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# PICDEM™ LCD 2 Demonstration Kit User's Guide

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# PICDEM™ LCD 2 DEMONSTRATION KIT USER'S GUIDE

## Table of Contents

**NOTES:**

# PICDEM™ LCD 2 DEMONSTRATION KIT USER'S GUIDE

# Preface

## NOTICE TO CUSTOMERS

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

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



## INTRODUCTION

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

- About this Guide
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support

## ABOUT THIS GUIDE

### 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.

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

**DOCUMENTATION CONVENTIONS**

| Description | Represents | Examples |
|---|---|---|
| **Arial font:** | | |
| Italic characters | Referenced books | *PICDEM LCD 2 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 |
| Text in angle brackets < > | A key on the keyboard | Press <Enter>, <F1> |
| **Courier 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` |
| | A binary number | `'b00100, 'b10` |
| Italic Courier New | A variable argument | *`file`*`.o`, where *`file`* can be any valid filename |
| 0xnnnn | A hexadecimal number where n is a hexadecimal digit | 0xFFFF, 0x007A |
| 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) {... }` |

## RECOMMENDED READING

This user's guide describes how to use the PICDEM LCD 2 Demonstration Kit. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

**Readme Files**

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

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

*"PIC18F85J90 Family Data Sheet"* (DS39770)
*"PIC18F6390/6490/8390/8490 Data Sheet"* (DS39629)
*"PIC16C9XX Data Sheet"* (DS30444)
*"PIC16C925/926 Data Sheet"* (DS39544)
*"PIC16F917/916/914/913 Data Sheet"* (DS41250)

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- **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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The Development Systems product group categories are:

- **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; 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® operating system 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 programmers. These include the MPLAB PM3 and PRO MATE® II device programmers and the 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)
- Technical Support
- Development Systems Information Line

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

In addition, there is a Development Systems Information Line which lists the latest versions of Microchip's development systems software products. This line also provides information on how customers can receive currently available upgrade kits.

The Development Systems Information Line numbers are:

1-800-755-2345 – United States and most of Canada

1-480-792-7302 – Other International Locations

# 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 and PIC16X9XX 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.

