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• Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

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PICDEM™ LCD 2 DEMONSTRATION KIT USER'S GUIDE

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Preface

NOTICE TO CUSTOMERS

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

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.

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

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INTRODUCTION

This chapter contains general information that will be useful to know before using the PICDEM™ LCD 2 Demonstration Board. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the PICDEM LCD 2 as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. "Introduction"** – Describes the hardware of the PICDEM LCD 2 Demonstration Board.
- **Chapter 2. "Getting Started"** – Describes how to use the PICDEM LCD 2 Demonstration Board.
- **Chapter 3. "Using the Demo Software"** – Describes how to use the application in Demo mode and also how it can be customized.
- **Appendix A. "Board Technical Information"** – Shows the schematic and layout diagrams for the PICDEM LCD 2 Demonstration Board.

PICDEM™ LCD 2 Demonstration Kit User's Guide

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

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

WARRANTY REGISTRATION

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

RECOMMENDED READING

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

The following documents are comprehensive references for Microchip's enhanced microcontrollers with LCD driver:

"PIC18F85J90 Family Data Sheet" (DS39770)
"PIC18F87J90 Family Data Sheet" (DS39933)
"PIC18F6390/6490/8390/8490 Data Sheet" (DS39629)
"PIC16C9XX Data Sheet" (DS30444)
"PIC16C925/926 Data Sheet" (DS39544)
"PIC16F917/916/914/913 Data Sheet" (DS41250)
"PIC16F/LF1946/47 Data Sheet" (DS41414)

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THE MICROCHIP WEB SITE

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

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

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

The Development Systems product group categories are:

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

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

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

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

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

DOCUMENT REVISION HISTORY

Revision C (November 2010)

- Added device information for the PIC16F/LF1946/7.

NOTES:

Chapter 1. Introduction

1.1 WELCOME

Thank you for purchasing the PICDEM LCD 2 Demonstration Kit from Microchip Technology Incorporated. The PICDEM LCD 2 demonstrates the capabilities of the PIC18FXXJ90, PIC18FXX90, PIC16X9XX, and PIC16X19XX families of devices.

The PICDEM LCD 2 can be used stand-alone with a preprogrammed part, with an in-circuit emulator (e.g., MPLAB® ICE) or with an in-circuit debugger (e.g., MPLAB ICD 2). Sample programs are provided to demonstrate the unique features of the supported devices.

The PICDEM LCD 2 Demonstration Kit comes with the following:

1. PICDEM LCD 2 Demonstration Board (Figure 1-1)
2. Sample Plug-in Module (PIM)
3. CD-ROM which contains:
   • Sample Programs
   • *"PICDEM™ LCD 2 Demonstration Kit User's Guide"*

If you are missing any part of the kit, please contact your nearest Microchip sales office listed in the back of this publication for help.

PICDEM™ LCD 2 Demonstration Kit User's Guide

1.2   PICDEM LCD 2 DEMONSTRATION BOARD HARDWARE FEATURES

The PICDEM LCD 2 Demonstration Board has the following hardware features; each feature's number corresponding to the number in Figure 1-1:

1. The demonstration board provides a daughter board option for the PIC18F85J90, PIC18F87J90, PIC18F8490, PIC16F914/917, PIC16F946, and PIC16F/LF1946/47 families of devices and MPLAB ICE. The board is also supplied with a PIM populated with a PIC18F85J90 device.

> **Note:** Optional PIMs populated with PIC18FXX90, PIC18FXX90, PIC16F9XX, and PIC16X19XX devices are available for purchase from Microchip Direct (www.microchipdirect.com).

The MPLAB ICE can be plugged onto the board without any transition socket for PIC18FXX90 devices. For other devices, a transition socket may be needed.

2. On-board adjustable voltage regulator for direct input from 9V, 100 mA AC/DC wall adapter or 3V button cell battery.
3. Jumper J15 to select different power options.
4. Green power-on indicator LED for direct input from 9V.
5. Varitronix custom segmented LCD display.
6. Jumpers, COM0, COM1, COM2 and COM3, to disconnect COM pins from on-board LCD and allow the usage of any customized LCD glass.
7. RS-232 connection and associated hardware for direct connection to RS-232 interface.
8. Jumpers, JP13 and JP14, to disconnect TX and RX.
9. In-Circuit Debugger (ICD) connector.
10. R44, 10 kΩ, potentiometer for devices with analog inputs.
11. Five push button switches (S1 through S5) for external stimulus and Reset.
12. Jumpers, JP19, JP18, JP1 and JP2, to disconnect switches from RB6, RB7, RA6 and RA7 input pins.
13. Jumper, J11, to select either 10 kΩ (POT R44) or the S1-S4 switches to AN0 (RA0).
14. Two green LEDs connected to RC3 and RC4 (device dependent).
15. Jumpers in J14 to disconnect LEDs from RC3 and RC4.
16. A slide switch (S6) to select either the resistor ladder or the charge pump option for generating the bias values for the LCD pins.
17. Jumper, JP21, to physically tie the resistor ladder to ground.
18. Unpopulated holes provided for crystal connection.
19. Jumpers, JP11 and JP12, to disconnect crystal from OSC1 and OSC2.
20. 32.768 kHz crystal with Timer1 for Real-Time Clock (RTC) operation.
21. A Microwire EEPROM 93AA46C provided on a socket.
22. Jumpers, JP15 and JP16, to disconnect EEPROM from CK and DT. Jumper, J6, to connect CS to GND or to RC4 (device dependent). Jumper, J13, to select either 128 x 8 or 64 x 16 memory organization.
23. Thermistor for sensing temperature.
24. Jumper, JP5, to connect thermistor to AN1 (RA1) (device dependent).
25. Jumper, JP17, to select either V$_{CC}$ or I/O to power the peripherals.
26. Unpopulated option for TC77 temperature sensor.
27. Prototype area for user hardware.
28. PICtail™ daughter board connection. (The pin names on the board are valid only for the PIC18F8490 device. For other devices, the PICtail daughter board pin connections may be different or not connected.)

