to be edited.

## 2.4.1 Select a Device

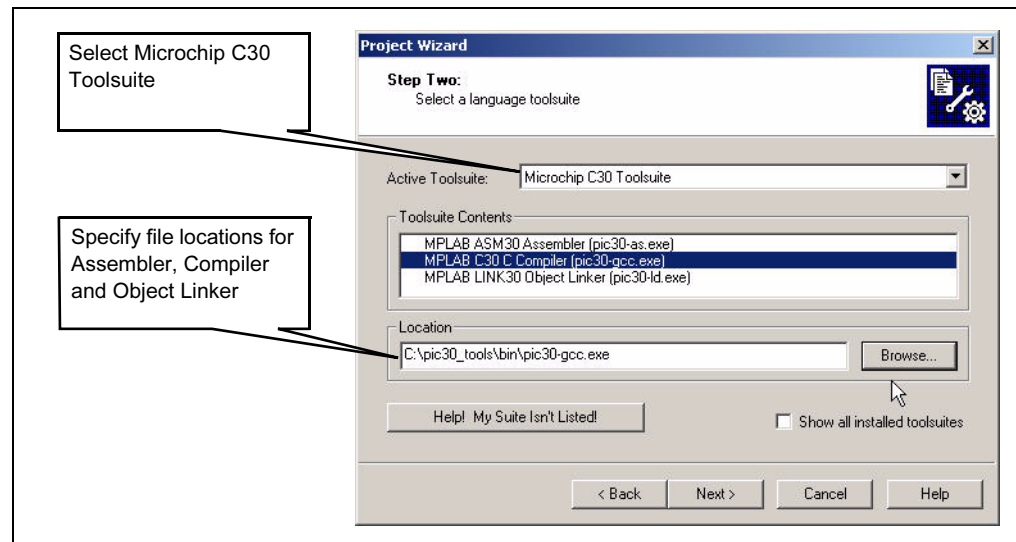
1. Start MPLAB IDE
2. Close any workspace that might be open (*File>Close Workspace*).
3. From the Project menu, select *Project Wizard*.
4. From the Welcome screen, click the **Next>** to display the Project Wizard Step One dialog (see Figure 2-2).

FIGURE 2-2: PROJECT WIZARD, STEP 1, SELECT A DEVICE



5. Select dsPIC30F6014 as the device and click **Next>**. The Project Wizard Step Two dialog displays (see Figure 2-3).

**FIGURE 2-3: PROJECT WIZARD, STEP 2, SELECT LANGUAGE TOOLSUITE**



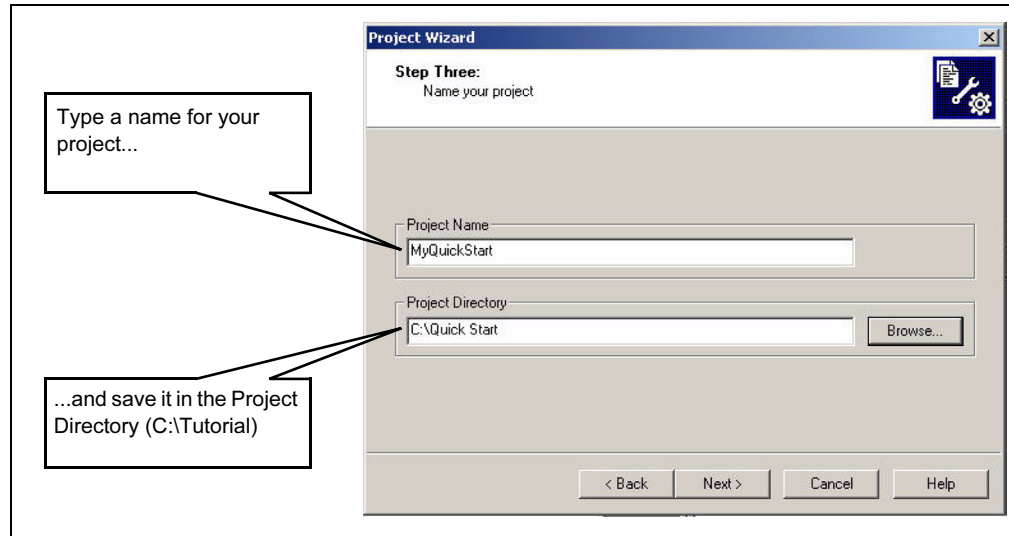
## 2.4.2 Select Language Toolsuite

1. From the **Active Toolsuite** pull-down menu, select Microchip C30 Toolsuite. This toolsuite includes the compiler, assembler and linker that will be used.
2. From **Toolsuite Contents**, select MPLAB ASM 30 Assembler (pic30-as.exe).
3. In the **Location** group, click **Browse...** and navigate to:  
C:\pic30\_tools\Bin\pic30-as.exe

**Note:** C:\ is the drive implemented for this tutorial example. The specific location on your system will depend on where you installed the MPLAB C30 compiler. If you haven't purchased the MPLAB C30 compiler, you can download a full-featured 60-day trial version from the Microchip web site ([www.microchip.com](http://www.microchip.com)). Follow the download links under *Products/Development Tools/Software*.

4. From **Toolsuite Contents**, select MPLAB C30 Compiler (pic30-gcc.exe).
5. In the **Location** block, click **Browse...** and navigate to:  
C:\pic30\_tools\Bin\pic30-gcc.exe
6. From **Toolsuite Contents**, select MPLAB LINK30 Object Linker (pic30-ld.exe).
7. In the **Location** block, click **Browse...** and navigate to:  
C:\pic30\_tools\Bin\pic30-ld.exe.
8. Click **Next>** to continue. The Project Wizard Step Three dialog displays (see Figure 2-4).

FIGURE 2-4: PROJECT WIZARD, STEP 3, NAME YOUR PROJECT



### 2.4.3 Name Your Project

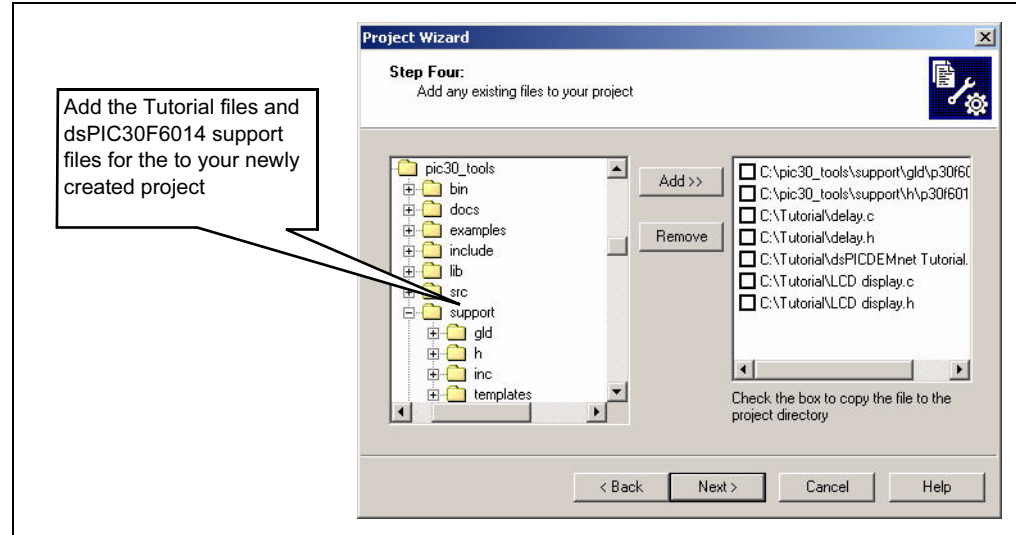
1. In the **Project Name** text box, type **MyTutorial**.
2. Click **Browse...** and navigate to **C:\Tutorial** to place your project in the Tutorial folder.
3. Click **Next>** to continue.

### 2.4.4 Add Files to Project

1. On the Project Wizard Step Four dialog (see Figure 2-5), locate the **C:\Tutorial** folder and add these files to the right side.  
`dsPICDEMnet Tutorial.c`  
`LCD Display.c`  
`LCD Display.h`  
`delay.c`  
`delay.h`
2. Navigate to the **C:\pic30\_tools\support\gld** folder and add file **p30f6014.gld** to include the linker script file in the project.
3. Navigate to the **C:\pic30\_tools\support\h** folder and add file **p30f6014.h** to include the header file in the project.

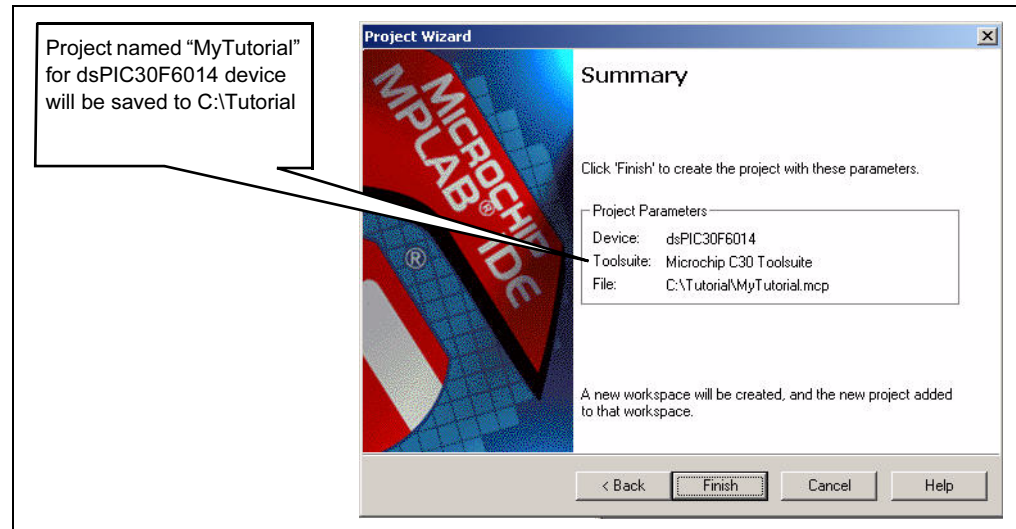
**Note:** The linker script file and header file locations for your environment may be different. The location will depend on where you installed the C30 compiler.

**FIGURE 2-5: PROJECT WIZARD, STEP 4, ADD FILES TO PROJECT**



4. There should now be seven files in the project. Click **Next>** to continue. The Project Wizard Summary screen (Figure 2-6) displays the parameters of your project.

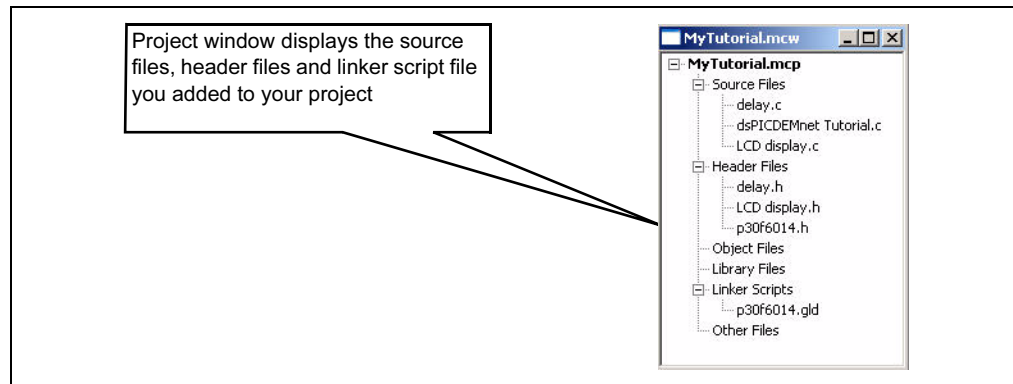
**FIGURE 2-6: PROJECT WIZARD SUMMARY SCREEN**



5. Click **Finish**.

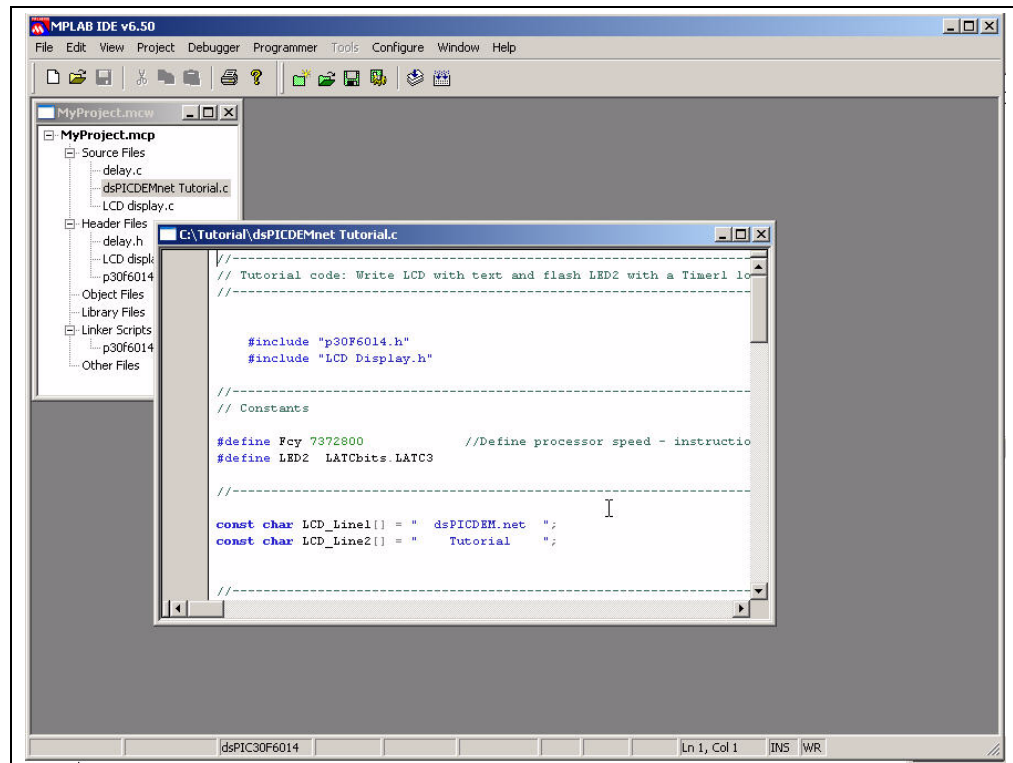
After the project wizard completes, the MPLAB project window shows the project and all the added files (see Figure 2-7).

**FIGURE 2-7: PROJECT WINDOW**



At this point a project and workspace have been created in MPLAB. MyTutorial.mcw is the workspace file and MyTutorial.mcp is the project file. Double-click the dsPICDEMnet Tutorial.c file in the project window to open it. MPLAB should look similar to Figure 2-8.

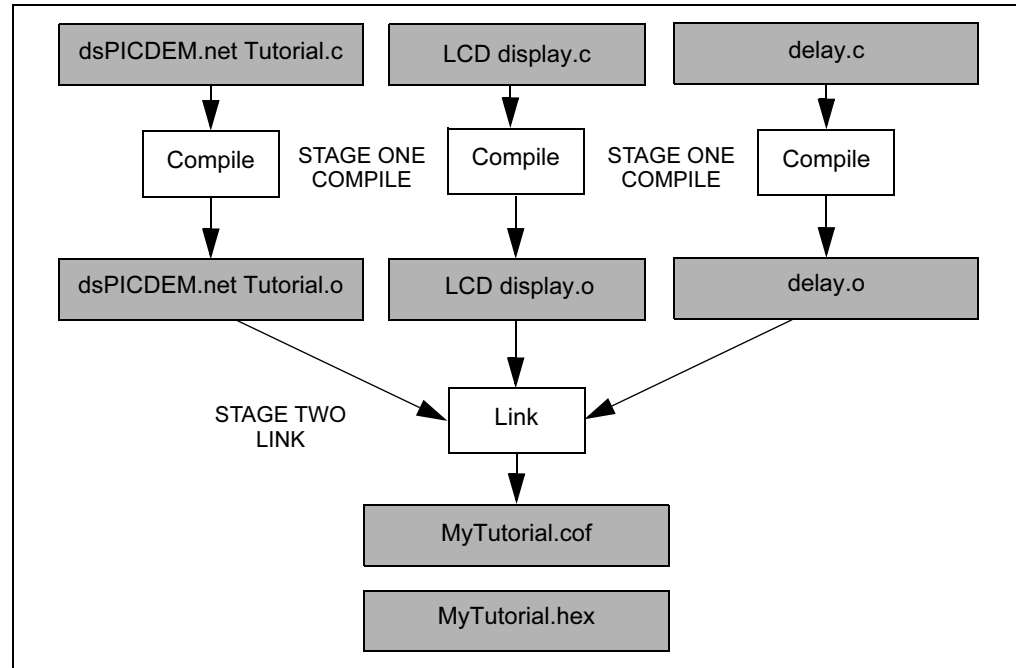
**FIGURE 2-8: MPLAB WORKSPACE**



## 2.5 BUILDING THE CODE

In this project, the code is built in two stages, as shown in Figure 2-9. First the source files are compiled into object files, then the object files are linked.

**FIGURE 2-9: CODE BUILDING PROCESS**



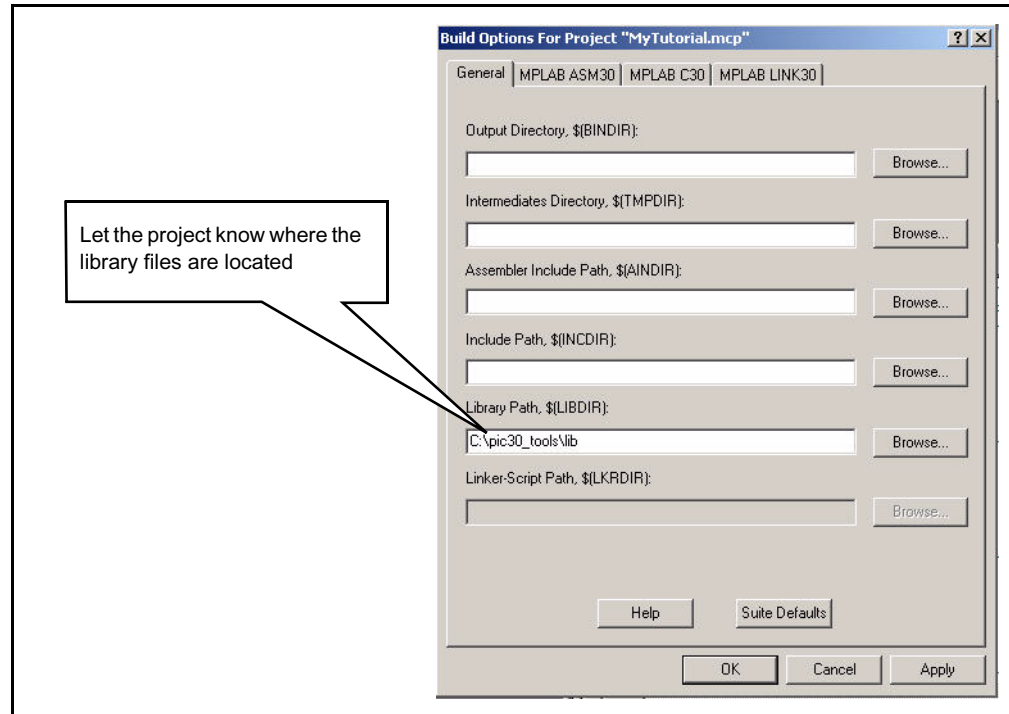
The `MyTutorial.hex` output file contains the data necessary to program the device. The `MyTutorial.cof` output file contains additional information that lets you debug the code at the source code level.

Before building, there are compiler and linker settings that must be specified. These settings indicate where to find the C library files and where to reserve space for the extra debug code when the MPLAB ICD 2 (In-Circuit Debugger) is used.

### 2.5.1 Set Project Build Options

The tutorial project does not explicitly use any libraries, but the C compiler startup library code is always automatically linked into the project. Use the *Project>Build Options>Project* menu to specify the location of the library files as shown in Figure 2-10.

FIGURE 2-10: BUILD OPTIONS



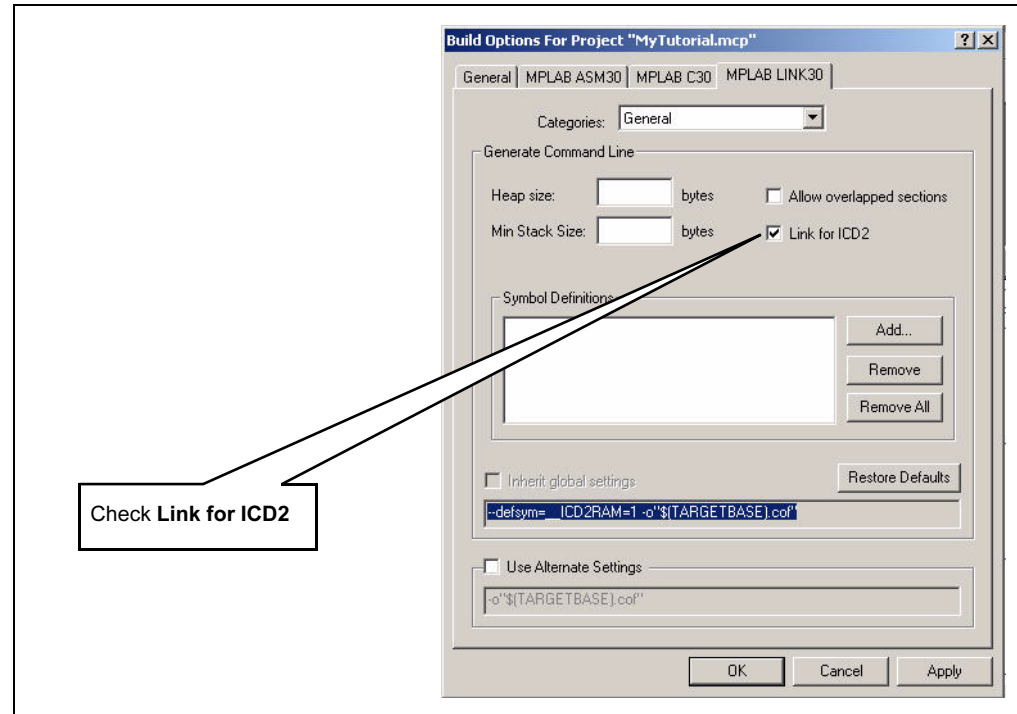
1. Select the Build Options General tab.
2. Add a Library Path by browsing to:  
C:\pic30\_tools\lib

**Note:** The library path for your environment may be different. The location will depend on where you installed the C30 compiler.

3. Select the MPLAB LINK30 tab to display the linker settings (see Figure 2-11).



**FIGURE 2-11: MPLAB LINK30 BUILD OPTIONS**



4. Check **Link for ICD2** to tell the linker to reserve space for the debug code used by the MPLAB ICD 2 In-Circuit Debugger.
5. Click **OK**.

## 2.5.2 Build the Project

At this point the project is ready to build.

1. From the Project menu select Make. The Build Output window displays (see Figure 2-12).
2. Observe the progress of the build.
3. When the BUILD SUCCEEDED message displays you are ready to program the device.

FIGURE 2-12: BUILD OUTPUT

```

Output
Build Version Control Find in Files
Make: The target "C:\Tutorial\LCD display.o" is out of date.
Executing: "C:\pic30_tools\bin\pic30-gcc.exe" -D__dsPIC30F6014__ -c -x c "LCD display.c" -o "LCD display.o" -g
Make: The target "C:\Tutorial\MyTutorial.cof" is out of date.
Executing: "C:\pic30_tools\bin\pic30-gcc.exe" -Wl,"C:\Tutorial\delay.o","C:\Tutorial\dsPICDEMnet Tutorial.o","C:\Tutorial\MyTutorial.o" -o "MyTutorial.cof"
writing MyTutorial.hex

section      PC address      byte address      length (w/pad)      actual length  (dec)
-----
.reset       0                      0                   0x8                  0x6 (6)
.text        0x100                 0x200              0x4ec               0x3b1 (945)
.dinit       0x376                 0x6ec              0x4                  0x3 (3)
.const       0x378                 0x6f0              0x44                0x33 (51)
.ivt         0x4                   0x8                0xf8                0xba (186)
.aivt        0x84                  0x108              0xf8                0xba (186)
.isr         0x39a                 0x734              0x4                  0x3 (3)

Total program memory used (bytes): 0x564 (1380)

Executing: "C:\Program Files\MPLAB IDE\dsPIC_Tools\Bin\Lcoff_iCoff.exe" "MyTutorial.cof"
Loaded C:\Tutorial\MyTutorial.cof
BUILD SUCCEEDED: Mon May 10 15:49:01 2004
    
```

If you experience problems with the build, double check all the steps in this tutorial and ensure that you are using the latest versions of the development tools. The latest upgrades are available on the Microchip web site ([www.microchip.com](http://www.microchip.com)).

If there are errors in the source code, you can double-click the error messages in the Output window and MPLAB will point to the offending line in the source code. This should not happen if the files were copied from the dsPICDEM.net Development Kit CD.

## 2.6 DEVICE CONFIGURATION AND PROGRAMMING

After you have built the code you must set up the configuration bits and then connect the tool you plan to use for programming, running and debugging the code.

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

### 2.6.1 Set Up Device Configuration

From the *Configure* menu select *Configuration Bits* to view the configuration bits (see Figure 2-13). Accept the settings resulting from your build. However, make sure these device categories are set up as shown here:

Category	Setting
Oscillator Source	Primary Oscillator
Primary Oscillator Mode	XT w/PLL 4x
Watchdog Timer	Disabled
Comm Channel Select	Use PGC/EMUC and PGD/EMUD

**FIGURE 2-13: CONFIGURATION SETTINGS**

Configuration Bits			
Address	Value	Category	Setting
F80000	FFF5	Clock Switching and Monitor	Sw Disabled, Mon Disabled
		Oscillator Source	Primary Oscillator
		Primary Oscillator Mode	XT w/PLL 4x
F80002	7FFF	Watchdog Timer	Disabled
		WDT Prescaler A	1:512
		WDT Prescaler B	1:16
F80004	FFCF	Master Clear Enable	Enabled
		PEOR Enable	Enabled
		Brown Out Voltage	4.5V
		POR Timer Value	64ms
F8000A	FFFF	General Code Segment Code Protect	Disabled
		General Code Segment Write Protect	Disabled
F8000C	C003	Comm Channel Select	Use PGC/EMUC and PGD/EMUD

After building the code and setting the configuration bits, use the MPLAB ICD 2 debugger to program the device and run and debug the code on the dsPICDEM.net Demonstration Board.

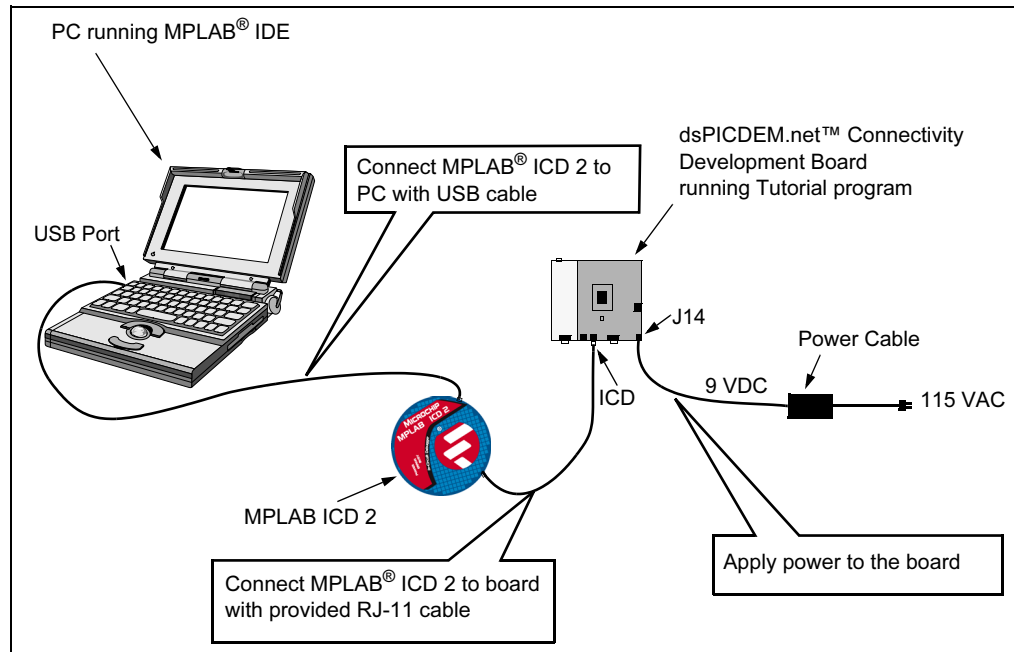
## 2.6.2 Enabling the MPLAB ICD 2 Connection

The MPLAB ICD 2 can be used to program and debug the dsPIC30F6014 device in-circuit on the dsPICDEM.net board.

**Note:** Before proceeding, make sure that the USB driver for the MPLAB ICD 2 has been installed on your PC (see the *MPLAB ICD 2 User's Guide* (DS51331) for details regarding the installation of the USB driver).

1. Connect the MPLAB ICD 2 to the PC with the USB cable (see Figure 2-14).
2. Connect the MPLAB ICD 2 to modular connector labeled ICD on the dsPICDEM.net board with the provided short RJ-11 cable.
3. Apply power to the board.

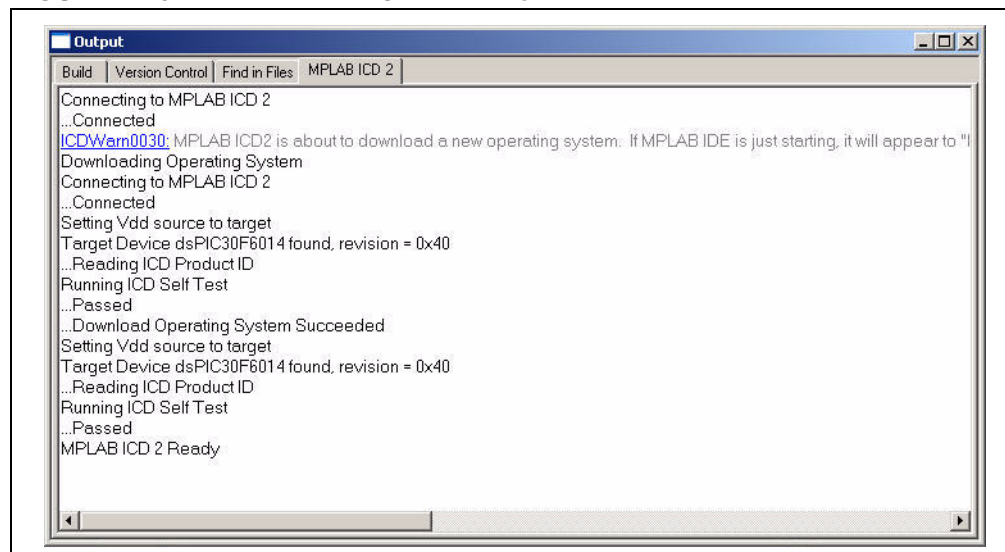
**FIGURE 2-14: TUTORIAL DEMONSTRATION SETUP**



4. From the *Debugger>Select Tool* menu, select **MPLAB ICD 2** as the debug tool.
5. From the *Debugger* menu, select **Connect**. MPLAB should report that it found the dsPIC30F6014 as shown in Figure 2-15.

