PICDEM™ 2 Plus Demonstration Board User's Guide

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Table of Contents

PICDEM™ 2 PLUS DEMONSTATION BOARD USER'S GUIDE

Preface

NOTICE TO CUSTOMERS

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

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level 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™ 2 Plus Demonstation Board 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 2 Plus Demonstration Board 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 2 Plus Demonstration Board.
- **Chapter 2. Getting Started** – Describes how to use the PICDEM 2 Plus Demonstration Board.
- **Chapter 3. Tutorial** – Describes how to use the application in demo mode and also how it can be customized.
- **Appendix A. Hardware Detail** – Shows the schematic and layout diagrams for the PICDEM 2 Plus 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 2 Plus Demonstration Board 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
'b*nnnn*	A binary number where *n* is a digit	'b00100, 'b10
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier font:		
Plain Courier	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
Italic Courier	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
`0x`*`nnnn`*	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 2 Plus Demonstration Board Kit. Other useful documents are listed below.

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 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

Chapter 1. Introduction

1.1 WELCOME

Thank you for purchasing the PICDEM 2 Plus Demonstration Board from Microchip Technology Incorporated. The PICDEM 2 Plus Demonstration Board is a simple board which demonstrates the capabilities of the 18, 28 and 40-pin PIC16 and PIC18 devices.

The PICDEM 2 Plus Demonstration Board can be used stand-alone with a programmed 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 2 Plus Demonstration Board Kit comes with the following:

1. PICDEM 2 Plus Demonstration Board (Figure 1-1)
2. Sample devices
3. CD-ROM, which contains:
   a) Sample programs
   b) PICDEM 2 Plus Demonstration Board User's Guide
   c) Reference Documents

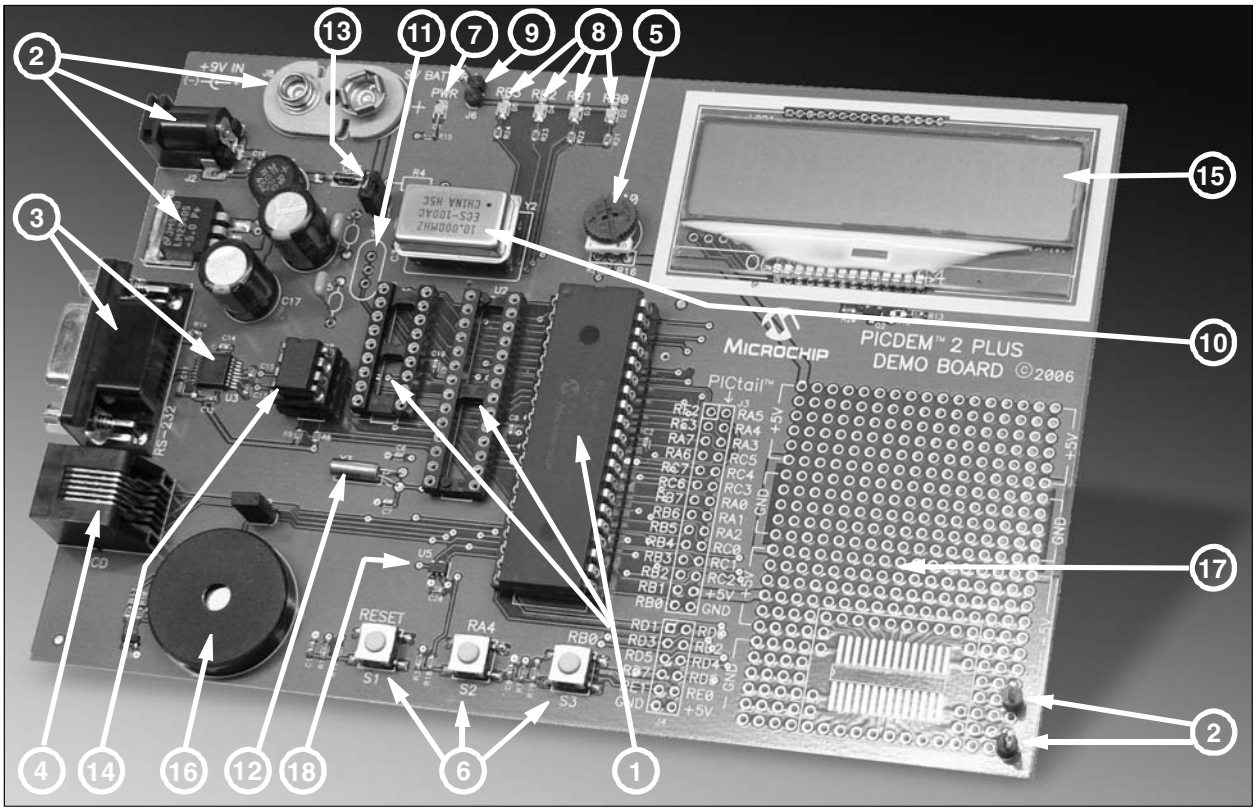
If you are missing any part of the kit, please contact your nearest Microchip sales office listed in the back of this publication for help.