FIGURE 1-1: **PICDEM™ LCD 2 HARDWARE**
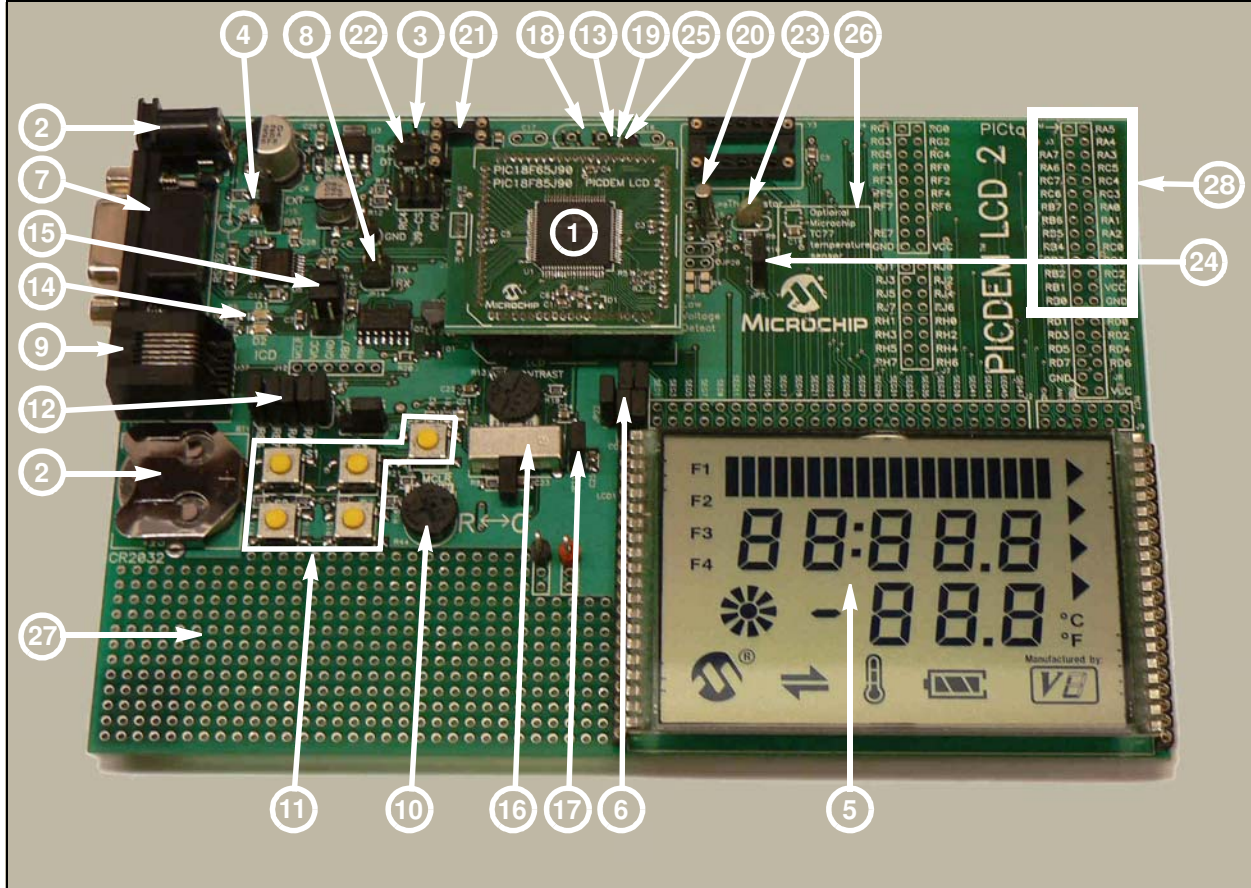
1.3 SAMPLE DEVICES

A PIM, populated with the PIC18F85J90, is included.

1.4 SAMPLE PROGRAMS

The PICDEM LCD 2 Demonstration Kit includes a CD-ROM with sample demonstration programs. Depending on the device, these programs may be used with some of the included sample devices with an In-Circuit Emulator (ICE) or with an In-Circuit Debugger (ICD). For each type of device (PIC16F946, PIC16F917, PIC18F8490, PIC18F85J90, PIC18F87J90 and PIC16F/LF1946/47), demo source code, several C and/or `.asm` files and compiled code (one HEX file) are provided.

PICDEM™ LCD 2 Demonstration Kit User's Guide

NOTES:

Chapter 2. Getting Started

The PICDEM LCD 2 may be used as a stand-alone board with a preprogrammed device, with an In-Circuit Emulator (ICE) or with an In-Circuit Debugger (ICD). For a list of PIC® microcontroller compatible ICEs or ICDs, please refer to the *"Microchip Development Systems Ordering Guide"* (DS30177).

