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**PICDEM™ 2 Plus  
Demonstration Board  
User's Guide**

# PICDEM™ 2 PLUS

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# PICDEM™ 2 Plus Demonstration Board User's Guide

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NOTES:



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## Preface

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### 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](http://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 “DSXXXXA”, where “XXXX” 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 online help. Select the Help menu, and then Topics to open a list of available online help files.

## INTRODUCTION

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

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

## 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, as well as how to program devices. The document is organized as follows:

- **Chapter 1. “Introduction”** – Introduces the PICDEM 2 Plus Demonstration Board and provides a brief description of the hardware.
- **Chapter 2. “Getting Started”** – 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, ICD or PICkit™ programmer.
- **Chapter 3. “Tutorial”** – Provides a detailed description of the tutorial program.
- **Appendix A. “Hardware Detail”** - Describes in detail the hardware of the PICDEM 2 Plus Demonstration Board.

# PICDEM™ 2 Plus Demonstration Board User's Guide

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

Description	Represents	Examples
<b>Arial font:</b>		
Italic characters	Referenced books	<i>MPLAB® IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> 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	<u><i>File&gt;Save</i></u>
Bold characters	A dialog button	Click <b>OK</b>
	A tab	Click the <b>Power</b> 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>
<b>Courier New font:</b>		
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	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets [ ]	Optional arguments	mcc18 [options] <i>file</i> [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

This user's guide describes how to use PICDEM™ 2 Plus Demonstration Board. 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.

**PIC16(L)F193X Data Sheet (DS40001364):** Consult this document for information regarding the PIC1934/6/7 28/40/44-pin Flash-based, 8-bit CMOS microcontrollers with XLP technology.

**PIC18(L)F2X/4XK22 Data Sheet (DS40001412):** Consult this document for information regarding the PIC18(L)F2X/4XK22 28/40/44-pin Flash-based, 8-bit CMOS microcontrollers with XLP technology.

**PIC16(L)F1826/27 Data Sheet (DS40001391):** Consult this document for information regarding the PIC16(L)F1826/27 28/40/44-pin Flash-based, 8-bit CMOS microcontrollers with XLP technology.

**TC74 Data Sheet (DS20001462):** Consult this document for information regarding the TC74 Tiny Serial Digital Thermal Sensor.

**MPLAB® X IDE User's Guide (DS50002027):** Consult this document for more information pertaining to the installation and features of the MPLAB® X Integrated Development Environment (IDE) software.

**MPLAB® Code Configurator User Guide (DS40001725):** Consult this document for more information pertaining to the installation and features of the MPLAB® Code Configurator plugin.

**MPLAB® PM3 Device Programmer User's Guide (DS50002278):** Consult this document for more information pertaining to the features and functions of the MPLAB® PM3 Universal Device Programmer.

**MPLAB® ICE Emulator User's Guide (DS50001159):** Consult this document for more information pertaining to the features and functions of the MPLAB® PM3 Universal Device Programmer.

**MPLAB® ICD 3 In-Circuit Debugger User's Guide (DS50001766):** Consult this document for more information pertaining to the features and functions of the MPLAB ICD 3 software.

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## PICKit™ 3 Microcontroller Programmer User's Guide (DS50002116):

Consult this document for instructions on how to use the PICKit™ 3 microcontroller programmer software and hardware

Refer to the MPLAB Code Configurator web page for further details:

[http://www.microchip.com/pagehandler/en\\_us/devtools/code\\_configurator/home.html](http://www.microchip.com/pagehandler/en_us/devtools/code_configurator/home.html).

## THE MICROCHIP WEB SITE

Microchip provides online support via our web site at [www.microchip.com](http://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

## DEVELOPMENT SYSTEMS CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at [www.microchip.com](http://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, assemblers, linkers and other language tools. These include all MPLAB C compilers; all MPLAB assemblers (including MPASM assembler); all MPLAB linkers (including MPLINK object linker); and all MPLAB librarians (including MPLIB object librarian).
- **Emulators** – The latest information on Microchip in-circuit emulators. This includes the MPLAB REAL ICE and MPLAB ICE 2000 in-circuit emulators.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debuggers. This includes MPLAB ICD 3 in-circuit debuggers and PICKit 3 debug express.
- **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 IDE Project Manager, MPLAB Editor and MPLAB SIM simulator, as well as general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include production programmers such as MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger and MPLAB PM3 device programmers. Also included are nonproduction development programmers such as PICSTART Plus and PICKit 2 and 3.



## 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://www.microchip.com/support>.

## REVISION HISTORY

### **Revision A (June 2011)**

Initial Release of this Document.

<p><b>Note:</b> This board (DM163022-1) has been updated from the previous version (DM163022). The user guide for the previous board version (DM163022) can be found online at the PICDEM 2 Plus web site (DS51275) <a href="http://www.Microchip.com/PICDEM2PLUS">www.Microchip.com/PICDEM2PLUS</a>.</p>
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### **Revision B (September 2011)**

Removed references to 4 MHz canned crystal oscillator connected to Y2. Part is not part of demonstration board.

### **Revision C (May 2015)**

Updated Figures 2-3, 2-4, 2-7; Updated the Recommended Reading section in Preface chapter; Use of MPLAB X and XC8 updated with MCC plugin; Other minor corrections.

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## Chapter 1. Introduction

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### 1.1 INTRODUCTION

Thank you for purchasing the PICDEM™ 2 Plus Demonstration Board from Microchip Technology Incorporated. The PICDEM 2 Plus Demonstration Board is a simple board that demonstrates the capabilities of Microchip's 8-bit, 18-, 28- and 40-pin PIC16FXXX, PIC16F1XXX, and PIC18 devices.

The PICDEM 2 Plus Demonstration Board can be used stand-alone with a programmed part, with an in-circuit emulator (for example, MPLAB® REAL ICE™) or with an in-circuit programmer/debugger (such as MPLAB® ICD 3 or PICKIT™ 3). Sample programs are provided to demonstrate the unique features of the supported devices.

### 1.2 DEVELOPMENT KIT CONTENTS

The PICDEM 2 Plus Demonstration Board kit comes with the following:

- PICDEM 2 Plus Demonstration Board (see [Figure 1-1](#))
- Sample devices (pre-loaded with program demonstration)

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.