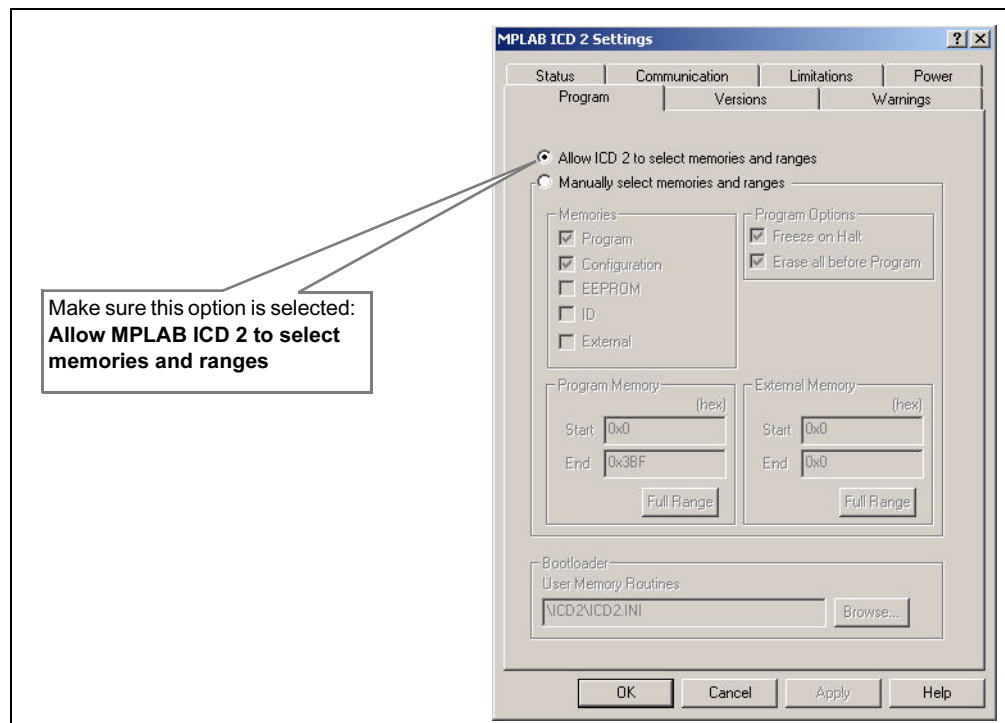
**Note:** MPLAB may need to download new firmware if this is the first time the MPLAB ICD 2 is being used with a dsPIC30F device. Allow it to do so. If any errors are shown, double-click the error message to get more information.

**FIGURE 2-15: ENABLING MPLAB ICD 2**



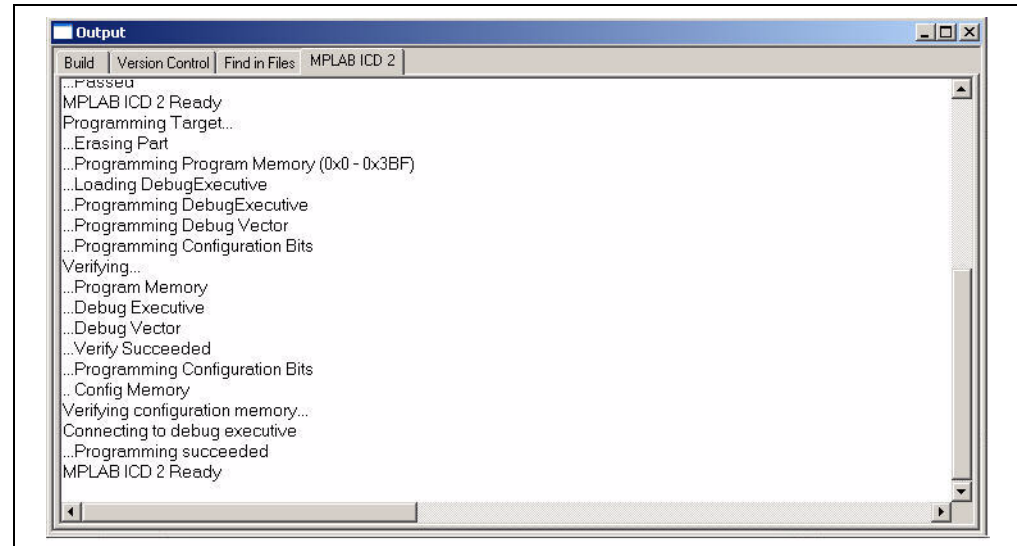
6. From the *Debugger* menu, select **Settings** to display the ICD Debugger settings (see Figure 2-16).

**FIGURE 2-16: MPLAB ICD 2 DEBUGGER SETTINGS**



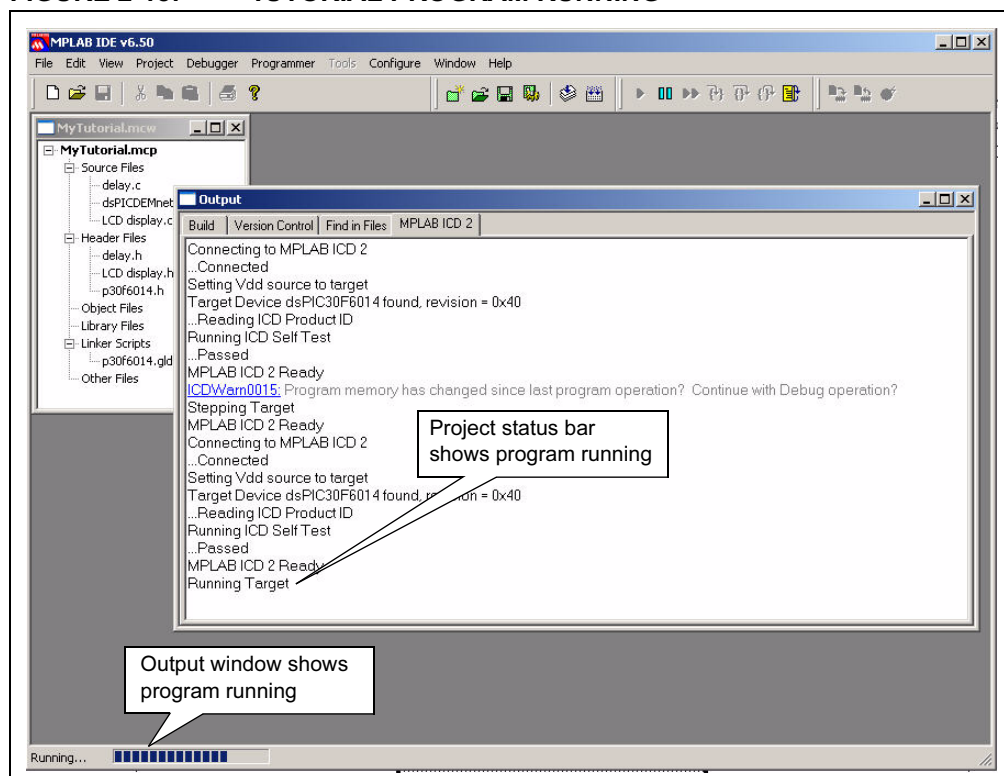
7. On the Program tab, ensure that **Allow ICD 2 to select memories and ranges** is selected. This setting will speed up programming by addressing only a small part of the total program memory.
8. Program the part (*Debugger>Program*). The Output window shows the results of the programming cycle as shown in Figure 2-17. The part is now programmed and is ready to run.

**FIGURE 2-17: MPLAB ICD 2 PROGRAM READY**



9. Run the code (*Debugger>Run*). The MPLAB Output window should indicate that the target is running (see Figure 2-18).

**FIGURE 2-18: TUTORIAL PROGRAM RUNNING**



On the board, LED2 should start blinking and the LCD display should display the following text:

**dsPICDEM.net**  
**Tutorial**

**Note:** When debugging with MPLAB ICD 2, it is always necessary to reprogram the part with the new code after each build. MPLAB will remind you with a message that states "Program memory has changed since last operation."

## 2.7 DEBUGGING THE CODE

The MPLAB ICD 2 debugger/programmer can be used to run, halt, and step the code. You can set a breakpoint so that program execution halts after the code has executed the instruction at the breakpoint. A green arrow points to the next line to be executed. The contents of the RAM and registers can be viewed when the processor has been halted.

MPLAB ICD 2 uses the following function keys to access the main debugging functions:

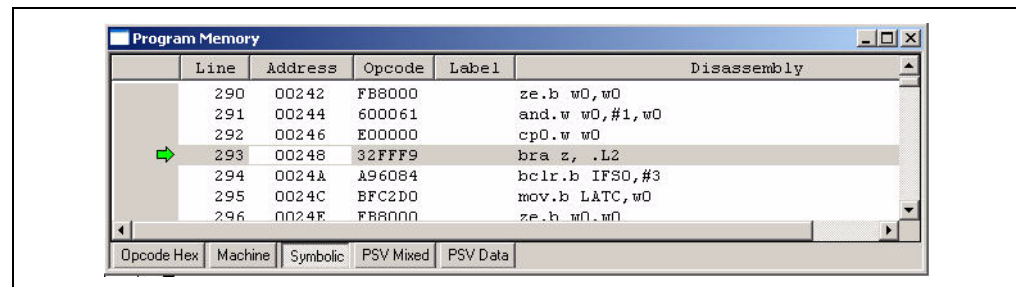
<F5>	Halt
<F6>	Reset
<F7>	Single Step
<F9>	Run

There are more functions available by right clicking on a line of source code. The most important of these are Set Breakpoint and Run to Cursor.

### 2.7.1 Display the Code

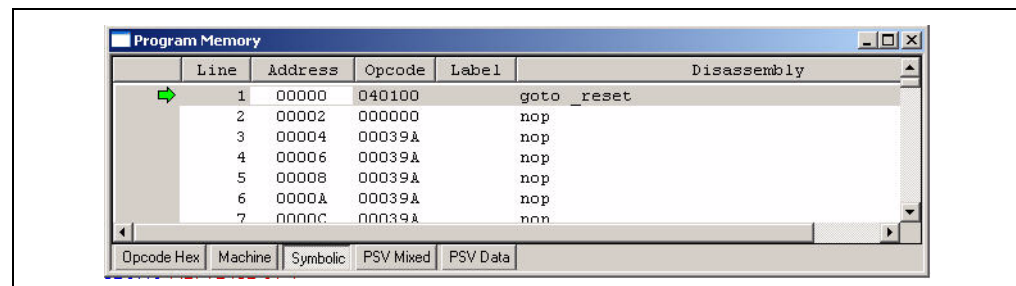
1. From the View menu, select Program Memory. The Program Memory window displays.
2. Select the **Symbolic** tab at the bottom of the window.
3. Press <F5> to halt the processor. The program stops and the green arrow points to the next instruction, as shown in Figure 2-19.

**FIGURE 2-19: PROGRAM HALTED**



4. Press <F6> to reset the program. The green arrow moves to address 00000, the `goto _reset` instruction, as shown in Figure 2-20. The linker inserted this instruction to make the program branch to the start of the code.

**FIGURE 2-20: PROGRAM RESET**



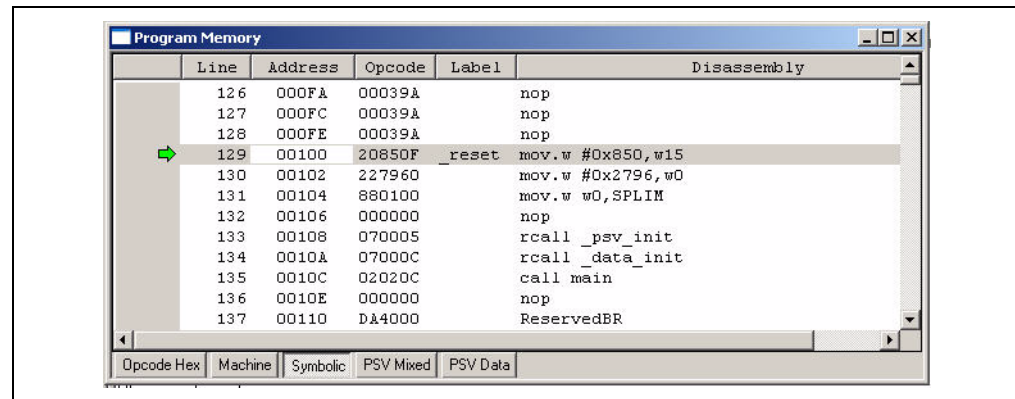


## 2.7.2 Step the Program

1. Press <F7> to single step the code. The green arrow moves to line 129, `_reset` `mov.w #0x850,w15`, as shown in Figure 2-21.

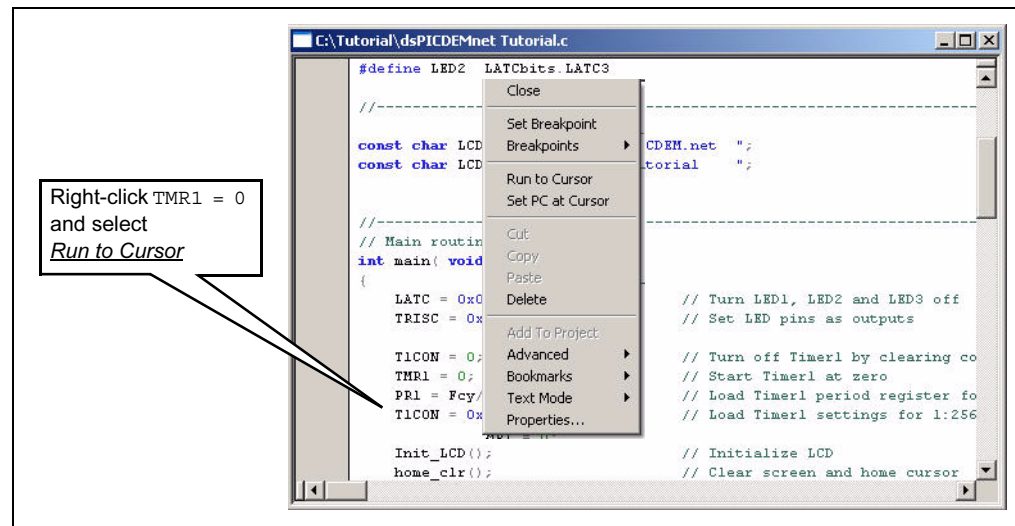
This code comes from a library (archive) file, `libpic30.a`, which is automatically linked into C30 compiler projects. This code line initializes the stack pointer and is part of the initialization code that the C30 compiler uses to set up the stack and initialize data. Notice line 135, `call main`. This instruction calls the `main()` routine from the `dsPICDEMnet Tutorial.c` source file.

**FIGURE 2-21: PROGRAM SINGLE STEPPED**



2. Open the `dsPICDEMnet Tutorial.c` source file. Double click on the file name in the Project Window if the file is not already open.
3. Select and right click line `TMR1 = 0;`, then choose Run to Cursor, as shown in Figure 2-22.

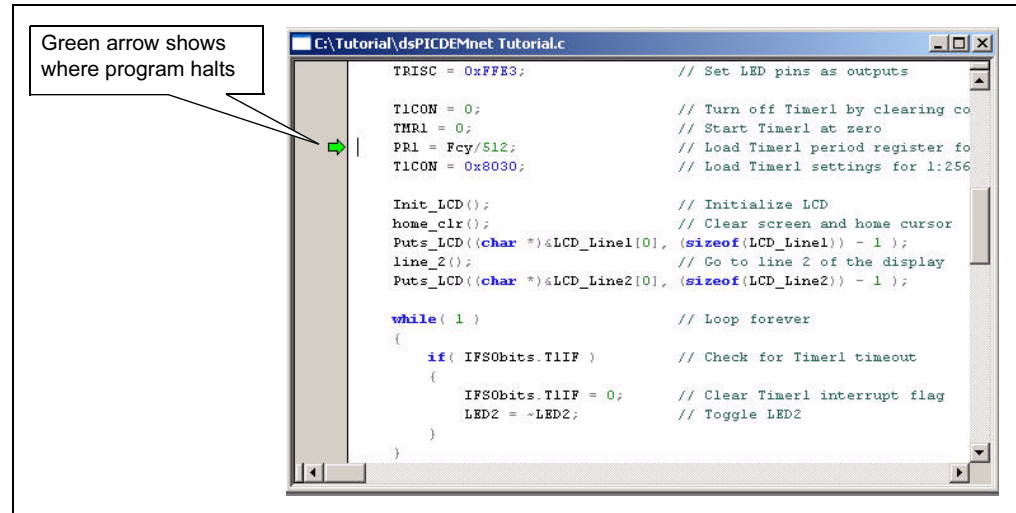
**FIGURE 2-22: RUN TO CURSOR COMMAND**



The code runs briefly until it reaches the specified line. It then halts with the green arrow pointing to the next line, as shown in Figure 2-23.

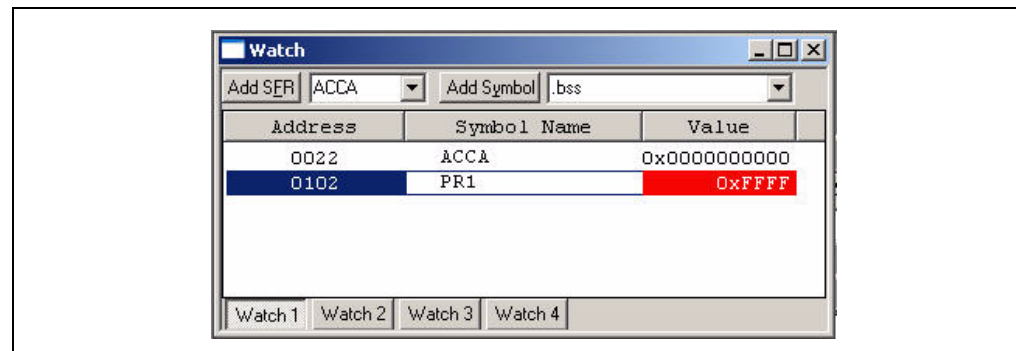


**FIGURE 2-23: PROGRAM HALTED AT CURSOR LOCATION**



4. From the View menu select Watch to open a Watch Window.
5. Select PR1 from the SFR pull-down list, then click **Add SFR**. The PR1 register is added to the Watch Window, as shown in Figure 2-24.
6. Press <F7> twice. Watch the PR1 value change to 0x3840 as the green arrow moves to PR1 = Fcy/512; in the code window.

**FIGURE 2-24: WATCH WINDOW DISPLAY**



## 2.7.3 Set Breakpoint

1. To set a breakpoint, right-click a line and select Set Breakpoint from the pop-up menu.

**Note:** An alternate method is to simply double click the line. This feature may need to be enabled by using the Edit>Properties menu.

For this example, find the following line of code and set a breakpoint.

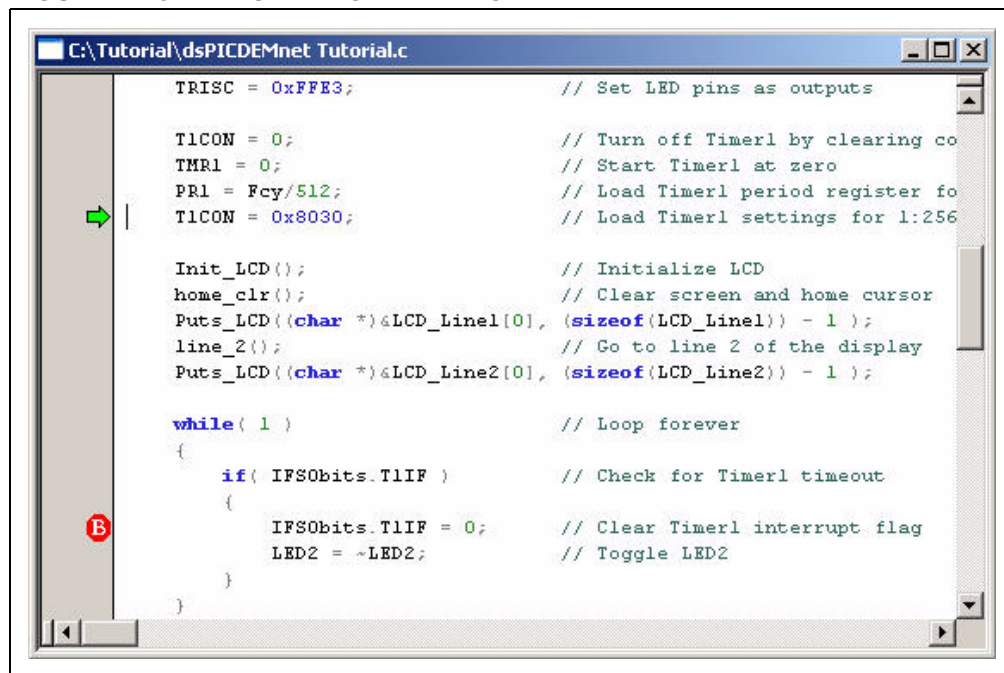
```
IFS0bits.T1IF = 0;
```

A red stop sign should appear in the gutter (grey bar on the left) of the source code window, as shown in Figure 2-25.

2. Press <F9> to run the code. The program will halt on the instruction following the breakpoint.

In this example, every time <F9> is pressed to run the code, the program runs through the timing delay loop once before reaching the breakpoint. It toggles LED2 each time.

**FIGURE 2-25: SETTING BREAKPOINT**



## 2.8 SUMMARY

This tutorial has demonstrated several features of the MPLAB IDE programmer and the MPLAB C30 compiler. It also demonstrated the use of the MPLAB ICD 2 debugger with the dsPICDEM.net board. After completing this tutorial you should be able to:

- Create a project using the project Wizard.
- Compile and link the code and set the configuration bits.
- Set up MPLAB to use the MPLAB ICD 2.
- Program the chip with the MPLAB ICD 2.
- View the code execution in program memory and source code.
- View registers in a Watch Window.
- Set a breakpoint and make the code halt at a chosen location.
- Use the function keys to Reset, Run, Halt and Single Step the code.

You can now add functionality to this simple project to create your own application.

To familiarize yourself with several dsPIC peripherals and associated board functions proceed to **Chapter 3. “Quick Start Program”**. The quick start sample project in Chapter 3 provides several code module building blocks to help you accelerate your proficiency with the dsPICDEM.net board.

---

## **Chapter 3. Quick Start Program**

---

### **3.1 INTRODUCTION**

This chapter describes a demonstration program made up of several Assembly and C module building blocks that exercise dsPIC30F peripherals and associated hardware on the dsPICDEM.net Development Board. These code modules are intended to increase your comfort level with the dsPIC by getting you started initializing and controlling peripherals. Additional code modules are provided to initialize and perform loopback tests on board hardware such as the 64Kx16 SRAM, RealTek 10-Base T NIC and Si303x Data Access Arrangement (DAA) and Analog Front End (AFE) circuits.

### **3.2 HIGHLIGHTS**

This chapter discusses:

- Quick Start Program Overview
- Creating the Project
- Building the Code
- Device Configuration and Programming
- Interacting with the Code
- Quick Start Demonstration Features and Peripherals
- Data and Control Flow
- Summary

### **3.3 QUICK START PROGRAM OVERVIEW**

The quick start program is provided to accelerate your proficiency in working with the dsPIC30F device and dsPICDEM.net Development Board to create your own embedded solutions. The building block code modules can be used to initialize and control several dsPIC peripherals and associated board functions.

The quick start program will also increase your familiarity with the dsPIC software development tools. You will use the MPLAB IDE to create a quick start project. You will use the MPLAB C30 compiler to build the quick start program. And you will use the MPLAB ICD 2 debugger to program the dsPIC30F chip and debug the program on the board. If you have not yet purchased the MPLAB C30 compiler you will need to download and install the full-feature 60-day trial available from the Microchip web site.

The quick start program basically displays information on the LCD screen and toggles LEDs in response to specific actions. Source files are provided on the dsPICDEM.net Development Kit Software CD in the dsPICDEM.net Board Sample Applications/Quick Start folder. Full source code is provided to assist in debugging.

The source files are used with a linker script file (`p30f6014.gld`) and a header file (`p30f6014.h`) from the MPLAB C30 compiler to form a simple quick start project. As you work with the step-by-step instructions you will become increasingly familiar with key features of the dsPIC30F.

There are three or four steps to this quick start, depending on the debug tool being used:

1. Create a project in MPLAB
2. Assemble and link the code
3. Program the chip if the MPLAB ICD 2 is being used
4. Debug the code with the MPLAB ICD 2

The MPLAB ICD 2 is used in the quick start procedures to illustrate debugging.

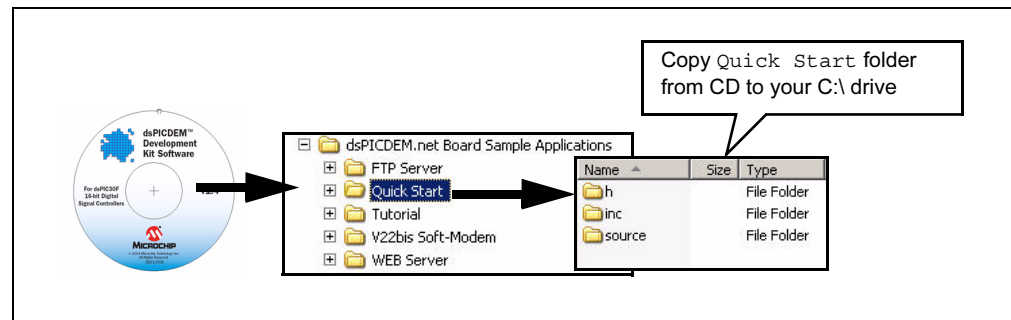
## 3.4 CREATING THE PROJECT

The first step is to create a project and a workspace in MPLAB. Usually, you will have one project in one workspace. 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 IDE configuration settings. MPLAB IDE contains a Project Wizard to help create new projects.

Before starting, copy the `Quick Start` folder on the dsPICDEM.net Development Kit Software CD to your `c:\` drive (see Figure 3-1).

**Note:** Files copied from the CD are read only; you will need to change the attributes of files that need to be edited.

**FIGURE 3-1: DEMONSTRATION CODE FILES**



The folder should contain these files:

### h files:

- `defines.h`
- `delay.h`
- `lcd.h`
- `nic_init_param.h`
- `nic_strings.h`
- `strings.h`

### inc files

- `device_Fcy.inc`
- `Si3021_mode.inc`
- `Si3021_outputs.inc`

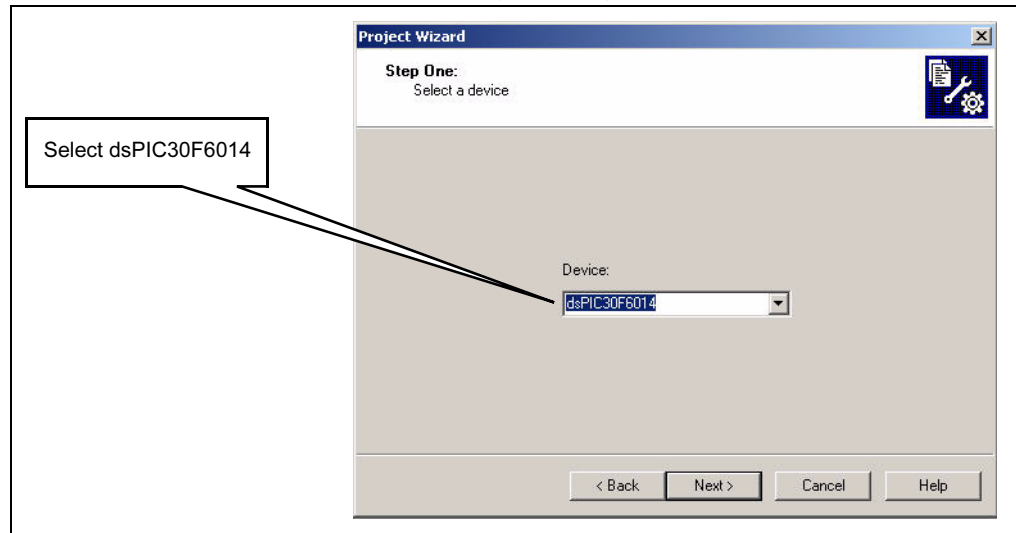
## source files

- |                      |                     |
|----------------------|---------------------|
| • 1khz.s             | • init_Sram.c       |
| • 2khz.s             | • init_Timers.s     |
| • bin2dec.c          | • init_Uart.s       |
| • Dac_Update.c       | • isr_Adc.s         |
| • delay.c            | • isr_Dci.s         |
| • device_config.s    | • isr_INTpin.s      |
| • display.s          | • isr_RealTek_NIC.s |
| • init_Adc.s         | • isr_Timers.s      |
| • init_Dci.s         | • isr_Uart1_tx.s    |
| • init_INTpin.s      | • lcd.c             |
| • init_Ports.s       | • main.c            |
| • init_RealTek_NIC.c | • TestCAN.c         |
| • init_Si3021.s      | • TestUart1.c       |
| • init_Spi1.s        | • traps.c           |

### 3.4.1 Select a Device

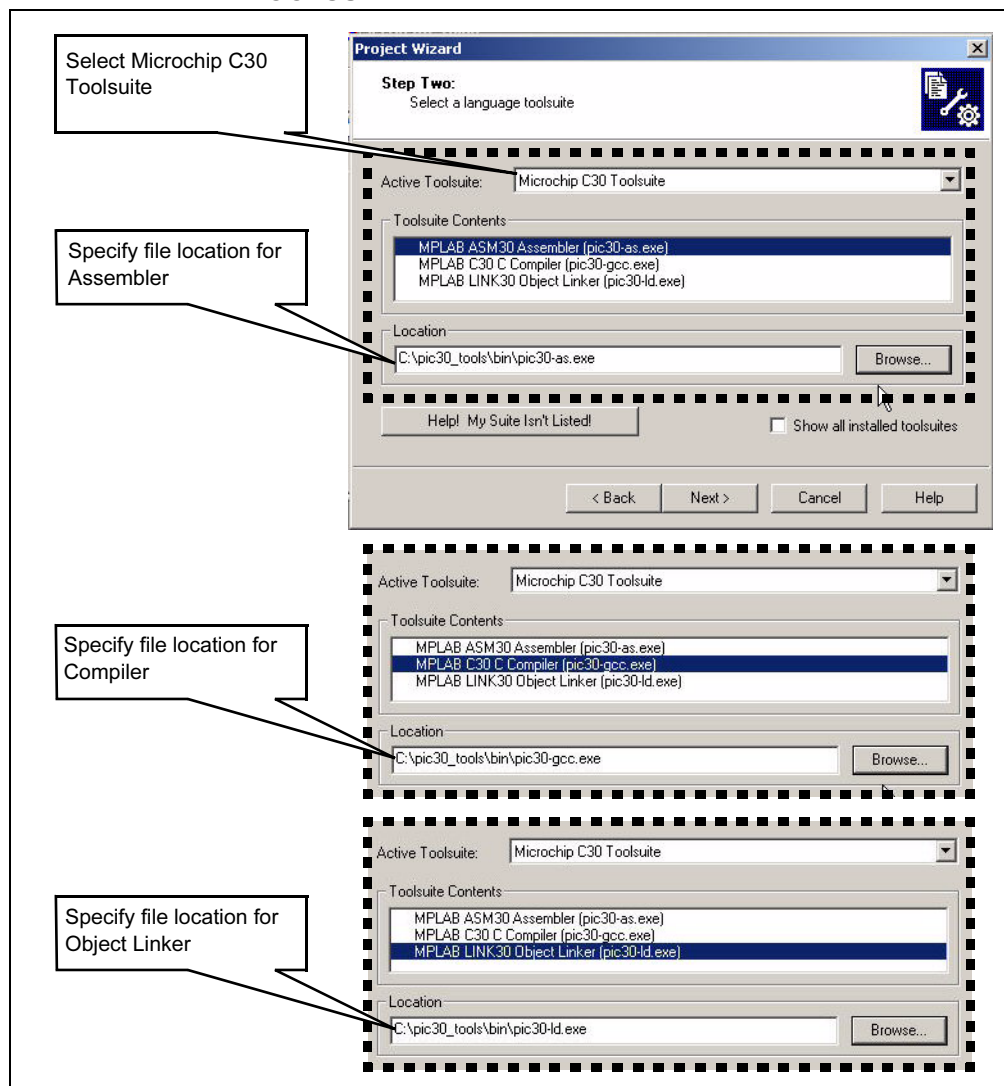
1. Start MPLAB IDE.
2. Close any workspace that might be open (*File>Close Workspace*).
3. From the Project menu, select *Project Wizard*.
4. From the Welcome screen, click the **Next>** to display the Project Wizard Step One dialog (see Figure 3-2).