## 1.2 PICDEM LCD 2 DEMONSTRATION BOARD HARDWARE FEATURES

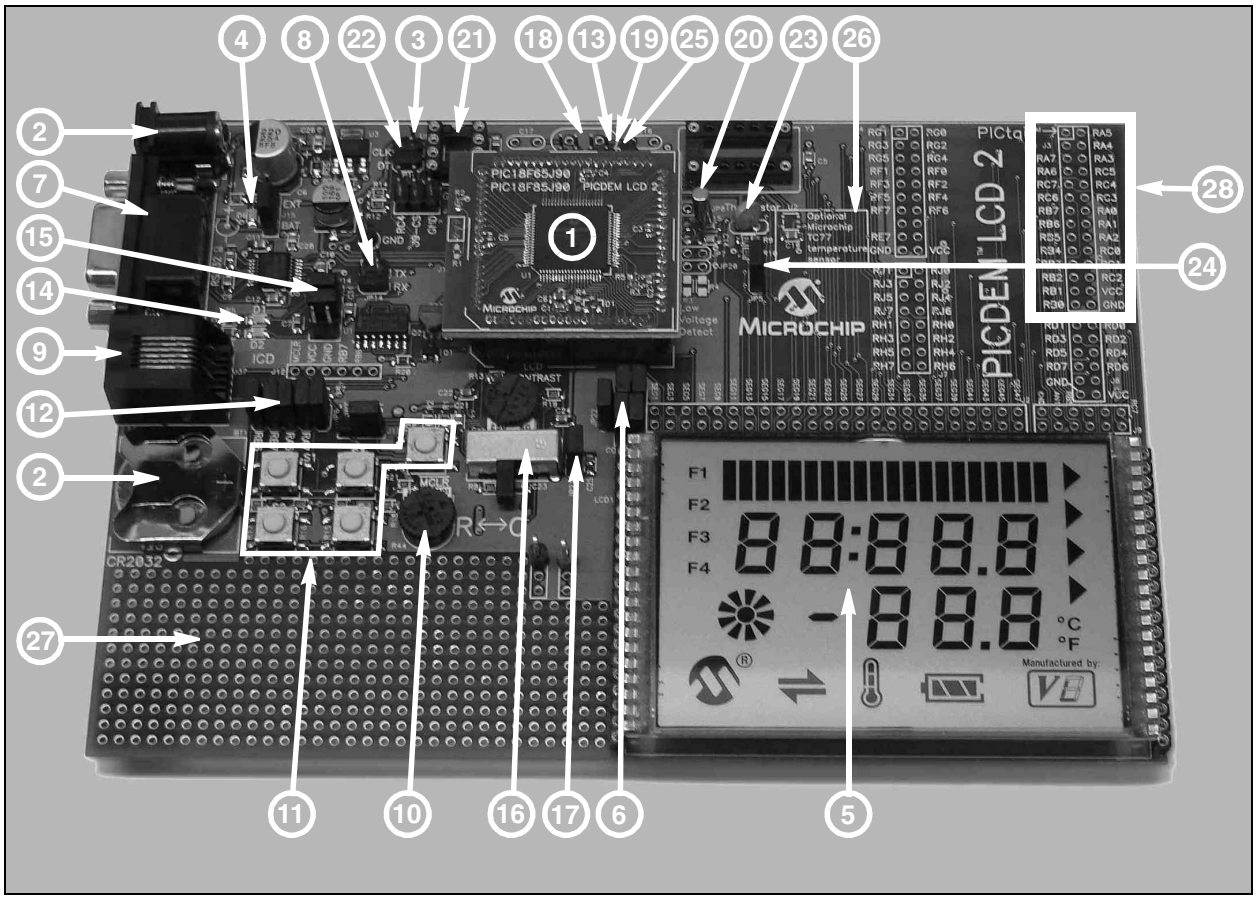
The PICDEM LCD 2 Demonstration Board has the following hardware features; each feature's number corresponding to the number in Figure 1-1:

1. The demonstration board provides a daughter board option for the PIC18F85J90, PIC18F8490, PIC16F914/917 and PIC16F946 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 and PIC16F9XX 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 and PIC18F85J90), demo source code, several C and/or `.asm` files and compiled code (one HEX file) are provided.

**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 VCC 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.

## 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 family 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 Vcc and I/O and connect I/O and RB0.