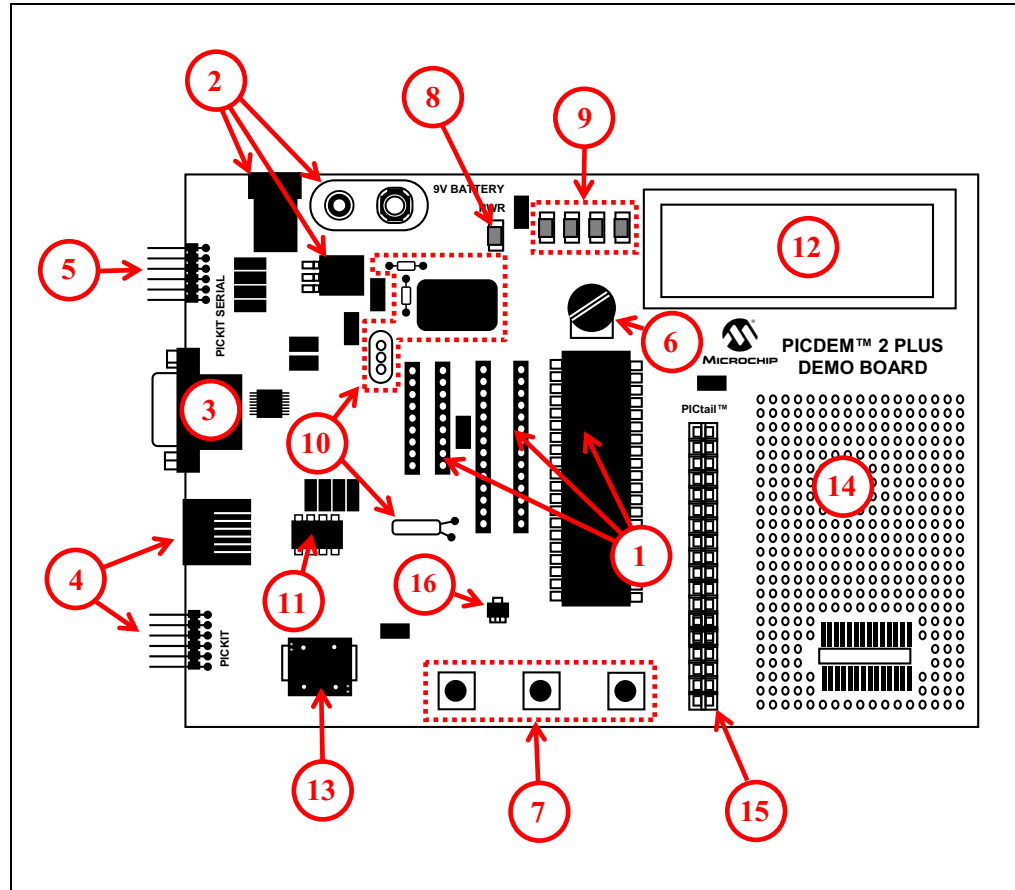
### 1.3 PICDEM™ 2 PLUS DEMONSTRATION BOARD

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. Programmer/debugger connectivity supporting MPLAB® ICD 3, MPLAB REAL ICE and PICKIT 3
5. PICKIT Serial Connector for analysis of serial communications peripherals such as SPI or I<sup>2</sup>C™
6. 5 kΩ pot for devices with analog inputs
7. Three push button switches for external stimulus and Reset
8. Power-on indicator LED
9. Four LEDs connected to PORTB
10. On-board external oscillators including:
  - a) Unpopulated DIP socket for canned crystal oscillator (Y2)
  - b) RC oscillator circuit (R4, C3)
  - c) Unpopulated holes for crystal connection (Y1)
  - d) 32.768 kHz crystal for Timer1 clock operation (Y3)

11. 32K x 8 Serial EEPROM
12. LCD display
13. Piezo buzzer
14. Prototype area for user hardware
15. Expansion Header for PICtail™ daughter card connectivity or user access to MCU pins
16. Microchip TC74 thermal sensor

**FIGURE 1-1: PICDEM 2 PLUS DEMONSTRATION BOARD HARDWARE**



# PICDEM™ 2 Plus Demonstration Board User's Guide

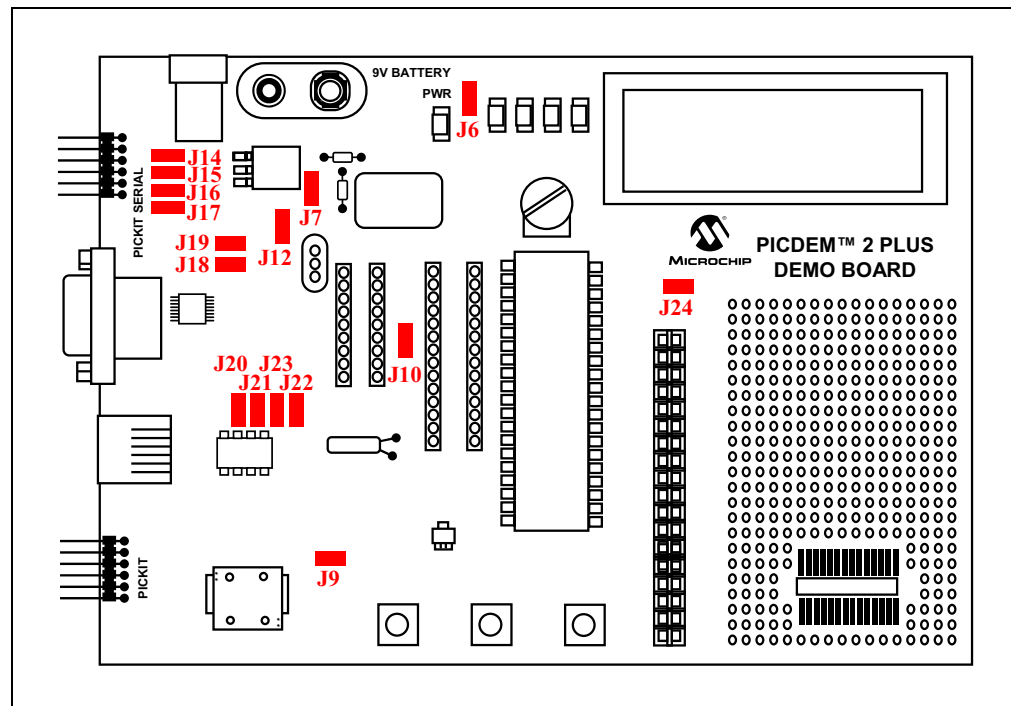
## 1.4 ON-BOARD JUMPER CONFIGURATIONS

Most of the on-board components have associated jumpers that will allow the user to either connect or disconnect a component(s) from the PIC® MCUs or other mounted components. [Table 1-1](#) and [Figure 1-2](#) detail these connections.

**TABLE 1-1: ON-BOARD JUMPER CONNECTIONS**

Jumper	Connection
J6	LEDs to PORTB
J7	On-board RC oscillator to PIC® MCUs
J9	Piezo buzzer to RC2 pin (*on 40-pin mid-range device, this is CCP1)
J10	VCAP connection for devices with on-chip voltage regulator
J12	2.7V source to RA1 (voltage divider off of 9V input voltage)
J14, 15, 16, 17	PICKIT™ Serial Header to I <sup>2</sup> C™ bus
J18,19	Tx and Rx from RS-232 components to PIC® MCUs
J20, 21, 22, 23	PIC® MCUs to I <sup>2</sup> C™ bus
J24	RA4 pin to RC2 pin (*on 40-pin mid-range device, this connects C1OUT to CCP1)

**FIGURE 1-2: PICDEM™ 2 PLUS DEMONSTRATION BOARD JUMPER LOCATIONS**



## 1.5 SAMPLE DEVICES

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

## 1.6 SAMPLE PROGRAMS

The PICDEM™ 2 Plus Demonstration Board kit sample demonstration programs can be found on the Microchip web site ([www.microchip.com/PICDEM2PLUS](http://www.microchip.com/PICDEM2PLUS)). These programs may be used with the included sample devices, with a REAL ICE (In-Circuit Emulator), MPLAB® ICD 3 (programmer/debugger) or with a PICKit™ 3 (programmer/debugger). For each type of device (PIC16 or PIC18), the demo source code (several .C and .H files) and the compiled code (one .hex file) are provided.

## 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), with an In-Circuit Debugger (ICD) or with a PICKIT™ programming device. For a list of PIC® microcontroller compatible ICEs, ICDs or PICKIT programming devices, see the Development Systems Ordering Guide.