1.2 PICDEM 2 PLUS DEMONSTRATION BOARD

The PICDEM 2 Plus Demonstration Board has the following hardware features:

1. 18, 28 and 40-pin DIP sockets. (Although three sockets are provided, only one device may be used at a time.)
2. On-board +5V regulator for direct input from 9V, 100 mA AC/DC wall adapter or 9V battery, or hooks for a +5V, 100 mA regulated DC supply.
3. RS-232 socket and associated hardware for direct connection to an RS-232 interface.
4. In-Circuit Debugger (ICD) connector.
5. 5 KΩ potentiometer for devices with analog inputs.
6. Three push button switches for external stimulus and Reset.
7. Power-on indicator LED.
8. Four LEDs connected to PORTB.
9. Jumper J6 to disconnect LEDs from PORTB.
10. 4 MHz canned crystal oscillator.
11. Unpopulated holes provided for crystal connection.
12. 32.768 kHz crystal for Timer1 clock operation.
13. Jumper J7 to disconnect on-board RC oscillator (approximately 2 MHz).
14. 32K x 8 Serial EEPROM.
15. LCD display.
16. Piezo buzzer.
17. Prototype area for user hardware.
18. Microchip TC74 thermal sensor.

FIGURE 1-1: PICDEM™ 2 PLUS HARDWARE



1.3 SAMPLE DEVICES

Two Flash devices are included. The device types may change, but will generally include PIC16 and PIC18 40-pin DIP devices.

1.4 SAMPLE PROGRAMS

The PICDEM 2 Plus Demonstration Board Kit includes a CD-ROM with sample demonstration programs. These programs may be used with the included sample devices, with an In-Circuit Emulator (ICE) or with an In-Circuit Debugger (ICD). For each type of device (PIC16 or PIC18), demo source code (several ASM files) and compiled code (one hex file) are provided.

1.5 PICDEM 2 PLUS DEMONSTRATION BOARD USER'S GUIDE

This document describes the PICDEM 2 Plus Demonstration Board, tutorial and demonstration software. Detailed information on individual microcontrollers may be found in the device's respective data sheet. Detailed information on In-Circuit Emulator (ICE) or In-Circuit Debugger (ICD) systems may be found in the respective tool's user guide.

Chapter 1: Introduction – This chapter introduces the PICDEM 2 Plus Demonstration Board and provides a brief description of the hardware.

Chapter 2: Getting Started – This chapter goes through a basic step-by-step process for getting your PICDEM 2 Plus Demonstration Board up and running as a stand-alone board or with an ICE or ICD.

Chapter 3: Tutorial – This chapter provides a detailed description of the tutorial program.

Appendix A: Hardware Description: This appendix describes in detail the hardware of the PICDEM 2 Plus Demonstration Board.

1.6 REFERENCE DOCUMENTS

Reference Documents may be obtained by contacting your nearest Microchip sales office (listed in the back of this document) or by downloading via the Microchip web site (www.microchip.com).

- Individual Data Sheets and Reference Manuals:
  - *"PIC16F87XA Data Sheet"* (DS39582)
  - *"PIC18F2420/2520/4420/4520 Data Sheet"* (DS39631)
  - *"PIC® Mid-Range MCU Family Reference Manual*" (DS33023)
  - *"PIC® 18C MCU Family Reference Manual"* (DS39500)
  - *"TC74 Tiny Serial Digital Thermal Sensor Technical Brief"* (DS21462)
- *"MPLAB® IDE, Simulator, Editor User's Guide"* (DS51025)
- *"MPASM™ Assembler, MPLINK™ Object Linker and MPLIB™ Object Librarian User's Guide"* (DS33014)
- *"PRO MATE® II User's Guide"* (DS30082)
- *"MPLAB® IDE PICSTART® Plus User's Guide"* (DS51028)
- *"MPLAB® ICE Emulator User's Guide"* (DS51159)
- *"MPLAB® ICD 2 User's Guide"* (DS51331)

Chapter 2. Getting Started

The PICDEM 2 Plus Demonstration Board 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 *Development Systems Ordering Guide* (DS30177) or the third party section of the Microchip web site: *www.microchip.com/thirdparty.*

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

The PICDEM 2 Plus Demonstration Board may be demonstrated immediately by following the steps listed below:

- Place the preprogrammed sample device in the appropriate socket on the PICDEM 2 Plus Demonstration Board board.
- Place a jumper on J6 (to enable the LEDs).
- Verify that the board is set up for a 4 MHz canned oscillator (i.e., no jumper on J7; a 4 MHz oscillator in Y2; Y1, C4 and C5 are unpopulated).
- Apply power to the PICDEM 2 Plus Demonstration Board. For information on acceptable power sources, see Appendix A.