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

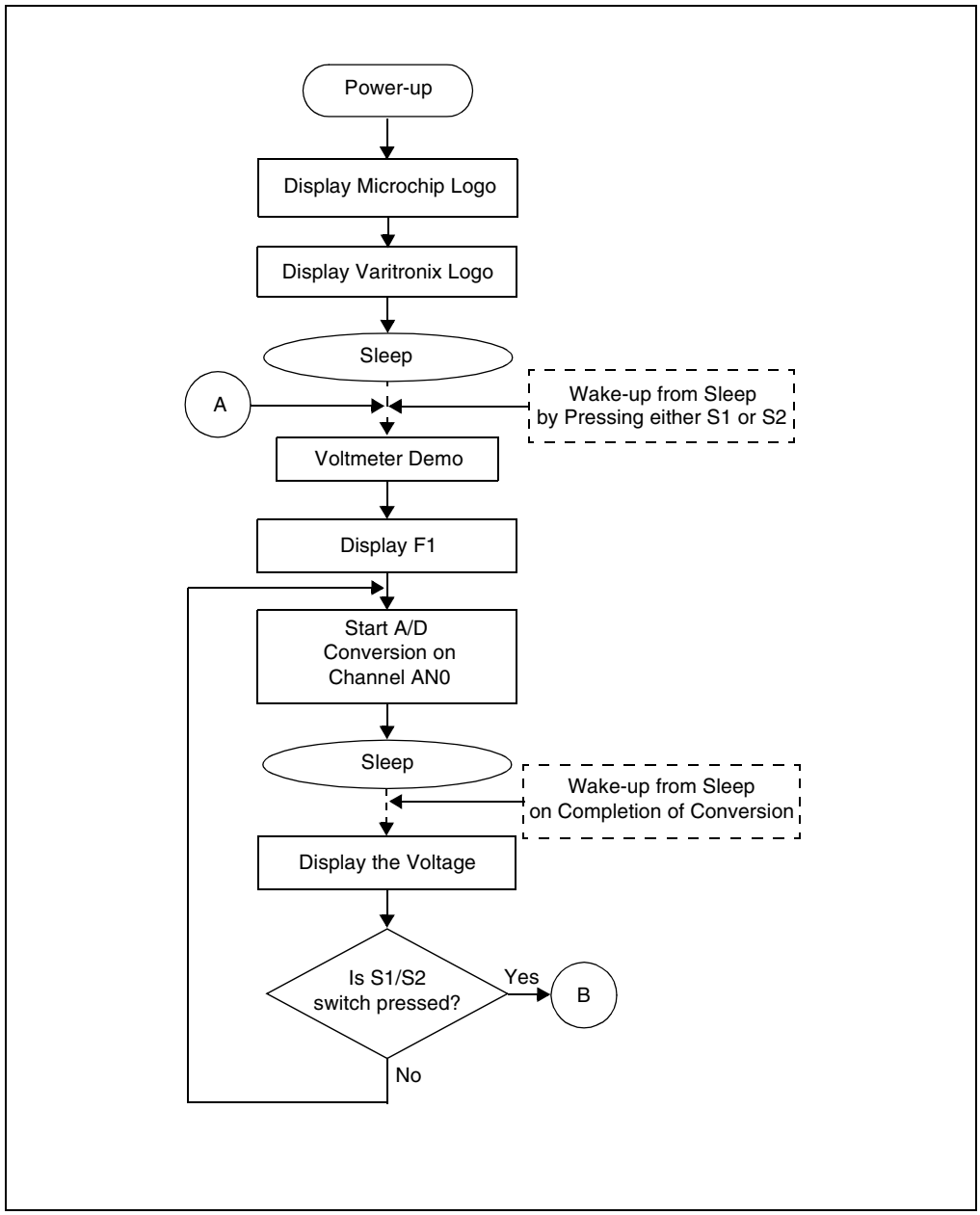