### 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.
- Confirm the jumpers are populated/removed according to [Table 2-1](#) below.
- Connect the programmer/debugger. See [Section 2.2 “Programming the Device”](#).
- Apply power to the PICDEM 2 Plus Demonstration Board. See [Section 2.3 “Powering the Board”](#).

**TABLE 2-1: JUMPER SETUP**

J6	OFF
J7	ON
J9	ON
J10	OFF
J12	ON
J14	ON
J15	ON
J16	ON
J17	ON
J18	ON
J19	ON
J20	OFF
J21	OFF
J22	OFF
J23	OFF
J24	OFF

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

- The program source code – the user source code may be used to program the device, or if this previously has been done, the sample program may be restored from the file included in the PICDEM 2 Plus installer.
- An assembler, such as MPASM™ assembler (available with MPLAB® X IDE), or a compiler, such as HI-TECH® C or MPLAB XC8 (PIC18 devices only).

The source code must be assembled or compiled into a hex file before it can be programmed into the device. Microchip Technology's MPLAB XC8 may also be used. Both are compatible with MPLAB X IDE.

Other assemblers/compilers may be used. For a list of these PIC® MCU compatible language tools, see the Microchip web site ([www.microchip.com](http://www.microchip.com)).

Once the sample program is in hex file format, a programmer can program a Flash device. Microchip Technology's PICKit or ICD 3 programmer may be used. Both are compatible with MPLAB X IDE.

Other programmers may be used. For a list of these PIC MCU compatible programmers, see the Microchip web site ([www.microchip.com](http://www.microchip.com)).

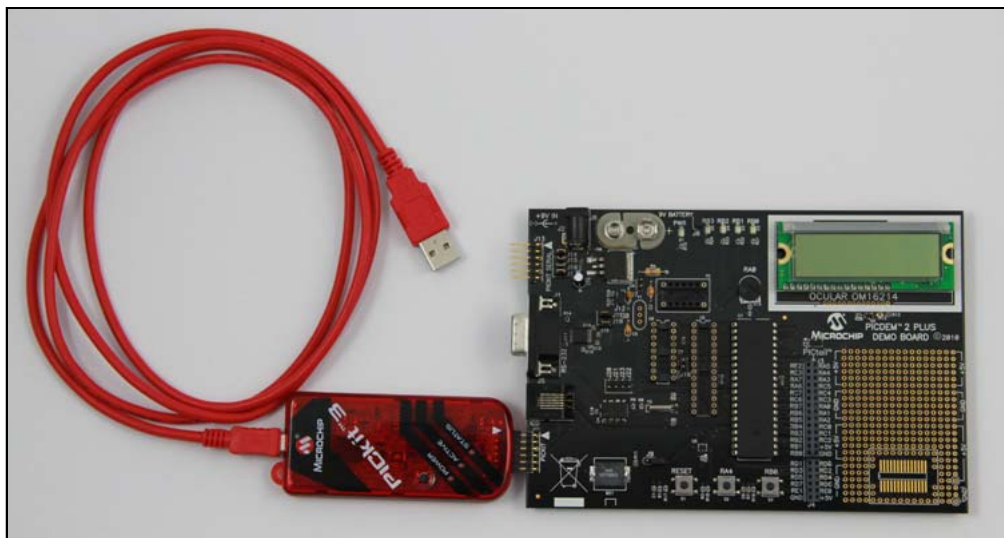
If the code protection bit(s) have not been programmed, the on-chip program memory can be read out for verification purposes.

## 2.2 PROGRAMMING THE DEVICE

The PICDEM 2 Plus Demonstration Board supports the ability to program a device through multiple options.

### 2.2.1 PICKit Programming

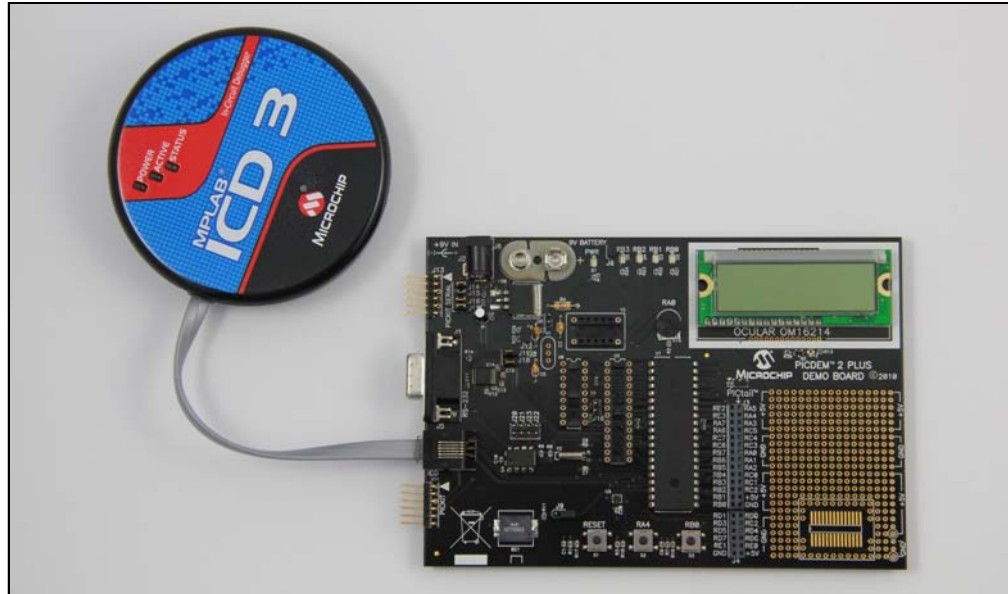
**FIGURE 2-1: PICKit™ PROGRAMMER AND BOARD CONNECTION HEADER**



Microchip's PICKit 3 In-Circuit Debugger/Programmer uses in-circuit debugging logic incorporated into each chip with Flash memory to provide a low-cost hardware debugger and programmer.

## 2.2.2 ICD Programming

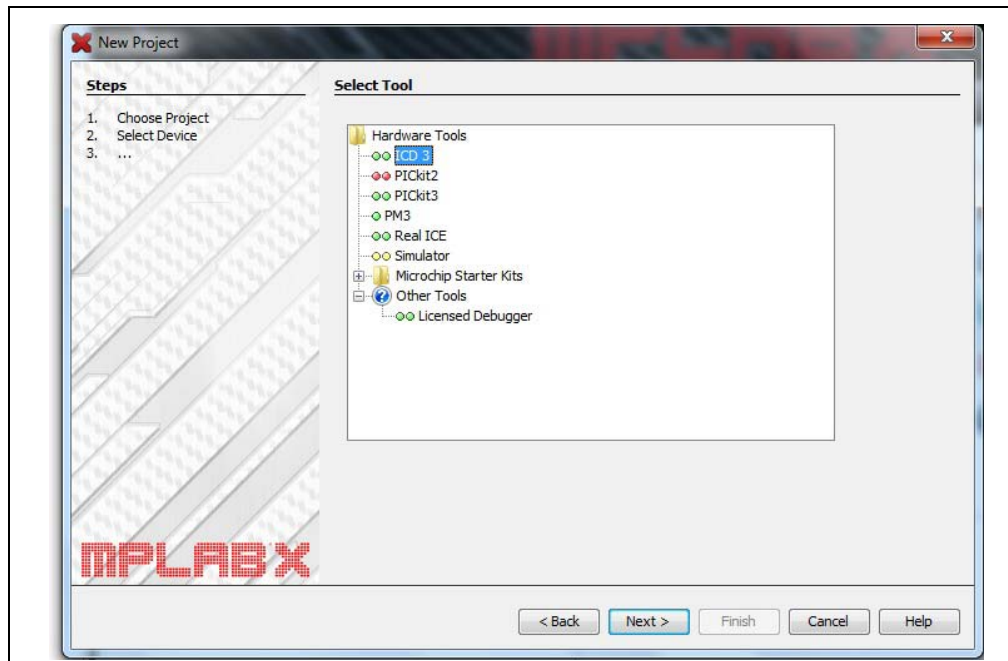
FIGURE 2-2: ICD PROGRAMMER AND BOARD CONNECTION HEADER