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

1. Program source code.

   User source code may be used to program the device or, if this has previously been done, the sample program may be restored from the file on the included CD-ROM.

2. An assembler, such as MPASM™ assembler (available with MPLAB IDE), or a compiler, such as MPLAB C18 (PIC18 devices only).

   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. For a list of these PIC® microcontroller compatible language tools, please refer to the third party section of the Microchip web site: *www.microchip.com/thirdparty.*

3. A device programmer, such as PRO MATE® II, MPLAB PM3, PICSTART® Plus or MPLAB ICD 2 (programmer functionality available with MPLAB IDE v6.00 or greater).

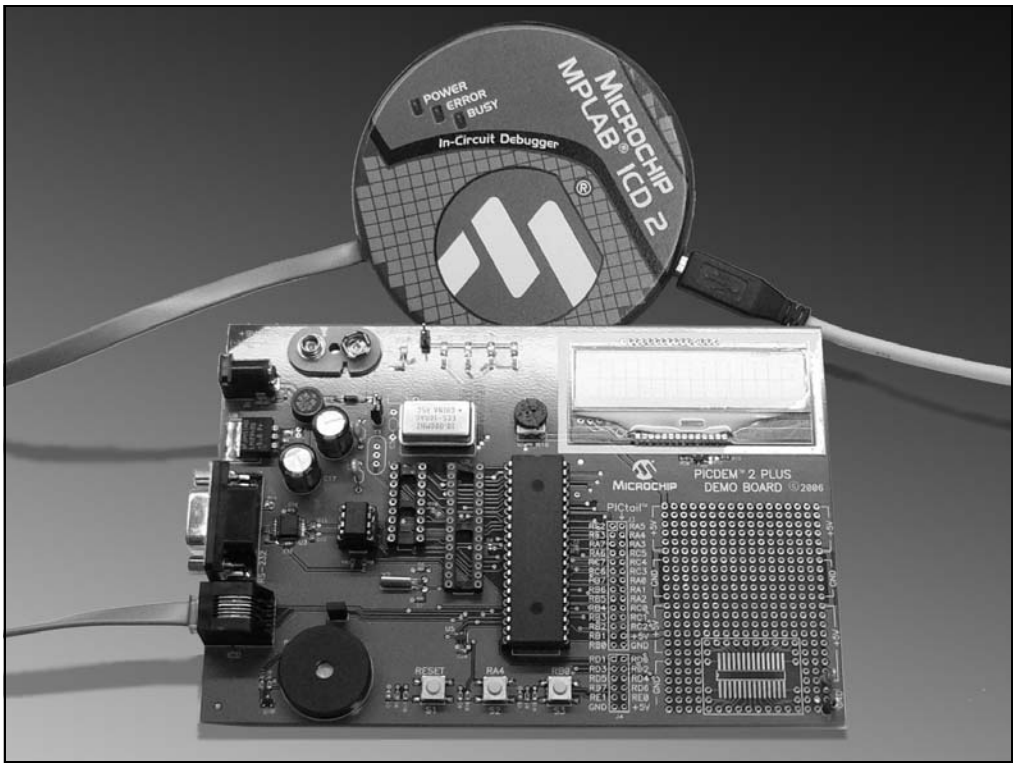
   Once the sample program is in hex file format, a programmer may be used to program a Flash device. Microchip Technology's PRO MATE II device programmer, PICSTART Plus development programmer or MPLAB ICD 2 may be used. All are compatible with MPLAB IDE. However, other programmers may be used. For a list of these PIC microcontroller compatible programmers, please refer to the third party section of the Microchip web site: *www.microchip.com/thirdparty.*

   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 2 PLUS DEMONSTRATION BOARD USED WITH AN IN-CIRCUIT EMULATOR OR IN-CIRCUIT DEBUGGER

To use PICDEM 2 Plus Demonstration Board with an In-Circuit Emulator (ICE) or In-Circuit Debugger (ICD), refer to the tool's user guide for instructions on how to power-up and configure the ICE/ICD, as well as how to connect to target boards (e.g., Figure 2-1).