2.1   PICDEM LCD 2 AS A STAND-ALONE BOARD – PREPROGRAMMED DEVICE

The PICDEM LCD 2 may be demonstrated immediately by following the steps listed below:

• Apply power to the PICDEM LCD 2. For information on acceptable power sources, see **Appendix A. "Board Technical Information"**.

> **Note:** In the event that the preprogrammed PICDEM LCD 2 Demonstration Board with the PIC18F85J90 PIM does not operate, check the following conditions:
>
> - The jumper, J15, is configured as per the power supply used. The slide switch, S6, is switched to C.
> - JP1, JP2, JP6, JP18 and JP19 are connected.
> - The middle two jumpers of J14 are connected.
> - JP9 and JP10 are connected.
> - J11 connecting POT to AN0 and JP17 connecting V_{CC} to I/O.
>
> The status of all other jumpers will not affect the preprogrammed demonstration.
>
> Refer to Figure A-1 in **Appendix A. "Board Technical Information"**.

To reprogram the sample device, the following will be necessary:

1. User source code may be programmed to the device or the sample program may be restored from the file on the included CD-ROM.

2. An assembler, such as the MPASM™ Assembler (available with MPLAB IDE), or a compiler, such as MPLAB C18 C Compiler (PIC18XXXX/18XXJXX devices only) must be used.

   Source code must be assembled or compiled into a HEX file before it can be programmed into the device. Microchip Technology's MPASM Assembler or MPLAB C18 C Compiler may be used. Both are compatible with MPLAB IDE; however, other assemblers/compilers may be used.

3. Once the sample program is in the HEX file format, it can be programmed to a Flash device using an MPLAB ICD 2 or PM3 with an ICSP™ module. Microchip Technology's MPLAB ICD 2 is compatible with MPLAB IDE.

   If the code protection bit(s) have not been programmed, the on-chip program memory can be read out for verification purposes.

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2.2 PICDEM LCD 2 USED WITH AN IN-CIRCUIT EMULATOR OR IN-CIRCUIT DEBUGGER

To use the PICDEM LCD 2 with an In-Circuit Emulator (ICE) or In-Circuit Debugger (ICD), refer to the tool's user's guide for instructions on how to power-up and configure the ICE/ICD, as well as how to connect to target boards.

Configure the PICDEM LCD 2 for the desired oscillator as described in Table 2-1. Refer to the ICE/ICD user's guide for any oscillator configuration requirements.

TABLE 2-1:   OSCILLATOR SELECTION

Oscillator Selection on PICDEM™ LCD 2	Modification on PICDEM™ LCD 2
Crystal	JP9 and JP10 not connected. No canned oscillator on board, crystal in Y2, JP11 and JP12 connected, caps in C16 and C17.
Canned Oscillator	Put canned oscillator on socket Y3. Y2 empty, JP9, JP11 and JP12 not connected.
Device Internal Oscillator	JP11 and JP12 not connected. No canned oscillator on board.
Ceramic Resonator – no internal caps	JP9 and JP10 not connected. No canned oscillator on board, resonator in Y2, JP11 and JP12 connected, caps in C16 and C17.
Ceramic Resonator – with internal caps	JP9 and JP10 not connected. No canned oscillator on board, resonator in Y2, JP11 and JP12 connected, C16 and C17 empty.

Note: The MPLAB ICE can be plugged onto the board without any transition socket for PIC18FXX90 devices. For other devices, a transition socket may be needed.

Chapter 3. Using the Demo Software

The demo programs are preprogrammed into the sample devices. Also, this program is included on the CD-ROM program disk for user reference. This demo program uses the functions or macros provided by the firmware LCD driver module to display the required characters, strings or icons on the LCD.

3.1 DEMO FIRMWARE OPERATION

The demo firmware is made up of four components, which are individually displayed on the LCD. The PIC microcontroller's internal RC oscillator is used as the system clock source.

1. **Voltmeter (F1)**
   This mode uses the A/D module to measure the voltage of the R44 pot through analog channel AN0, and displays a voltage between 0.00V and 3.30V on the LCD using the LCD module. Voltage is continually updated until the mode is exited by pressing either the S1 or S2 switch.

2. **Thermometer (F2)**
   This mode uses the A/D module to measure the voltage of the thermistor R11 through analog channel AN1, and converts to temperature both in Celsius and Fahrenheit and displays the temperature on the LCD using the LCD module. Temperature is continually updated until the mode is exited by pressing either the S1 or S2 switch.

3. **Clock (F3)[1]**
   This mode uses the Timer1 module and a 32 kHz clock crystal. Once this mode is entered from the main menu, the Real-Time Clock will start counting from 00:00:00. The S3 switch is used to increment minutes and the S4 switch is used to increment hours. To perform the increment operations, press and hold the switches. The clock keeps running continuously until the mode is exited by pressing either the S1 or S2 switch.

4. **Charge Pump and Software Contrast (F4)[1]**
   This mode is available only for the PIC18F85J90 and PIC18F87J90 families of devices and uses the on-board charge pump and LCD voltage regulator. The LCD module is configured in Charge Pump mode and software contrast is achieved by either pressing S3 to increase the contrast or S4 to decrease the contrast until the mode is exited by pressing either the S1 or S2 switch. By exiting this mode, the Voltmeter mode is entered and retains the contrast level.