FIGURE 3-2: PROJECT WIZARD, STEP 1, SELECT A DEVICE



5. Select dsPIC30F6014 as the device and click **Next>**. The Project Wizard Step Two dialog displays (see Figure 3-3).

FIGURE 3-3: PROJECT WIZARD, STEP 2, SELECT LANGUAGE TOOLSUITE



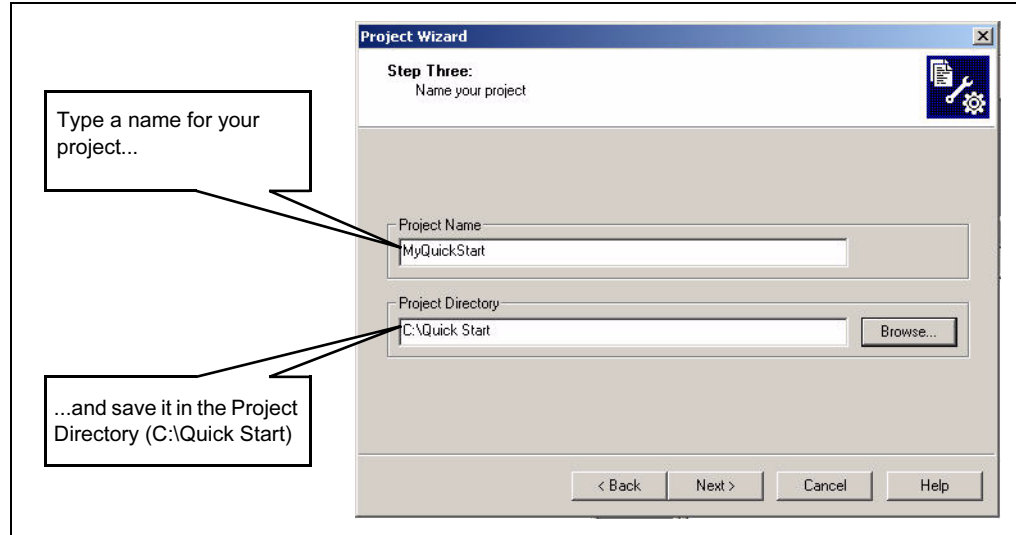
### 3.4.2 Select Language Toolsuite

1. From the **Active Toolsuite** pull-down menu, select Microchip C30 Toolsuite. This toolsuite includes the compiler, assembler and linker that will be used.
2. Set **Toolsuite Contents** to MPLAB ASM 30 Assembler (pic30-as.exe).
3. Set **Location** to: C:\pic30\_tools\Bin\pic30-as.exe.

**Note:** C:\ is the drive implemented for this example. The specific location of the MPLAB C30 compiler may be different on your system.

4. Reset **Toolsuite Contents** to MPLAB C30 Compiler (pic30-gcc.exe).
5. Set **Location** to: C:\pic30\_tools\Bin\pic30-gcc.exe.
6. Reset **Toolsuite Contents** to MPLAB LINK30 Object Linker (pic30-ld.exe).
7. Set **Location** to: C:\pic30\_tools\Bin\pic30-ld.exe.
8. Click **Next>** to continue. The Project Wizard Step Three dialog displays (see Figure 3-4).

**FIGURE 3-4: PROJECT WIZARD, STEP 3, NAME YOUR PROJECT**



### 3.4.3 Name Your Project

1. In the **Project Name** text box, type **MyQuickStart**.
2. Click **Browse...** and navigate to `C:\Quick Start` to place your project in the Quick Start folder.
3. Click **Next>** to continue.

### 3.4.4 Add Files to Project

1. On the Project Wizard Step Four dialog (see Figure 3-5), locate the `C:\Quick Start` folder and add all the hex, source and include files to the right side.

Select and add all the files in the `Quick Start/h` folder:

- `defines.h`
- `delay.h`
- `lcd.h`
- `nic_init_param.h`
- `nic_strings.h`
- `strings.h`

Select and add all the files in the `Quick Start/inc` folder:

- `device_Fcy.inc`
- `Si3021_mode.inc`
- `Si3021_outputs.inc`

Select and add all the files in the `Quick Start/source` folder:

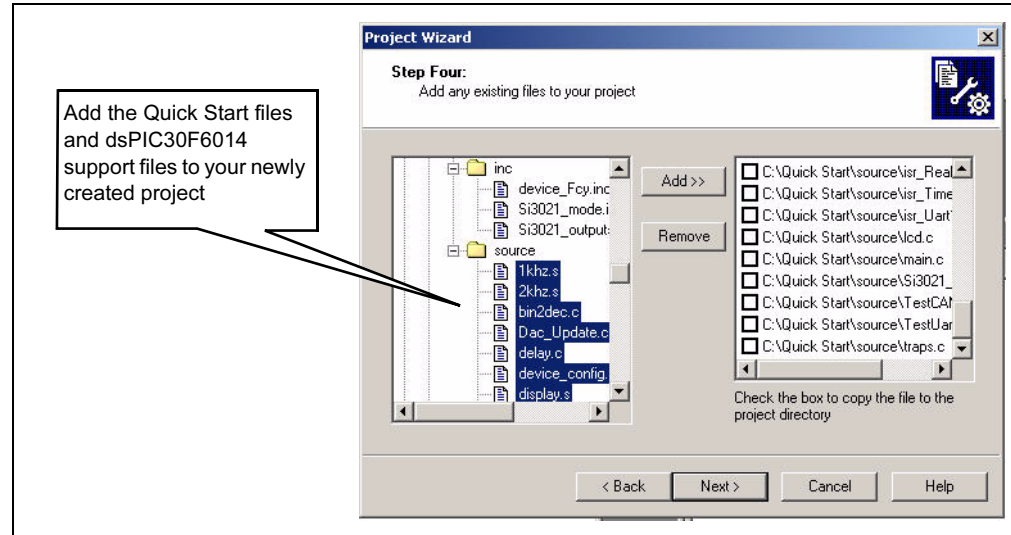
- `bin2dec.c`
- `Dac_Update.c`
- `delay.c`
- `init_RealTek_NIC.c`
- `init_Sram.c`
- `lcd.c`
- `main.c`
- `TestCAN.c`
- `TestUart1.c`
- `traps.c`
- `1khz.s`
- `2khz.s`
- `device_config.s`
- `display.s`
- `init_Adc.s`
- `init_Dci.s`
- `init_INTpin.s`
- `init_Ports.s`
- `init_Si3021.s`
- `init_Spil.s`
- `init_Timers.s`
- `init_Uart.s`
- `isr_Adc.s`
- `isr_Dci.s`
- `isr_INTpin.s`
- `isr_RealTek_NIC.s`
- `isr_Timers.s`
- `isr_Uart1_tx.s`



2. Navigate to the C:\pic30\_tools\support\gld folder and add file p30f6014.gld to include the linker script file in the project.
3. Navigate to the C:\pic30\_tools\support\h folder and add file p30f6014.h to include the header file in the project.

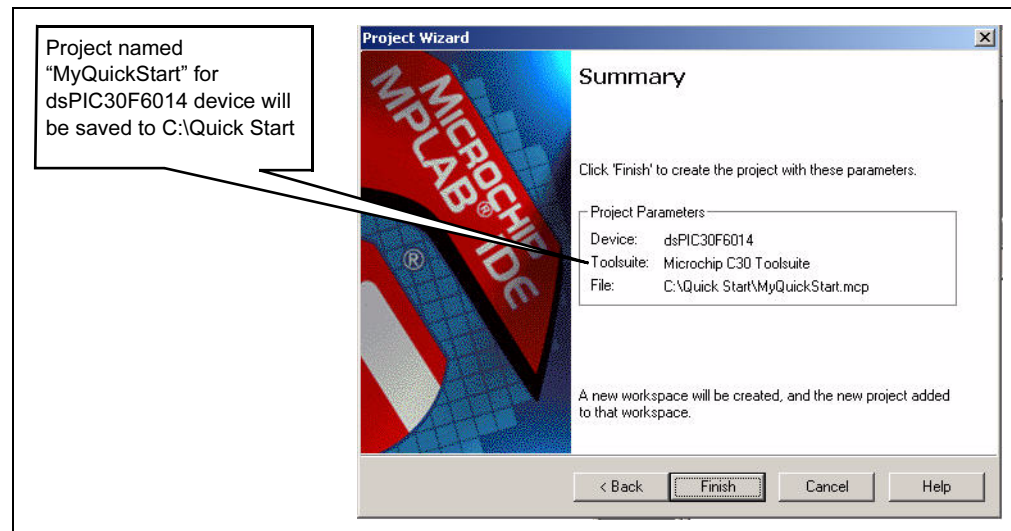
**Note:** The linker script file and header file locations for your environment may be different. The location will depend on where the C30 compiler is installed.

**FIGURE 3-5: PROJECT WIZARD, STEP 4, ADD FILES TO PROJECT**



4. Click **Next>** to continue. The Project Wizard Summary screen (Figure 3-6) displays the parameters of your project.

**FIGURE 3-6: PROJECT WIZARD SUMMARY SCREEN**



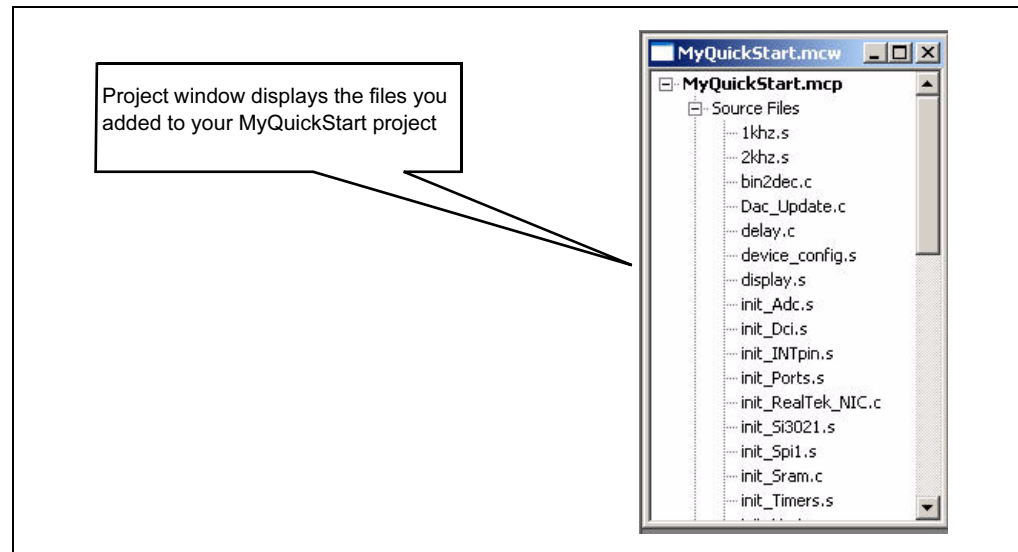
5. Click **Finish**.



# Quick Start Program

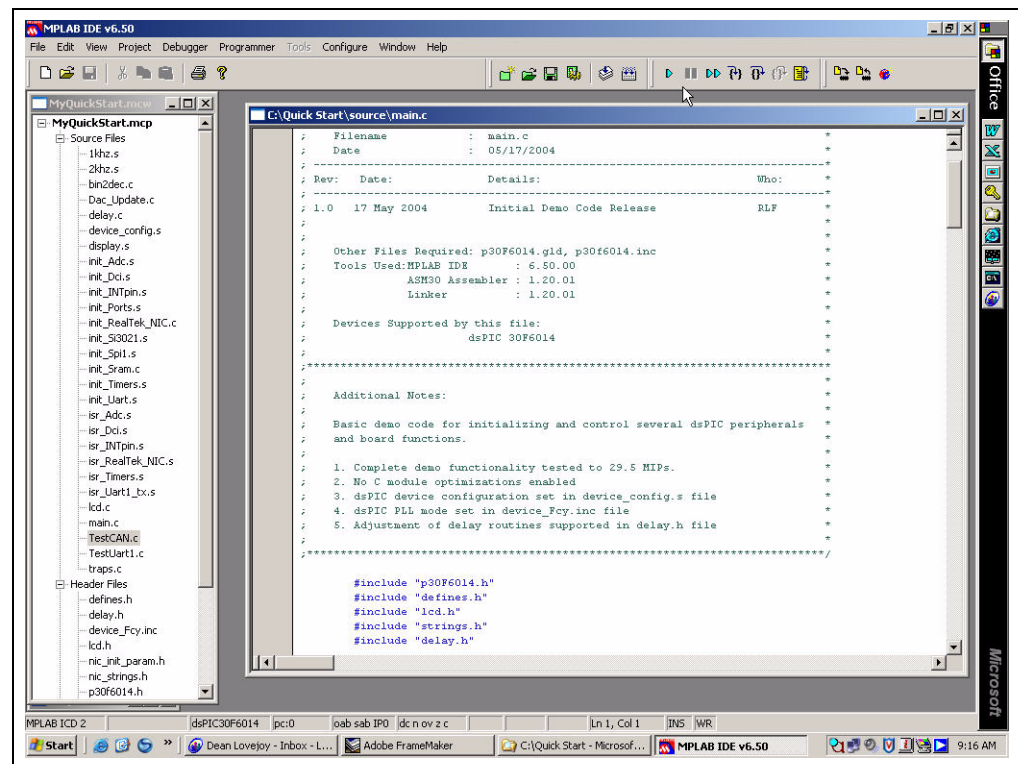
After the project wizard completes, the MPLAB project window shows the project and all the added files (see Figure 3-7).

**FIGURE 3-7: PROJECT WINDOW**



At this point a project and workspace have been created in MPLAB. MyQuickStart.mcw is the workspace file and MyQuickStart.mcp is the project file. Double-click the main.c file in the project window to open it. MPLAB should look similar to Figure 3-8.

**FIGURE 3-8: MPLAB WORKSPACE**



## 3.5 BUILDING THE CODE

In this project, the code is built in two stages. First the source files are compiled into object files, then the object files are linked.

The MyQuickStart.hex output file contains the data necessary to program the device. The MyQuickStart.cof output file contains additional information that lets you debug the code at the source code level.

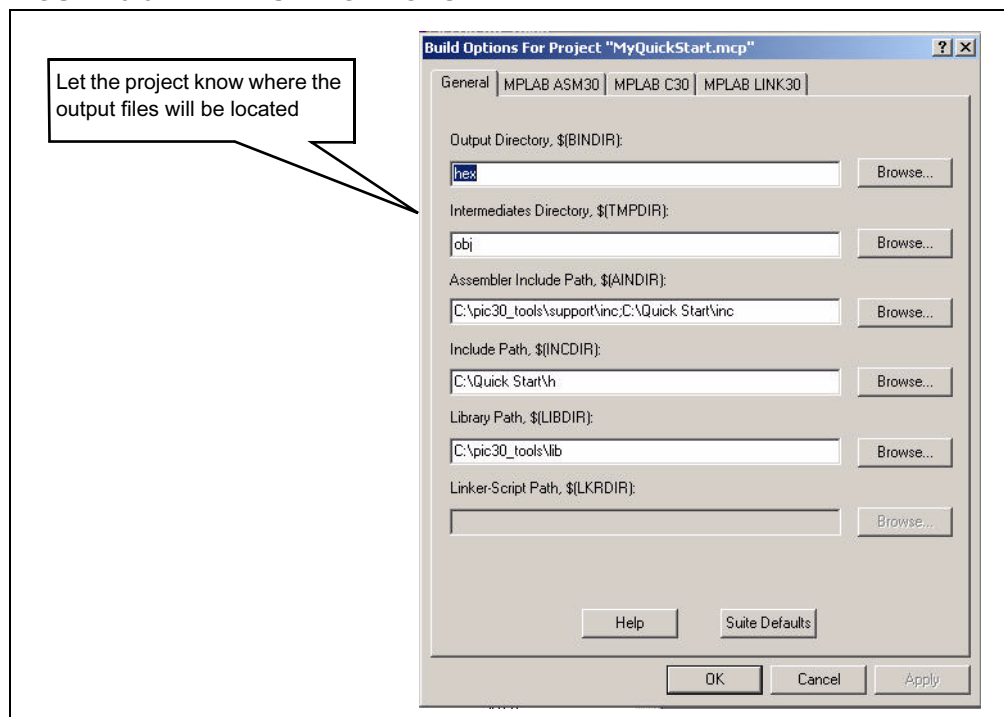
Before building the program, compiler and linker settings must be specified. These settings indicate where to find the C library files and where to reserve space for the extra debug code when the MPLAB ICD 2 (In-Circuit debugger) is used.

### 3.5.1 Set Project Build Options

The Quick Start project does not explicitly use any libraries, but the C compiler startup library code is always automatically linked into the project. Use the Project>Build Options>Project menu to display the Build Options dialog.

1. Select the General tab.
2. Type or browse to the file locations shown in Figure 3-9.

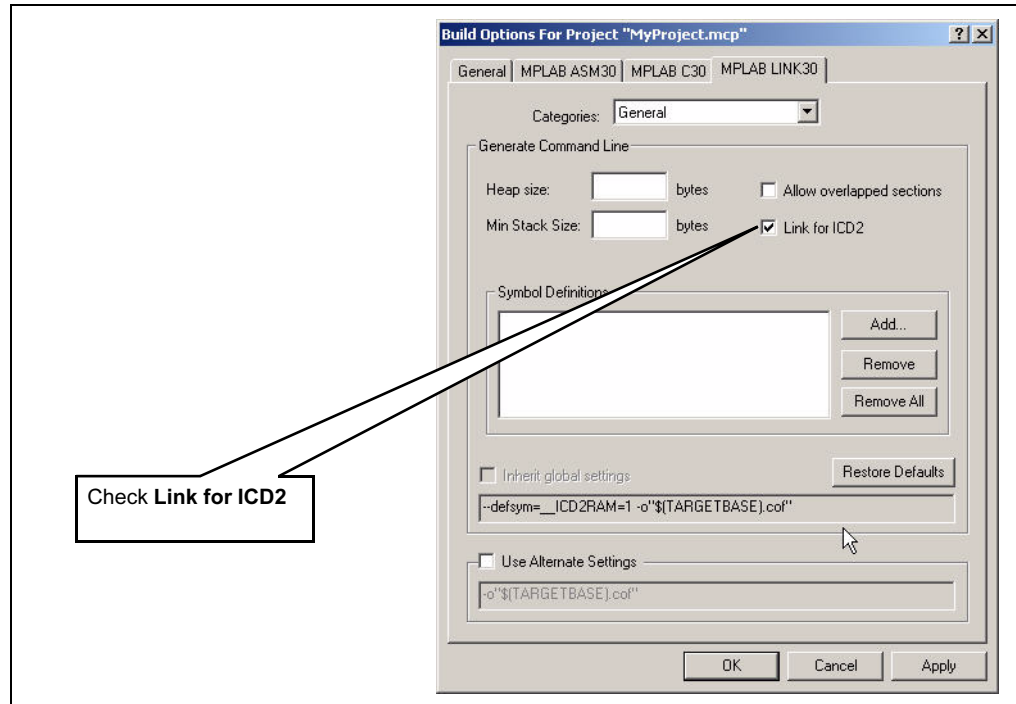
**FIGURE 3-9: BUILD OPTIONS**



**Note:** The library path for your environment may be different. The location will depend on where you installed the C30 compiler.

3. Select the MPLAB LINK30 tab to display the linker settings.
4. Check **Link for ICD2** to tell the linker to reserve space for the debug code used by the MPLAB ICD 2 In-Circuit Debugger (see Figure 3-10).
5. Click **OK**.

**FIGURE 3-10: MPLAB LINK30 BUILD OPTIONS**

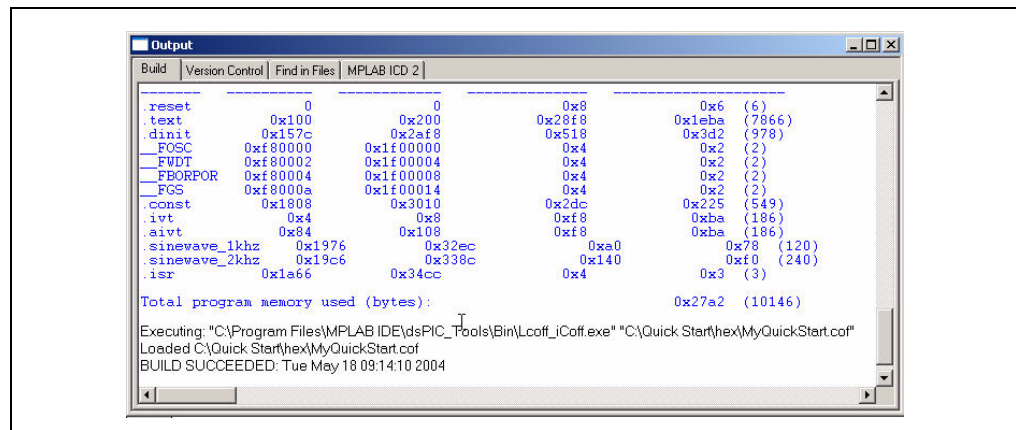


### 3.5.2 Build the Project

At this point the project is ready to build.

1. From the **Project** menu select **Build All**. The Build Output window displays (see Figure 3-11).
2. Observe the progress of the build.
3. When the BUILD SUCCEEDED message displays you are ready to program the device.

**FIGURE 3-11: BUILD OUTPUT**



If you experience any problems with the build, double-click the error messages in the Output window and MPLAB will point to the offending line in the source code. This should not happen if the files were copied from the dsPICDEM.net Development Kit CD. Double check all the steps in this section and ensure that you are using the latest versions of the development tools. The latest upgrades are available on the Microchip web site ([www.microchip.com](http://www.microchip.com)).

## 3.6 DEVICE CONFIGURATION AND PROGRAMMING

After you have built the code you must set up the configuration bits and then connect the tool you plan to use for programming, running and debugging the code.

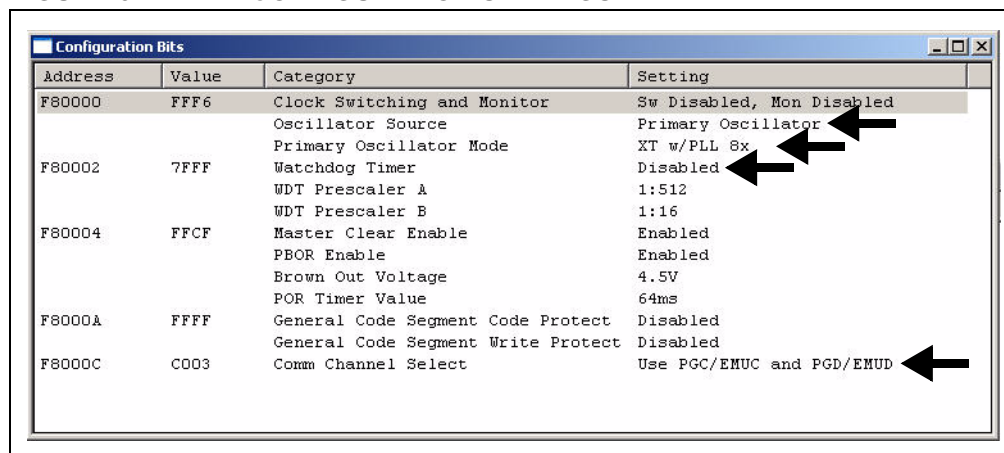
**Note:** Before proceeding, make sure that the USB driver for the MPLAB ICD 2 has been installed on your PC (see the *MPLAB ICD 2 User's Guide* (DS51331) for more details regarding the installation of the USB driver).

### 3.6.1 Set Up Device Configuration

From the *Configure* menu select *Configuration Bits* to view the configuration bits and set up the bits as shown in Figure 3-12. The settings that will most likely need to change are:

Oscillator Source	Primary Oscillator
Primary Oscillator Mode	XT w/PLL 8x
Watchdog Timer	Disabled
Comm Channel Select	Use PGC/EMUC and PGD/EMUD

**FIGURE 3-12: CONFIGURATION SETTINGS**



After building the code and setting the configuration bits, the MPLAB ICD 2 debugger can be used to run and debug the code on the dsPICDEM.net Demonstration Board. Follow the instructions in one of the next two sections depending on which tool you are using.

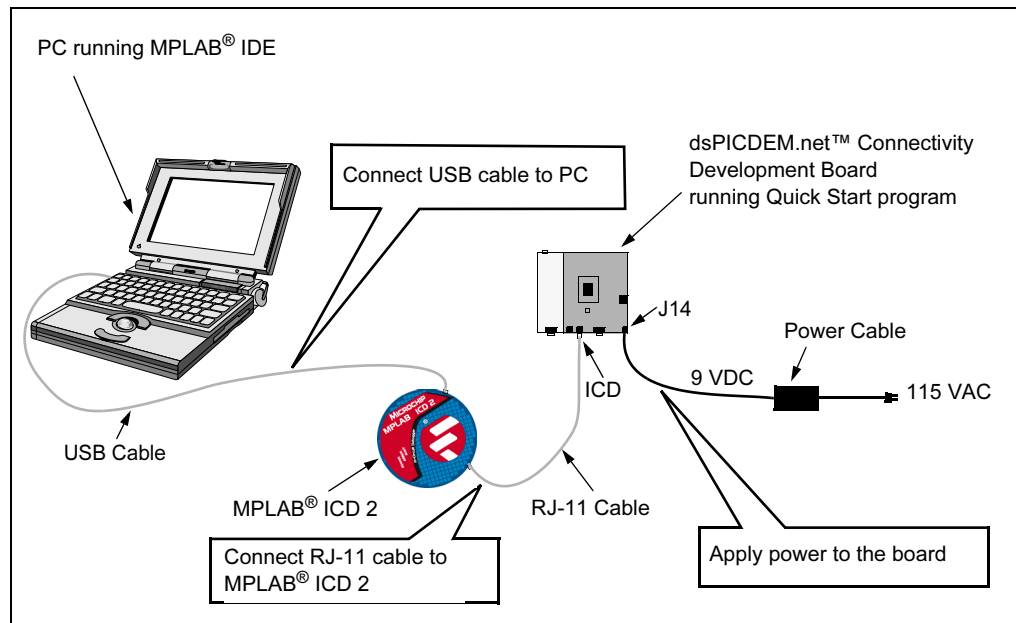
### 3.6.2 Enabling the MPLAB ICD 2 Connection

The MPLAB ICD 2 can be used to program and debug the dsPIC30F6014 device in-circuit on the dsPICDEM.net board.

**Note:** Before proceeding, make sure that the USB driver for the MPLAB ICD 2 has been installed on your PC (see the *MPLAB ICD 2 User's Guide* (DS51331) for details regarding the installation of the USB driver).

1. Connect the MPLAB ICD 2 to the PC with the USB cable (see Figure 3-13).
2. Connect the MPLAB ICD 2 to modular connector labeled ICD on the dsPICDEM.net board with the provided short RJ-11 cable.
3. Apply power to the board.

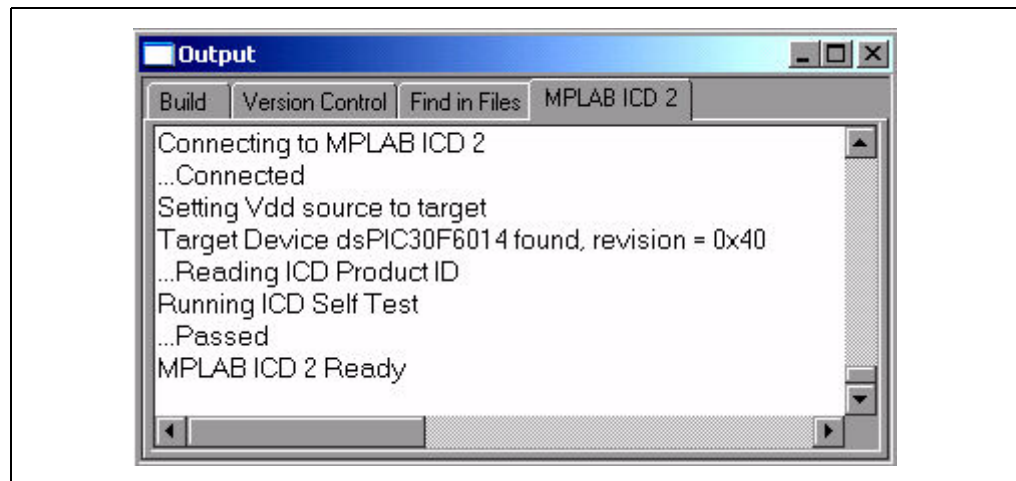
**FIGURE 3-13: dsPICDEM.net™ DEVELOPMENT BOARD CONNECTED TO MPLAB® ICD 2**



4. From the Debugger>Select Tool menu, select MPLAB ICD 2 as the debug tool.
5. From the Debugger menu, select Connect. MPLAB should report that it found the dsPIC30F6014 as shown in Figure 3-14.

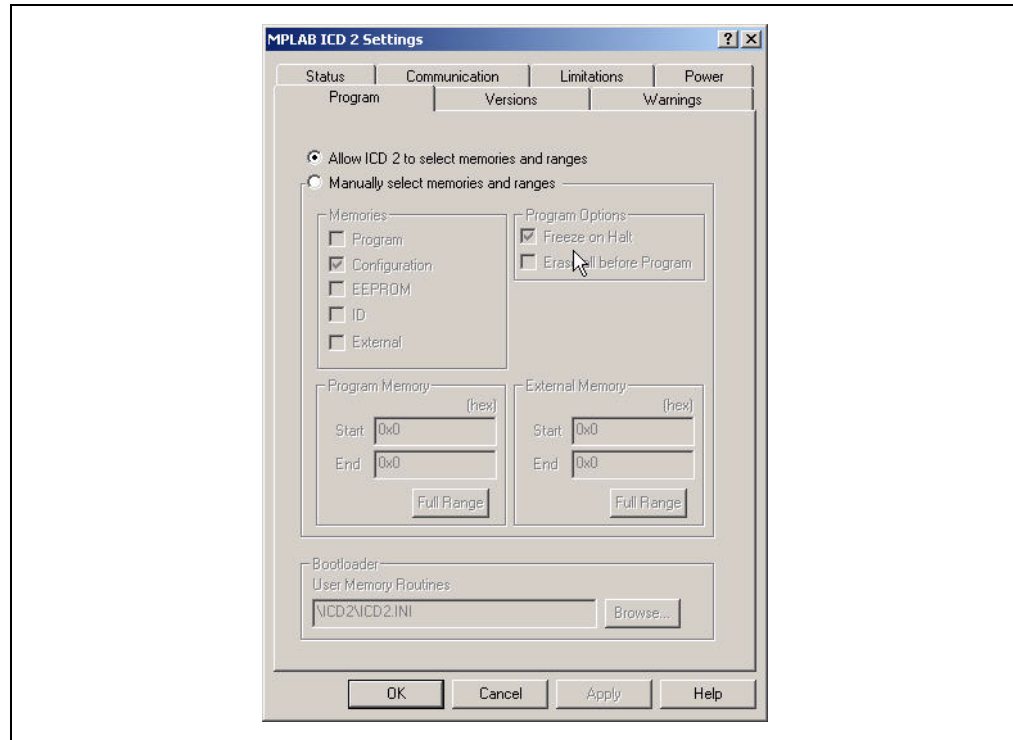
**Note:** MPLAB may need to download new firmware if this is the first time the MPLAB ICD 2 is being used with a dsPIC30F device. Allow it to do so. If any errors are shown, double-click the error message to get more information.

**FIGURE 3-14: ENABLING MPLAB ICD 2**



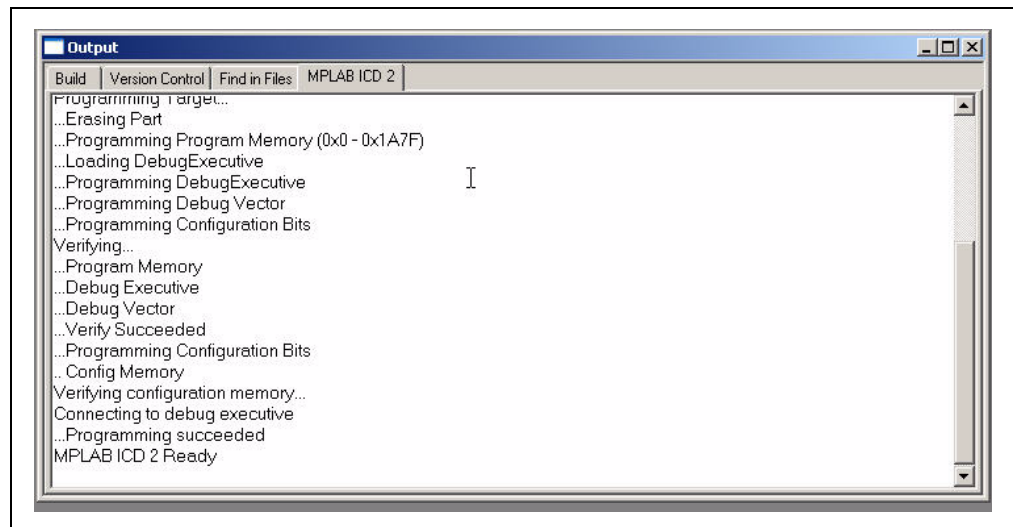
6. From the Debugger menu, select Settings to display the ICD Debugger settings (see Figure 3-15).
7. On the Program tab, ensure that "Allow ICD 2 to select memories and ranges" is selected. This setting will speed up programming by addressing only a small part of the total program memory.