FIGURE 2-1: PICDEM™ 2 PLUS CONNECTED TO MPLAB® ICD 2 USING USB



Configure the PICDEM 2 Plus Demonstration Board 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™ 2 Plus Demonstration Board	Modification on PICDEM 2 Plus Demonstration Board
RC	J7 installed, Y1 and Y2 unpopulated
Crystal	J7 removed, Y2 unpopulated, crystal in Y1, capacitors in C4 and C5
Canned Oscillator	J7 removed, oscillator in Y2 (Y1, C4, C5 unpopulated)
Resonator (no internal capacitors)	J7 removed, Y2 unpopulated, resonator in Y1, capacitors in C4 and C5
Resonator (with internal capacitors)	J7 removed, Y2 unpopulated, resonator in Y1, C4 and C5 unpopulated

Chapter 3. Tutorial

The tutorial program is preprogrammed into the sample device, (i.e., `p16demo.hex` for a PIC16 device and `p18demo.hex` for a PIC18 device). Also, this program is on the included CD-ROM program disk for user reference, (i.e., if the sample device has been reprogrammed with another program, the tutorial may be reprogrammed into the device).

For detailed information on the PICDEM 2 Plus Demonstration Board hardware, please refer to Appendix A.

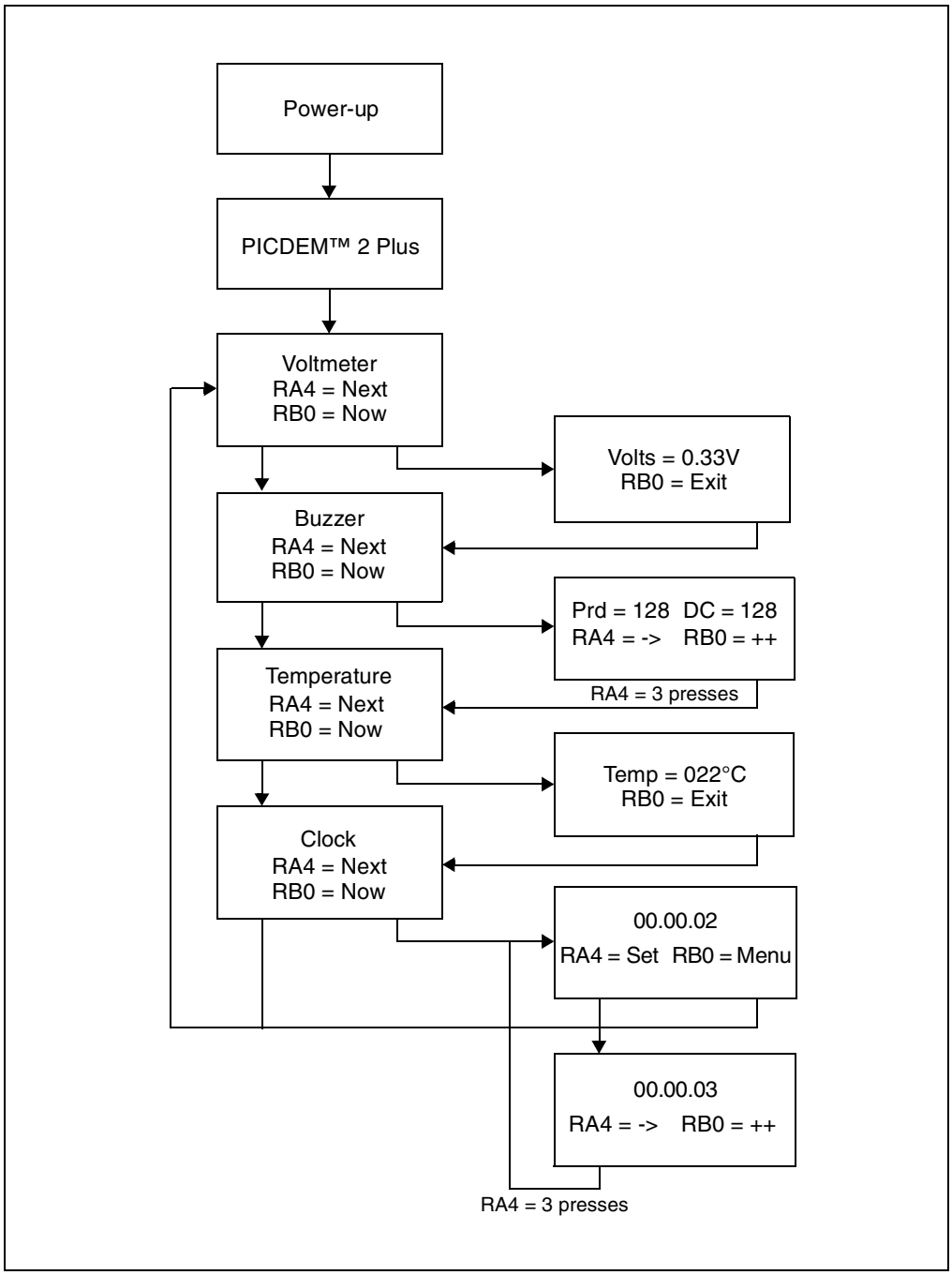
3.1 TUTORIAL PROGRAM OPERATION

The tutorial program is made up of four components, which are individually displayed on the LCD.