**FIGURE 3-2: DEMO PROGRAM FLOWCHART**

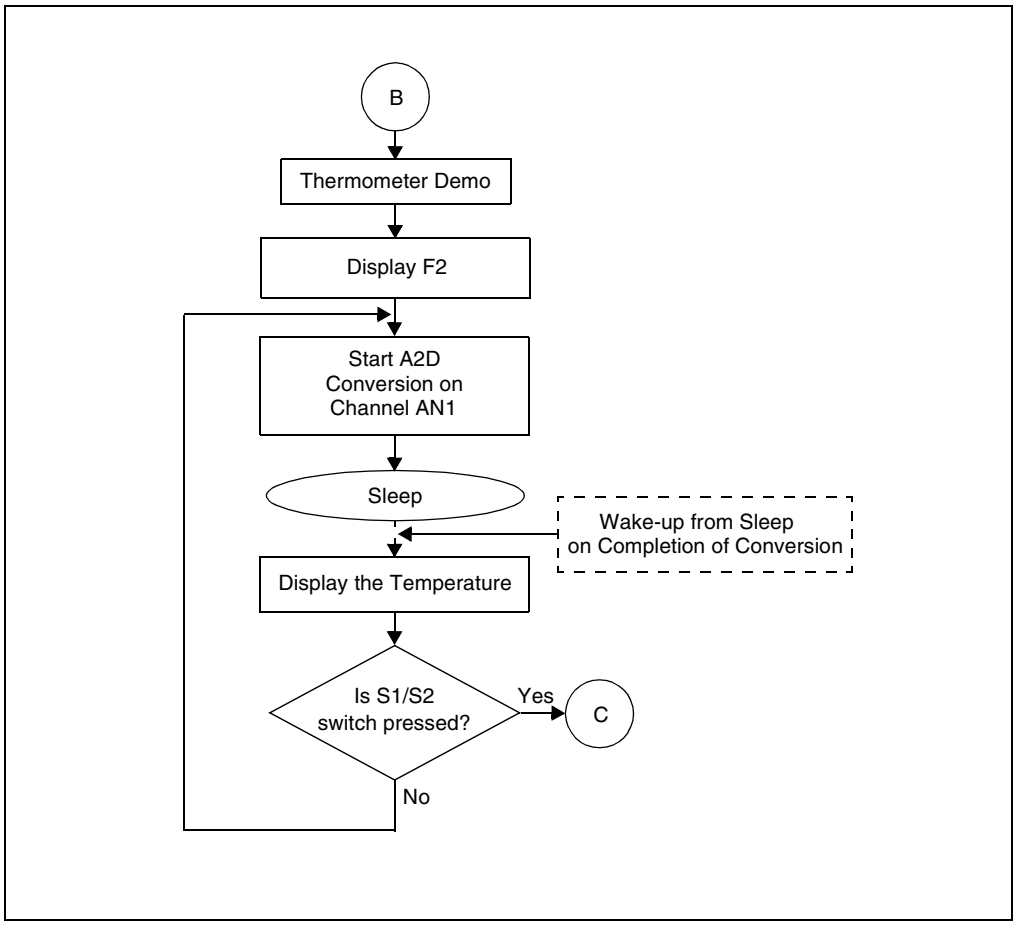