**FIGURE 3-15: MPLAB ICD 2 DEBUGGER SETTINGS**



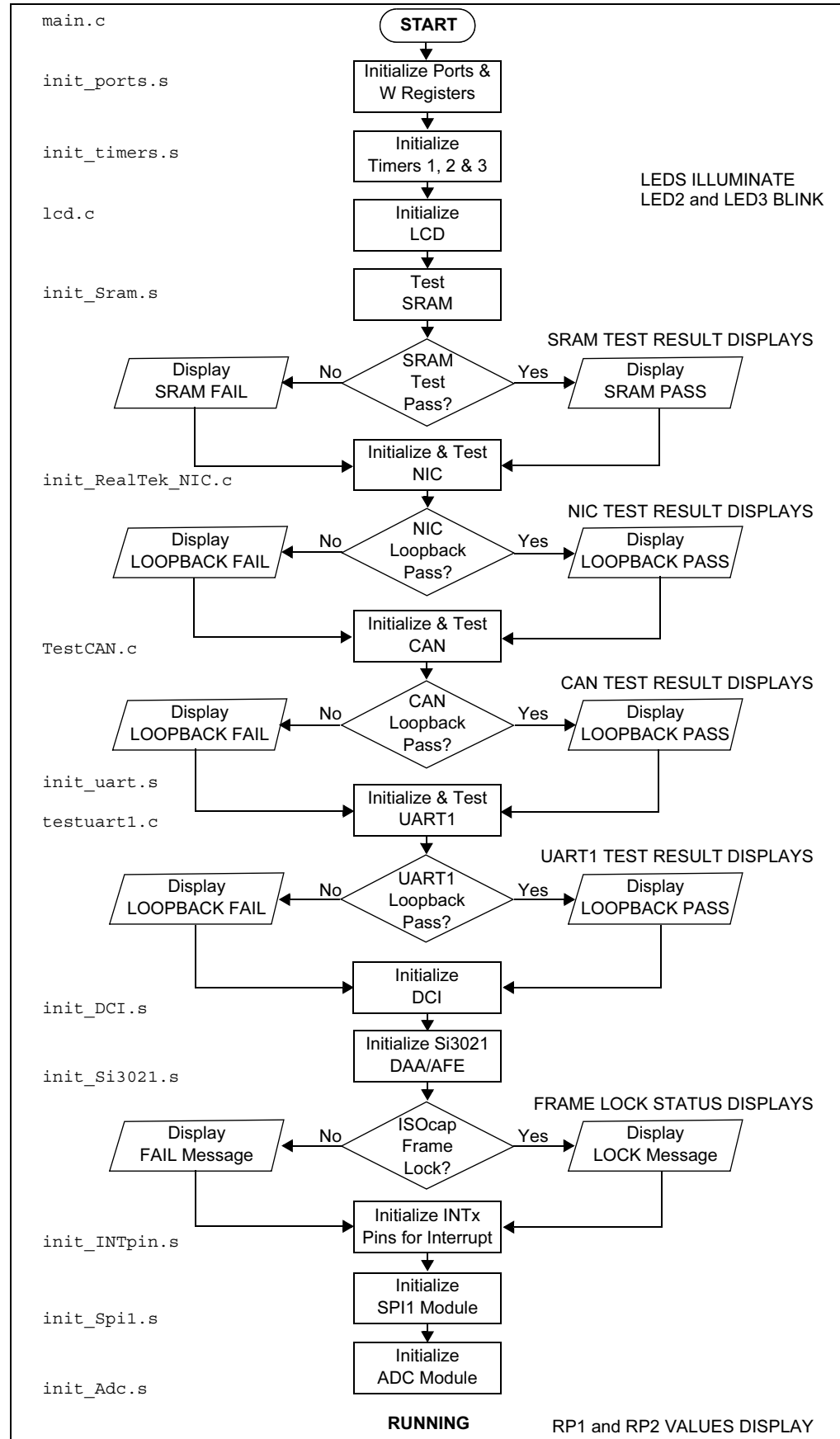
8. Program the part (*Debugger>Program*). The Output window shows the results of the programming cycle as shown in Figure 3-16. The part is now programmed and is ready to run.

**FIGURE 3-16: OUTPUT WINDOW**



9. Run the code (*Debugger>Run*). The program initializes and tests the peripherals, as depicted in Figure 3-17. Note the responses on the dsPICDEM.net board as the program executes. These responses are indicated along the right side of the flow chart. The code modules are identified along the left side of the flow chart.

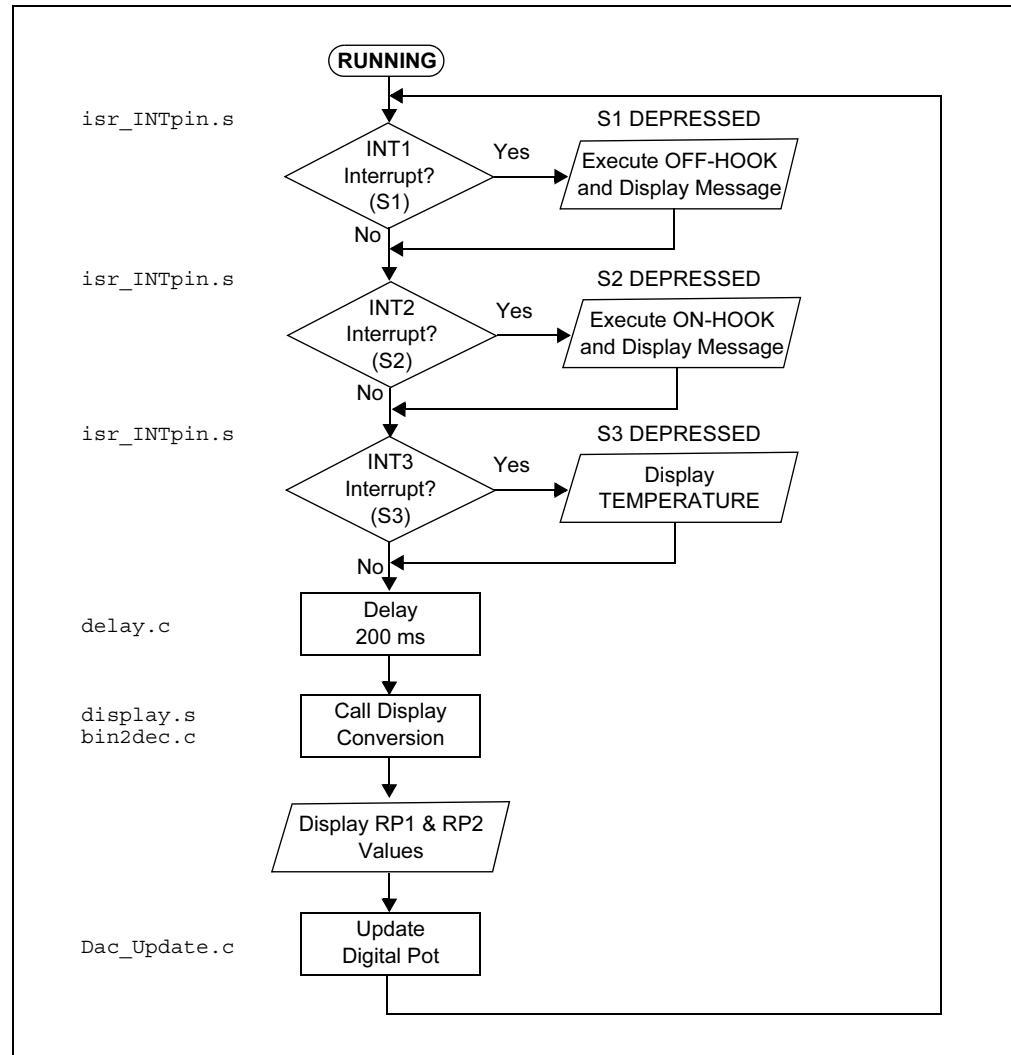
**FIGURE 3-17: PERIPHERAL INITIALIZATION AND TEST PROGRAM FLOW**



At this point the program is running in the main loop (see Figure 3-18). The LCD displays the current values of potentiometers RP1 and RP2:

<b>RP1= 3.44v</b>
<b>RP2= 2.14v</b>

**FIGURE 3-18: QUICK START PROGRAM MAIN LOOP**





## 3.7 INTERACTING WITH THE CODE

With the program running you can interact with the peripherals on the dsPICDEM.net board and observe the results on the LCD.

1. Depress **S1**.

The LCD displays the message: **Off\_Hook mode**.

In this mode, the dsPIC commands the Si3021 DAA/AFE to go off-hook and seize the line (i.e., the typical routine for a modem to connect to the PSTN). For this demonstration the dsPIC transmits a single tone to the AFE via the Data Converter Interface module on the dsPIC device. After the off-hook routine is completed the LCD reverts to the routine that displays the values of RP1 and RP2. The tone continues to be generated and can be heard until switch S2 is depressed.

2. Depress **S2**.

The LCD displays the message: **Ready... On\_Hook**.

For this routine, the dsPIC commands the Si3021 DAA/AFE to go on-hook (i.e., the typical condition when a modem releases the telephone line). For this demonstration the dsPIC terminates the data transfer from the Data Converter Interface to the Si3021 AFE. After the on-hook routine is completed the LCD reverts to the routine that displays the values of RP1 and RP2.

3. Depress **S3**.

The LCD displays the temperature as measure by sensor U2 followed by the **Ready... On\_Hook** message and then reverts to the RP1 and RP2 readings.

4. Touch U2 (located just left of the LCD) for a few seconds, then depress S3 again.

Notice the changed value of the temperature sensor.

5. Adjust RP1 and/or RP2.

Notice the changed value(s).

## 3.8 QUICK START DEMONSTRATION FEATURES AND PERIPHERALS

The intent of the Quick Start demonstration is to give you hands-on experience with the dsPIC30F processor and peripheral features. At this point, you can examine the program (`main.c`) and/or individual code modules in MPLAB IDE. You can set breakpoints to examine specific activities. Or you can step through the code modules one instruction at a time.

### 3.8.1 dsPIC30F Peripheral Features

The Quick Start demonstration program initializes and controls these dsPIC30F peripherals and associated board functions:

- **Timer1** – Configured as a 16-bit timer with 1:1 prescaler used as toggle rate for LED1.
- **Timer2** – Configured as 16-bit timer with a 1:1 prescaler used as toggle rate for LED2.
- **Timer3** – Configured as 16-bit timer with a 1:1 prescaler used as toggle rate for LED3.
- **UART1 TX** – Used to transmit demonstration data to the PC for display.
- **SPI™ 1** – Used to communicate to the MCP42050 Dual Channel Digital potentiometer.
- **12-bit ADC** – Used to convert multiple analog signals, such as potentiometer and temperature values (TC1047A temperature sensor).

- **Data Converter Interface** – Interfaced to an external Si303x DAA/AFE chipset for PSTN interface control and monitor.
- **INTx pins** – Used for detecting switch S1-S3 inputs.
- **PORTD pins, RD0-RD15** – Used to interface to 64Kx16 SRAM, 10-base T NIC and 2x16 LCD.

## 3.9 DATA AND CONTROL FLOW

### 3.9.1 Power-up Sequence

Table 3-1 provides more details on the power-up peripheral initialization sequence illustrated in Figure 3-17.

**TABLE 3-1: POWER-UP PERIPHERAL INITIALIZATION SEQUENCE**

Seq	Module or Board Function	Initialization Process
1	Timer1	Configured to count to 2.2 mS and reset.
2	Timer2	Configured to count to 3.95 mS and reset.
3	Timer3	Configured to count to 2.2 mS and reset.
4	2x16 LCD	Initialization of 2x16 character LCD, via PORTD pins RD0-RD15.
5	64Kx16 SRAM	Initialization and test of 64Kx16 SRAM, via PORTD pins RD0-RD15. Testing is performed by writing and reading back a specific incrementing pattern.
6	10-base T NIC	Initialization and test of 10-base T NIC, via PORTD pins RD0-RD15. Testing is performed by performing internal loop-back tests as supported by the NIC.
7	UART1	The transmitter is configured for interrupt-driven operation at 38400 baud.
8	Data Converter Interface (DCI)	Configured for Slave mode. Configured to communicate to the Si303x DAA/AFE chipset operating in Master mode. Some DAA/AFE self test routines are executed.
9	External interrupt pins INT1-INT3	Configured to interrupt on the falling edge and used for switches S1-S3, respectively.
10	SPI™ 1	Configured for communication with MCP42050 Dual Channel Digital potentiometer.
11	12-bit ADC	Configured to continuously sample channels AN3 (temperature sensor U2), AN4 (RP1) and AN5 (RP2).

### 3.9.2 Main Loop Code Execution

Table 3-2 explains the step-by-step execution sequence of the Main Loop shown in Figure 3-18

**TABLE 3-2: MAIN LOOP CODE EXECUTION SEQUENCE**

Seq.	Program Task
1	Check state of variable "hook_status", which is modified in either INT1, INT2 and INT3 Interrupt Service Routines.
2	12-bit ADC collects a sample each from the digital potentiometer RP1 and RP2 and temperature sensor, U2.
3	Data obtained from ADC is converted to ASCII for display by UART and LCD.
4	LCD is updated with Potentiometer RP1 and RP2 values.
5	SPI 1 transmit RP1 and RP2 values to dual channel digital potentiometer. Monitor of potentiometer output is via PW0 and PW1 test points on board.

## 3.9.3 Interrupts Used in the Demonstration Program

### 3.9.3.1 EXTERNAL INTERRUPTS TO MAIN ROUTINE

External interrupts INT1-INT3 are controlled by switches S1-S3 respectively.

Each switch is monitored by the respective Interrupt pin, INT1-INT3. For each switch detected the variable "hook\_status" is modified in the ISR. The variable "hook\_status" is then monitored in the main loop and based upon the variable state one of three actions are taken.

### 3.9.3.2 12-BIT ADC INTERRUPTS

The 12-bit module is configured to continually sample and convert channels AN3 (temperature sensor U2), AN4 (RP1) and AN5 (RP2). When all three signals have been converted an ADC module based interrupt occurs and the ISR code simply saves off the converted values to variables defined in data memory. Outside the interrupt this "raw" data is converted to ASCII by a simple conversion routine and then used by the UART and LCD display code modules.

### 3.9.3.3 UART TRANSMIT INTERRUPTS

Approximately every 200 mS, data is transmitted via the UART to the HyperTerminal session window. The term "data" refers to the following:

- Analog data such as RP1 and RP2 voltages
- Temperature sensor data, U2

### 3.9.3.4 TIMER1

Timer1 is a 16-bit timer that uses the instruction cycle as its time-base. It is configured to time out and generate an interrupt every 2.2 milliseconds. The Timer1 Interrupt Service Routine (ISR) simply toggles LED1 and clears the associated interrupt flag.

### 3.9.3.5 TIMER2

Timer2 is a 16-bit timer that uses the instruction cycle as its time-base. It is configured to time out and generate an interrupt every 3.95 milliseconds. The Timer2 Interrupt Service Routine (ISR) increments a variable, tests bit 9 of this variable and if set toggles LED2. If LED2 is toggled the ISR resets this same variable to zero. Finally the associated interrupt flag is cleared.

### 3.9.3.6 TIMER3

Timer3 is a 16-bit timer that uses the instruction cycle as its time-base. It is configured to time out and generate an interrupt every 2.2 milliseconds. The Timer3 Interrupt Service Routine (ISR) increments a variable, tests bit 9 of this variable and if set toggles LED3. If LED3 is toggled the ISR resets this same variable to zero. Finally the associated interrupt flag is cleared.

### 3.10 SUMMARY

This quick start demonstration program is aimed at getting users more familiar with the dsPIC peripherals and dsPICDEM.net Development Board functions. In working through this demonstration you should also become more comfortable with features of MPLAB IDE and the MPLAB C30 compiler and the use of the MPLAB ICD 2 debugger with the dsPICDEM.net board.

After working with the Quick Start program you will have:

- Increased your understanding of how the dsPIC30F works with its peripherals.
- Gained a further understanding of how to initialize and control dsPIC30F peripherals and associated board functions.
- Reduced the learning cycle for getting started with your development using the dsPIC30F product family.

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## **Chapter 4. HTTP Web Server Demonstration**

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### **4.1 INTRODUCTION**

This chapter describes a sample program that demonstrates Web-based monitoring and control of an embedded application operating with the CMX-MicroNet TCP/IP Stack configured for Hyper Text Transfer Protocol (HTTP) Web Server protocol.

### **4.2 HIGHLIGHTS**

Information in this chapter includes:

- Demonstration Overview
- Demonstration Setup
- Configuring your Laptop or Desktop PC
- HTTP Web Server Demonstration
- Debugging TIPS
- Troubleshooting
- Using HTTP Web Server in Your Application

### **4.3 DEMONSTRATION OVERVIEW**

This demonstration program runs on the dsPIC30F6014 using the CMX-MicroNet TCP/IP Stack configured for HTTP Web Server protocol to support remote monitoring and control of the application over an Ethernet connection.

The CMX-MicroNet TCP/IP Stack is designed for optimized use of Flash and RAM Memory on dsPIC30F devices. This software runs directly on the processor with no gateways or PCs required. The stack can be run in stand-alone mode or work in conjunction with an RTOS. This demonstration uses approximately 4.2K instructions in Flash and 300 bytes in RAM, not including the HTML, java applets and .jpg and .gif images.

In this demonstration the dsPIC “serves-up” HTML pages to a browser and implements two basic HTML form methods: GET and POST. The GET and POST methods are demonstrated in the form of requests from and updates to the HTML page displayed on a browser. These functions enable you to monitor and change functions on the dsPICDEM.net board.

The GET method retrieves information from the potentiometers, temperature sensor and switches to illustrate monitoring functionality. The POST method uploads information to the LCD and LEDs on the board to illustrate control and updating functionality. For this demonstration the HTML page served-up by the dsPIC device is stored in the Flash Program Memory. Alternatively, the dsPICDEM.net board provides a 24LC515 Serial I<sup>2</sup>C EE 64 Kbyte Memory device that can be used to store the HTML pages.

## 4.4 DEMONSTRATION SETUP

### 4.4.1 Equipment Requirements

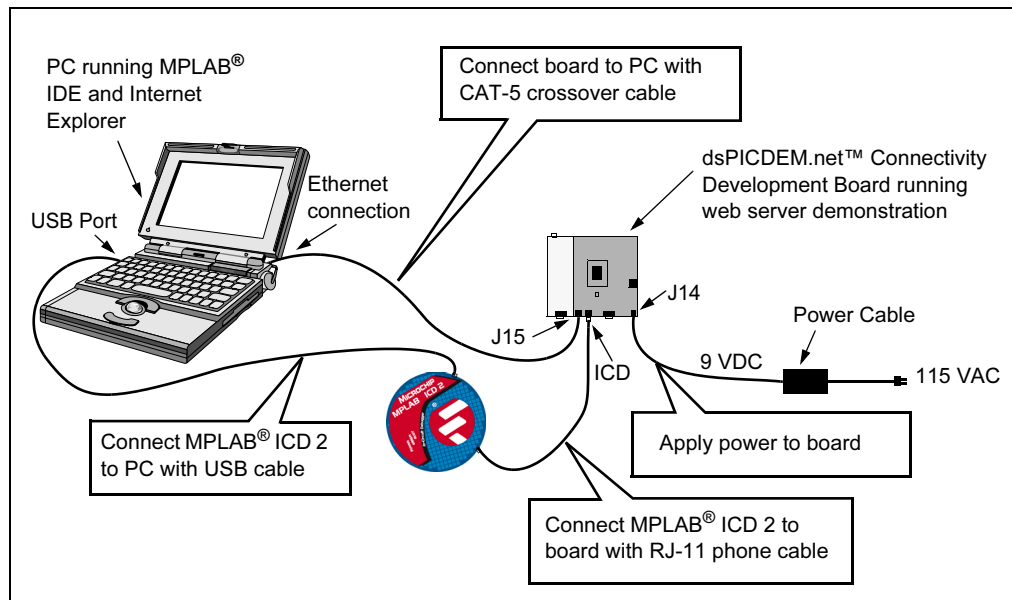
The HTTP Web Server demonstration requires the following equipment:

- dsPICDEM.net Development Board Kit with dsPIC30F6014 Plug-in-Module (PIM)
- CAT-5 crossover cable (or standard Ethernet cable and access to a network or hub)
- MPLAB IDE Integrated Development Environment
- MPLAB ICD 2 In-Circuit Debugger
- Laptop or Desktop PC with RS-232 serial port or USB port for connecting to the MPLAB ICD 2 In-Circuit Debugger
- RJ-11 phone cable for connecting the MPLAB ICD 2 to the dsPICDEM.net board

### 4.4.2 Equipment Setup

Connect the dsPICDEM.net board to your PC or laptop as shown in Figure 4-1.

**FIGURE 4-1: WEB SERVER DEMONSTRATION SETUP**

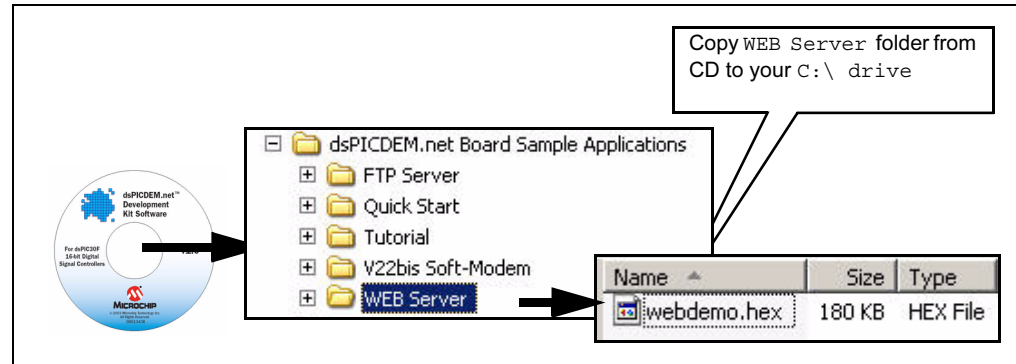


1. Connect the MPLAB ICD 2 to your PC with the USB cable.
2. Using the short RJ-11 phone cable, connect the MPLAB ICD 2 to RJ-11 modular connector **ICD** on the board.
3. Connect one end of the supplied CAT-5 crossover cable to RJ-45 modular connector **J15** on the board and the other end to the Ethernet network card on the PC or Laptop.
4. Connect the dsPICDEM.net power cable to the power input connector (**J14**).

## 4.4.3 WEB Server Program Setup

Copy the WEB Server folder from the dsPICDEM.net Development Kit Software CD to the C:\ drive on your PC or laptop (see Figure 4-2).

FIGURE 4-2: WEB SERVER DEMONSTRATION CODE



## 4.5 CONFIGURING YOUR LAPTOP OR DESKTOP PC

This HTTP Web Server demonstration is configured to operate with a Static IP address. To run the demonstration program you must configure the local Network Connections on your laptop or Desktop to use a compatible Static IP address.

**Note:** Before reconfiguring your network connection settings for this demonstration, make a note of your current PC settings. You will want to restore your original PC settings after you complete this demonstration.

To reconfigure your network connections, follow these steps:

1. From the Windows desktop, click Start>Settings>Network Connections> Local Area Connection.
2. Right-click Local Area Connection and select Properties. The Local Area Connection Properties dialog displays your current connections.
3. On the **General** tab, scroll down the list of connections to Internet Protocol TCP/IP, then click **Properties**. The Internet Protocol (TCP/IP) Properties dialog displays, as shown in Figure 4-3.

**Note:** Record your current settings so you can restore them later.

4. On the **General** tab, check **Use the following IP address:** and type in these settings:

IP Address:

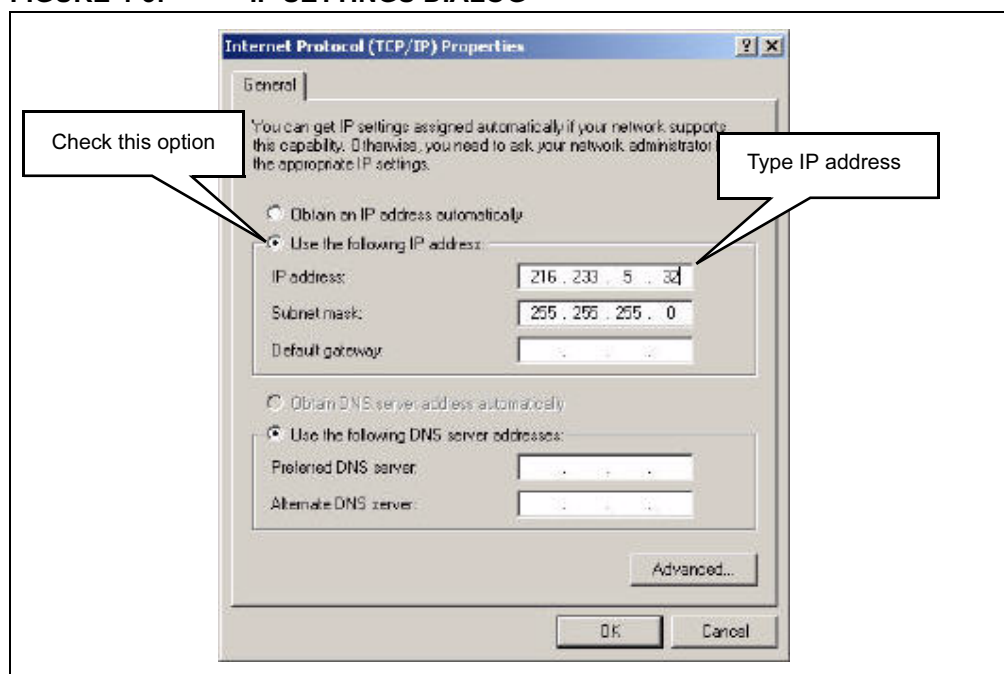
216 . 233 . 5 . 32

Subnet mask:

255 . 255 . 255 . 0

5. Check **OK** in each dialog box until you close all the windows. Depending on the version of Windows you are running, you may be required to reboot your PC for the changes to take effect.
6. Proceed with the HTTP Web Server demonstration.

FIGURE 4-3: IP SETTINGS DIALOG



## 4.6 HTTP WEB SERVER DEMONSTRATION

### 4.6.1 Programming the dsPIC30F6014 Device

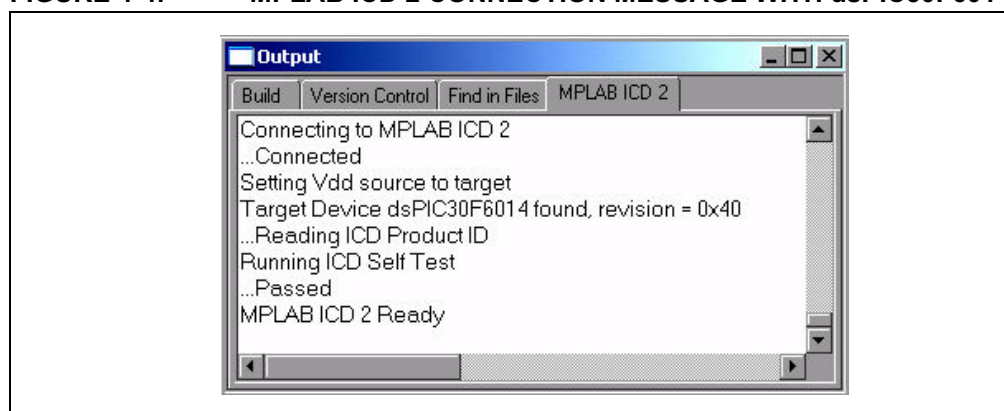
The dsPIC30F6014 device must be programmed with the HTTP Web demonstration program (`webdemo.hex`). If you have previously loaded this program on a dsPIC30F6014 device you can proceed directly to **Section 4.6.2 “Start HTTP Web Server Session”**.

1. Apply power to the board. The green **POWER** LED illuminates.
2. Launch MPLAB IDE on your PC. From the *Configure* menu, choose *Select Device*, then select *dsPIC30F6014*.
3. Select *Programmer>Select Programmer>MPLAB ICD 2*. You should see a connection message in the output window, as shown in Figure 4-4.

If the MPLAB ICD 2 does not initially connect and recognize the dsPIC30F6014 device, click the MPLAB ICD 2 puck icon on the MPLAB IDE toolbar.

The output window should then indicate a successful connection.

FIGURE 4-4: MPLAB ICD 2 CONNECTION MESSAGE WITH dsPIC30F6014

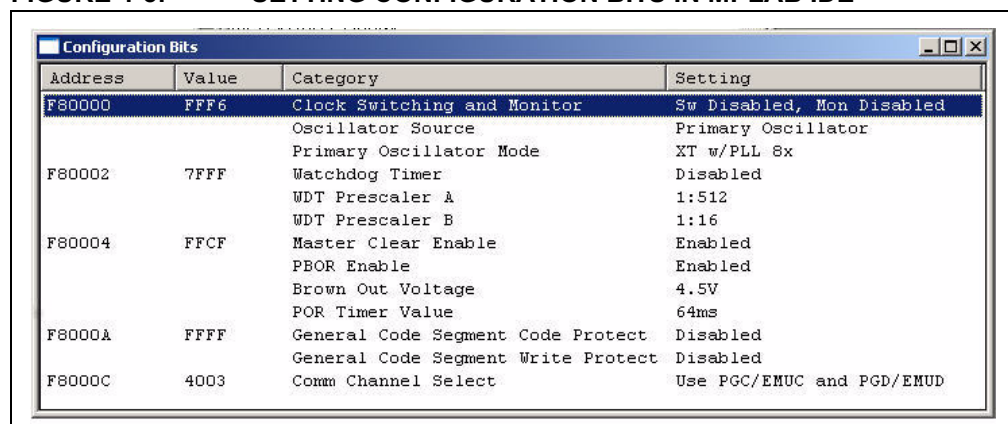




# HTTP Web Server Demonstration

4. From the MPLAB IDE *File* menu, select *Import*. Browse to the C:\WEB Server directory where you saved the webdemo.hex file, select it and click **Open**.
5. From the MPLAB IDE *Configure* menu, select *Configuration Bits* and verify the device configuration settings shown in Figure 4-5.

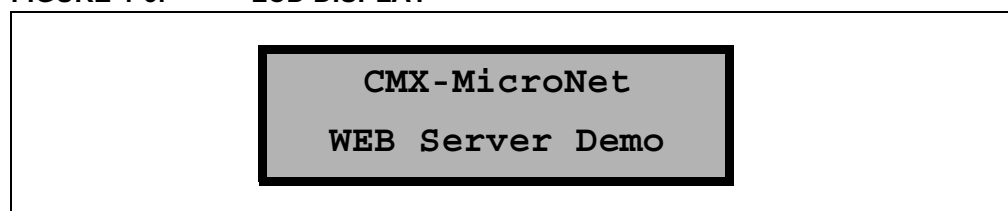
**FIGURE 4-5: SETTING CONFIGURATION BITS IN MPLAB IDE**



Address	Value	Category	Setting
F80000	FFF6	Clock Switching and Monitor	Sw Disabled, Mon Disabled
		Oscillator Source	Primary Oscillator
		Primary Oscillator Mode	XT w/PLL 8x
F80002	7FFF	Watchdog Timer	Disabled
		WDT Prescaler A	1:512
		WDT Prescaler B	1:16
F80004	FFCF	Master Clear Enable	Enabled
		PBOR Enable	Enabled
		Brown Out Voltage	4.5V
		POR Timer Value	64ms
F8000A	FFFF	General Code Segment Code Protect	Disabled
		General Code Segment Write Protect	Disabled
F8000C	4003	Comm Channel Select	Use PGC/EMUC and PGD/EMUD

6. From the MPLAB IDE *Programmer* menu select *Program*. The webdemo.hex file downloads to the dsPIC30F6014. The Output Window records the process as it occurs and indicates completion by displaying "MPLAB ICD 2 Ready".
7. Remove the MPLAB ICD 2 cable from the board then press "RESET" on the demonstration board to run the program. The LCD on the dsPICDEM.net board indicates that the program is running, as shown in Figure 4-6.