The MPLAB® ICD 3 In-Circuit Debugger System is Microchip's most cost-effective, high-speed hardware debugger/programmer for Microchip Flash Digital Signal Controller (DSC) and microcontroller (MCU) devices. It debugs and programs PIC® Flash microcontrollers and dsPIC® DSCs with the powerful, yet easy-to-use graphical user interface of MPLAB X Integrated Development Environment (IDE).

The debugger/programmer for the project can be selected while creating a new MPLAB X project. When a new project is created in MPLAB X, the tool is selected in the hardware selection process (Figure 2-3).

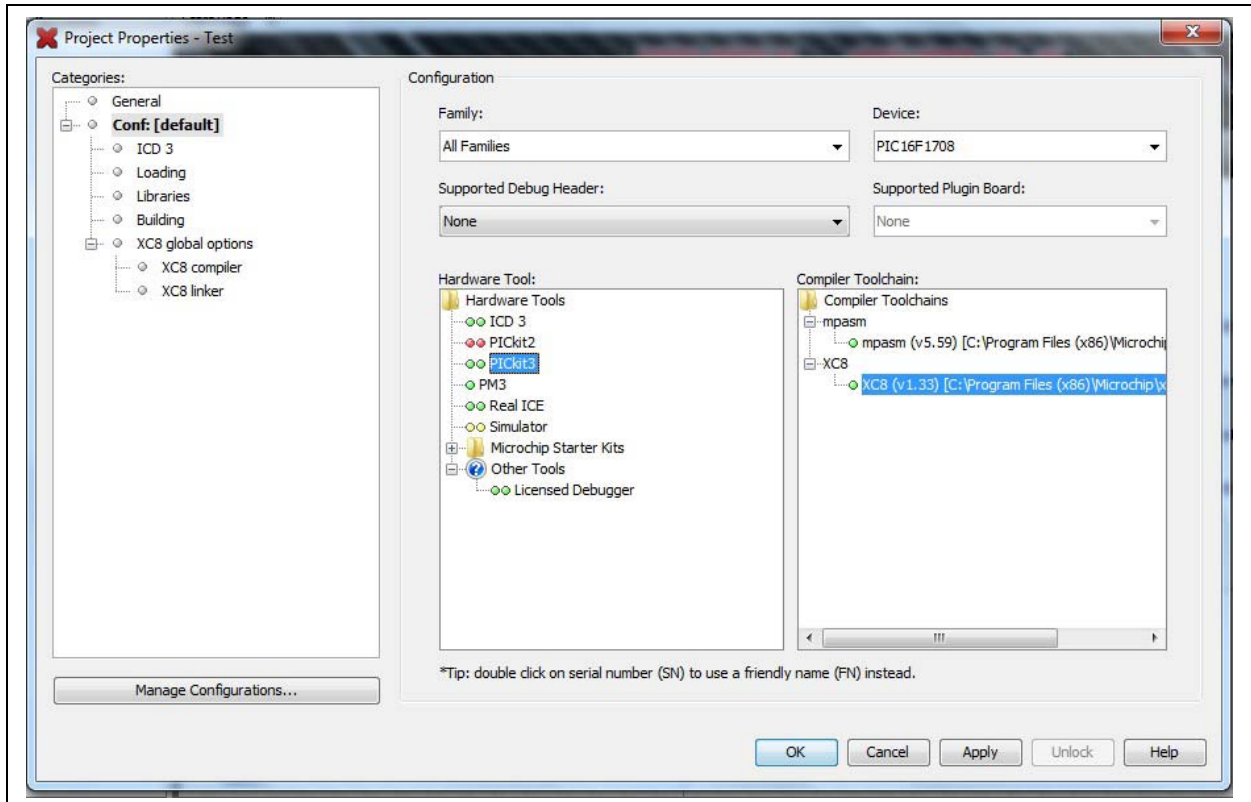
FIGURE 2-3: SELECT TOOL





MPLAB X also allows modification of project properties (Figure 2-4). We can configure the debugger by right clicking on the main project and selecting **Properties**.

**FIGURE 2-4: MODIFY PROJECT PROPERTIES**

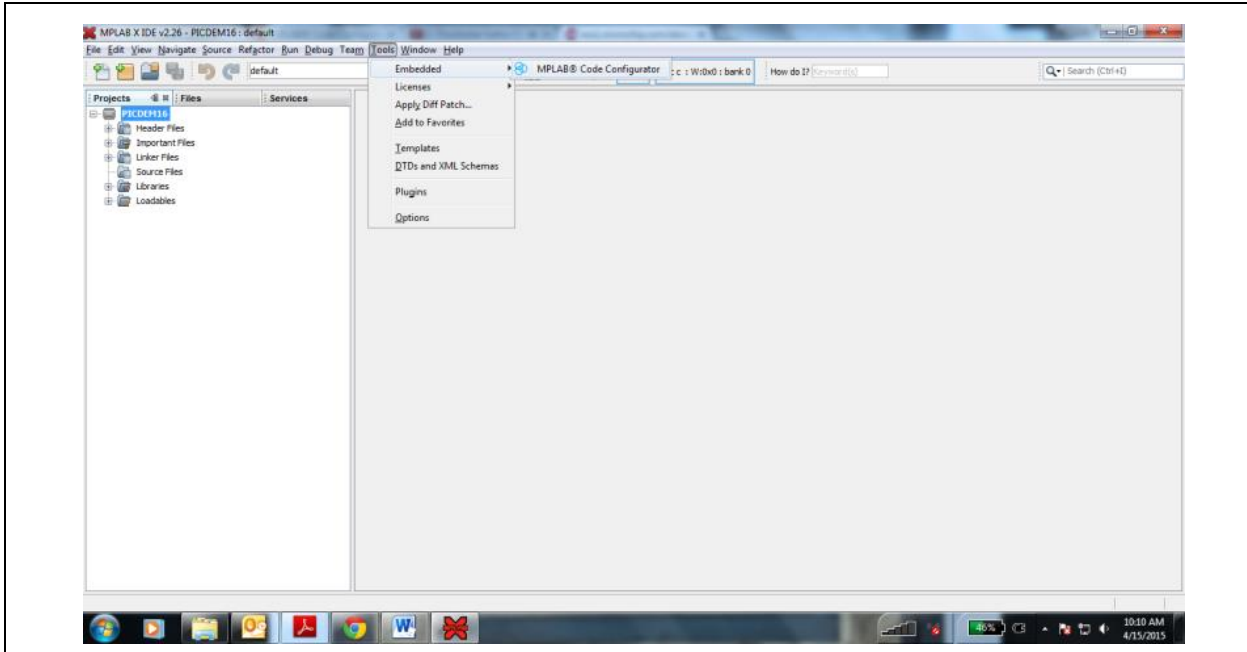


Refer to the MPLAB<sup>®</sup> X IDE User's Guide (DS50002027) for further details on creating a project. The MPLAB<sup>®</sup> Code Configurator (MCC) is a plugin tool for MPLAB X IDE which generates drivers for controlling and driving peripherals of PIC microcontrollers. It generates source and header files based on the selections made in the GUI and adds it to the active project to MPLAB X.