**FIGURE 3-3: DEMO PROGRAM FLOWCHART**

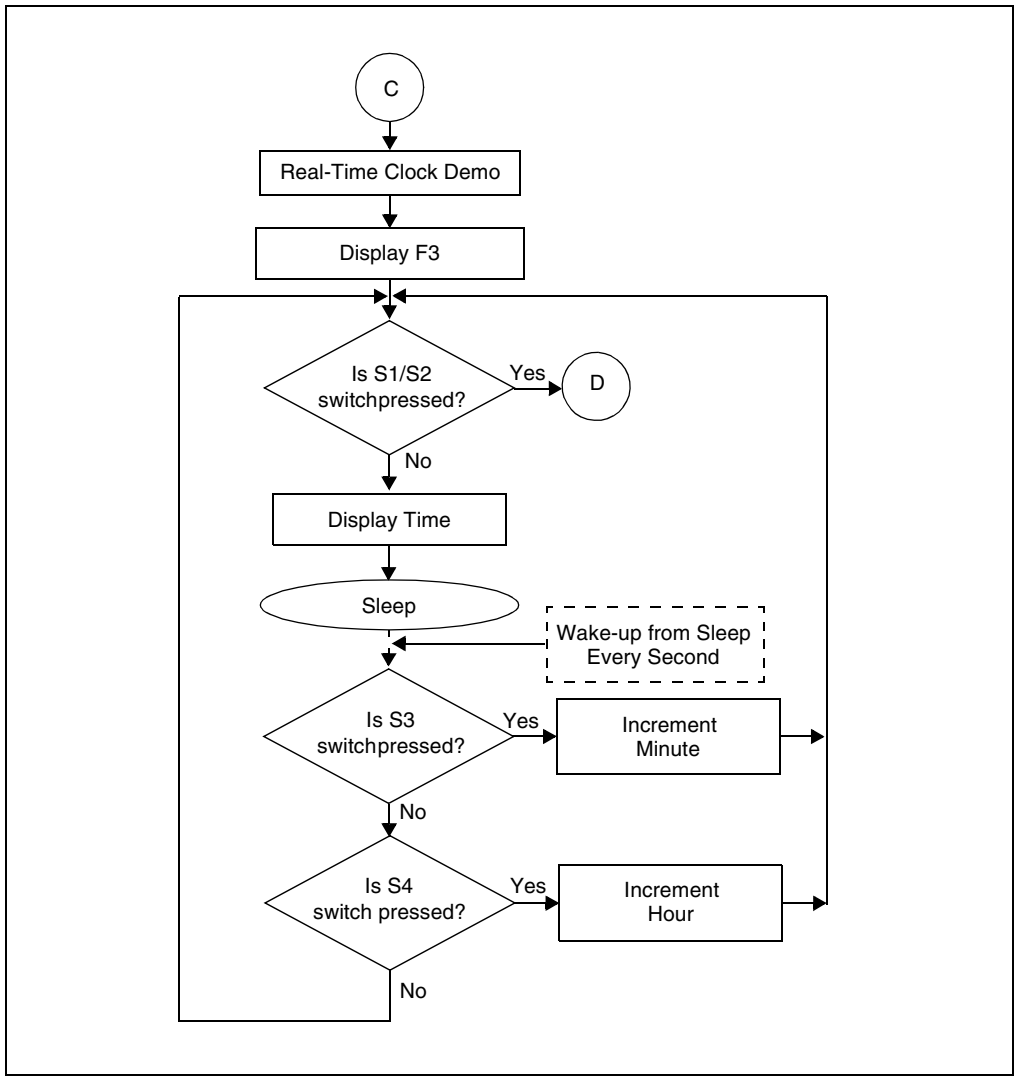


**FIGURE 3-4: DEMO PROGRAM