**FIGURE 4-6: LCD DISPLAY**



## 4.6.2 Start HTTP Web Server Session

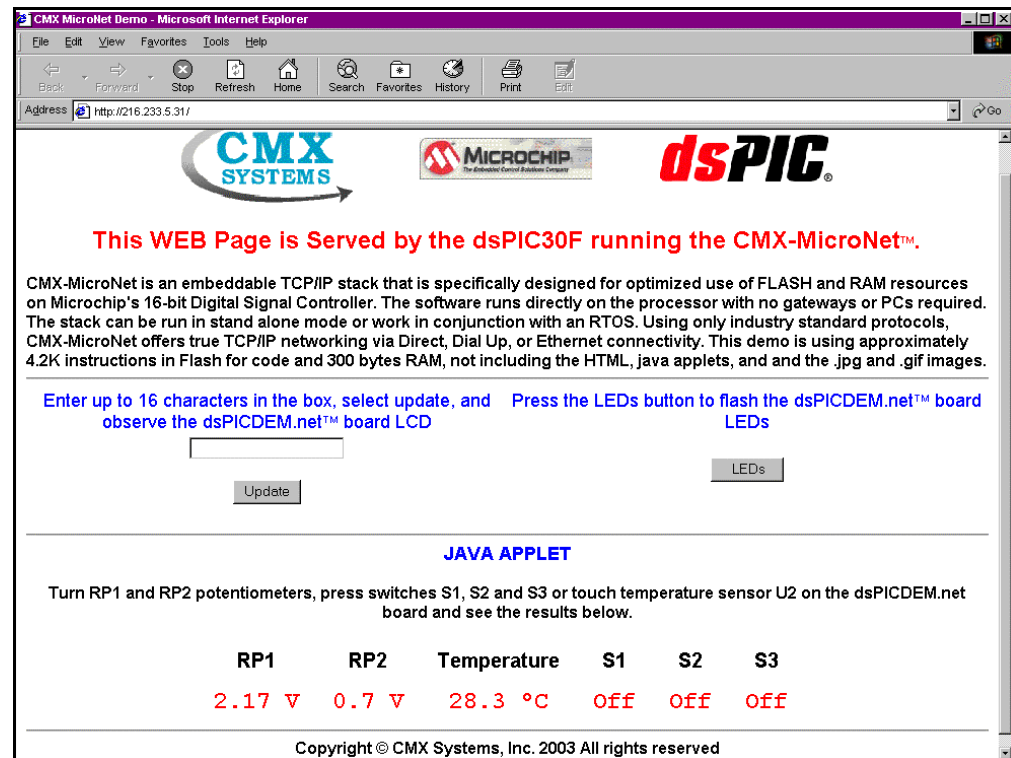
This demonstration is intended to run with Windows 98, NT, and XP using Internet Explorer 5 or 6 or Netscape 4.7.

1. Launch your browser.
2. Type the following URL address:

**http://216.233.5.31**

The dsPIC30F6014 Web Server returns the HTML page shown in Figure 4-7.

**FIGURE 4-7: WEB PAGE FROM dsPIC30F6014**



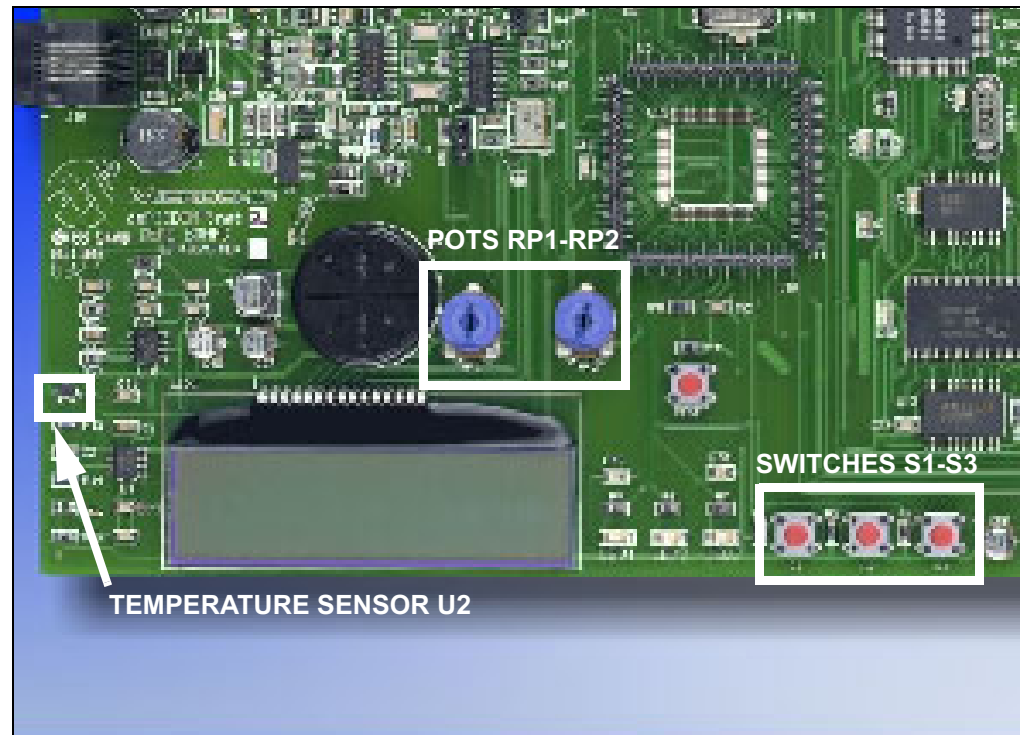
If you encounter a connection problem refer to **Section 4.8 "Troubleshooting"**.

## 4.6.3 Monitor the dsPICDEM.net™ Development Board

This demonstration shows how you might monitor devices used in your embedded application program over an Ethernet connection (or over the internet). In this portion of the demonstration you will monitor the voltage on potentiometers RP1 and RP2, the temperature on sensor U12 and the status of switches S1, S2 and S3 (see Figure 4-8).

1. On the dsPICDEM.net board, adjust potentiometers RP1 and RP2. Observe the associated voltage value changing on the web page.
2. Touch temperature sensor U2 and monitor the temperature displayed on the web page.
3. Press switches S1-S3 and observe the switch indicators on the web page change between Off (red) and On (green).

**FIGURE 4-8: MONITORED DEVICES**



### 4.6.4 Control the dsPICDEM.net™ Development Board

This portion of the demonstration illustrates how you can remotely control functions in an embedded application from your browser. Information you enter on the web page affects the LEDs and LCD display on the dsPICDEM.net board.

1. Repeatedly click the LEDs button on the web page. LED1, LED2 and LED3 on the dsPICDEM.net development board toggle up and down in sequence for each mouse click.
2. Enter up to 16 characters in the text box on the web page, then click the LCD button.

The information you typed displays as line 2 of the LCD on the dsPICDEM.net board.

3. Repeat step 2. The last typed entry replaces line 2 of the LCD.

**FIGURE 4-9: CONTROLLED DEVICES**



### 4.6.5 Hyper Text Transfer Protocol

HTTP is the defacto standard for transferring World Wide Web documents, although it is designed to be extensible to almost any document format. HTTP Version 1.1 is documented in RFC 2068. HTTP Version 1.0 (deprecated) is documented in RFC 1945. See also the W3C's work on the standard at: [www.w3.org/Protocols/](http://www.w3.org/Protocols/).

HTTP operates over TCP connections, usually to port 80, though this can be overridden and another port used. After a successful connection, the client transmits a request message to the server, which sends a reply message back. HTTP messages are human-readable. An HTTP server can be manually operated with a command such as Telnet Server 80.

The simplest HTTP message is "GET url", to which the server replies by sending the named document.

In HTML, you can specify two different submission methods for a form. The method is specified inside a form element, using the METHOD attribute. The difference between METHOD="GET" (the default) and METHOD="POST" is primarily defined in terms of form data encoding.

## 4.7 DEBUGGING TIPS

Use a packet sniffer to monitor all the transmitted frames and observe exactly what is going on in real-time (see Figure 4-10). A packet sniffer can be used with the PC-side TCP/UDP client/server test programs that are included with the MicroNet software. A number of good packet sniffers are available as freeware.

Freeware Packet Sniffers for Windows include:

- AnalogX PacketMon ([www.analogx.com](http://www.analogx.com))
- Anasil ([www.sniff-tech.com](http://www.sniff-tech.com))
- CommView ([www.tamosoft.com](http://www.tamosoft.com))
- Ethereal ([www.ethereal.com](http://www.ethereal.com))
- Sniff'em ([www.sniff-em.com](http://www.sniff-em.com))

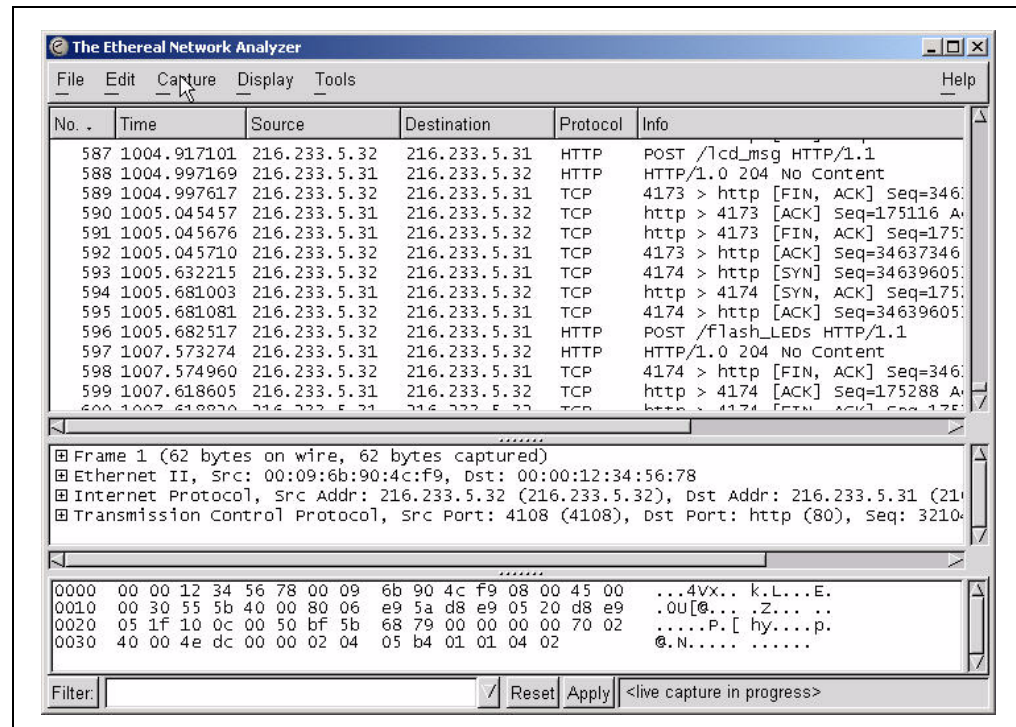
Commercially available packet sniffers include:

- Klos Technologies' SerialView, PacketView ([www.klos.com](http://www.klos.com))
- Windows Packet sniffing library for C#, C++, VB ([www.packet-sniffing.com](http://www.packet-sniffing.com))

For additional information on packet sniffers, refer to:

[www.robertgraham.com/pubs/sniffing-faq.html](http://www.robertgraham.com/pubs/sniffing-faq.html)

**FIGURE 4-10: ETHEREAL FREEWARE PACKET SNIFFER**



## 4.8 TROUBLESHOOTING

The HTTP Web Server program has been tested on a dsPICDEM.net connectivity board like the one you have received. No problems have been encountered (hence none expected when you run the demonstration).

The Java applets used in the HTTP Web Server program have been tested with Internet Explorer 5 and 6 and Netscape 4.7 from Windows 98, NT, and XP platforms. Depending on the Java settings in your browser, you may experience the following error message when the browser begins communication with the dsPIC30F-based Web Server and attempts to load the Java applet:

### Loading class dsPICDEMO

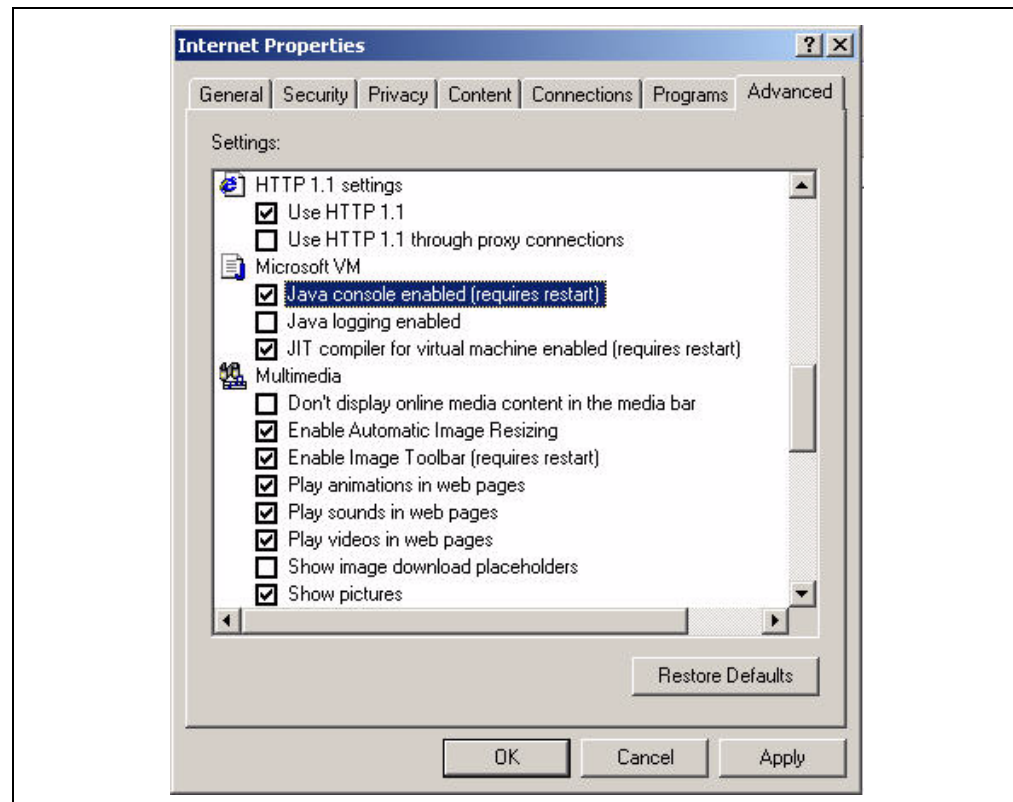
### Exception:java.lang.NullPointerException

To remedy this error condition, use this procedure:

**Note:** The exact steps may be slightly different depending on the version of Windows, the browser type and browser version you are using.

1. Open the Internet Properties (XP) dialog box.  
From your browser select Tools>Internet Options.  
From Windows select Start>Settings>Control Panel>Internet Options>Advanced.  
Ensure that Java console enabled (requires restart) is selected (see Figure 4-11). Click OK and allow the browser to restart.

**FIGURE 4-11: BROWSER JAVA SETTINGS**

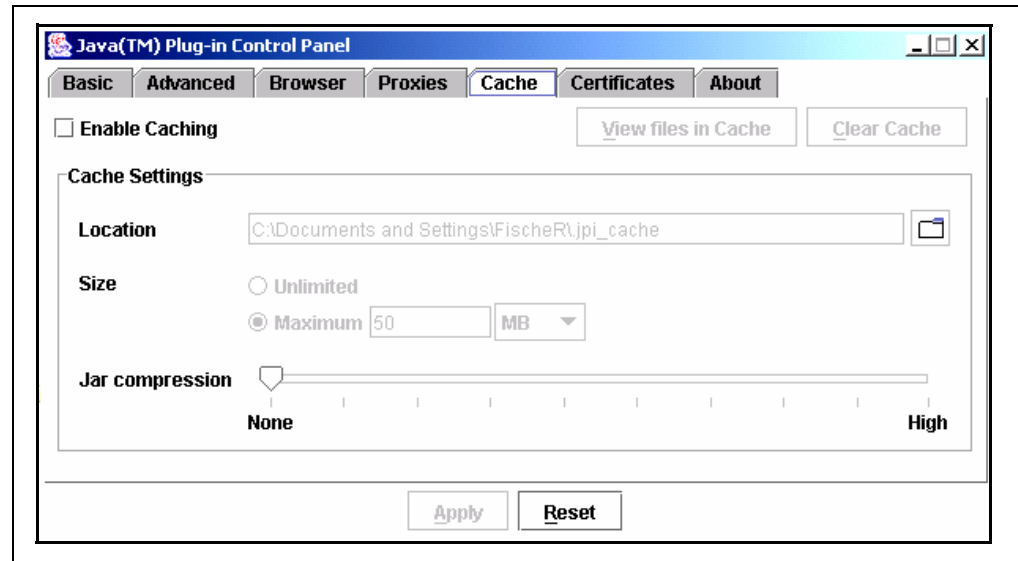


# HTTP Web Server Demonstration

Next, go to Control Panel and select the Java Plug-in application. Open this application and select the Cache tab. Ensure the “Enable Caching” box is deselected. Once complete click on the Apply and close this control panel.

Retry the browser refresh function and see if the entire HTML page is now displayed correctly.

**FIGURE 4-12: JAVA PLUG-IN BROWSER SETTINGS**



## 4.9 USING HTTP WEB SERVER IN YOUR APPLICATION

Operating the dsPIC30F with the CMX MicroNet TCP/IP stack gives you the ability to send data across the Internet. However, you must decide how to use it in your design. If you are simply looking for an interactive method of monitoring real time values as they are changing within your target device, you may want to utilize the HTTP protocol and server already developed. By setting up a series of URLs or “links”, you can have the HTTP module format the information in the form of HTML files.

If you require a more efficient or a secure form of interaction, you could set up a proprietary method of communication and deliver it within the payload of the TCP packet itself. A Windows application could be created in order to communicate, interact and manage a group of your devices on the Net. One step further may be to give the ability of the devices themselves to interact with each other.

**NOTES:**



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## **Chapter 5. FTP Server Demonstration**

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### **5.1 INTRODUCTION**

This chapter describes a sample program that demonstrates remote monitoring and control of an embedded application using File Transfer Protocol (FTP) communication.

### **5.1 HIGHLIGHTS**

Information in this chapter includes:

- Application Overview
- Demonstration Setup
- Configuring your Laptop or Desktop PC
- FTP Server Demonstration
- Summary

### **5.2 APPLICATION OVERVIEW**

This demonstration program illustrates file transfers between an embedded application on the dsPIC30F6014 and a remote computer. The embedded application uses the CMX-MicroNet TCP/IP Stack configured as an FTP Server. The FTP server “associates” system application data with a virtual file system implemented in the dsPIC Flash memory.

A typical dsPIC30F FTP application allows data files produced by the dsPIC device and stored in the virtual file system to be retrieved remotely for such tasks as data logging, inventory control, performance analysis, and more, on the remote computer system. Some applications may update Program Flash on a remote dsPIC device from a central server location. In other applications, FTP activity may execute on a scheduled basis using automatic error detection/correction to ensure that data is properly transmitted and received.

CMX-MicroNet FTP Server is fully compliant with Internet Engineering Task Force (IETF) and Request for Comments (RFC) standards and supports Windows-, DOS-, UNIX- and Linux-based FTP clients. For detailed information on these standards, refer to: [www.ietf.org/](http://www.ietf.org/) and [www.faqs.org/rfcs/](http://www.faqs.org/rfcs/), respectively.

This sample application demonstrates two main activities supported by the dsPIC30F6014 FTP Server:

- Retrieving a file on the FTP server from an FTP client
- Transmitting data to the FTP server from an FTP client

This demonstration is set up to run with a Microsoft Windows FTP client or at the command prompt.

## 5.3 DEMONSTRATION SETUP

### 5.3.1 Equipment Requirements

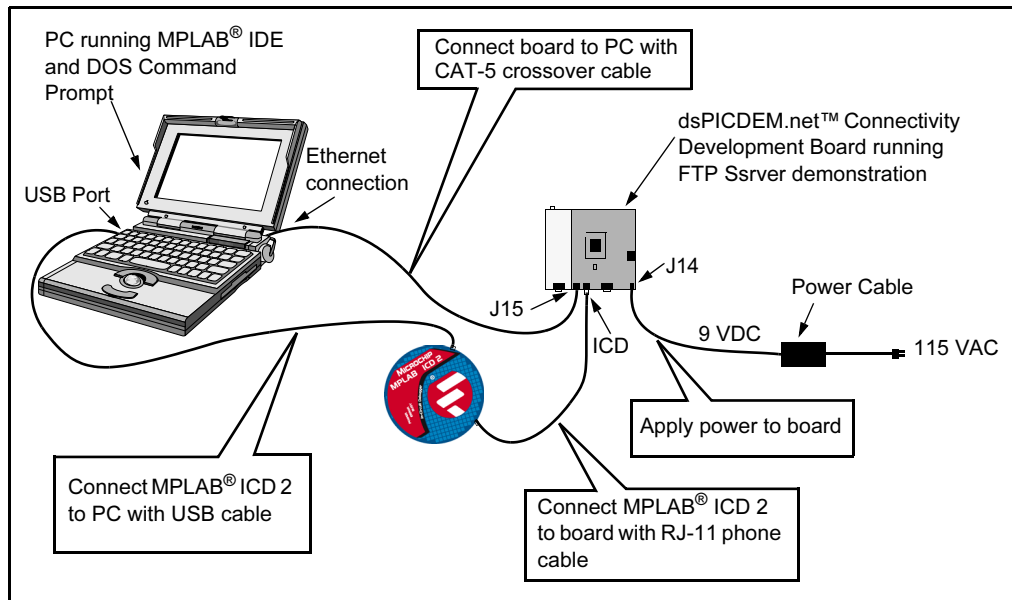
This demonstration requires the following equipment:

- dsPICDEM.net Development Board Kit with dsPIC30F6014 Plug-in-Module (PIM)
- Crossover Cable (or standard Ethernet cable and access to a network or hub)
- MPLAB IDE Integrated Development Environment
- MPLAB ICD 2 In-Circuit Debugger
- Laptop or Desktop PC with RS-232 serial port or USB port for connecting to the MPLAB ICE 2 In-Circuit Emulator
- RJ-11 phone cable for connecting the MPLAB ICD 2 to the dsPICDEM.net board.

### 5.3.2 Equipment Setup

Connect the dsPICDEM.net board to your PC or laptop as shown in Figure 5-1.

**FIGURE 5-1: FTP SERVER DEMONSTRATION SETUP**

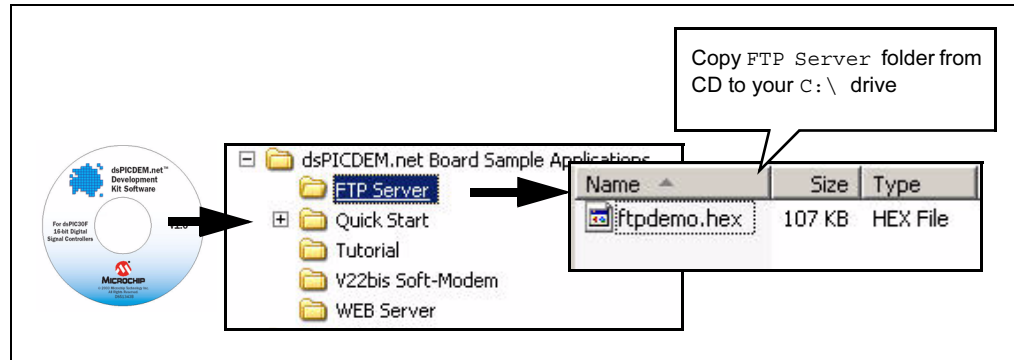


1. Connect the MPLAB ICD 2 to your PC with the USB cable.
2. Using the short RJ-11 phone cable, connect the MPLAB ICD 2 to RJ-11 modular connector **ICD** on the board.
3. Connect one end of the supplied CAT-5 crossover cable to RJ-45 modular connector **J15** on the board and the other end to the Ethernet network card on the PC or Laptop.
4. Connect the dsPICDEM.net power cable to the power input connector (**J14**).

## 5.3.3 FTP Server Program Setup

Copy the FTP Server folder from the dsPICDEM.net Development Kit Software CD to the C:\ drive on your PC or laptop (see Figure 5-2).

**FIGURE 5-2: FTP SERVER DEMONSTRATION CODE**



## 5.4 CONFIGURING YOUR LAPTOP OR DESKTOP PC

The FTP server demonstration is configured to operate with a Static IP address. To run the sample program you must configure the local network connections on your laptop or desktop computer to use a compatible Static IP address.

**Note:** Before you reconfigure your network connection settings for this sample program, make a note of your current PC settings. You will want to restore your original PC settings after you complete the demonstration.

### 5.4.1 Network Connections

To reconfigure your network connections, follow these steps:

1. From the Windows desktop, click Start>Settings>Network Connections> Local Area Connection.
2. Right-click Local Area Connection and select Properties. The Local Area Connection Properties dialog displays your current connections.
3. On the **General** tab, scroll down the list of connections to **Internet Protocol TCP/IP**, then click **Properties**. The Internet Protocol (TCP/IP) Properties dialog displays, as shown in Figure 5-3. **Make a note of your current settings so you can restore them later.**
4. On the **General** tab, check **Use the following IP address:** and type in these settings:

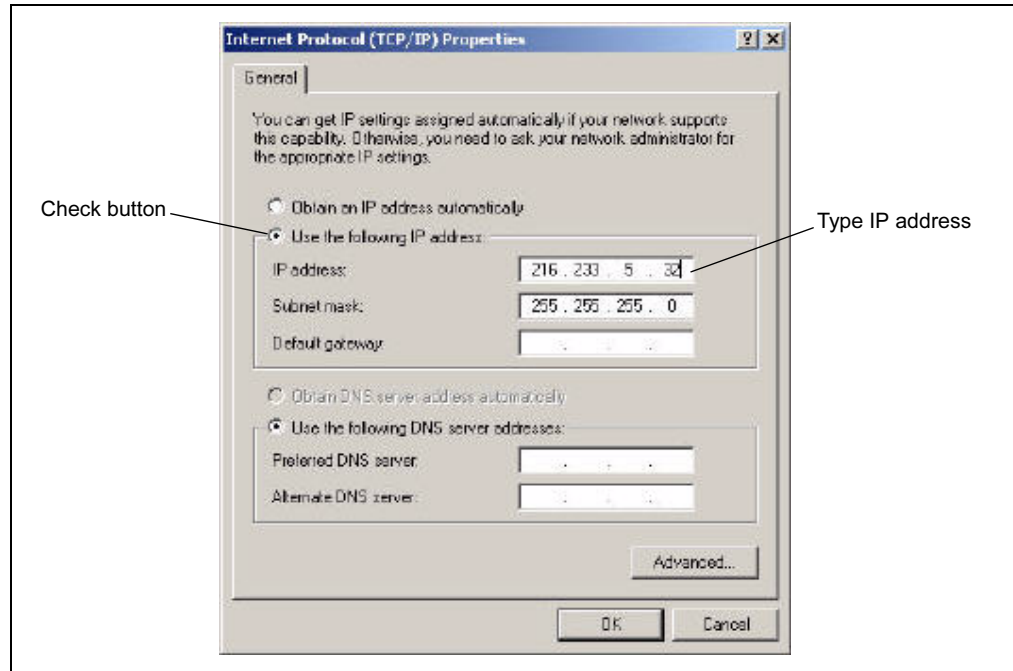
**IP Address:**

216 . 233 . 5 . 32

**Subnet mask:**

255 . 255 . 255 . 0

5. Check **OK** in each dialog box until you close all the windows. Depending on the version of Windows you are running, you may be required to reboot your PC for the changes to take effect.
6. Proceed with the FTP Server demonstration.

**FIGURE 5-3: IP SETTINGS DIALOG**

## 5.5 FTP SERVER DEMONSTRATION

### 5.5.1 Programming the dsPIC30F6014 Device

This exercise requires that the dsPIC30F6014 device be programmed with the FTP demonstration program (ftpdemo.hex). If you have previously loaded this program on a dsPIC30F6014 device you can proceed directly to **Section 5.5.2 “Start FTP Server Session”**.

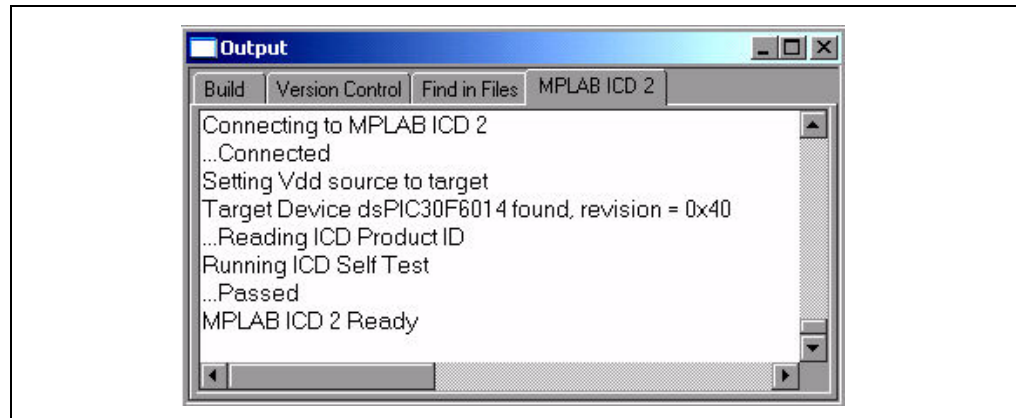
1. Apply power to the board. The green **POWER** LED illuminates.
2. Launch MPLAB IDE on your PC. From the *Configure* menu, choose *Select Device*, then select *dsPIC30F6014*.
3. From the MPLAB IDE *Debugger* menu, choose *Select Tool*, then select *MPLAB ICD 2*. You should see a connection message in the output window, as shown in Figure 5-4.

# FTP Server Demonstration

If the MPLAB ICD 2 does not initially connect and recognize the dsPIC30F6014 device, click the MPLAB ICD 2 puck icon on the MPLAB IDE toolbar.

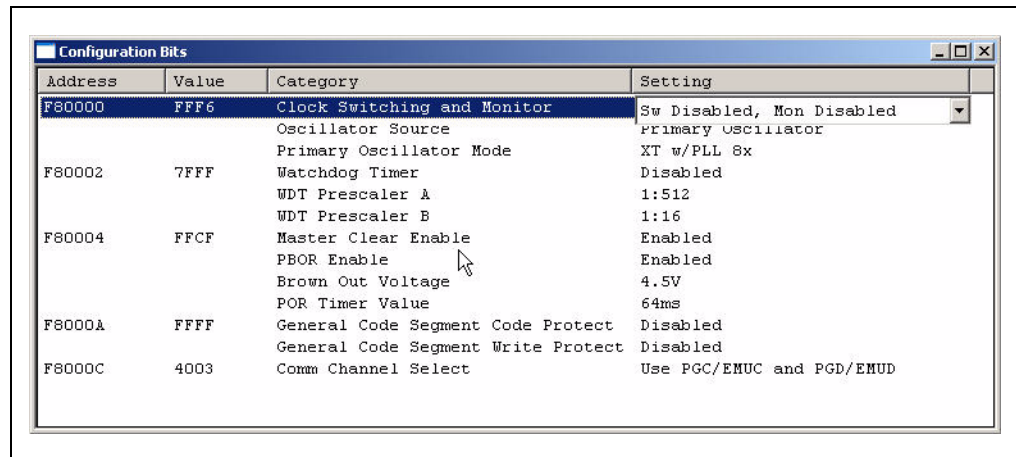
The output window should then indicate a successful connection.