# PICDEM™ 2 Plus Demonstration Board User's Guide

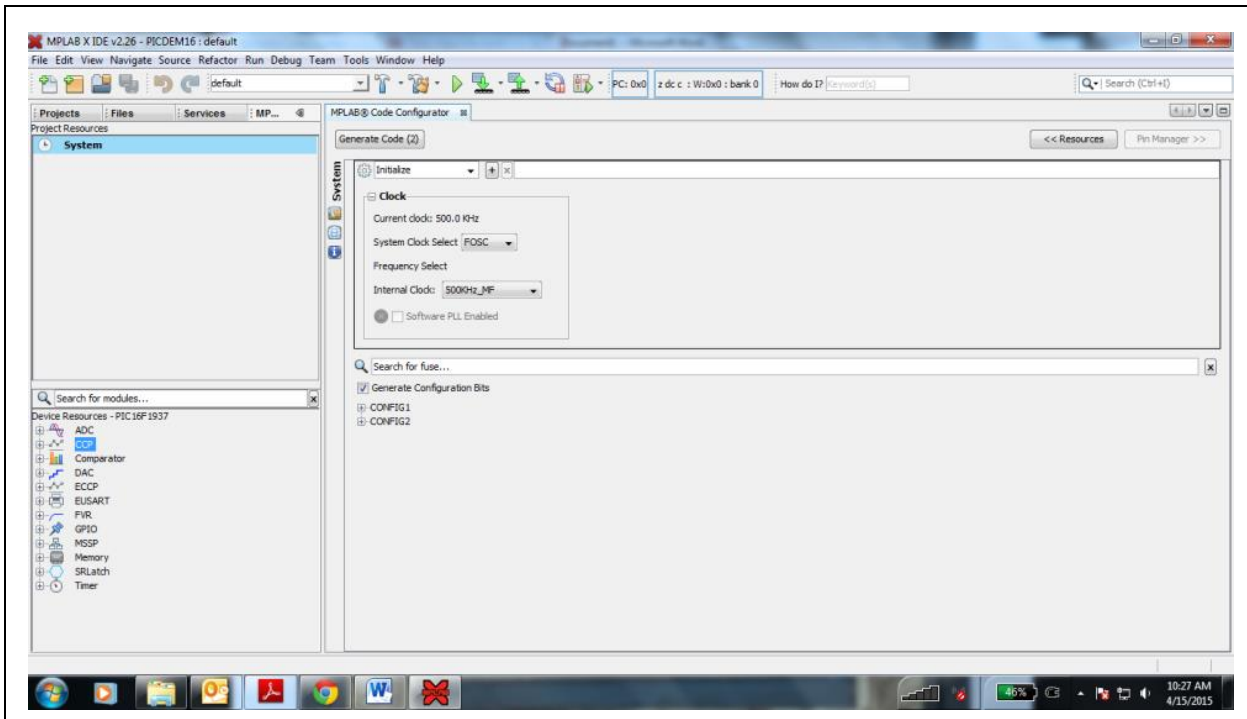
To open the MCC plugin tool, Click on **Tools** -> **Embedded** and click on **MPLAB Code Configurator** as shown in the [Figure 2-5](#).

**FIGURE 2-5: OPEN MPLAB® X CODE CONFIGURATOR**



Once the MCC tool is launched, the sections – Project Resources Area, Device Resources Area, Composer Area and Pin Manager Area are displayed. The sections of the MCC tool are as shown in the image [Figure 2-6](#).

**FIGURE 2-6: DIFFERENT SECTIONS OF THE MCC PLUGIN**



Refer to the MPLAB® Code Configurator User's Guide (DS40001725) for further details on how to configure the system clock, Configuration bits and various peripherals for the project.

## 2.3 POWERING THE BOARD

The PICDEM 2 Plus Demonstration Board supports the ability to power the board through multiple options.

### 2.3.1 External 9V Connector

**FIGURE 2-7: 9V EXTERNAL POWER SUPPLY**



The PICDEM 2 Plus Demonstration Board can be powered with an external 9V power supply.

- Connect 9V power supply to a wall outlet.
- Connect to the board as shown in [Figure 2-7](#). The on-board regulator will reduce the input voltage to 5V for safe PIC device operation.

### 2.3.2 External 9V Battery

**FIGURE 2-8: 9V EXTERNAL BATTERY**

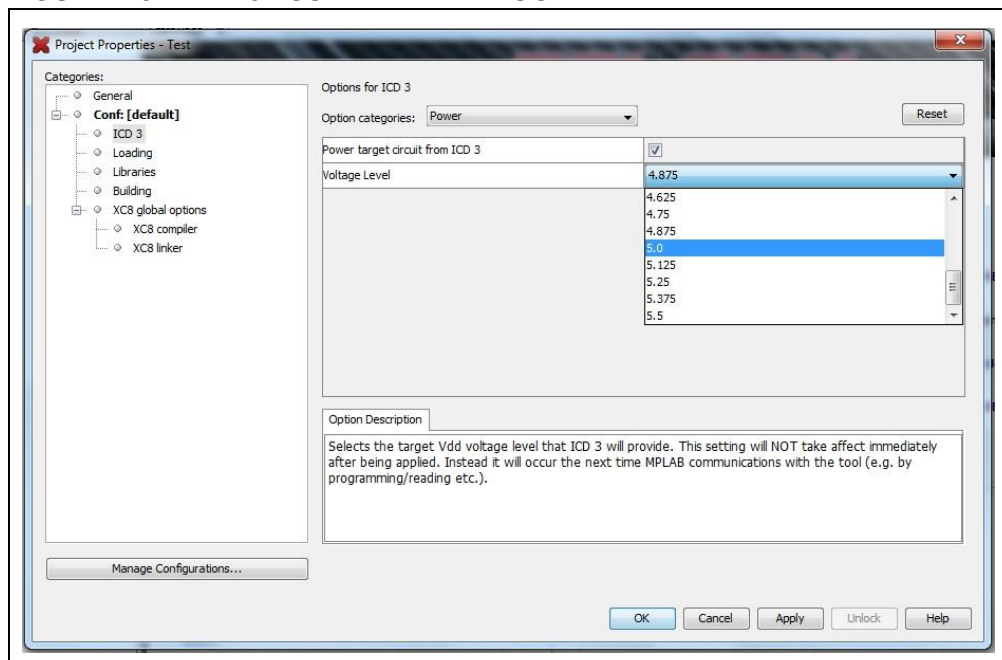


The PICDEM 2 Plus Demonstration Board can be powered with an external 9V battery for a power supply.

- Connect the 9V battery to the board [B].
- The on-board regulator will reduce the input voltage to 5V for safe PIC device operation.