FLOWCHART**

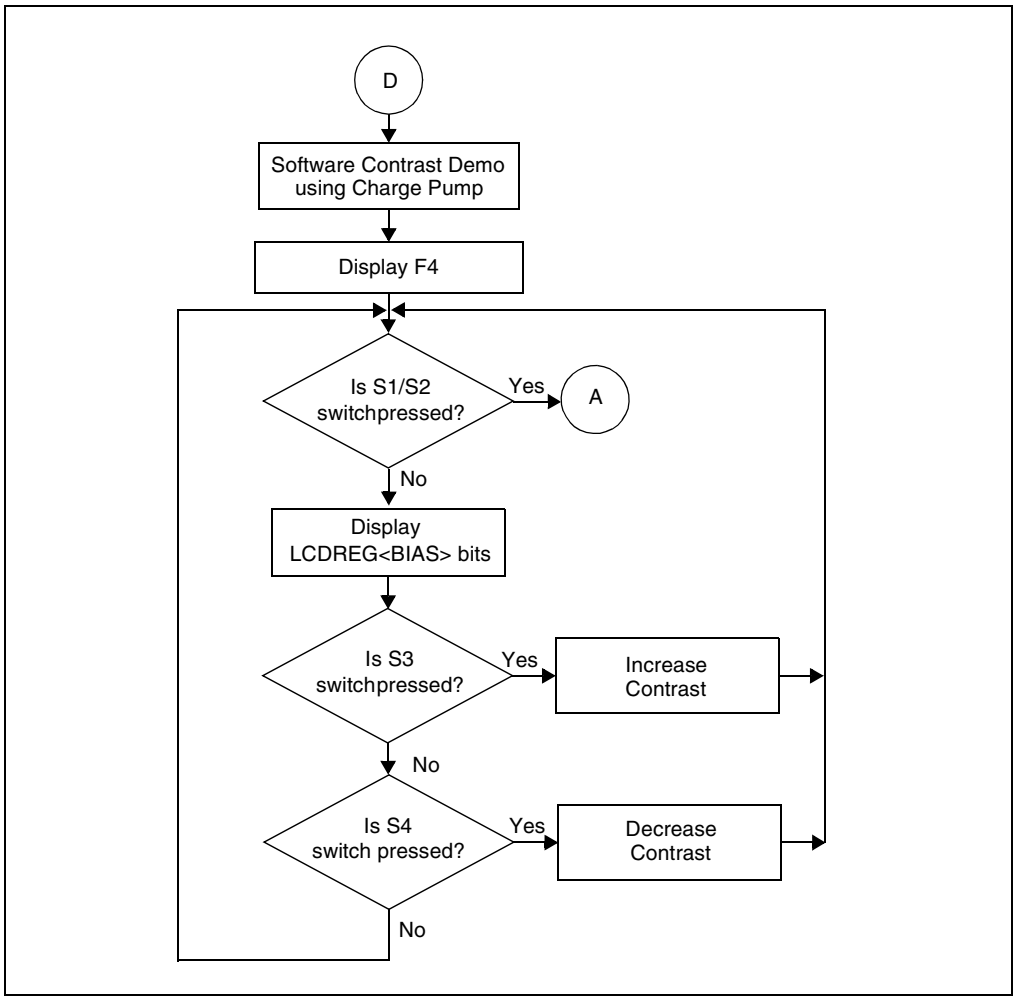
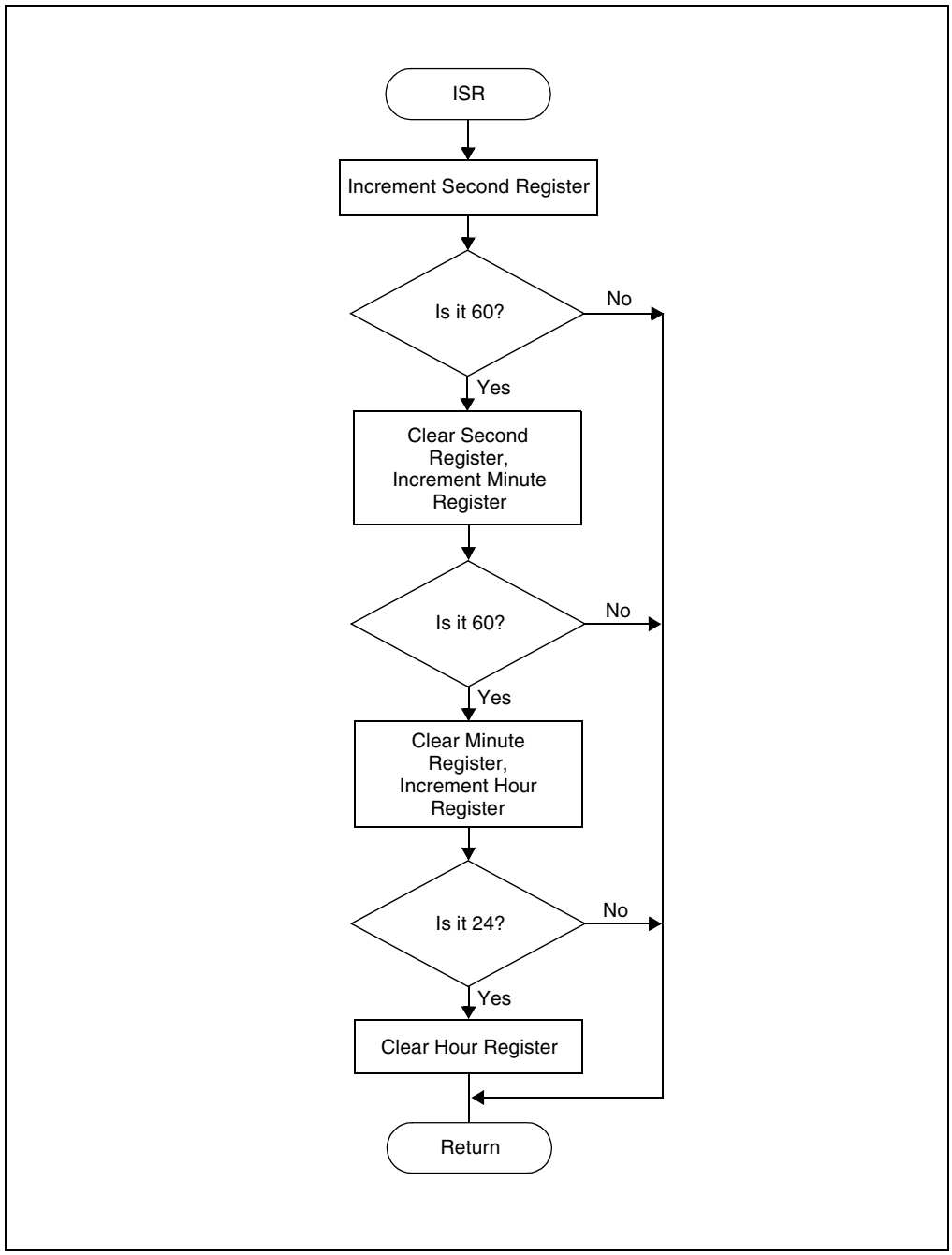