**FIGURE 5-4: MPLAB ICD 2 CONNECTION MESSAGE WITH dsPIC30F6014**



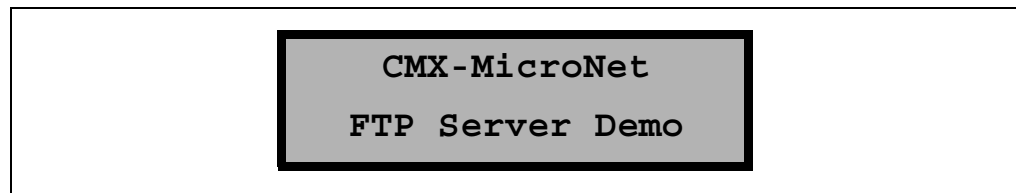
4. From the MPLAB IDE File menu, select Import. Browse to c : \FTP Server and open ftpdemo.hex.
5. From the MPLAB IDE Configure menu select "Configuration Bits" and verify the device configuration settings shown in Figure 5-5.

**FIGURE 5-5: FTP SERVER CONFIGURATION BITS SETTINGS**



6. From the MPLAB IDE Debugger menu select Program. The ftpdemo.hex file downloads to the dsPIC30F6014. The Output Window records the process as it occurs and indicates completion by displaying "MPLAB ICD 2 Ready".
7. Press <F6> to reset the program, then press <F9> to run the program. The LCD on the dsPICDEM.net board indicates that the program is running, as shown in Figure 5-6.

**FIGURE 5-6: LCD DISPLAY FOR FTP DEMONSTRATION**



## 5.5.2 Start FTP Server Session

After programming the demonstration into the dsPIC30F6014, follow these steps:

1. If CMX-MicroNet FTP Server is not running, press <F6> (Reset) followed by <F9> (Run).
2. From Windows, open a DOS command session.
3. From the command line prompt, type "ftp 216.233.5.31" to connect to the dsPIC30F6014 FTP Server.

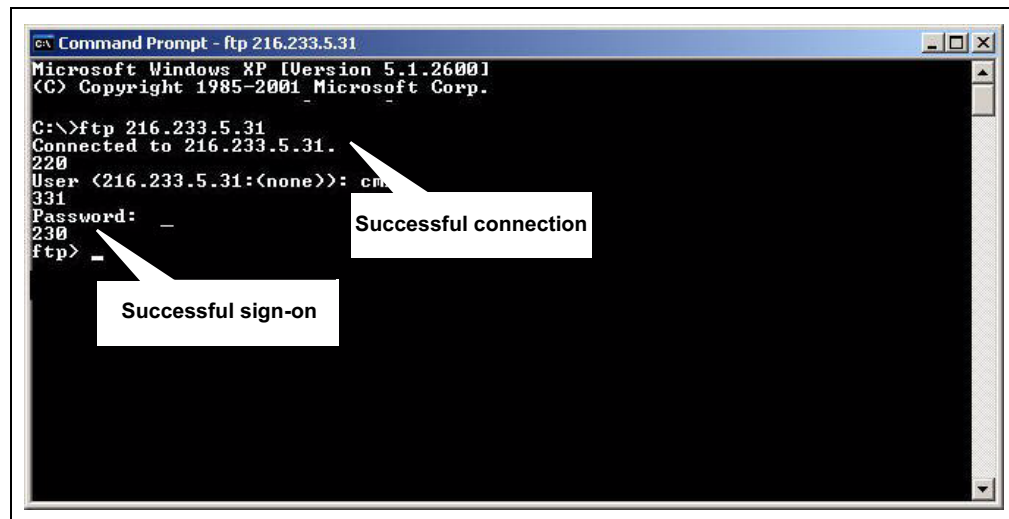
When the connection is made you will be prompted for your user name and password.

4. For the user name type "cmx".
5. When prompted for the password, type "password".

**Note:** Both the user and password are case-sensitive. Be sure both entries are lower case.

Upon successful sign-on you will have connected to the FTP Server running on the dsPIC30F6014 device. You will see a transaction sequence similar to that shown in Figure 5-7.

**FIGURE 5-7: LOG ON FTP SERVER SESSION**



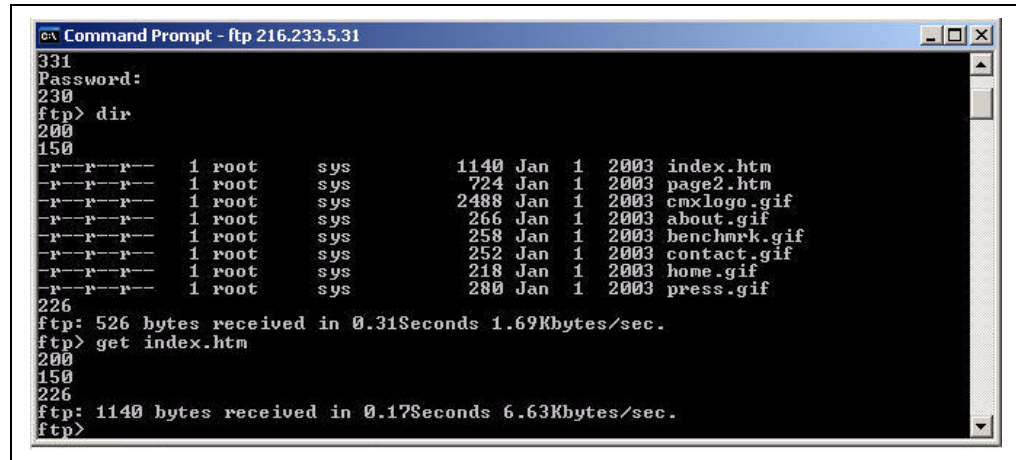
This screen shows when the connection is made and when the user is successfully logged on. This program only uses commands necessary to receive files from and send files to the dsPIC30F device. For information on the command set supported by CMX-MicroNet FTP Server, refer to the "FTP FUNCTIONS" section of the *CMX-MicroNet TCP/IP STACK Manual*.

## 5.5.3 Receive File From FTP Server

This portion of the demonstration shows how you might retrieve a file from the FTP Server virtual file system in dsPIC30F6014 memory.

1. At the ftp> prompt, type “dir”.
2. The FTP Server returns a listing of the files in its virtual file system, as shown in Figure 5-8.

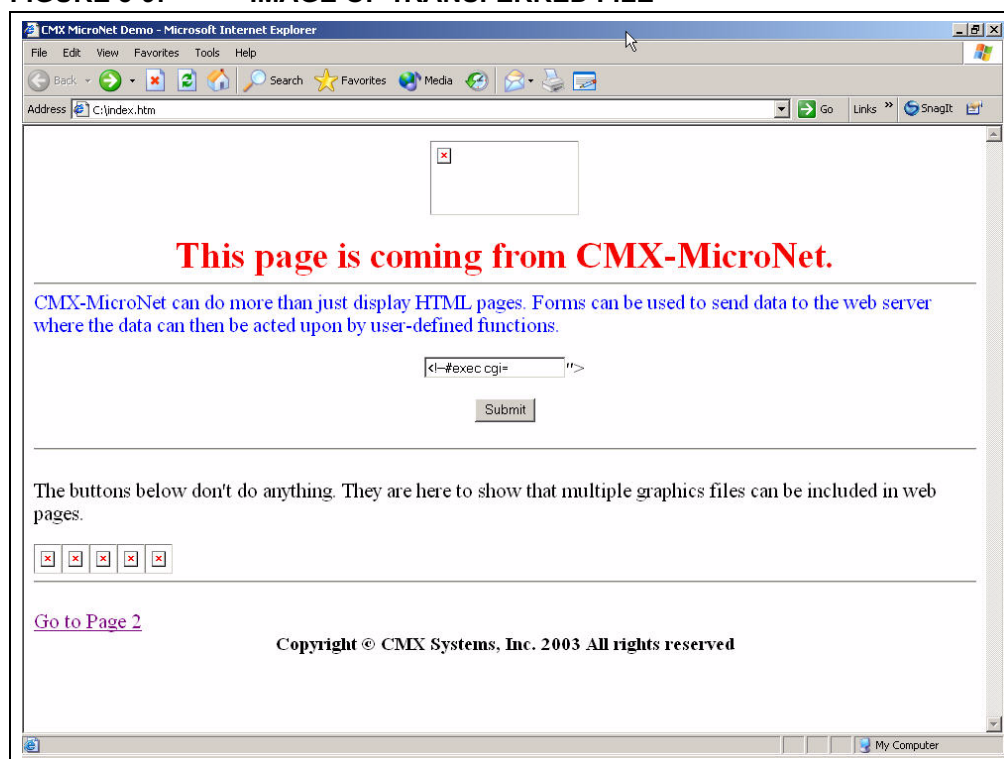
**FIGURE 5-8: RECEIVING A FILE FROM THE FTP SERVER**



```
c:\ Command Prompt - ftp 216.233.5.31
331
Password:
230
ftp> dir
200
150
-r--r--r-- 1 root sys 1140 Jan 1 2003 index.htm
-r--r--r-- 1 root sys 724 Jan 1 2003 page2.htm
-r--r--r-- 1 root sys 2488 Jan 1 2003 cmxlogo.gif
-r--r--r-- 1 root sys 266 Jan 1 2003 about.gif
-r--r--r-- 1 root sys 258 Jan 1 2003 benchmrk.gif
-r--r--r-- 1 root sys 252 Jan 1 2003 contact.gif
-r--r--r-- 1 root sys 218 Jan 1 2003 home.gif
-r--r--r-- 1 root sys 280 Jan 1 2003 press.gif
226
ftp: 526 bytes received in 0.31Seconds 1.69Kbytes/sec.
ftp> get index.htm
200
150
226
ftp: 1140 bytes received in 0.17Seconds 6.63Kbytes/sec.
ftp>
```

3. At the next ftp> prompt, type **get index.htm**.  
As the file downloads, the DOS screen displays status milestones: command received (200), file ready to send (150), and file transferring (226).
4. When the file transfer is complete, the status displays the number of bytes transferred, how long it took, and the transfer rate achieved. At the next ftp> prompt, type “quit” to close the FTP session, but leave the DOS session running.
5. In Windows, locate and view the transferred file using a graphics program (see Figure 5-9). This file is located in the directory from which you ran the DOS command FTP session (c : \).

**FIGURE 5-9: IMAGE OF TRANSFERRED FILE**



## 5.5.4 Send a File to FTP Server

This portion of the demonstration shows how you might transfer a file to the embedded application. The demonstration process is conducted in three parts. First you create a file on your PC to transfer to the dsPIC30F6014 FTP Server. Next you open an FTP session and transfer the file. And finally, you use MPLAB IDE to examine the actual contents of the FTP virtual file memory on the dsPIC30F6014 device.

### To create the demonstration file to be transferred:

1. At the DOS command line prompt, type "notepad".
2. When Notepad displays, type the following message:  
"This is a test file to demonstrate the dsPIC30F6014 FTP Server."
3. Save the message as **c:\testdemo.txt**.

### To transfer the demonstration file:

1. Open another FTP session (see **Section 5.5.2 "Start FTP Server Session"**).
2. At the ftp> prompt, type "put testdemo.txt".

As the transfer progresses, milestones are displayed sequentially. When the file transfer is complete, the status displays the number of bytes transferred, how long it took, and the transfer rate achieved.

3. At the next ftp> prompt, type "dir" to verify that the file is now in the FTP server virtual data memory. The listing shows that the file is included, as shown in Figure 5-10.



**FIGURE 5-10: FTP SEND DEMONSTRATION SESSION**

```

C:\> Command Prompt - ftp 216.233.5.31
-r-r-r-r- 1 root    sys      252 Jan  1  2003  contact.gif
-r-r-r-r- 1 root    sys      218 Jan  1  2003  home.gif
-r-r-r-r- 1 root    sys      280 Jan  1  2003  press.gif
226
ftp: 526 bytes received in 0.16Seconds 3.37Kbytes/sec.
ftp> put testdemo.txt
200
150
226
ftp: 63 bytes sent in 0.00Seconds 63000.00Kbytes/sec.
ftp> dir
200
150
-r-r-r-r- 1 root    sys      1140 Jan  1  2003  index.htm
-r-r-r-r- 1 root    sys      724 Jan  1  2003  page2.htm
-r-r-r-r- 1 root    sys      2488 Jan  1  2003  cmxlogo.gif
-r-r-r-r- 1 root    sys      266 Jan  1  2003  about.gif
-r-r-r-r- 1 root    sys      258 Jan  1  2003  benchmark.gif
-r-r-r-r- 1 root    sys      252 Jan  1  2003  contact.gif
-r-r-r-r- 1 root    sys      218 Jan  1  2003  home.gif
-r-r-r-r- 1 root    sys      280 Jan  1  2003  press.gif
-r-r-r-r- 1 root    sys       64 Jan  1  2003  testdemo.txt
226
ftp: 594 bytes received in 0.34Seconds 1.73Kbytes/sec.
ftp>
  
```

4. At the ftp> prompt, type “quit” to end the FTP session. Then type “exit” to close the DOS command prompt.
5. Go to MPLAB IDE and press <F5> to halt the FTP Server program in the dsPIC30F6014.

**To examine FTP Server memory:**

1. In MPLAB IDE select View > File Registers. The File Registers window displays the contents of the FTP Server virtual file.

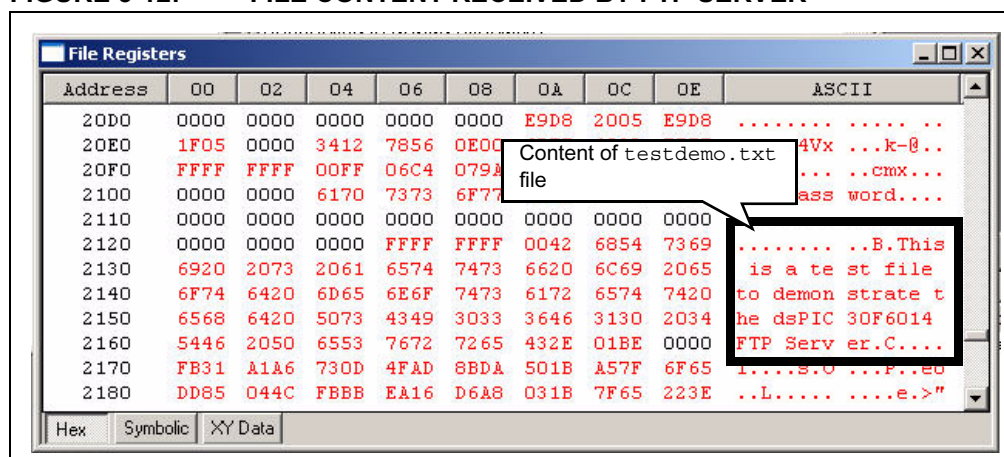
The information displayed in red represents new data in FTP Server memory. Information related to this demonstration starts around address location 0x850.

2. Page down the File Registers window to until you see the values displayed in red. Examine the ASCII data to look for the file name (testdemo.txt) in the ASCII area, as shown in Figure 5-11.

**FIGURE 5-11: FTP VIRTUAL FILE DIRECTORY ENTRY**

Address	00	02	04	06	08	0A	0C	0E	ASCII
10C0	0000	0000	0000	0000	0000	0000	0000	5551	.....QU
10D0	5449	0000	0000	0000	0000	0000	0000	0000	IT.....
10E0	0000	0000	0000	0000	0000	0000	0000	3232	.....
10F0	000A	0000	0000	0000	0000	0000	0000	0000	Shows testdemo.txt file
1100	6E69	6564	2E78	7468	006D	0000	0000	0000	index.htm
1110	0000	0000	0B10	DC6A	0000	0082	6574	7473	.....j. ....test
1120	6564	6F6D	742E	7478	0000	0000	0000	0000	demo.txt
1130	0040	0000	212C	0009	0000	0000	0000	0000	0....!
1140	0000	0000	0000	0000	0000	0000	0000	0000	.....
1150	0000	0000	0000	0000	0000	0000	0000	0000	.....
1160	0000	0000	0000	0000	0000	0000	0000	0000	.....
1170	0000	0000	0000	0000	0000	0000	0000	0000	.....

3. Next, scroll down to the next block of red data (approximately at address 0x2000-0x2100). Examine the ASCII area to find the content of the testdemo.txt file, as shown in Figure 5-12.

**FIGURE 5-12: FILE CONTENT RECEIVED BY FTP SERVER**


4. In MPLAB, close the workspace and exit the program.

## 5.6 SUMMARY

This demonstration has illustrated the basic capability of the dsPIC30F6014 functioning as an embedded FTP Server.

As stated in **Section 5.2 “Application Overview”** an embedded FTP server may be suitable in such applications such as data logging, inventory control, remote system performance analysis and remote reprogramming of the dsPIC Program Memory Flash, just to mention a few. The FTP Server uses the TCP/IP protocol layer, which ensures an ordered reliable delivery of the data.

The Program Memory Flash and Data RAM resources requirements for the CMX-MicroNet Stack is presented in Table 5-1.

**TABLE 5-1: RESOURCES FOR THE CMX-MICRONET STACK**

Flash	
UDP/IP + Core	4470 bytes
TCP/IP + Core	7827 bytes
UDP/TCP/IP + Core	8685 bytes
PPP	6681 bytes
Modem	447 bytes
HTTP Server	3888 bytes
Virtual File	885 bytes
Ethernet	2652 bytes
DHCP Client	2202 bytes
FTP Server	3657 bytes
TFTP Client	723 bytes
BOOTP	684 bytes
SMTP	1918 bytes
Utility	1314 bytes
RAM (not including buffer sizes)	
UDP/SLIP	56 bytes
TCP/HTTP/PPP	304 bytes
Ethernet	38 bytes

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## Chapter 6. V.22bis Soft Modem Demonstration

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### 6.1 INTRODUCTION

This chapter describes the dsPIC30F Soft Modem demonstration running on the dsPICDEM.net Development Board. The demonstration software is a subset of the dsPIC30F data modem library offered by Microchip. The dsPIC30F data modem library is composed of ITU-T compliant algorithms for V.21, V.22, V.22bis, V.23, V.32 and V.32bis modem recommendations and Bell standard 103. The dsPIC30F data-modem included as part of the dsPICDEM.net Connectivity Development Board and demonstrated in this section supports V.22bis and all lower data pump modulations. Full source code for V.22bis and lower data pump modulations is provided on the dsPICDEM.net Development Kit Software CD. V.32bis is not part of this demonstration package but is available for purchase.

For detailed information on the soft modem refer to the *dsPIC30F Soft Modem User's Guide* provided on the dsPICDEM.net Development Kit Software CD.

### 6.1 HIGHLIGHTS

Information covered in this chapter includes:

- Demonstration Overview
- Demonstration Configurations
- Demonstration Procedures
- Reprogramming the dsPIC30F6014
- Description of dsPIC30F Soft Modem
- dsPIC30F Soft Modem AT Command Set
- Troubleshooting the Connection
- Regulatory Compliance Reference Information
- ITU-T Specifications

### 6.2 DEMONSTRATION OVERVIEW

This demonstration illustrates the ability of the dsPIC30F Soft Modem to connect to another modem for transmitting and receiving data over the PSTN. The demonstration program implements real-time ITU-T V.22bis Transmit and Receive Data Pump Modulations. For specific information related to key features and performance metrics for the dsPIC30F Soft Modem see **Section 6.6 "Description of dsPIC30F Soft Modem"**.

Some possible applications implied by this demonstration include:

- POS Terminals
- Set Top Boxes
- Drop Boxes
- Fire Panels
- Internet-enabled home security systems
- Internet-connected power, gas and water meters
- Internet-connected vending machines
- Smart Appliances
- Industrial Monitoring

## 6.3 DEMONSTRATION CONFIGURATIONS

The soft modem demonstration is set up to run either as a pair of dsPIC30F devices running the soft modem and connected end-to-end, or as a dsPIC30F device communicating with a remote terminal equipped with a standard reference modem.

The LEDs and switches on the dsPICDEM.net board are not used for the soft modem demonstration.

### 6.3.1 Equipment Requirements

The soft modem demonstration requires the following equipment:

- dsPICDEM.net Development Board for originate/answer modem
- dsPICDEM.net Development Board or standard reference modem for answer/originate modem
- PC or laptop for configuring and controlling dsPIC30F soft modem(s) via AT commands
- PC or laptop for configuring and controlling standard reference modem via AT commands
- Analog phone line for each originate and answer modem
- RJ-11 phone cable for each dsPICDEM.net board and standard reference modem (not provided)

<b>Note:</b> Connect dsPICDEM.net to an analog line only. Using a non-analog line (e.g., digital, PBX Multi line) may damage the modem.
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### 6.3.2 Selecting the Demonstration Configuration

Figure 6-1 illustrates the set-up configuration for operating the end-to-end soft modem demonstration. This configuration requires the modem software on both dsPICDEM.net boards. The soft modem is controlled by AT commands entered on the Windows HyperTerminal (or suitable alternative terminal emulator) running on the PC or Laptop. This demonstration requires two analog phone lines, one each for the originate and answer modems.

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**FIGURE 6-1: END-TO-END DEMONSTRATION SET UP**

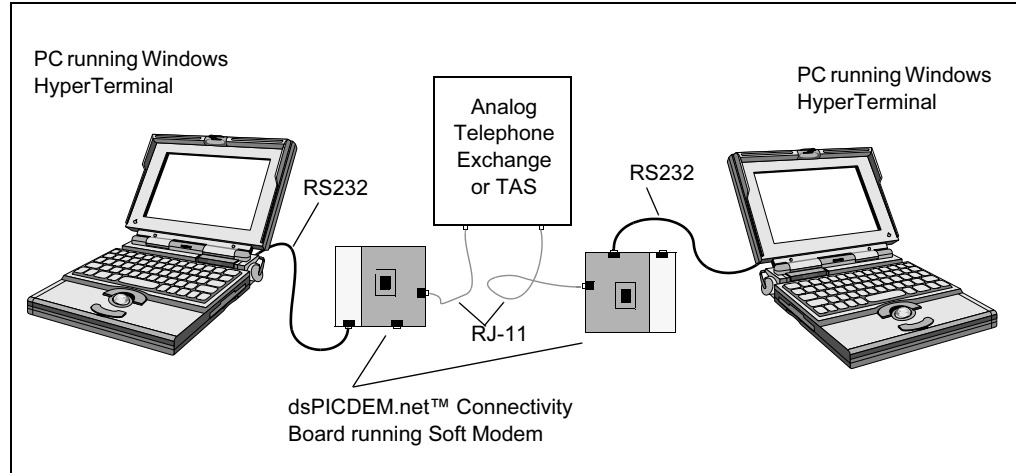
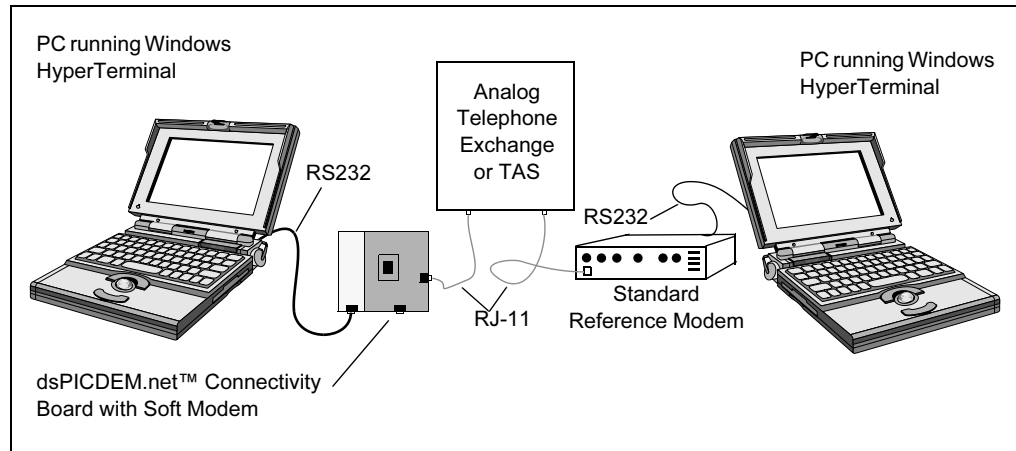


Figure 6-2 illustrates the set-up configuration for the interoperability soft modem demonstration. With this configuration, one terminal is the dsPIC30F running the soft modem. The other terminal is a PC or laptop with a standard reference modem. (See **Section 6.8.1 “Standard Reference Modems”** for a list of tested reference modems). The soft modem is controlled by AT commands entered on the HyperTerminal or suitable terminal emulator program running on a PC or laptop. The other terminal is controlled by the terminal emulator on the opposite PC or laptop. This demonstration requires two analog phone lines, one each for the originate and answer modems.

**FIGURE 6-2: INTEROPERABILITY DEMONSTRATION SET UP**



## 6.4 DEMONSTRATION PROCEDURES

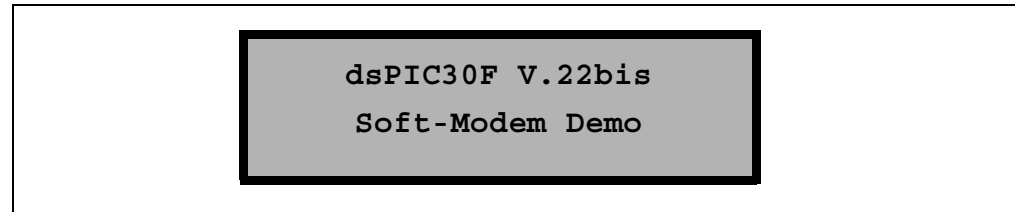
Follow these steps to exercise the soft modem functionality in real time. The dsPIC30F6014 device plugged into the dsPICDEM.net board has been pre-programmed with the V.22bis data-modem for this demonstration. If the demonstration program has been replaced by another application, you will need to reprogram the dsPIC30F6014 (see **Section 6.5 “Reprogramming the dsPIC30F6014”** for instructions on programming the soft modem into the dsPIC).

### 6.4.1 Initialize the Hardware

1. Configure the demonstration for end-to-end operation, as shown in Figure 6-1, or interoperability, as shown in Figure 6-2.
2. Make sure the 2x2 shunts on J17 and J19 are inserted in vertical alignment (perpendicular to the LCD display)
3. Apply power to the dsPICDEM.net Board(s) and/or the standard reference modem.
4. Press and release the RESET switch located to the right of the LCD.

The LCD acknowledges that the soft modem is initialized, as shown in Figure 6-3

**FIGURE 6-3: LCD DISPLAY**



### 6.4.2 Configure the Terminal for dsPIC30F Soft Modem

These procedures assume, but do not require, that you are using the Windows HyperTerminal.

1. Start HyperTerminal on both PCs. If you are set up for interoperability and are using a standard reference modem on one terminal, consult the modem user manual for specifics on configuring the modem.
2. Configure HyperTerminal with these settings:
  - Bits per second = 19200
  - Data bits = 8
  - Parity = None
  - Stop bits = 1
  - Flow Control = HardwareSet the Comm Channel appropriately for each PC.

# V.22bis Soft Modem Demonstration

- Execute these AT commands on each HyperTerminal and note the response.

Command*	Response
AT<ENTER>	OK
AT&F<ENTER>	OK
ATX0	OK
ATS0=1	OK

\*Refer to **Section 6.7 “dsPIC30F Soft Modem AT Command Set”** for descriptions of AT commands supported.

## 6.4.3 Initiate Communication

At this point, the dsPIC30F Soft Modem is ready to establish a dial connection with another modem.

- Initiate dialing with the following AT command:

ATD<dial string>

where <dial string> indicates the telephone number of the remote soft modem.

By default, 'auto answer after one ring' is enabled. The remote soft modem answers the call after one ring and connects in V.22bis and V.42 (LAPM) Mode. ITU-T Recommendation V.42 contains a High Level Data Link Control (HDLC) protocol referred to as Link Access Procedure for Modems (LAPM) and defines error-correcting protocols for modems. The following result codes are displayed on both the Hyper Terminals upon a successful connection.

CARRIER        2400  
PROTOCOL       LAPM  
CONNECT        19200

You should hear the call negotiation and training sequence on the call progress speaker. If you are using a standard reference modem on one terminal, the connection message transmitted and displayed on the PC may be slightly different but should present this same basic information. See **Section 6.8.6 “Response Messages for Successful Modem Connections”** for an example of a connection message provided by a USR 5686E type modem.

- With the two modems connected, test data transfer by typing information on one terminal and verifying that the same data is displayed on the other terminal.
- Test file transfer by creating a brief text file and using following file transfer options on the HyperTerminal.

HyperTerminal>Transfer>Send Text File

HyperTerminal>Transfer>Capture File

- Repeat the test procedure for the other modulation protocols by executing the following AT commands:

Protocol	Command
V.22bis-2400 bps	AT+MS=2,0,300,2400
V.22bis-1200 bps	AT+MS=2,0,300,1200
V.23 bps	AT+MS=3,0,300,1200
V.21 bps	AT+MS=0,0,300,300
Bell 103-300 bps	AT+MS=1,0,300,300

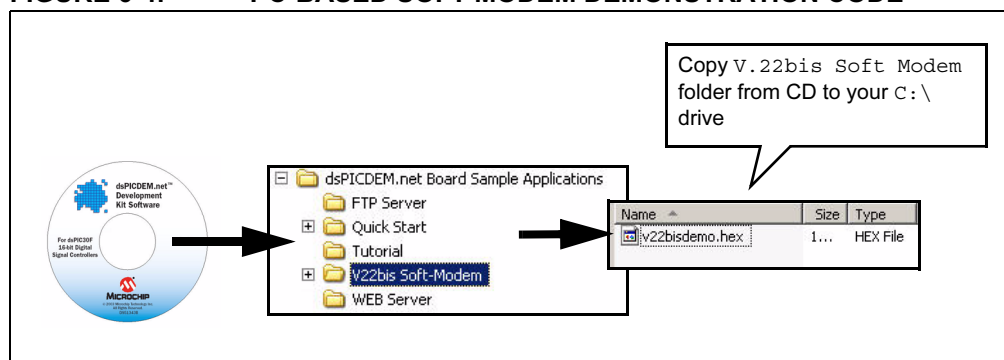
5. You may need to reset and reconfigure the standard reference modem for enabling these specific data modulations. Consult the standard reference modem user's manual for this information.

An example of configuring a USB modem for V.21 and V.23 is presented in **Section 6.8.4 “V.23 Connection Between dsPIC30F Soft Modem and US Robotics Modem”** and **Section 6.8.5 “V.21 connection Between dsPIC30F Soft Modem and US Robotics Modem”**

## 6.5 REPROGRAMMING THE dsPIC30F6014

Should you need to reprogram the dsPIC30F6014 device begin by copying the PC-Based Soft Modem folder from the dsPICDEM.net Development Kit Software CD to the C:\drive on your PC or laptop (see Figure 6-4).

**FIGURE 6-4: PC-BASED SOFT MODEM DEMONSTRATION CODE**

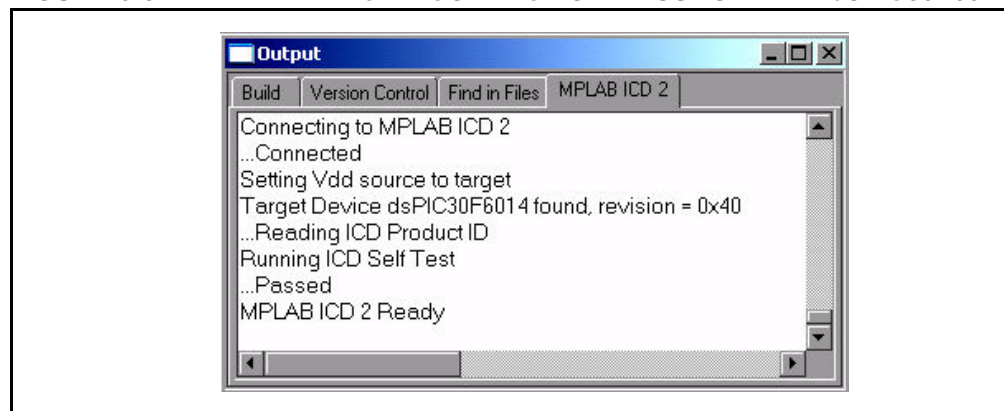


The easiest way to get the soft modem demonstration up and running is to program the provided .hex file into the dsPIC device using this procedure:

1. Apply power to the board. The green **POWER** LED illuminates.
2. Launch MPLAB IDE on your PC. From the menu bar select Configure>Select Device>dsPIC30F6014.
3. Select Programmer>Select Tool>MPLAB ICD 2. You should see a connection message in the MPLAB IDE output window, as shown in Figure 6-5.