## 2.3.3 Power by Programmer

FIGURE 2-9: 5V SUPPLIED BY PROGRAMMER



The PICDEM 2 Plus Demonstration Board can also be powered with a PICKit or ICD programming device.

- Open Project Properties window. Select ICD 3/PICKit 3 under Categories.
- Select **Power** from the Option Categories drop-down list.
- Click the checkbox if you want the tool to provide power to the target board. Select a voltage level from the list that the tool should provide the board.

## Chapter 3. Tutorial

The tutorial program is preprogrammed into the sample device. The PIC16 device's program was built using the MPLAB® X IDE and MPLAB® XC8 compiler along with MCC Plugin for MPLAB X IDE. These programs are included in the PICDEM™ 2 Plus installer file found at [www.Microchip.com/PICDEM2PLUS](http://www.Microchip.com/PICDEM2PLUS).

In case the device has been reprogrammed to a user's unique code, the device can always be reprogrammed with the tutorial program if installed.

For detailed information on the PICDEM 2 Plus hardware, please refer to [Appendix A. "Hardware Detail"](#).

### 3.1 TUTORIAL PROGRAM OPERATION

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

#### 3.1.1 Voltmeter

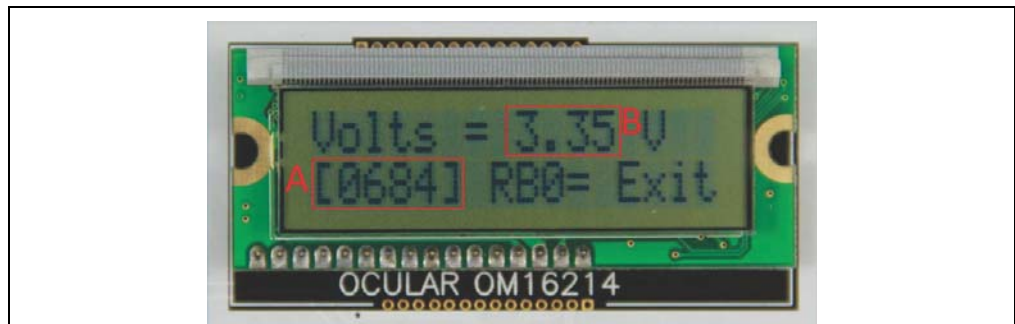
**FIGURE 3-1: VOLTMETER DISPLAY AND COMPONENT**



This mode uses the A/D module to measure the voltage of the RA0 pot (R16) and displays a voltage between 0.00V and 5.00V on the LCD.

Voltage is continually updated until the mode is exited by pressing RB0.

**FIGURE 3-2: VOLTAGE READINGS**



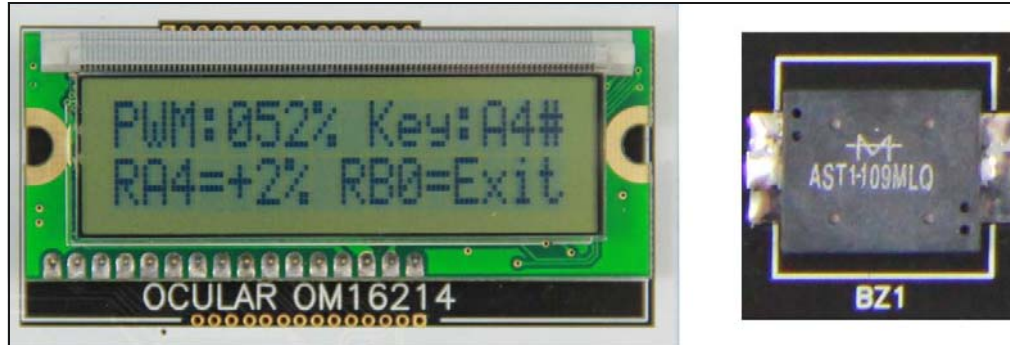
#### Reading the Voltmeter Display (ADC)

A) (ADRESH:ADRESL) ADC conversion result. Range: 10-bit (0-1023).

B) Voltage representation.

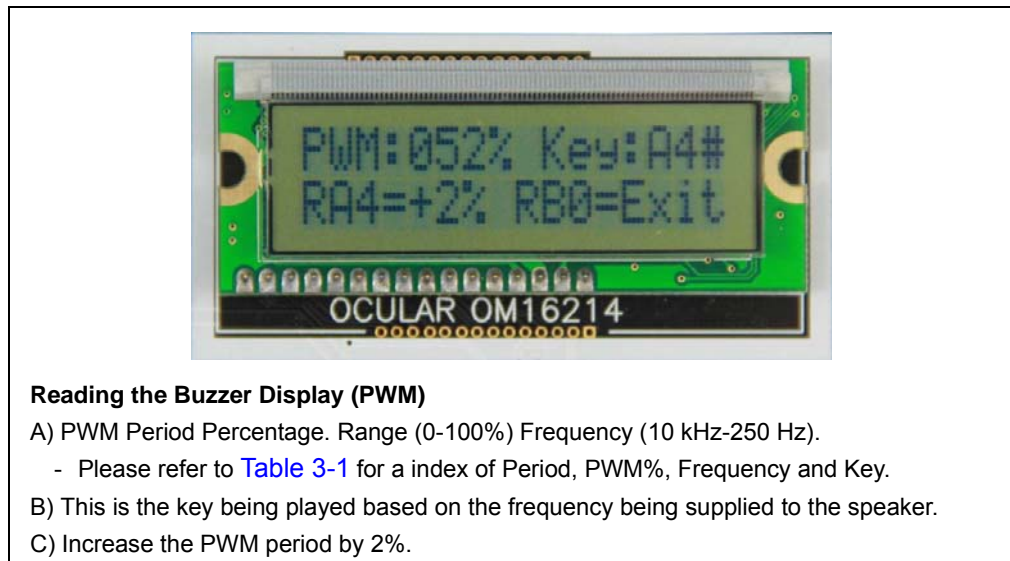
## 3.1.2 Buzzer

FIGURE 3-3: BUZZER DISPLAY AND COMPONENT



This mode turns on the Piezo buzzer using the CCP1 module I/O pin, RC2.

FIGURE 3-4: BUZZER READINGS

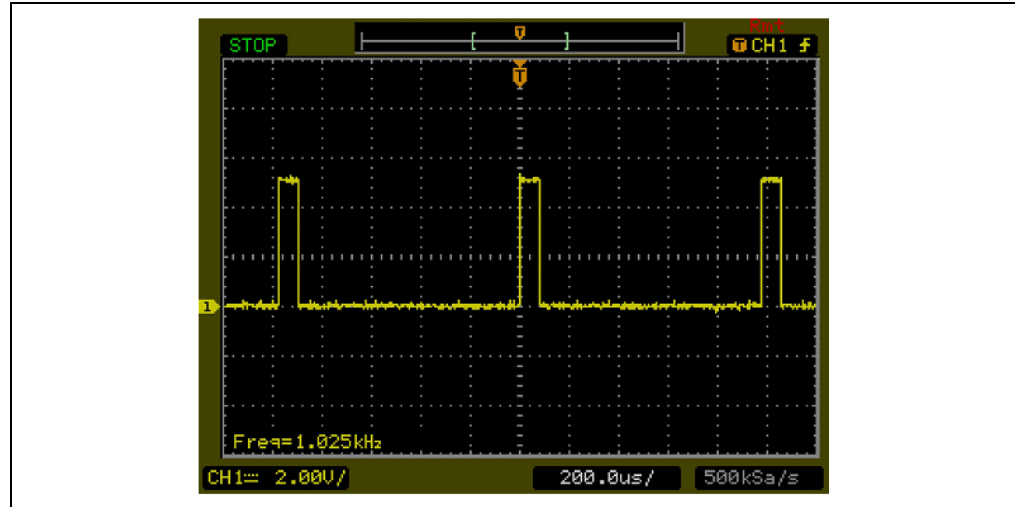


The period and duty cycle of the CCP1 frequency can be changed while the buzzer is on. The changes in period are recognized immediately in the buzzer tone. By changing the period, the buzzer frequency changes.