1. **Voltmeter**
   This mode uses the ADC module to measure the voltage of the R16 potentiometer and display a voltage between 0.00V and 5.00V on the LCD. Voltage is continually updated until the mode is exited by pressing RB0.
2. **Buzzer**
   This mode turns on the Piezo buzzer, using the CCP1 module I/O pin, RC2. The period and duty cycle of the CCP1 frequency can be changed while the buzzer is on. The changes in period and duty cycle are recognized immediately in the buzzer tone. To change the period and/or the duty cycle, press RB0 under the "Buzzer" menu. The buzzer will then sound off with the default setting of 80h for the period and duty cycle. The cursor will flash over the period's first digit, indicating that the PR2 register is ready to be incremented. To change the duty cycle, press RA4 once and the cursor will now flash over the duty cycle's first digit, indicating it is now ready to increment the CCPR1L register. The next press of RA4 will exit the buzzer function.
3. **Temperature**
   This mode uses a TC74 thermal sensor to measure ambient temperature in Celsius and then display that temperature on the LCD. Communication between the PIC microcontroller and sensor is accomplished using the MSSP module. This mode is exited by pressing RB0. This mode contains code that will write to the external on-board EEPROM. Every two seconds, the code will write to a defined EEPROM address and store the current temperature in that address.
4. **Clock**
   Once this mode is entered from the main menu, a real-time clock will start counting from 00:00:00. The Timer1 module and a 32 kHz clock crystal are used to establish a real-time clock. By pressing RA4, the clock time can be set to the user's preference. When RA4 is pressed to set the time, the cursor will flash over the hours ten digit. Press RA4 again and the cursor will now flash over the minutes ten digit. RB0 is used to increment hours and minutes whenever the cursor is flashing over either. After the minutes have been set, press RA4 and the time will be set and the LCD is returned to an active clock display.

The data that is sent to the LCD is also sent to the RS-232 serial port using the USART on the PIC microcontroller. A HyperTerminal™ program on the PC will be able to display the same information that is displayed on the LCD.

FIGURE 3-1: TUTORIAL PROGRAM FLOW CHART



3.2 SOURCE CODE AND APPLICATION NOTES

In addition to the assembled tutorial program (hex files), source code used to create these hex files is included on the PICDEM 2 Plus Demonstration Board CD-ROM. Both source code and related hex files are found in device-specific directories.

Application Notes are also included on the CD-ROM for additional examples of use.

For information on how to reprogram the device with new or modified code, or how to restore the tutorial program, please see **Section 2.1 "PICDEM 2 Plus Demonstration Board as a Stand-Alone Board – Preprogrammed Device"**.

NOTES:

Appendix A. Hardware Detail

The PICDEM 2 Plus Demonstration Board hardware is extremely simple and is intended to illustrate the ease of use of various PIC microcontrollers. The PICDEM 2 Plus Demonstration Board features the following hardware elements:

A.1 PROCESSOR SOCKETS

Although three sockets are provided, only one device may be used at a time.

- 18-pin socket
- 28-pin socket
- 40-pin socket

A.2 DISPLAY

Four red LEDs are connected to PORTB of each processor type. The PORTB pins are set high to light the LEDs. These LEDs may be disconnected from PORTB by removing jumper J6.

One green LED is provided to determine whether there is power to the PICDEM 2 Plus Demonstration Board board (LED on) or not (LED off).

A.3 POWER SUPPLY

There are three ways to supply power to the PICDEM 2 Plus Demonstration Board:

- A 9V battery can be plugged into J8.
- A 9V, 100 mA unregulated AC or DC supply can be plugged into J2. A power supply can be purchased through Microchip, Part #AC162039.
- A +5V, 100 mA regulated DC supply can be connected to the hooks provided.

Note: The PICDEM 2 Plus Demonstration Board kit does not include a power supply.

MPLAB ICE 2000 users have a regulated +5V power supply available in the logic probe connector and can easily connect to the hooks on PICDEM 2 Plus Demonstration Board (red probe to +5V and black probe to GND).

MPLAB ICD 2 users may use the ICD to power the target board to 5V, up to 200 mA, if the MPLAB ICD 2 is connected to the PC with a serial cable.

A.4 RS-232 SERIAL PORT

An RS-232 level shifting IC has been provided with all necessary hardware to support connection of an RS-232 host through the DB9 connector. The port is configured as DCE and can be connected to a PC using a straight-through cable.

The PIC16/PIC18 RX and TX pins are tied to the RX and TX lines of the MAX232A.