> **Note 1:** For low-power battery operation in JP17, remove jumper on V_{CC} and I/O and connect I/O and RB0.

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FIGURE 3-1: **DEMO PROGRAM FLOWCHART**

```
                    ┌──────────────┐
                    │   Power-up   │
                    └──────┬───────┘
                           ▼
              ┌────────────────────────┐
              │ Display Microchip Logo │
              └────────────┬───────────┘
                           ▼
              ┌────────────────────────┐
              │ Display Varitronix Logo│
              └────────────┬───────────┘
                           ▼
              ╭────────────────────────╮
              │         Sleep          │
              ╰────────────┬───────────╯
    ╭───╮                  ▼         ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
    │ A │──────────────────◄─────────   Wake-up from Sleep
    ╰───╯                  │          by Pressing either S1 or S2
                           ▼         └ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
              ┌────────────────────────┐
              │     Voltmeter Demo     │
              └────────────┬───────────┘
                           ▼
              ┌────────────────────────┐
              │       Display F1       │
              └────────────┬───────────┘
                           ▼
              ┌────────────────────────┐
              │       Start A/D         │
              │     Conversion on       │
              │     Channel AN0         │
              └────────────┬───────────┘
                           ▼
              ╭────────────────────────╮
              │         Sleep          │
              ╰────────────┬───────────╯
                           │          ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
                           ◄─────────   Wake-up from Sleep
                           ▼          on Completion of Conversion
              ┌────────────────────────┐ └ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
              │   Display the Voltage  │
              └────────────┬───────────┘
                           ▼
                      ╱─────────╲
                     ╱  Is S1/S2  ╲  Yes   ╭───╮
                     ╲ switch pressed?╱─────│ B │
                      ╲─────────╱           ╰───╯
                           │ No
```
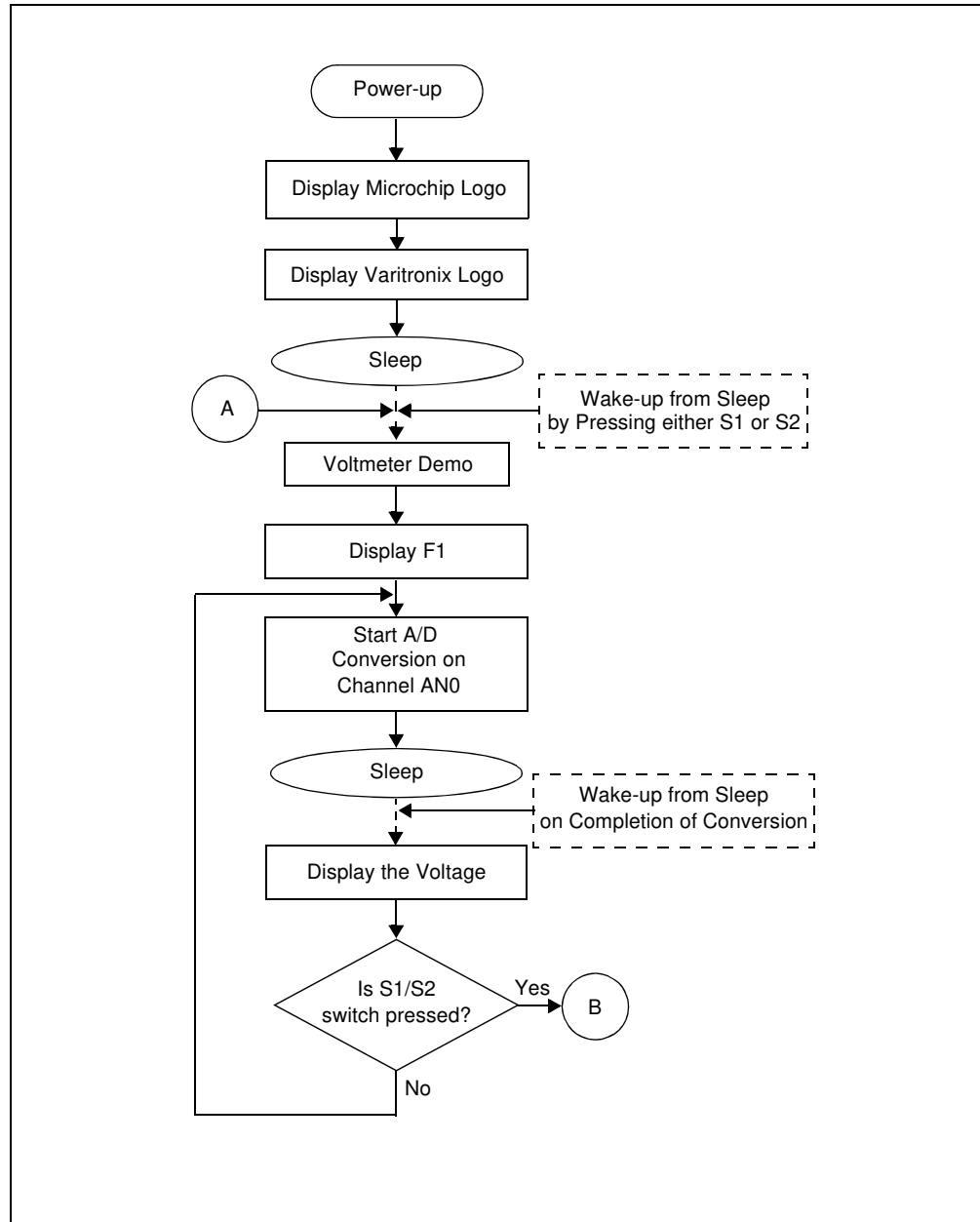
FIGURE 3-2: **DEMO PROGRAM FLOWCHART**