- To change the period, press RB0 under the “Buzzer” menu.
- The buzzer will sound off with the default frequency of 10 kHz and a period of 05h (0%).
- By pressing the RB4 button the period will increase by 5 (2%).
- The LCD will display the current Key being played by the buzzer based upon the period.
- Press RB0 to exit the buzzer function.

[Figure 3-3](#) shows an example of a signal supplied to the buzzer.

**FIGURE 3-5: BUZZER SIGNAL**



**TABLE 3-1: BUZZER INDEX**

Period	PWM	Frequency	Key
5	0.00%	10 KHz	----
10	2.00%	5 KHz	D8#
15	4.00%	4 KHz	B7
20	6.00%	3 KHz	F7#
25	8.00%	2.45 KHz	D7#
30	10.00%	2 KHz	C7
35	12.00%	1.73 KHz	A6
40	14.00%	1.52 KHz	G6
45	16.00%	1.36 KHz	F6
50	18.00%	1.23 KHz	D6#
55	20.00%	1.16 KHz	D6
60	22.00%	1.03 KHz	C6
65	24.00%	950 Hz	A5#
70	26.00%	880 Hz	A5
75	28.00%	823 Hz	G5#
80	30.00%	775 Hz	G5
85	32.00%	730 Hz	F5#
90	34.00%	690 Hz	F5
95	36.00%	653 Hz	E5
100	38.00%	620 Hz	D5#
105	40.00%	590 Hz	D5
110	42.00%	560 Hz	C5#
115	44.00%	530 Hz	C5
120	46.00%	510 Hz	----
125	48.00%	495 Hz	B4
130	50.00%	478 Hz	----
135	52.00%	460 Hz]	A4#
140	54.00%	442 Hz	A4
145	56.00%	427 Hz	----
150	58.00%	414 Hz	G4#
155	60.00%	400 Hz	----
160	62.00%	390 Hz	G4
165	64.00%	375 Hz	----
170	66.00%	365 Hz	F4#
175	68.00%	355 Hz	----
180	70.00%	345 Hz	F4
185	72.00%	335 Hz	----
190	74.00%	326 Hz	E4
195	76.00%	318 Hz	----
200	78.00%	310 Hz	D4#
205	80.00%	300 Hz	----
210	82.00%	295 Hz	D4
215	84.00%	290 Hz	----
220	86.00%	284 Hz	C4#
225	88.00%	277 Hz	----
230	90.00%	270 Hz	----
235	92.00%	264 Hz	----
240	94.00%	259 Hz	C4
245	96.00%	254 Hz	----
250	98.00%	249 Hz	----
255	100.00%	245 Hz	B3

## 3.1.3 Temperature

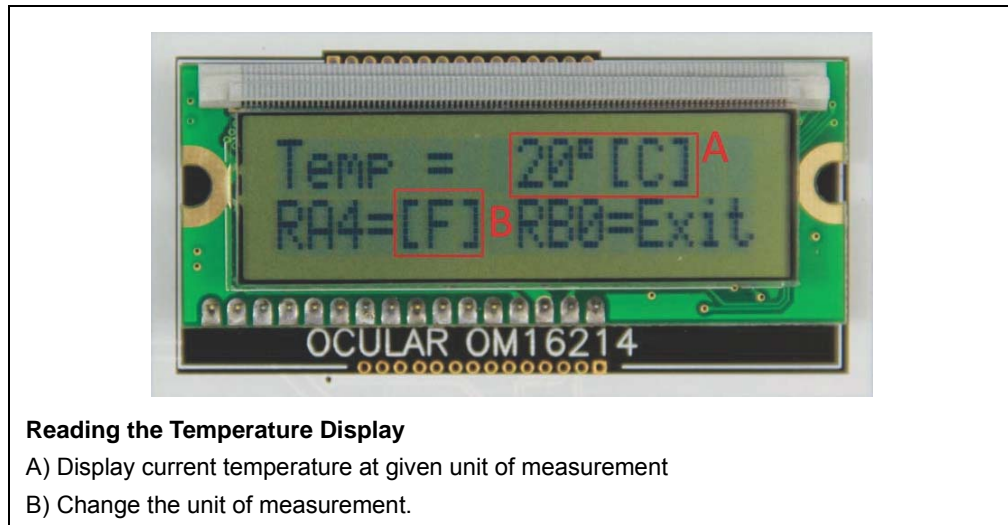
FIGURE 3-6: TEMPERATURE DISPLAY AND COMPONENT



This mode uses a TC74 thermal sensor to measure ambient temperature in Celsius and then display the temperature on the LCD. The user has the option to change the display between Celsius and Fahrenheit by pressing RB4.

Communication between the PIC® MCU and sensor is accomplished using the MSSP module. This mode is exited by pressing RB0. Ensure that Jumpers J22 and J23 should be removed for I<sup>2</sup>C™ communication.

FIGURE 3-7: TEMPERATURE READINGS

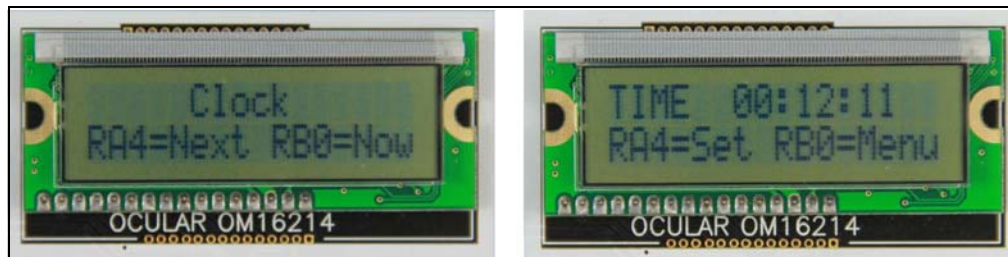


### Reading the Temperature Display

- A) Display current temperature at given unit of measurement
- B) Change the unit of measurement.