A.5 SWITCHES

Three switches provide the following functions:

- S1 – $\overline{\text{MCLR}}$ to hard reset the processor
- S2 – Active-low switch connected to RA4
- S3 – Active-low switch connected to RB0

Switches S1 and S3 have debounce capacitors, whereas S2 does not, allowing the user to investigate debounce techniques.

When pressed, the switches are grounded. When Idle, they are pulled high (+5V).

A.6 OSCILLATOR OPTIONS

- RC oscillator (2 MHz approximately) supplied. This oscillator may be disabled by removing jumper J7.
- Pads provided for user furnished crystal and two capacitors.
- Removable 4 MHz canned oscillator.
- 32.768 kHz (watch type) crystal for Timer1.

A.7 ANALOG INPUT

A 5 kΩ potentiometer is connected through a series 470Ω resistor to AN0.

The potentiometer can be adjusted from V_{DD} to GND to provide an analog input to the parts with an ADC module.

A.8 ICD CONNECTOR

By way of the modular connector (J5), the MPLAB ICD 2 can be connected for low-cost debugging. The ICD connector utilizes RB6 and RB7 of the microcontroller for in-circuit debugging.

A.9 TEMPERATURE SENSOR

This is a serial digital thermal sensor (TC74) connected to the 28 and 40-pin microcontrollers via RC3 and RC4. Communication is accomplished with the TC74 via its 2-wire I^2C™ compatible serial port. This device has a (binary) address of '1001101'.

A.10 SERIAL EEPROM

A 24L256 256K (32K x 8) serial EEPROM is included on the board to illustrate I^2C bus concepts.

A.11 LCD

An LCD display with two lines, 16 characters each, is connected to the 28 and 40-pin sockets. There are three control lines (RD4:RD6) and four data lines (RD3:RD0).

A 5 kΩ potentiometer may be installed into R20 to adjust contrast on the LCD. If this is done, R5 and R6 need to be removed.

A.12 SAMPLE DEVICES

A sample part programmed with a simple program is included in the PICDEM 2 Plus kits.

Table A-1 lists the I/O features and port connections for each processor type.

TABLE A-1: I/O FEATURES AND EQUIVALENT PORT CONNECTIONS

Feature	PIC Device (by pin count)		
	18-pin	28-pin	40-pin
LEDs (D2-D5)	RB3:RB0		
USART	N/A	RC6:RC7	
Master Reset (S1)	$\overline{\text{MCLR}}$		
User-defined (S2)	RA4		
User-defined (S3)	RB0		
Potentiometer (R16)	RA0		
LCD1	N/A	RA3:RA1	RA3:RA1 and RD3:RD0
EEPROM (Ux)	N/A	RC3/RC4	
Buzzer (P1)	N/A	RC2	
ICD Connector (J5)	RB6:RB7	RB6:RB7	
Temperature sensor (Ux)	N/A	RC3:RC4	
Crystal oscillator (Y1)	OSC1 and OSC2		
External oscillator (Y2)	OSC1		

Legend: N/A - feature not available for this device

A.13 BOARD LAYOUT AND SCHEMATICS

The following figures show the parts layout (silkscreen) and schematics for the PICDEM 2 Plus Demonstration Board.