**FIGURE 3-5: DEMO PROGRAM FLOWCHART**

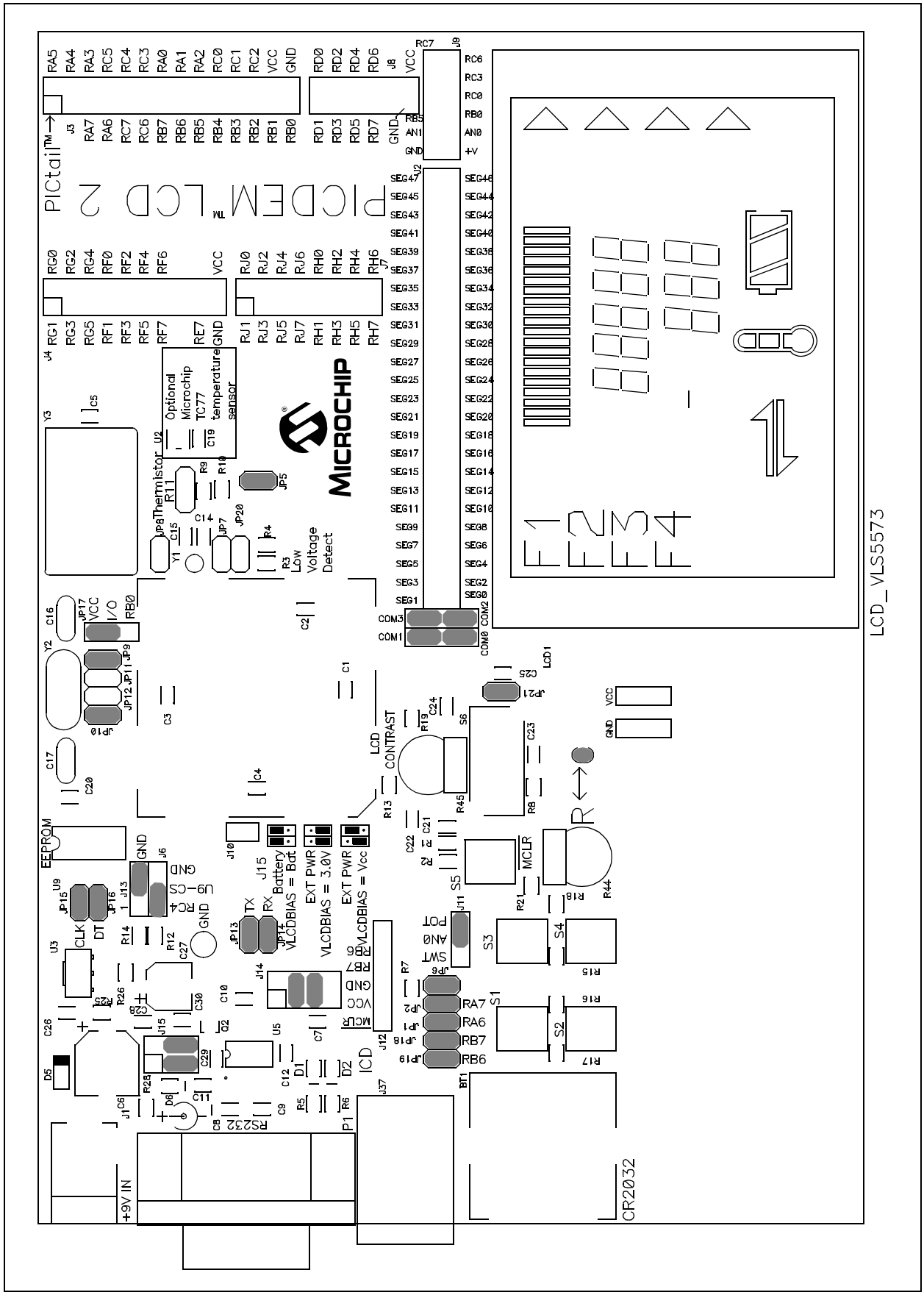


# Appendix A. Board Technical Information

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 PIC18F8490, PIC16F946 and PIC16F917 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(†)**