PICDEM™ LCD 2 Demonstration Kit User's Guide
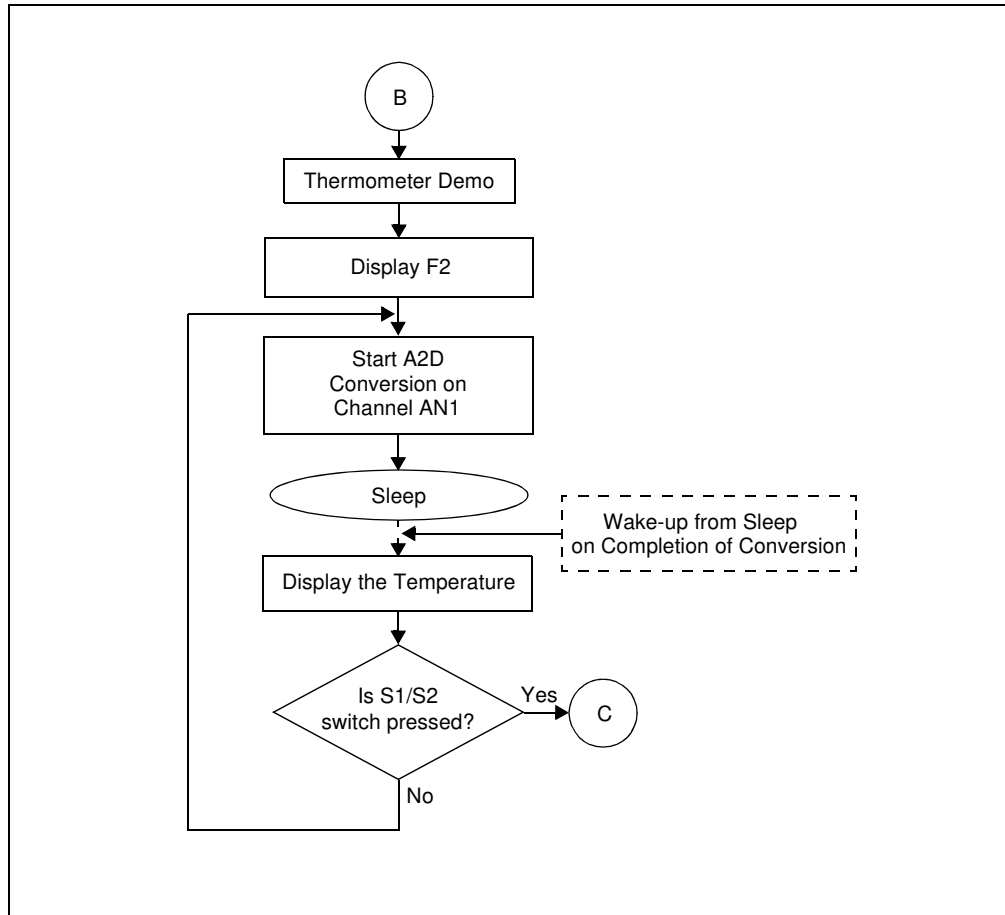
FIGURE 3-3:   **DEMO PROGRAM FLOWCHART**
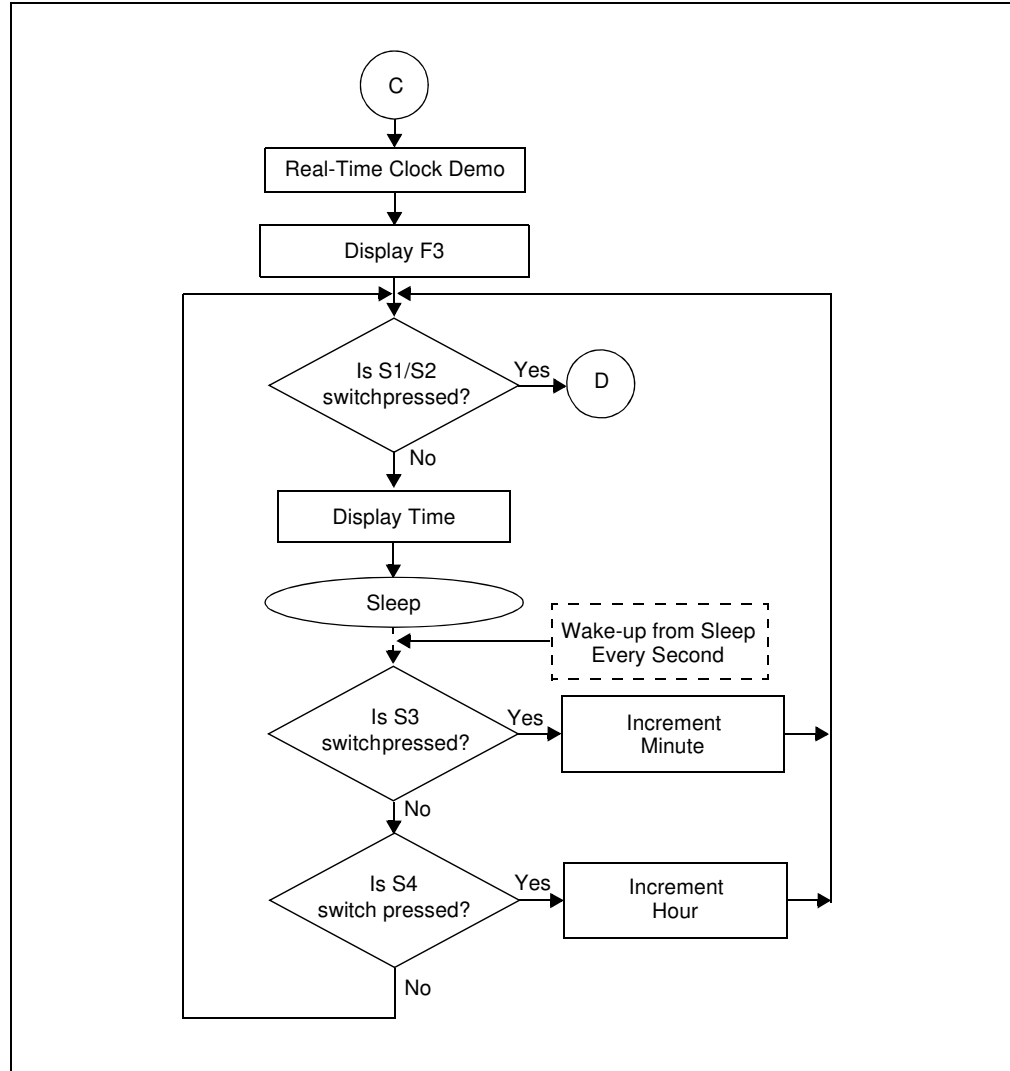
FIGURE 3-4: **DEMO PROGRAM FLOWCHART**
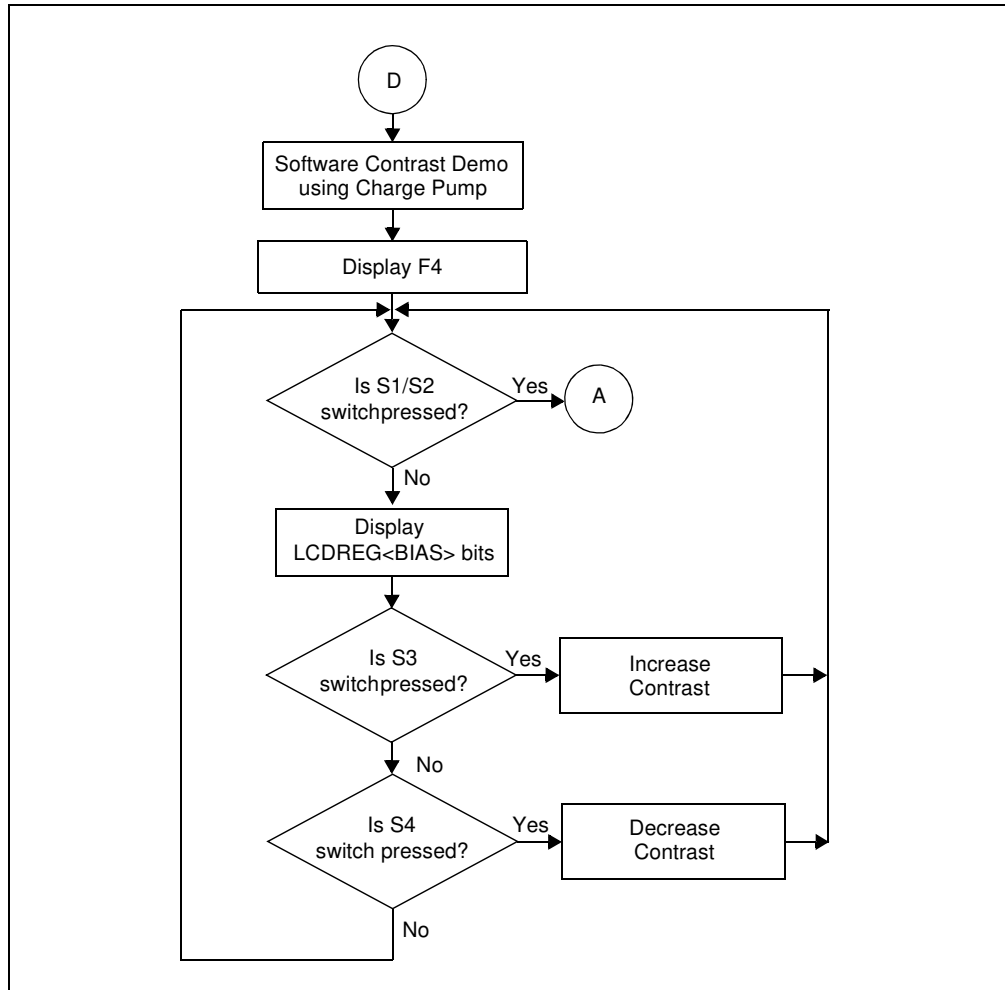
FIGURE 3-5: **DEMO PROGRAM FLOWCHART**

```
                    ┌─────────────┐
                   (     ISR      )
                    └──────┬──────┘
                           │
              ┌────────────▼────────────┐
              │ Increment Second Register│
              └────────────┬────────────┘
                           │
                        ◇──▼──◇
                      ◇         ◇    No
                    ◇  Is it 60? ◇──────────►