FIGURE A-1: PICDEM™ 2 PLUS DEMONSTRATION BOARD PARTS LAYOUT

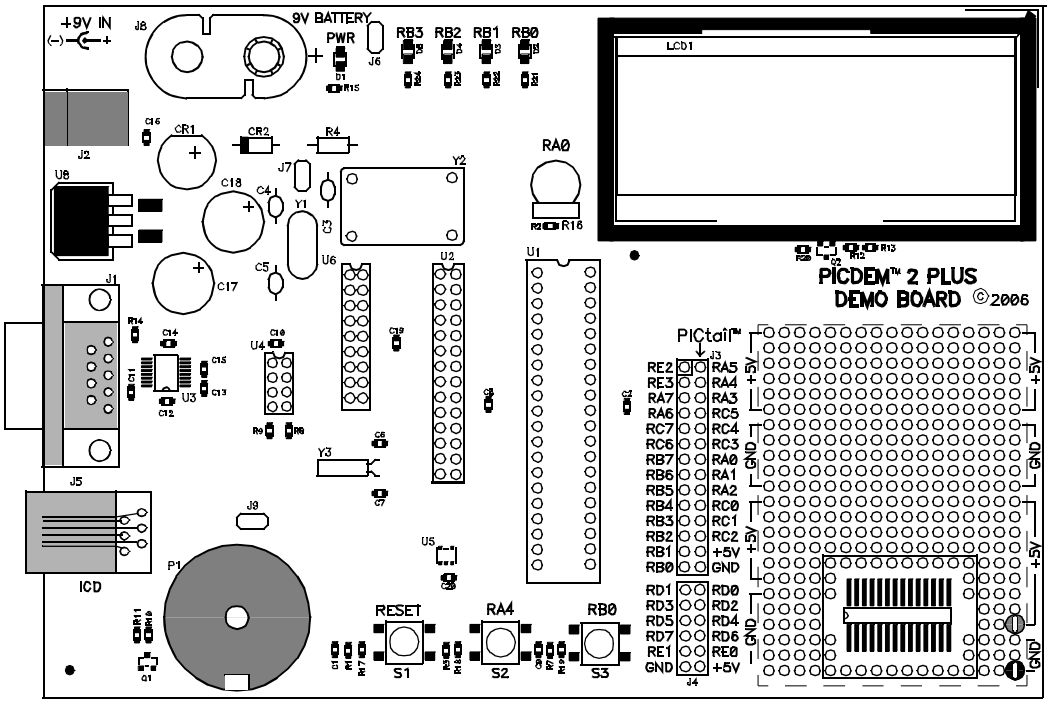


FIGURE A-2: PICDEM™ 2 PLUS DEMONSTRATION BOARD SCHEMATIC, SHEET 1 (MICROCONTROLLER SOCKETS, LCD OPTIONS, OSCILLATOR OPTIONS, EEPROM AND SENSOR)