If the MPLAB ICD 2 does not initially connect and recognize the dsPIC30F6014 device, click the MPLAB ICD 2 puck icon on the MPLAB IDE toolbar. The output window should then indicate a successful connection.

**FIGURE 6-5: MPLAB ICD 2 CONNECTION MESSAGE WITH dsPIC30F6014**





# V.22bis Soft Modem Demonstration

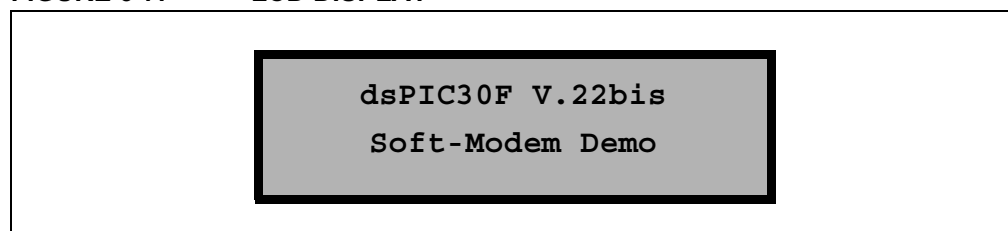
4. From the MPLAB IDE *File* menu, select *Import*. Select V22bisdemo.hex and click **Open**.
5. From the MPLAB IDE *Configure* menu, select *Configuration Bits* and verify the device configuration settings shown in Figure 6-6.

**FIGURE 6-6: CONFIGURATION BITS WINDOW**

Configuration Bits			
Address	Value	Category	Setting
F80000	C306	Clock Switching and Monitor	Sw Disabled, Mon Disabled
		Oscillator Source	Primary Oscillator
		Primary Oscillator Mode	XT w/PLL 8x
F80002	003F	Watchdog Timer	Disabled
		WDT Prescaler A	1:512
		WDT Prescaler B	1:16
F80004	8703	Master Clear Enable	Enabled
		PBOR Enable	Disabled
		Brown Out Voltage	4.5V
		POR Timer Value	64ms
F8000A	0007	General Code Segment Code Protect	Disabled
		General Code Segment Write Protect	Disabled
F8000C	C003	Comm Channel Select	Use PGC/EMUC and PGD/EMUD

6. From the MPLAB IDE *Programmer* menu select *Program*. The V22bisdemo.hex file downloads to the dsPIC30F6014. The Output Window records the process as it occurs and indicates completion by displaying "MPLAB ICD 2 Ready".
7. Remove the MPLAB ICD 2 cable from the board then press RESET on the demonstration board to run the program. The LCD on the dsPICDEM.net board indicates that the program is running, as shown in Figure 6-7.

**FIGURE 6-7: LCD DISPLAY**



At this point you are ready to run the soft modem demonstration, as described in **Section 6.4 "Demonstration Procedures"**.

## 6.6 DESCRIPTION OF dsPIC30F SOFT MODEM

The Microchip data modem library includes ITU-T compliant algorithms for V.21, V.22, V.22bis, V.23, V.32 and V.32bis modem recommendations as well as Bell standard 103.

These are the important parameters:

- V.21, V.23 and Bell 103 are Frequency Shift Keying (FSK) modems.
- V.32, V.32bis and V.22bis are Quadrature Amplitude Modulated (QAM) modems.
- V.22 is a Phase Shift Keyed (PSK) modem.
- V.21, V.22, V.22bis, V.32 and V.32bis are two-wire, full-duplex modems.
- V.23 is full-duplex when it operates with a 75-bps backwards channel.
- V.22bis includes fallback to V.22, V.23 and V.21 standards.
- V.32bis optionally falls back to V.22bis, V.22, V.23 and V.21 standards.

These key parameters are further detailed in Table 6-1.

**TABLE 6-1: SOFT MODEM FEATURES AND PERFORMANCE**

Algorithm <sup>(1)</sup>	Performance			Memory <sup>(2)</sup> (Kbytes)		MIPS
	Data Rate (bps)	Half/Full Duplex	Data Modulation	Program	Data	
V.21/Bell 103 <sup>(4)</sup>	300	Full	FSK	13	1.0	4.5
V.22/V.22bis	1200	Full	PSK/QAM	22	1.7	7
	2400					
V.23 <sup>(4)</sup>	1200	Half	FSK	15	1.0	4.5
	600					
V.32	9600	Full	QAM/TCM	31	3.2	12
	4800					
v.32BIS	14400	Full	QAM/TCM	36	3.6	15
	1200					
	9600					
	7200					
	4800					
v.42	n/a			14	2.0	1.5
DP + V.42 API	n/a			7	1.2	-
AT Command Set	n/a			7	0.15	-

**Note 1:** Data pump modules, V.21, V.22, V.22bis, V.23, V.32, V.32bis and Bell 103 are implemented in Assembly language. V.42, Data Pump and AT Command APIs are implemented in C language.

**2:** The program/data memory usage for the V-series data pumps is NOT cumulative, due to the sharing of components internally.

**3:** Memory size does not account for application which combines data pump, V.42 and AT commands (if required).

**4:** V.21/Bell 103 and V.23 data pumps do not require V.42.

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## 6.7 dsPIC30F SOFT MODEM AT COMMAND SET

The AT commands listed in Table have been selected to serve embedded soft modem applications on the dsPIC30F product family. These commands are a subset of the overall AT command set. Although the command set includes support for up to V.32bis, only V.22bis is supported in this demonstration.

**TABLE 6-2: AT COMMAND SET FOR dsPIC30F SOFT MODEM**

Command	Description
<b>En</b>	<b>Command Echo</b> <b>E0</b> – Inhibits the echoing of commands to the computer <b>E1</b> – Echoes commands to the computer
<b>Hn</b>	<b>Hang Up And Hook Control</b> <b>H</b> – Modem hangs up and go on-hook. <b>H0</b> – Causes the modem to go on-hook <b>H1</b> – Causes the modem to go off-hook
<b>Ln</b>	<b>Control Speaker Volume</b> <b>L0</b> – Speaker Turn off <b>L1</b> – Low <b>L2</b> – Medium (Default) <b>L3</b> – High
<b>In</b>	<b>Information and Identification</b> This command has various options which are used to instruct the modem to provide specific information about itself <b>I0</b> – Displays the modem controller firmware revision <b>I3</b> – Same as I0 <b>I4</b> – Current modem settings <b>I6</b> – Link diagnostics
<b>Qn</b>	<b>Quiet Mode</b> Determines whether the modem sends result codes and status codes (OK, BUSY, RING, etc.) to the terminal. <b>Q0</b> – Display result codes, user sees command responses (e.g., OK) <b>Q1</b> – Result codes are suppressed, user does not see responses
<b>Vn</b>	<b>Result Code Form</b> Selects whether the modem sends long form (in words) or short form (numeric) result codes the terminal. <b>V0</b> – Numeric result codes <b>V1</b> – English result codes (e.g., CONNECT, BUSY etc.)
<b>A</b>	<b>Answer</b> Modem goes off hook, transmits answer tone and waits for a carrier response from the remote modem.
<b>Dnnn..</b>	<b>Dial</b> Dials a telephone number and attempts to connect. The dial command must be the last command on the line. To cancel the Dial command, press any key. To dial 5588257, type ATD5588257
<b>T</b>	<b>Local Loop Back</b> Modem Starts Local loop back
<b>On</b>	<b>Enter Connect State and Retrain</b> <b>O0</b> – Leave online command mode and return to online data mode. <b>O1</b> – Issues the retrain command

**TABLE 6-2: AT COMMAND SET FOR dsPIC30F SOFT MODEM (CONTINUED)**

Command	Description															
<b>Wn</b>	<b>Negotiation Progress Message Control</b> <b>W0</b> – CONNECT result code reports DTE speed; disable the display of all extended result codes. <b>W1</b> – CONNECT result code reports DTE speed, enable the display of CARRIER and PROTOCOL extended codes only. <b>W2</b> – CONNECT result code reports DCE speed; disable the display of all the extended result codes.															
<b>Xn</b>	<b>Dial Tone And Busy Tone Detection</b> <b>X0</b> – Busy detect and dial tone detect disabled <b>X1</b> – Busy detect and dial tone detect disabled <b>X2</b> – Busy detect disabled and dial tone detect enabled <b>X3</b> – Busy detect enabled and dial tone detect disabled <b>X4</b> – Busy detect and dial tone detect enabled															
<b>&amp;F</b>	<b>Modem Reset</b> Restore settings to defaults (Modem reset).															
<b>&amp;Kn</b>	<b>Modem Flow Control</b> This command determines how the flow control between the computer and the local modem is handled. <b>&amp;K0</b> – Disable local flow control <b>&amp;K3</b> – Enable RTS/CTS (Hardware) flow control (default) <b>&amp;K4</b> – Enable XON/XOFF (Software) flow control															
<b>&amp;Qn</b>	<b>Communication Mode</b> <b>Q5</b> – Modem negotiates an Error-corrected link (default) <b>Q6</b> – Selects asynchronous operation															
<b>+MS_1,2,3,4,</b>	<b>Select Modulation</b> +MS=<mod>,<automod>,<minrate>,<maxrate> Where, <mod>        - Is specified modulation <automod> - Enables the auto mode operation. This mode is always enabled. <minrate>   - Sets the lowest modem speed <maxrate>   - Sets the highest modem speed <table><tr><th>&lt;Mod&gt;</th><th>Modulation</th><th>Possible Rates (bps)</th></tr><tr><td>0</td><td>V.21</td><td>300</td></tr><tr><td>2</td><td>V.22bis</td><td>2400 or 1200</td></tr><tr><td>3<sup>1</sup></td><td>V.23</td><td>1200</td></tr><tr><td>9</td><td>V.32</td><td>9600 or 4800</td></tr></table> By default V.32-9600 mode is selected and V.22bis/V.23/V.21 modes can be selected by the following commands respectively  V.32bis-14400 bps    - AT+MS=9,0,300,14400 V.32bis-12000 bps   - AT+MS=9,0,300,12000 V.32bis-9600 bps    - AT+MS=9,0,300,9600 V.32bis-7200 bps    - AT+MS=9,0,300,7200 V.32-9600 bps        - AT+MS=8,0,300,9600 V.32-4800 bps        - AT+MS=8,0,300,4800 V.22bis -2400 bps    - AT+MS=2,0,300,2400 V.22bis-1200 bps    - AT+MS=2,0,300,1200 V.23 bps              - AT+MS=3,0,300,1200 V.21 bps              - AT+MS=0,0,300,300 Bell 103 -300 bps    - AT+MS=1,0,300,300  <b>Note 1:</b> For V.23, originating mode transmits at 75 bps and receives at 1200 bps. Answering mode transmits at 1200 bps and receives at 75 bps.	<Mod>	Modulation	Possible Rates (bps)	0	V.21	300	2	V.22bis	2400 or 1200	3 <sup>1</sup>	V.23	1200	9	V.32	9600 or 4800
<Mod>	Modulation	Possible Rates (bps)														
0	V.21	300														
2	V.22bis	2400 or 1200														
3 <sup>1</sup>	V.23	1200														
9	V.32	9600 or 4800														

# V.22bis Soft Modem Demonstration

TABLE 6-2: AT COMMAND SET FOR dsPIC30F SOFT MODEM (CONTINUED)

Command	Description
<b>ATSn=x</b> <b>ATSn?</b>	<b>S-Registers</b> These registers are used set some of the simple modem configurations. Command writes the value 'x' to the specified S-register (n). Command displays the value of S-register (n)
<b>S0</b>	<b>Ring to Auto-answer On</b> Sets the number of rings required before the modem answers. Auto answer ring count. Default Value: S0 = 1
<b>S1</b>	<b>Ring Counter</b> Counts and stores the number of rings from an incoming call.
<b>S6</b>	<b>Wait Before Dialing</b> Sets the number of seconds the modem waits for dial tone before dialing. Default Value S6 = 1
<b>S7</b>	<b>Wait for Carrier After Dial/Answer</b> Sets the number of seconds the modem waits for a carrier or answers before returning on-hook and sending a NO CARRIER result code. Default Value S7 = 60
<b>S91</b>	<b>Transmit Signal Level</b> This register is used to specify the transmit signal level in -dBm value. Default Value S91 = 12 (-12 dBm)
<b>+++</b>	<b>Escape Sequence</b> This is a three character escape code used to enter into the command mode from the data mode.

## 6.8 TROUBLESHOOTING THE CONNECTION

The dsPIC30F Soft Modem has undergone multiple levels of testing, ranging from extensive bench testing using standard, off-the-shelf reference modems to full ITU-T compliance testing. The reference modems used in the testing are listed in Table 6-3.

Reference modems are not all equal in terms of data pump (DP) modulations they support as power-on default. For example, the US Robotics External 56K modem, model 5686E, supports V.21 and V.23, but only if it is enabled via suitable AT commands. Attempts to connect with V.21 and V.23 will fail until these DP modulations have been enabled.

Also the US Robotics External 56K modem, model 5686E, does not support V.32 9600 bps (NTCM). The modem will disconnect after the rate exchange sequence during the V.32 hand shake, since this is an invalid speed setting in V.32 mode. It connects at 9600 bps (TCM) in V.32bis mode.

This troubleshooting section does not address every specification or operational feature of the reference modems. It is intended to be a starting point should you experience some basic connection issues.

### 6.8.1 Standard Reference Modems

The dsPIC30F Soft Modem has undergone extensive testing to ensure ITU-T compliance and robust system operation. During performance and interoperability testing, the reference modems listed in Table 6-3 were used in both the originate and answer modes while communicating with the dsPIC30F Soft Modem on the dsPICDEM.net Connectivity Board.

**TABLE 6-3: REFERENCE MODEMS**

Reference Modem	Model	Description
U.S. Robotics	5686E	External V.90/V.92 56k Fax/Modem
U.S. Robotics	0839	External Sportster 33.6 Fax/Modem
U.S. Robotics	98117203	External Sportster Voice 33.6 Fax/Modem
Zoom	2949	External V.90 Fax/Modem
Zoom	3049	External V.92 Fax/Modem
D-Link	DMF-336/E	External 33.6 Fax/Modem
D-Link	DMF-560/ES	External 56k Data/Fax/Voice Modem
3Com	455630-01	External 56k Fax/Modem

### 6.8.2 ITU-T V.8 Support

Currently the dsPIC30F Soft Modem falls back to other modulations only through V.8 handshake. Therefore the dsPIC30F Soft Modem will not be able to establish a connection in any DP modulation mode with reference modems that do not support the V.8 handshake.

For example, D-Link and Zoom reference modems do not support the V.23 modulation selection through V.8 handshake when they are in originating mode. Therefore the dsPIC30F Soft Modem in answer mode will not be able to establish a V.23 connection with these reference modems. However in answer mode, these reference modems do support the falling back to V.23 modulations through V.8 handshake. Therefore the dsPIC30F Soft Modem in originate mode is able to establish a V.23 connection with these reference modems.

### 6.8.3 Data Flow Control

By default, the dsPIC30F Soft Modem uses hardware flow control for data transfer. The dsPIC30F Soft Modem uses the UART flow control pins (RTS & CTS) on the dsPICDEM.net connectivity board. This configuration requires that a two-position shunt be installed in the vertical position on jumpers J17 and J19. Also, it is necessary to enable the hardware flow control in HyperTerminal (or other terminal emulation program running on the PC).

It is possible to change the flow control mode of the dsPIC30F Soft Modem to Xon/Xoff by using a specific AT command (AT&Kn) and selecting a corresponding flow control mode in the HyperTerminal.

## 6.8.4 V.23 Connection Between dsPIC30F Soft Modem and US Robotics Modem

Following are AT commands for enabling V.23 between the dsPIC30F Soft Modem and US Robotics Model 5686E Reference Modem. If the AT command is valid, HyperTerminal displays 'OK' as the response message. If the AT command is invalid or unsupported, HyperTerminal displays 'ERROR' as the response message.

Supported AT commands for V.23 connection on US Robotics Modem:

AT Command	Function
AT&F1	Enable factory default settings
ATS0=1	Enable auto answer after one ring
ATS27=16	Enable the V.23 fallback

AT commands for V.23 connection on dsPIC30F Soft Modem:

AT Command	Function
AT&F	dsPIC30 Soft Modem default settings
AT+MS=3,0,300,1200	Force V.23 connection

## 6.8.5 V.21 connection Between dsPIC30F Soft Modem and US Robotics Modem

Following are AT commands for enabling V.21 between the dsPIC30F Soft Modem and US Robotics Model 5686E Reference Modem. If the AT command is valid, HyperTerminal displays 'OK' as the response message. If the AT command is invalid or unsupported, HyperTerminal displays 'ERROR' as the response message.

Supported AT commands for V.21 connection on US Robotics Modem:

AT Command	Function
AT&F1	Factory Default settings
ATS0=1	Enable auto answer after one ring
ATS27=1	Enable the V.21 fallback

Supported AT commands for V.21 connection on dsPIC30F Soft Modem:

AT Command	Function
AT&F	Enable dsPIC30F Soft Modem default settings
AT+MS=0,0,300,300	Force V.21 connection

<p><b>Note:</b> In almost all the modems, a V.42 LAPM connection is not supported for V.21 and V.23 data pump modulation modes. Hence a connection will be established in Non-V.42 mode (PROTOCOL NONE).</p>
--

### 6.8.6 Response Messages for Successful Modem Connections

Table 6-3 lists connection messages displayed on the HyperTerminal when a successful modem connection has been established between the dsPIC30F Soft Modem and the US Robotics Model 5686E modem using the V22bis demonstration.

**TABLE 6-4: SUCCESSFUL CONNECTION RESPONSE MESSAGES**

Data Pump Modulation	dsPIC30F Soft Modem	US Robotics Model 5686E
V.22bis 2400 bps	CARRIER 2400 PROTOCOL LAPM CONNECT 19200	CONNECT 2400/ARQ/LAPM
V.22 1200 bps	CARRIER 1200 PROTOCOL LAPM CONNECT 19200	CONNECT 1200/ARQ/LAPM
V.23 1200 bps	CARRIER 1200/75 PROTOCOL NONE CONNECT 19200 (dsPIC30F Soft Modem is the answer modem)	CONNECT 75/1200/NONE (USRobotics is the originate modem)
	CARRIER 75/1200 PROTOCOL NONE CONNECT 19200 (dsPIC30F Soft Modem is the originate modem)	CONNECT 1200/75/NONE (USRobotics is the answer modem)
V.21 300 bps	CARRIER 300 PROTOCOL NONE CONNECT 19200	CONNECT
Bell 103	TBP	TBP

## 6.9 REGULATORY COMPLIANCE REFERENCE INFORMATION

Every country has telecommunication laws that prohibit the connection of unapproved telecommunication devices, including modems, to the phone line. Approval by a country's telecommunications regulatory agency may entail hardware/firmware modifications to your end-system modem in order to comply with telecommunication laws. Approval could require modifications for radio-frequency interference, pulse dial make/break ratios, redial capabilities, and so forth.

The words "approved or compliant for use in country XYZ" mean that the modem has been modified to comply with the telecommunication laws of that country. An American modem approved by the Federal Communications Commission (FCC) in the United States and imported to Germany would not be a legal telecommunications device in Germany. FCC approval in the USA does not imply BZT approved in Germany.

The Silicon Laboratories chipsets used with the dsPICDEM.net 1 and dsPICDEM.net 2 Connectivity Boards are compliant with FCC, Japan Approval Institute for Telecommunications Equipment (JATE) and Common Technical Regulation (CTR\_21) country-specific Post, Telephone & Telegraph (PTT) specifications. The chipsets can be fully programmed for AC termination, DC termination, ringer impedance and ringer threshold, enabling the devices to meet worldwide telephone line interface requirements. The devices interface directly to standard modem DSPs or system interface circuits.



## 6.9.1 Federal Communications Commission

The Federal Communications Commission (FCC) rules (47 C.F.R. Part 68) governs the direct connection of Terminal Equipment (TE) to the Public Switched Telephone Network (PSTN), and to wireline carrier-owned facilities used to provide private line services.

## 6.9.2 Industry Canada DOC CS-03

Approval of equipment for Canada is relatively straight-forward. Testing and compliance should be in accordance with technical standard CS-03. The requirements are well harmonized with FCC part-68. In many instances it is possible to use FCC reports to obtain Industry Canada DOC CS-03 approval.

For additional information on FCC part-68 and approved test facilities refer to [www.fcc.gov](http://www.fcc.gov).

## 6.9.3 Common Technical Regulation CTR-21

CTR-21 is a Common Technical Regulation that defines a harmonized standard for analog access to the PSTN throughout the European Economic Area (EEA) and Switzerland. In the past, analog standards were not harmonized. Manufacturers were required to go to each country and test analog equipment to that country's unique specifications. CTR-21 simplifies this process by enabling manufacturers to go to one test lab and take one compliance test for all EEA member countries. The result is faster product delivery throughout the EEA market.

## 6.9.4 Japan Approval Institute for Telecommunications Equipment

JATE is the institute that approves telecommunications equipment for use with Japan's public telephone network. Approved equipment bears a JATE approval mark or number. For more information on JATE refer to: [www.jate.or.jp/index\\_e.html](http://www.jate.or.jp/index_e.html) or Nippon Telegraph and Telephone (NTT) Corporation: [www.ntt.co.jp/index\\_e.html](http://www.ntt.co.jp/index_e.html).

## 6.10 ITU-T SPECIFICATIONS

Table 6-5 lists the ITU-T specifications used for development of the soft modem and DTMF implementation on the dsPIC30F product family

**TABLE 6-5: ITU-T SPECIFICATIONS**

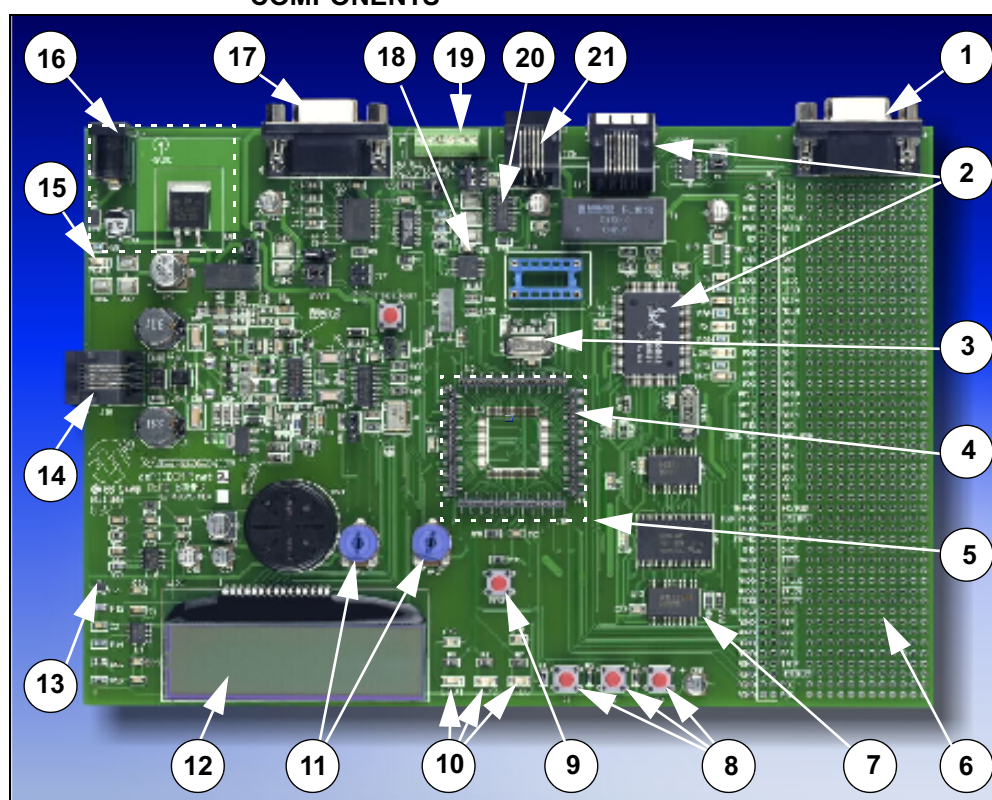
ITU-T Specification	Name Of The Document
ITU-T V.32bis	A duplex modem operating at data signalling rates of up to 14400 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits.
ITU-T V.32	A family of 2-wire, duplex modems operating at data signalling rates of up to 9600 bit/s for use on the general switched telephone network and on leased telephone-type circuits.
ITU-T V.22bis	2400 bits per second duplex modem using the frequency division technique standardized for use on the general switched telephone network and on point-to-point 2-wire leased telephone-type circuits.
ITU-T V.21	300 bits per second duplex modem standardized for use in the general switched telephone network.
ITU-T V.23	600/1200-baud modem standardized for use in the general switched telephone network.
ITU-T V.8	Procedures for starting sessions of data transmission over the public switched telephone network.
ITU-T V.25	Automatic answering equipment and general procedures for automatic calling equipment on the general switched telephone network including procedures for disabling of echo control devices for both manually and automatically established calls.
ITU-T V.42	Error-correcting procedures for DCEs using asynchronous-to-synchronous conversion.
ITU-T V.56bis	Network transmission model for evaluating modem performance over 2-wire voice grade connections.
ITU-T V.56ter	Test procedure for evaluation of 2-wire 4 kHz voice band duplex modems.
ITU-T Q.23	Technical features of push-button telephone sets.
ITU-T Q.24	Multi-frequency push-button signal reception.

## Chapter 7. dsPICDEM.net Development Hardware

### 7.1 dsPICDEM.net Hardware Components

Figure 7-1 illustrates the major components that comprise the dsPICDEM.net Development Board. Table 7-1 identifies these hardware elements and points to the specific instructions for using each item.

**FIGURE 7-1: dsPIC30F6014 16-BIT SIGNAL CONTROLLER HARDWARE COMPONENTS**



**TABLE 7-1: dsPICDEM™.net DEVELOPMENT BOARD HARDWARE**

No.	Hardware Element	No.	Hardware Element
1	CAN Port (Section 7.1.2)	12	LCD Graphic Display (Section 7.1.9)
2	10-Base T Ethernet (Section 7.1.12)	13	Temperature Sensor (Section 7.1.4)
3	Oscillator (Section 7.1.18)	14	PSTN Telephone Interface (Section 7.1.11)
4	Emulation Header (Section 7.1.15)	15	Power On Indicator (Section 7.1.17)
5	Sample Devices (Section 7.1.21)	16	Power Supply (Section 7.1.16)
6	Prototyping Area (Section 7.1.20)	17	RS-232 Serial Port (Section 7.1.1)
7	64kx16 External SRAM (Section 7.1.14)	18	Serial EE Memory (Section 7.1.13)
8	Push Button Switches (Section 7.1.6)	19	RS-485/RS-422 Port (Section 7.1.3)
9	Reset Switch (Section 7.1.19)	20	Digital Potentiometer (Section 7.1.8)
10	LEDs (Section 7.1.7)	21	ICD 2 Connector (Section 7.1.10)
11	Analog Potentiometers (Section 7.1.5)		

## 7.1.1 RS-232 Serial Port

A single RS-232 serial communication channel is provided on the dsPICDEM.net Development Board. This serial communication channel, labeled J5, can be configured as an RS-232 or RS-485/RS-422 communication channel via jumpers J17, J18 and J19. The following jumper connections are required for RS-232 serial communications:

- J19, shunt pins 1-2 for Tx channel support
- J19, shunt pins 3-4 for Rx channel support
- J17, shunt pins 1-2 for Request-to-Send (RTS) support
- J17, shunt pins 3-4 for Clear-to-Send (CTS) support

**Note:** The shunts for J17 and J19 must be connected vertically.

- J18, shunt pins 2-3 for Rx connection to the dsPIC device

Jumper 19 connects the dsPIC UART channel 1 U1RX and U1TX pins to an RS-232 level shifting IC, U7. The serial port is configured as DCE, and can be connected to a PC using a straight-through cable. If hardware handshaking is required, inserting shunts on jumper J17 will connect CTS and RTS to port pins RA9 and RA10 on the dsPIC device. These pins can support CTS/RTS through a bit-bang control approach. Both pins are connected to IC U7.

## 7.1.2 CAN Port

The CAN RXD and TXD lines of the MCP2551 are connected to the dsPIC CANRX and CANTX pins. CAN bus signals, CANH and CANL, are available on the DB9 connector J4. The CANH and CANL bus can be locally terminated with a 120 ohm by inserting jumper, J3.

## 7.1.3 RS-485/RS-422 Port

Signals for the RS-485/RS-422 port are available on the 6-pin terminal block labeled TB1. The terminal block is configurable from RS-485 to RS-422 by removing the jumper on J2. Inserting jumper J1 will terminate the bus with a 120 ohm resistor.

The RX485 and TX485 lines of the MAX489E can be tied to the dsPIC UART channel 1 U1RX and U1TX pins by the following jumper settings:

- J19, shunt pins 1-2 for Tx channel support
- J19, shunt pins 3-4 for Rx channel support

**Note:** The shunts for J19 must be connected vertically.

- J18, shunt pins 1-2 for Rx connection to the dsPIC device

MAX489E receiver and driver output enables are controlled by port pins RG0 and RG1, respectively.

## 7.1.4 Temperature Sensor

This is a -40°C to +125°C linear output temperature sensor (TC1047A) connected to analog channel AN3 of the dsPIC device. The output of the temperature sensor, U2, is fed through a second order low-pass filter before connection to the dsPIC device. The LP filter cutoff frequency is set at 10 Hz. The output voltage range for the TC1047A is typically 750 mV at +25°C. The TC1047A exhibits a typical 10 mV/C voltage slope.

## 7.1.5 Analog Potentiometers

Two 5 kOhm potentiometers are connected to analog channels AN4 and AN5. The voltage output range for each potentiometer is between 0 VDC and 5 VDC. The voltage source is provided by VR1, through a low-pass filter. VR1 is the main voltage regulator for all components on the development board.

## 7.1.6 Push Button Switches

Three switches, S1-S3, are connected to port pins RA12-RA14, respectively on the dsPIC device. The signal lines are normally pulled up to +5 VDC through 10 k $\Omega$  resistors. Pressing the switch will short the line to ground. Port pins RA12-RA14 are configured as the INT1-INT3 external interrupt pins.

## 7.1.7 LEDs

Three red LEDs, LED1-LED3, are connected to port pins RC2 to RC4, respectively on the dsPIC device. The LED anodes are tied to VDD through a 1.2K resistor.

## 7.1.8 Digital Potentiometer

A dual channel digital potentiometer, MCP42050, is provided on the development board. Control of the digital potentiometer is via the dsPIC SPI 1 communication channel. The outputs of the digital potentiometer are applied to test points PW0 and PW1.

## 7.1.9 LCD Graphic Display

A 2 x 16 character dot matrix LCD display is provided on the development board. The dsPIC device accesses the LCD via PORTD pins RD0-RD7. The three LCD control signals, RS, RW and E are connected to dsPIC port pins RA6, RB11 and RA7 respectively.

## 7.1.10 ICD Connector

By way of the modular connector ICD, the MPLAB ICD 2 can be connected for low-cost programming and debugging of the dsPIC device. Programming and debugging the dsPIC device is through dedicated use of the PGC/EMUC/RB1 and PGD/EMUD/RB0 pins on the development board.

## 7.1.11 Public-Switch Telephone Network (PSTN) Interface

The dsPICDEM.net Development board is available in 2 configurations, one using the Si3035 chipset for the FCC and JATE compliant designs and the other using Si3034 chipset for worldwide applications. The dsPIC communicates with this port with its Data Converter Interface (DCI).

The Si3035 chipset is composed of the Si3012 DAA and a Si3021 AFE ICs. The dsPIC communicates to the Si3021 AFE via its DCI peripheral module. The Si3034 chipset is composed of a Si3014 DAA and the same Si3021 AFE.

A speaker is provided on the development board and provides for call progress monitoring.

For detailed operation, please refer to the Si3034 and Si3035 data sheets available on [www.silabs.com](http://www.silabs.com).

### **7.1.12 10-Base T Ethernet**

An Ethernet interface is provided using the Realtek RTL8019 ethernet controller. This is accessed via the bidirectional bus on PORTD. For detailed operation of this device please see the RTL8019 data sheet from Realtek

- STATUS LEDs: Four LEDs are provided:
  - LINK STATUS – This LED can be used for link status.
  - XMIT and RX – When the board is connected correctly, these are normally lit, and flash OFF (inverted logic), when the board is transmitting or receiving a packet (respectively).
  - BNC – This LED is enabled as default and indicates medium type.