                      ◇         ◇
                        ◇──┬──◇
                        Yes │
              ┌────────────▼────────────┐
              │      Clear Second        │
              │       Register,          │
              │    Increment Minute      │
              │        Register          │
              └────────────┬────────────┘
                           │
                        ◇──▼──◇
                      ◇         ◇    No
                    ◇  Is it 60? ◇──────────►
                      ◇         ◇
                        ◇──┬──◇
                        Yes │
              ┌────────────▼────────────┐
              │      Clear Minute        │
              │       Register,          │
              │    Increment Hour        │
              │        Register          │
              └────────────┬────────────┘
                           │
                        ◇──▼──◇
                      ◇         ◇    No
                    ◇  Is it 24? ◇──────────►
                      ◇         ◇
                        ◇──┬──◇
                        Yes │
              ┌────────────▼────────────┐
              │   Clear Hour Register    │
              └────────────┬────────────┘
                           │
                    ┌──────▼──────┐
                   (    Return     )
                    └─────────────┘
```
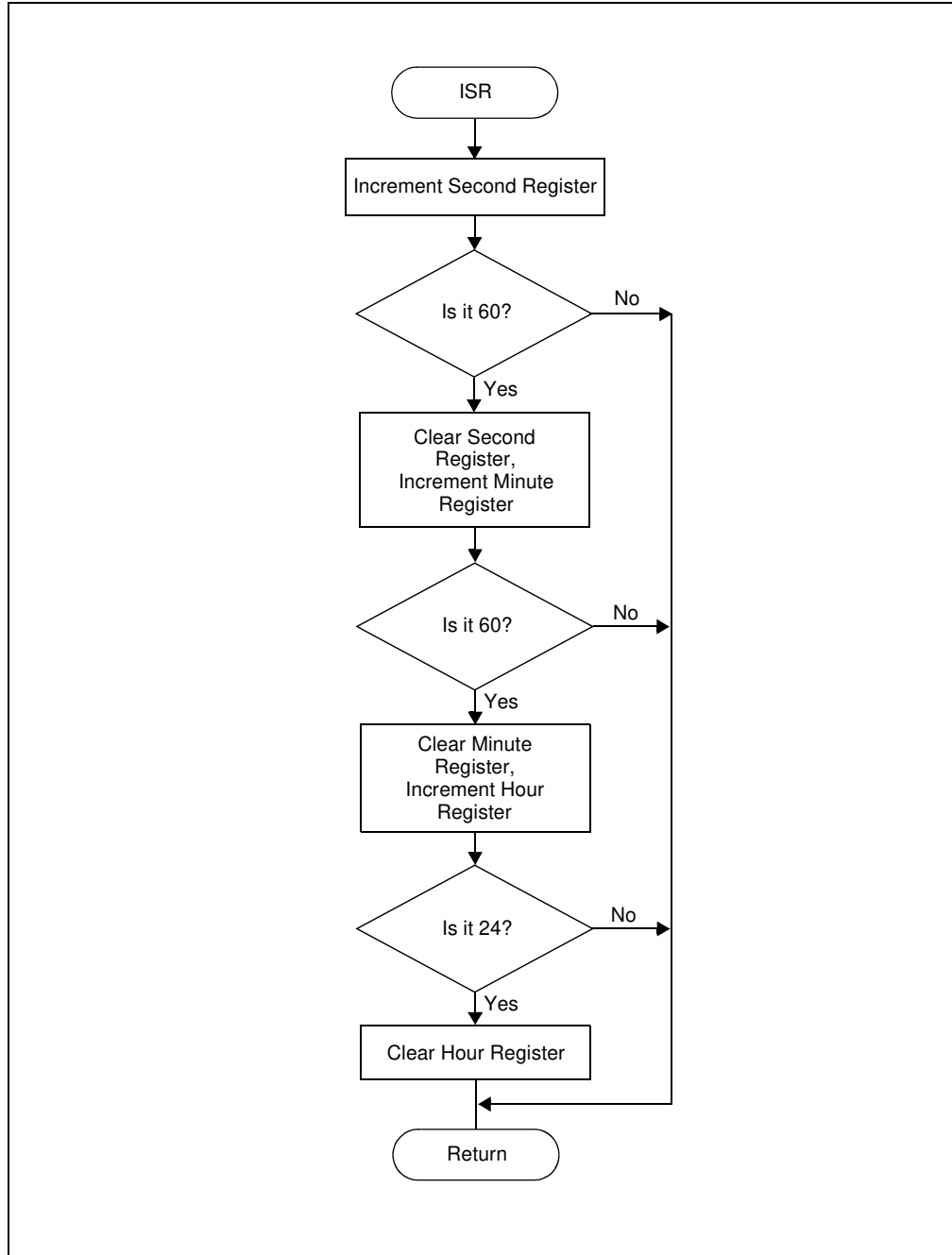
Appendix A. Board Technical Information