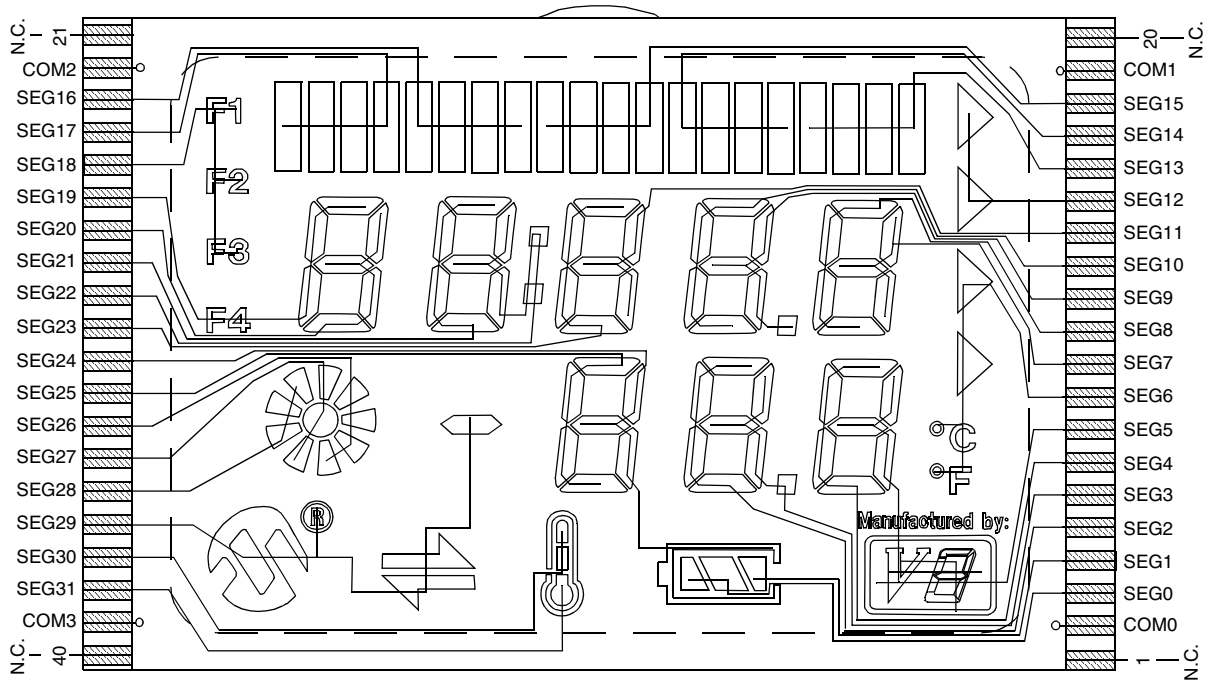
| Item | Part number |
|---|---|
| PICDEM LCD 2 PIM Pack<br>• PIC18F8490 PIM<br>• PIC16F946 PIM<br>• PIC16F917 PIM | MA180019 |
| PIC18F85J90 PIM | MA180022 |

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

## A.2 LCD DISPLAY

A custom made segmented LCD glass, manufactured by the Varitronix Corporation, is provided as shown in Figure A-2. This LCD has 4 commons and 32 segments. Table A-2 provides a few of the specifics for the display. Refer to the Varitronix specification sheet (VL_5573_V00) for additional details.

**FIGURE A-2: PICDEM™ LCD 2 DISPLAY**




**Legend:** N.C. = No connection

© VL Electronics

**TABLE A-2: LCD GLASS SPECIFICATIONS**

| Type | Specification |
|---|---|
| P.I.D. | VL_5573_V00 |
| Mode/Color/Type | Positive / -- / TN |
| Viewing Direction | 6:00 O'Clock |
| Driving Scheme | 1/4 Duty, 1/3 Bias |
| Drive Voltage (VLCD) | ~3.0 Volt (p-p), +20°C |
| Operating Temperature | 0°C - +50°C |
| Storage Temperature | -10°C - +60°C |
| Polarizer – Front | STD.Transmissive |
| Polarizer – Back | STD.Reflective |

Since the glass used on the PICDEM LCD 2 operates at 3V, there is a voltage protection circuit on the LCDBIAS3 pin, which is enabled in the default configuration. When enabled, even if the $V_{DD}$ is greater than 3V, it regulates the LCDBIAS3 voltage such that it always maintains the value to 3V. This is not necessary for operation of the LCD module, but it is a protection circuit to prevent accidentally applying voltages higher than 3V to the LCD glass present on the board.