Connection to the Ethernet is supported via the RJ-45 modular connector.

### **7.1.13 Serial EE Memory Device**

A Microchip 24LC515 serial EEPROM provides 512 Kbit (64 Kbyte) of storage for constants such as Web pages, linearization tables for sensors and custom data tables. The 24LC515 is programmable via a two-wire serial I<sup>2</sup>C™ interface.

### **7.1.14 64k x 16 External SRAM**

A Cypress 1 Mbit (64k words) CY7C1021B CMOS Static RAM is provided and can be used to store temporary data for product development or diagnostic purposes. The CY7C1021B is accessible via a multiplexed bus on PORTD pins RD0-RD15. The SRAM control signals, CE, OE and WE are provided by the dsPIC PORTB pins RB9, RB10 and RB11 respectively.

Two 74HCT573 Octal D-latches are implemented for latching the SRAM address. The high and low byte control signals, BHE and BLE, of the SRAM are tied to ground, through zero ohm resistors. Reads and writes to the SRAM are performed in the x16 data mode.

The following is a typical sequence of steps for accessing the external SRAM device:

1. Place 16-bit address on PORTD and set pin direction (TRISD) as outputs
2. Assert ALE (RB12) to a logic '1' from a logic '0' to latch address
3. Assert control signal OE (RB10) to a logic '0' for a read or logic '1' for a write
4. For a write, place data on PORTD
5. Assert CE (RB9) to a logic '0' to select SRAM chip
6. If performing a read, read data on PORTD
7. If performing a write, assert control signal WE (RB11) to a logic '1' from a logic '0'
8. Assert control signal CE (RB9) to a logic '1' to deselect the SRAM

### **7.1.15 Emulation Header**

Headers J10-J13 provide for a connection to the MPLAB ICE 4K In-Circuit Emulator. The emulation headers also support the processor adaptor boards (see **Section 7.1.21 "Sample Devices"**). The processor adaptor boards enable quick change out of the 80-pin TQFP device.

## 7.1.16 Power Supply

The dsPICDEM.net Development Board is powered by a +9V AC/DC wall adapter. A single +5 VDC regulator provides all board components with +5 VDC. Analog components are sourced from this same regulator through a low-pass filter circuit. Separate analog and digital ground planes are connected through a single point.

Jumper J6 allows the supplied power source to be bypassed and an alternate supply to be provided.

## 7.1.17 Power-on Indicator

A green LED is connected to the input of the regulators to indicate the presence of power.

## 7.1.18 Oscillator

- Crystal oscillator (7.3728 MHz) supplied.
- Thru holes and pads provided for user furnished watch-type crystal and two capacitors for SOSC1 and SOSC2.
- Socket and pads for an output pull up resistor for user furnished crystal oscillator to processor.
- External clock connections from J8.

**TABLE 7-2: OSCILLATOR SELECTIONS**

Oscillator Selection on dsPICDEM™	Modifications on dsPICDEM™
Crystal	R61, R62, R67, C42, C41 and XTAL2 open, U16 empty. Crystal in XTAL3, caps in C40 and C39.
Mini Crystal	R67, R61, R62, C40, C39 and XTAL3 open, U16 empty. Crystal in XTAL2, caps in C42 and C41.
Canned Oscillator	R67, R61, R62, C42, C41, C40, C39, XTAL2 and XTAL3 open, U16 installed.
RC	R61, R62, C42, C41, C40, XTAL2 and XTAL3 open, U16 empty. Cap in C39 and resistor in R67.
External Clock	R67, C42, C41, C40, C39, U16, XTAL2 and XTAL3 open. 0 ohm installed for R61 and R62.

## 7.1.19 Reset Switch

This switch is tied to the  $\overline{\text{MCLR}}$  pin on the dsPIC controller, and is used to reset the device.

## 7.1.20 Prototyping Area

A prototyping area and associated header are provided which enables additional ICs and attachment boards to be added.

## 7.1.21 Sample Devices

A sample dsPIC device programmed with the demonstration code is included in the dsPICDEM.net Development Board Kit. The 80-pin TQFP is soldered to a 1.5" x 1.5" adaptor PCB which is inserted onto the emulation header, J11 and J13-J15. Careful device handling should be used for inserting and extracting the adaptor board.

The orientation of the adaptor board is important. The Microchip logo and device part numbering should be aligned to read from left to right before the insertion of the adapter board.

**NOTES:**





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## **Appendix A. Hardware Schematics**

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### **A.1 BOARD LAYOUT AND SCHEMATICS**

#### **A.1.1 dsPICDEM.net 1 and dsPICDEM.net 2 Development Board**

The following figures show the parts layout (silk screen) and schematics for the dsPICDEM.net 1 and dsPICDEM.net 2 Development Board.

**FIGURE A-1: dsPICDEM.net™ DEVELOPMENT BOARD LAYOUT**

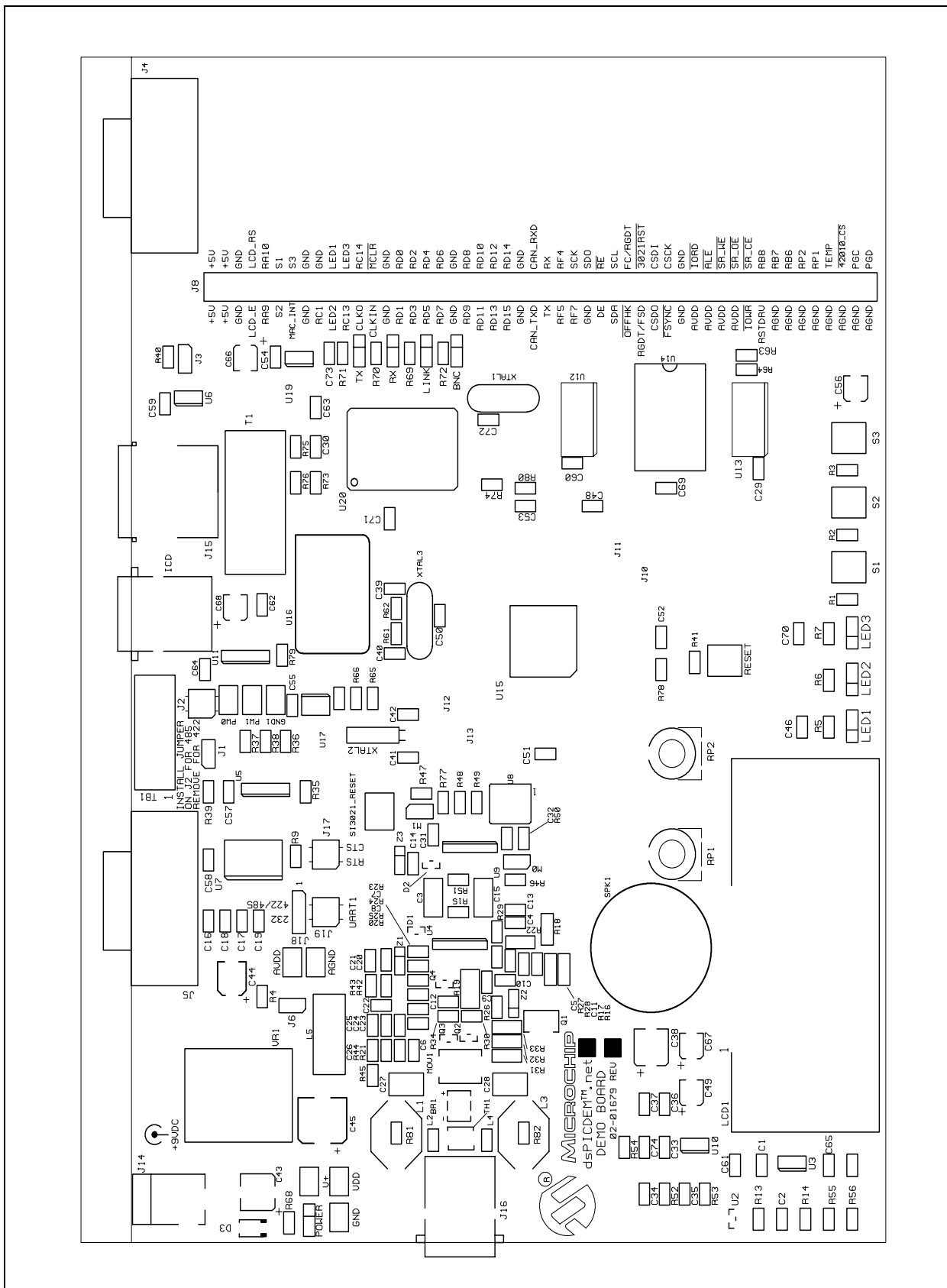
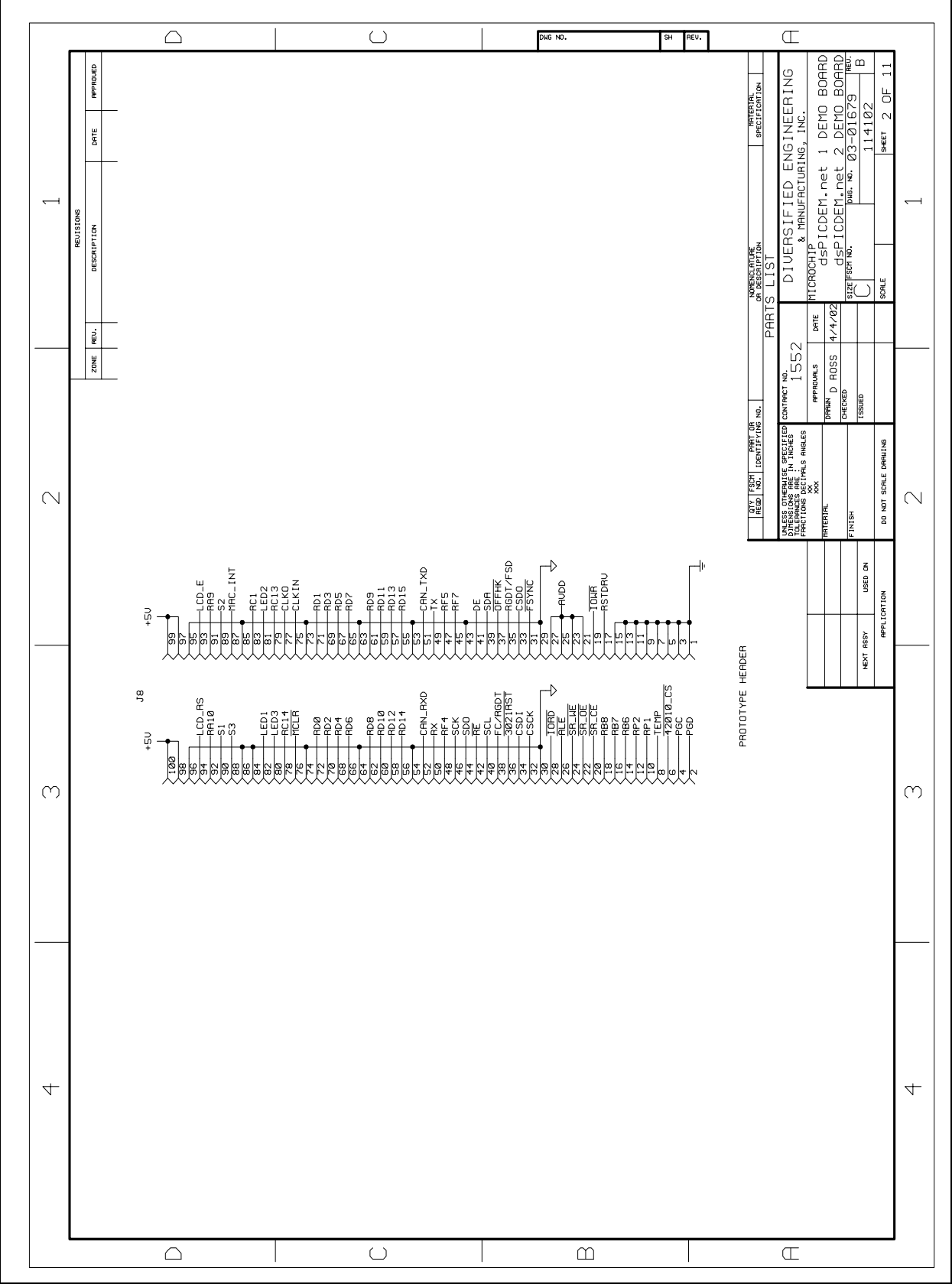




FIGURE A-3: dsPICDEM.net™ DEVELOPMENT BOARD SCHEMATIC (SHEET 2 OF 11)



**FIGURE A-4: dsPICDEM.net™ DEVELOPMENT BOARD SCHEMATIC (SHEET 3 OF 11)**

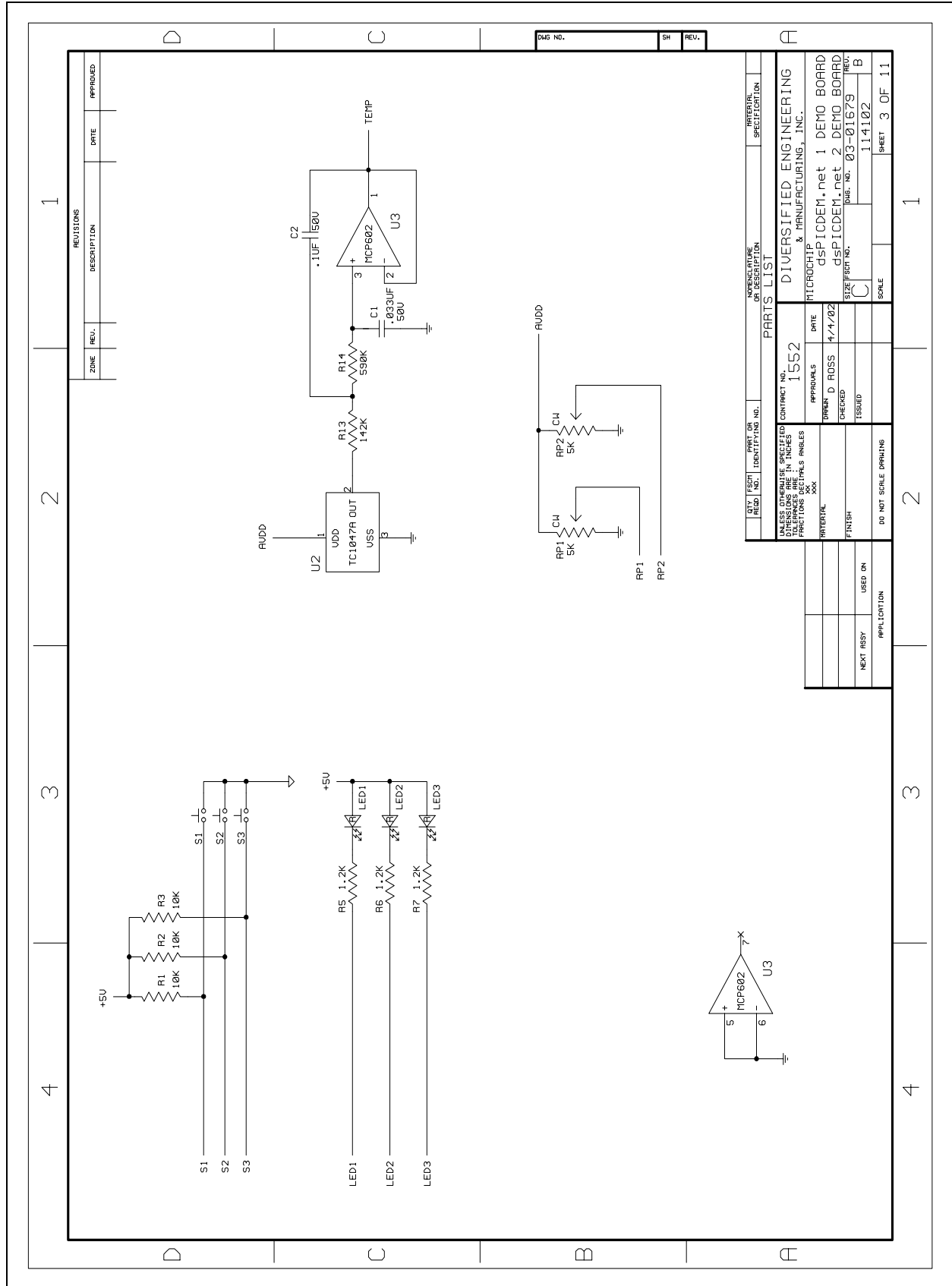
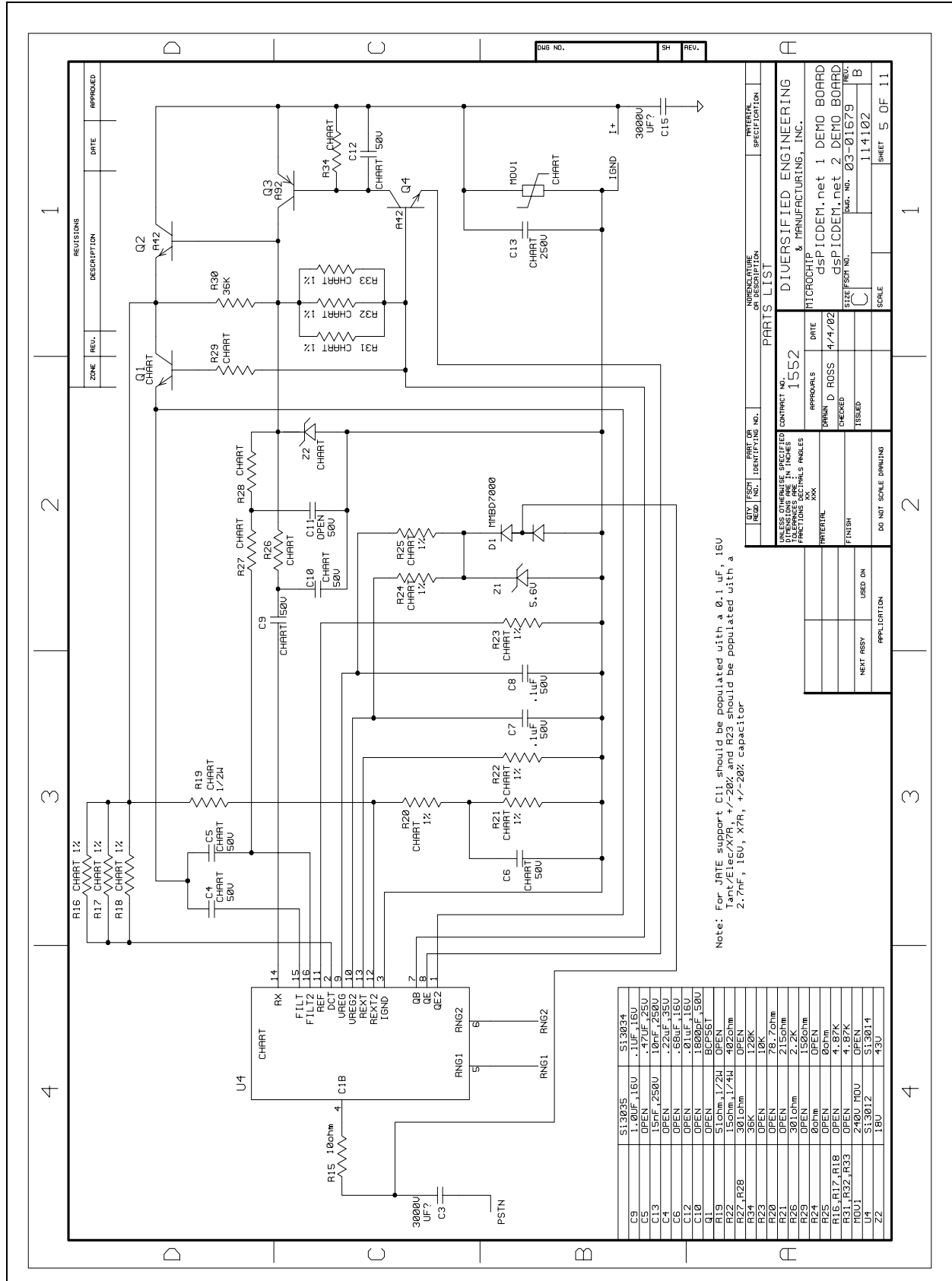




FIGURE A-6: dsPICDEM.net™ DEVELOPMENT BOARD SCHEMATIC (SHEET 5 OF 11)



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**FIGURE A-8: dsPICDEM.net™ DEVELOPMENT BOARD SCHEMATIC (SHEET 7 OF 11)**

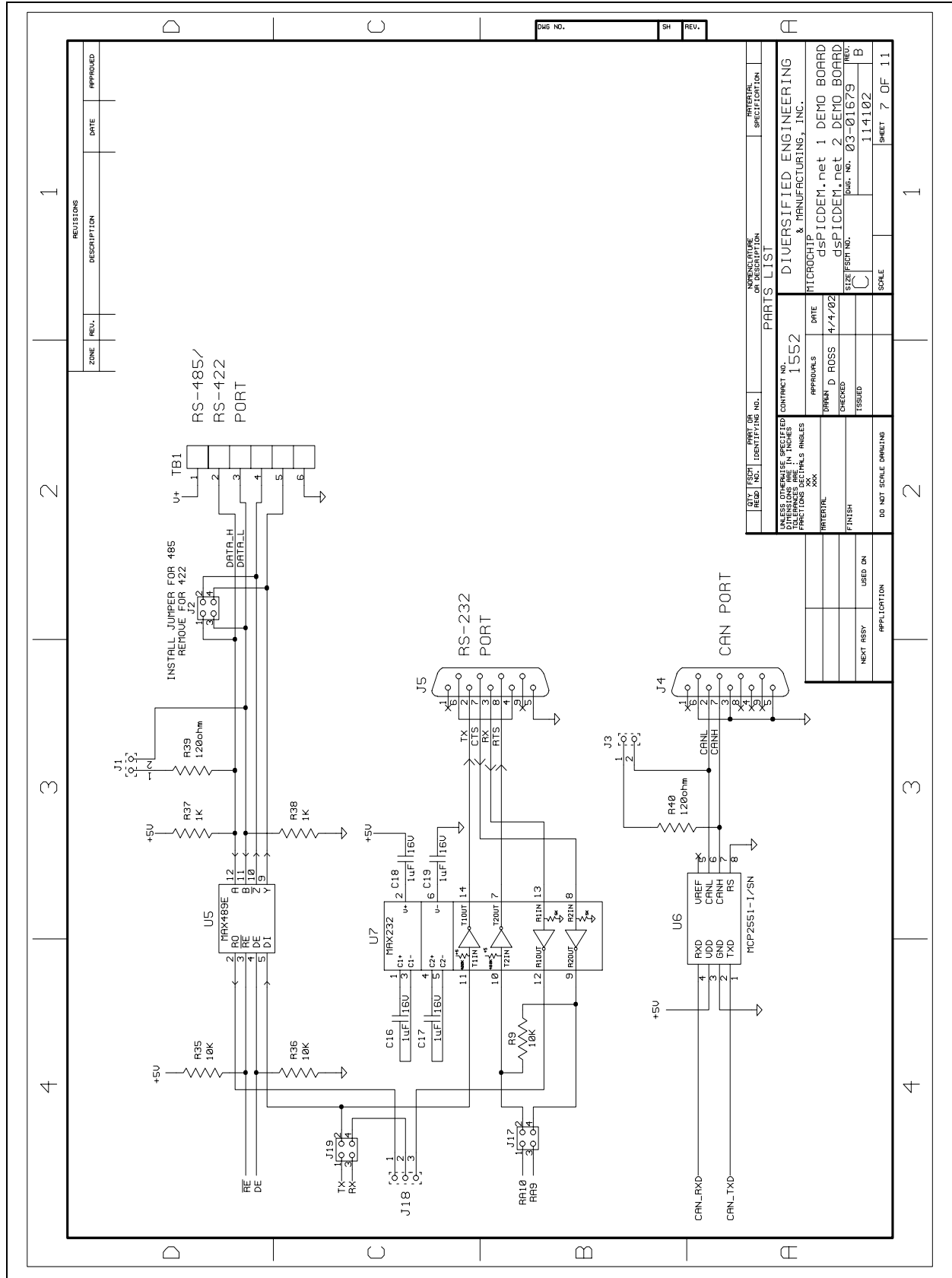


FIGURE A-9: dsPICDEM.net™ DEVELOPMENT BOARD SCHEMATIC (SHEET 8 OF 11)

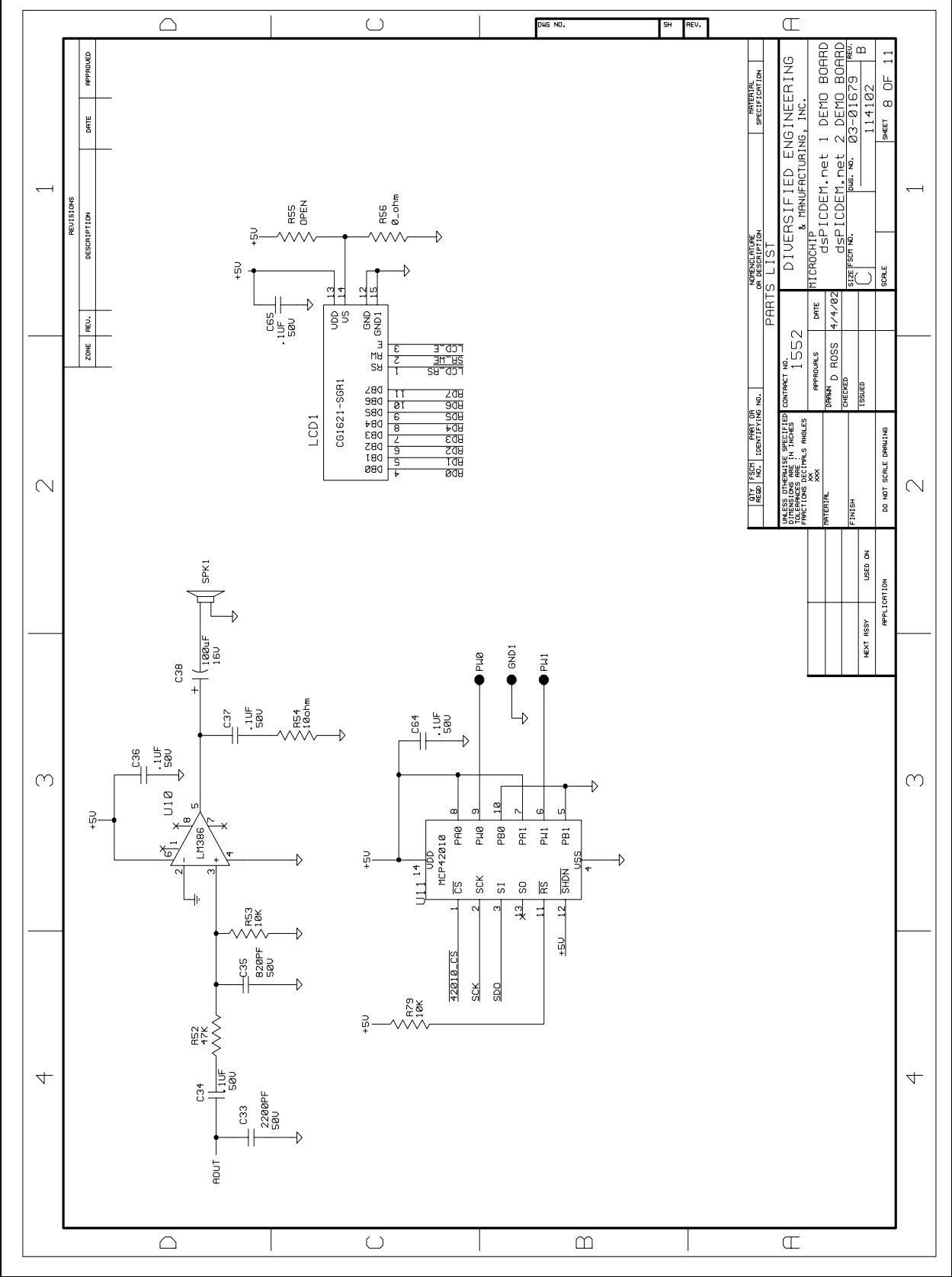
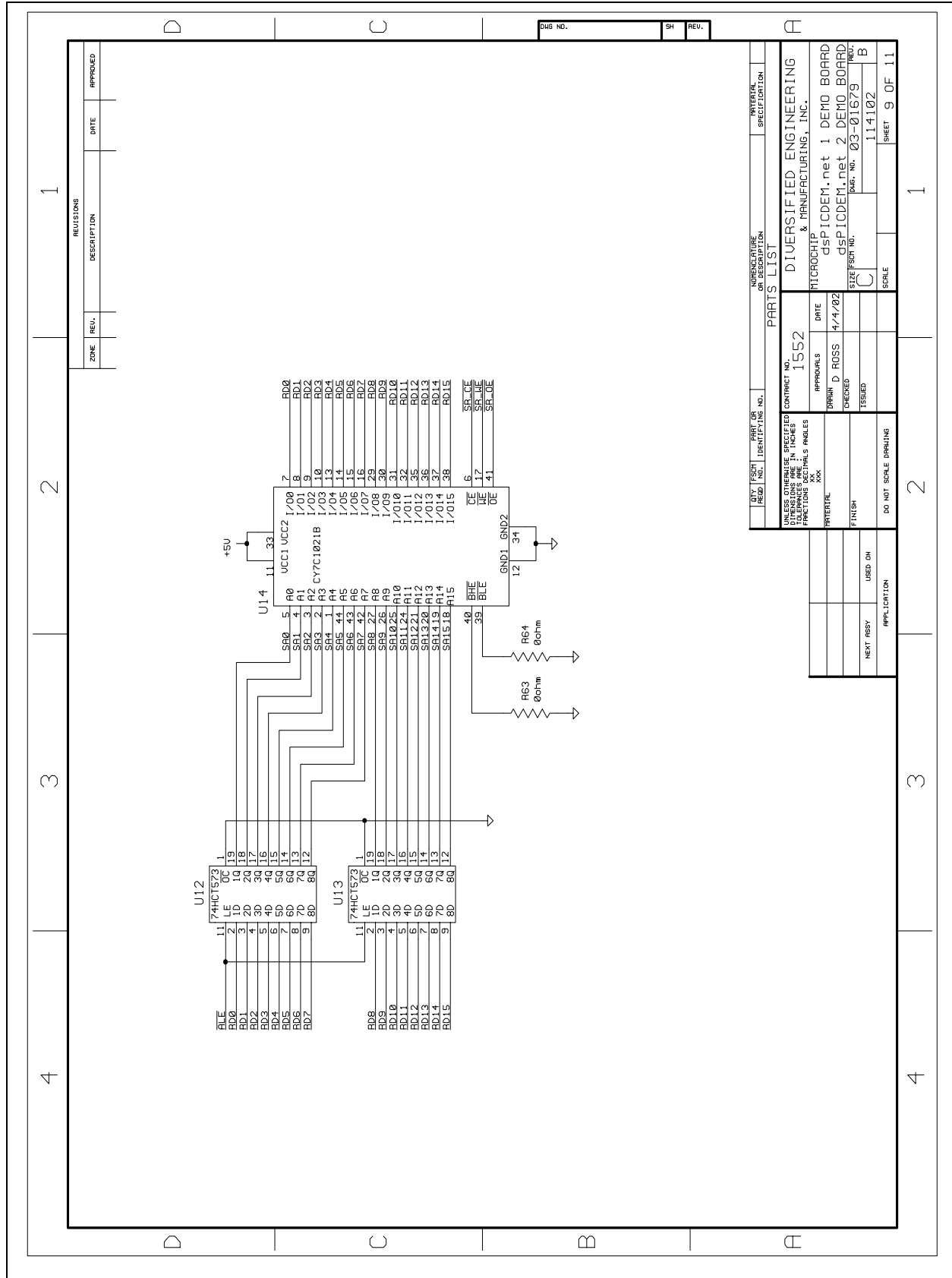


FIGURE A-10: dsPICDEM.net™ DEVELOPMENT BOARD SCHEMATIC (SHEET 9 OF 11)







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