The PICDEM™ LCD 2 hardware is not complicated and is intended to illustrate the ease of use of various PIC® microcontrollers. The PICDEM LCD 2 features the following hardware elements.

> **Note:** Many of the following hardware sections will require specific demo board jumper configurations. If a jumper is not listed in a particular section, then that jumper has no effect on the circuitry within the hardware section you are working. Figure A-1 shows a diagram of the PICDEM LCD 2 silkscreen with all necessary jumpers highlighted in gray. Also, refer to the schematic for circuit connections.

FIGURE A-1:   PICDEM™ LCD 2 DEFAULT JUMPER LOCATION
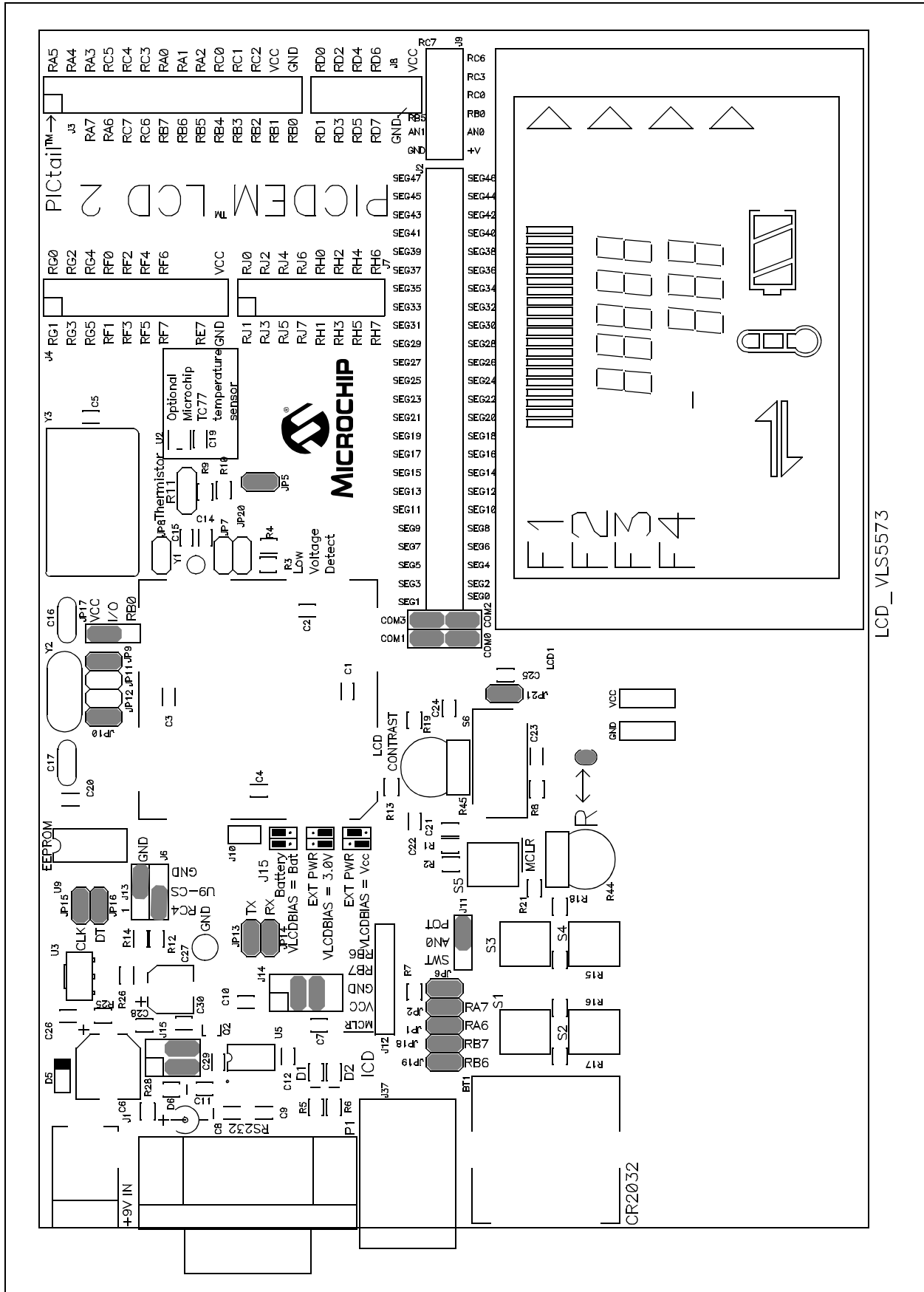
A.1 PROCESSORS

While there is no actual processor populated on the board, a processor is provided with the plug-in module (PIM) that is shipped with the demonstration board. The default processor on the PIM is the PIC18F85J90.

The board also supports the PIC18F87J90, PIC18F8490, PIC16F946, PIC16F917, and PIC16F/LF1946/47 processors, which have been designed for use with the PICDEM LCD 2. These three processors are in the PICDEM LCD 2 PIM Pack which is available for separate purchase.

The part numbers for a replacement PIC18F85J90 and the PIM pack are given in Table A-1.

TABLE A-1: PART NUMBERS[†]

Item	Part number
PICDEM LCD 2 PIM Pack • PIC18F8490 PIM • PIC16F946 PIM • PIC16F917 PIM	MA180019
PIC18F85J90 PIM	MA180022
PIC16F1946/7 PIM PIC16LF1946/7 PIM	MA160016 MA160015

† For the availability and pricing of parts, go to www.microchipdirect.com.

> **Note:** The PIC16LF1946/7 PIM (MA160015) is limited to a maximum of 3.3V operating voltage.