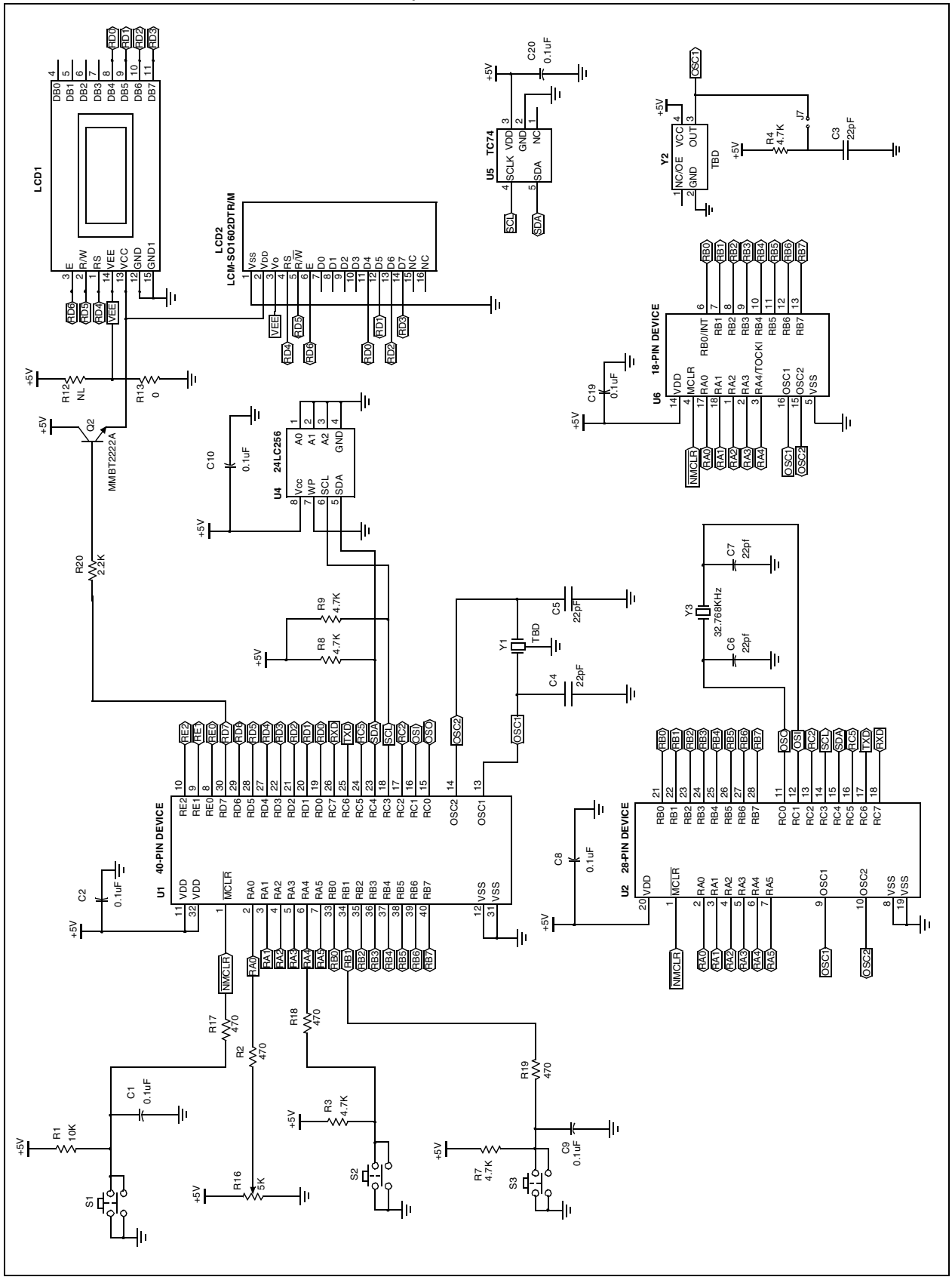
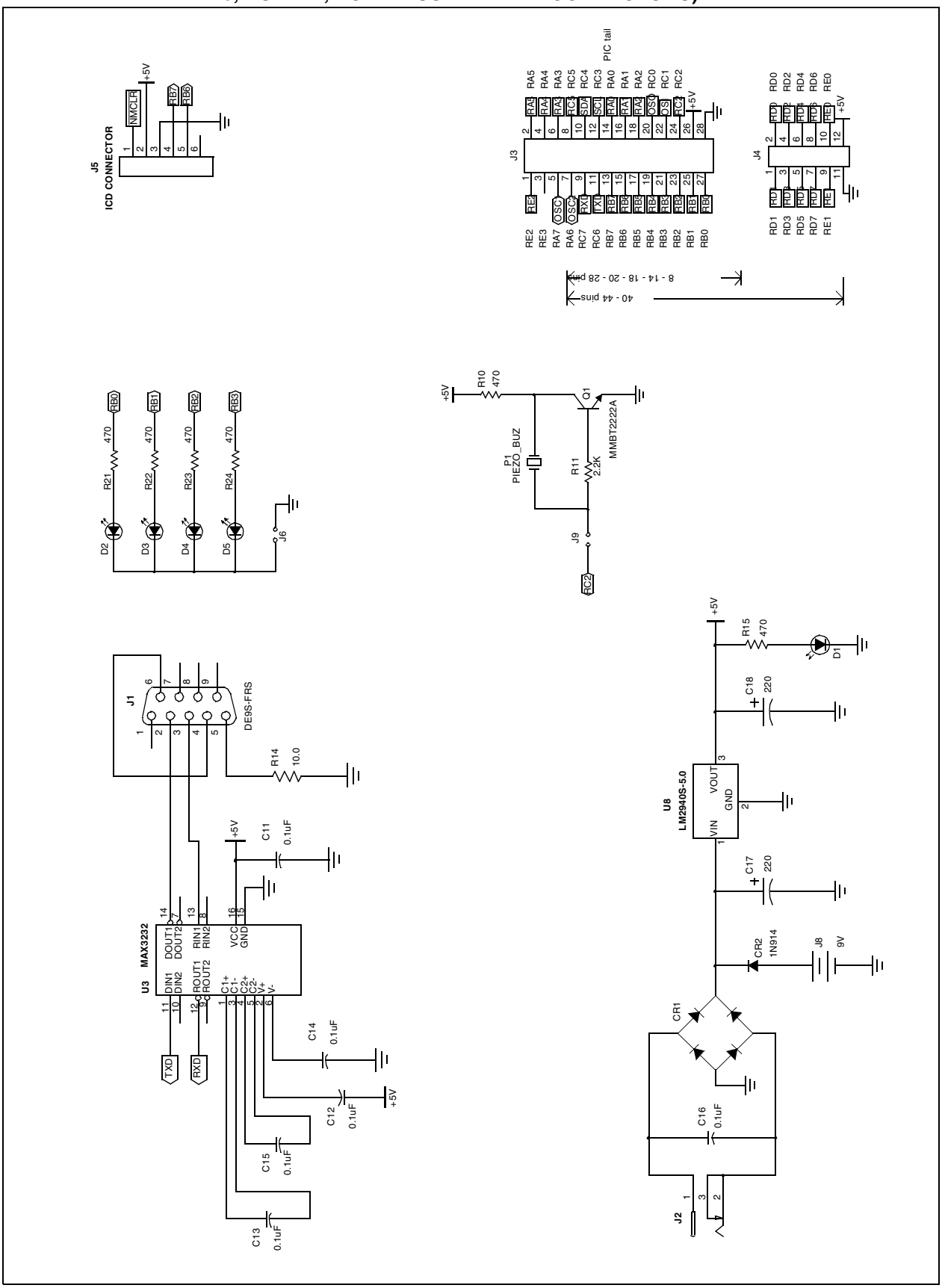


FIGURE A-3: PICDEM™ 2 PLUS DEMONSTRATION BOARD SCHEMATIC, SHEET 2 (USART, LEDs, BUZZER, POWER SUPPLY AND CONNECTORS)



Index

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