## 3.1.4 Clock

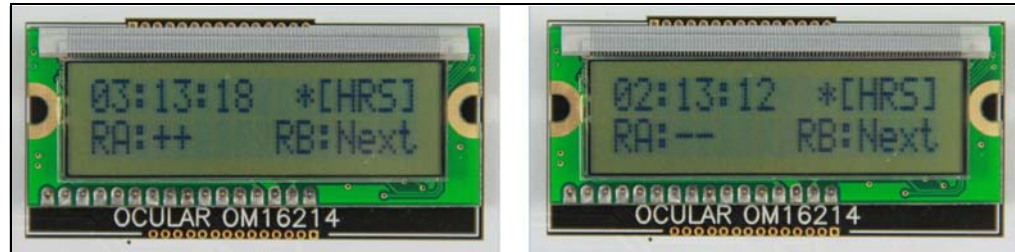
FIGURE 3-8: CLOCK DISPLAY





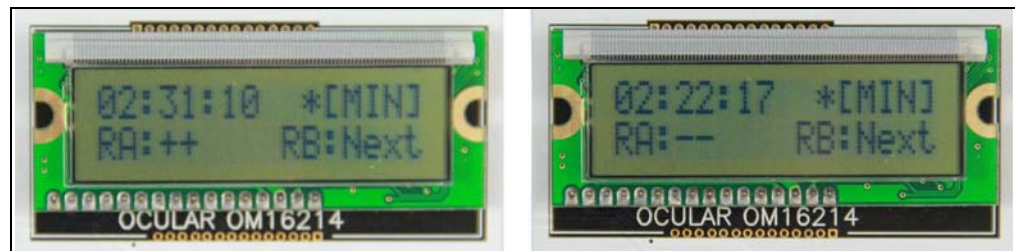
The Real-Time Clock will start counting from 00:00:00 at the start of the program. The Timer1 module and a 32 kHz clock crystal are used to establish a Real-Time Clock. By pressing RA4 within the clock function, the clock time can be set to the user's preference. The user has the option to set the hours or minutes of the clock.

**FIGURE 3-9: INCREMENT/DECREMENT HOURS**



By pressing RA4 within the set function, the user can set the hours. The user first has the option to increment the hours, one hour at a time by pressing RA4. If the user presses RB0 within the increment hour's function, the program will then allow the user to decrement the hours, one hour at a time by pressing RA4. When the user presses RB0 again the program will return to the clock display screen.

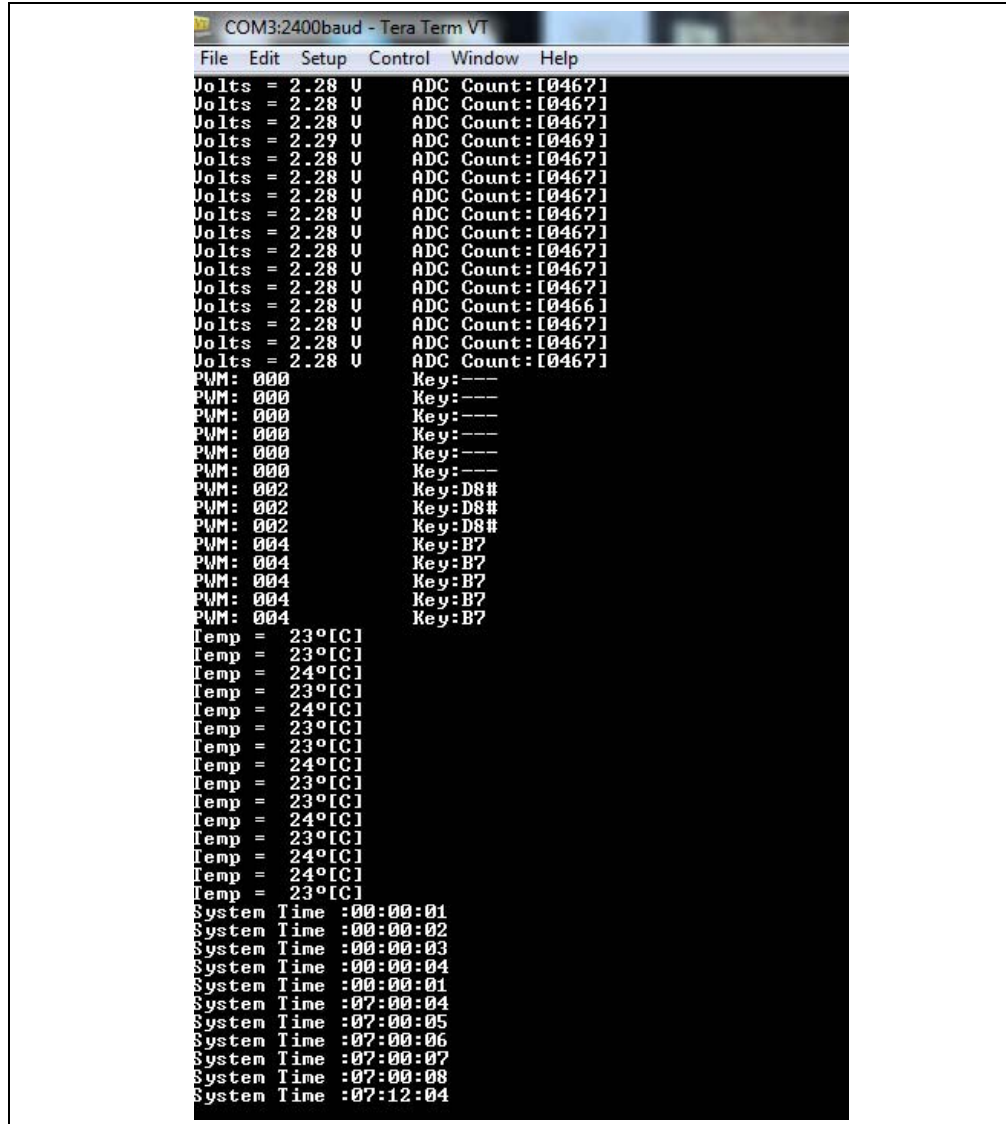
**FIGURE 3-10: INCREMENT/DECREMENT MINUTES**



By pressing RB0 within the set function, the user can set the minutes. The user first has the option to increment the minutes, one minute at a time by pressing RA4. If the user presses RB0 within the increment minute's function, the program will then allow the user to decrement the minutes, one minute at a time by pressing RA4. When the user presses RB0 again the program will return to the clock display screen.

## 3.1.5 USART

FIGURE 3-11: USART DATA



The screenshot shows a terminal window titled "COM3:2400baud - Tera Term VT". The window contains the following text output:

```
File Edit Setup Control Window Help
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.29 U      ADC Count: [0469]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0466]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
Volts = 2.28 U      ADC Count: [0467]
PWM: 000           Key: ---
PWM: 000           Key: ---
PWM: 000           Key: ---
PWM: 000           Key: ---
PWM: 000           Key: ---
PWM: 000           Key: ---
PWM: 002           Key: D8#
PWM: 002           Key: D8#
PWM: 002           Key: D8#
PWM: 004           Key: B7
PWM: 004           Key: B7
PWM: 004           Key: B7
PWM: 004           Key: B7
Temp = 23°C [C]
Temp = 23°C [C]
Temp = 24°C [C]
Temp = 23°C [C]
Temp = 24°C [C]
Temp = 23°C [C]
Temp = 23°C [C]
Temp = 24°C [C]
Temp = 23°C [C]
Temp = 23°C [C]
Temp = 24°C [C]
Temp = 23°C [C]
Temp = 24°C [C]
Temp = 24°C [C]
Temp = 24°C [C]
Temp = 23°C [C]
System Time :00:00:01
System Time :00:00:02
System Time :00:00:03
System Time :00:00:04
System Time :00:00:01
System Time :07:00:04
System Time :07:00:05
System Time :07:00:06
System Time :07:00:07
System Time :07:00:08
System Time :07:12:04
```

The data displayed on the LCD within all the program functions is also sent to the RS-232 serial port using the USART on the PIC MCU. A terminal emulator program on the PC will be able to display the same information that is displayed on the LCD. Ensure the jumpers J20 and J21 are not connected for USART communication.

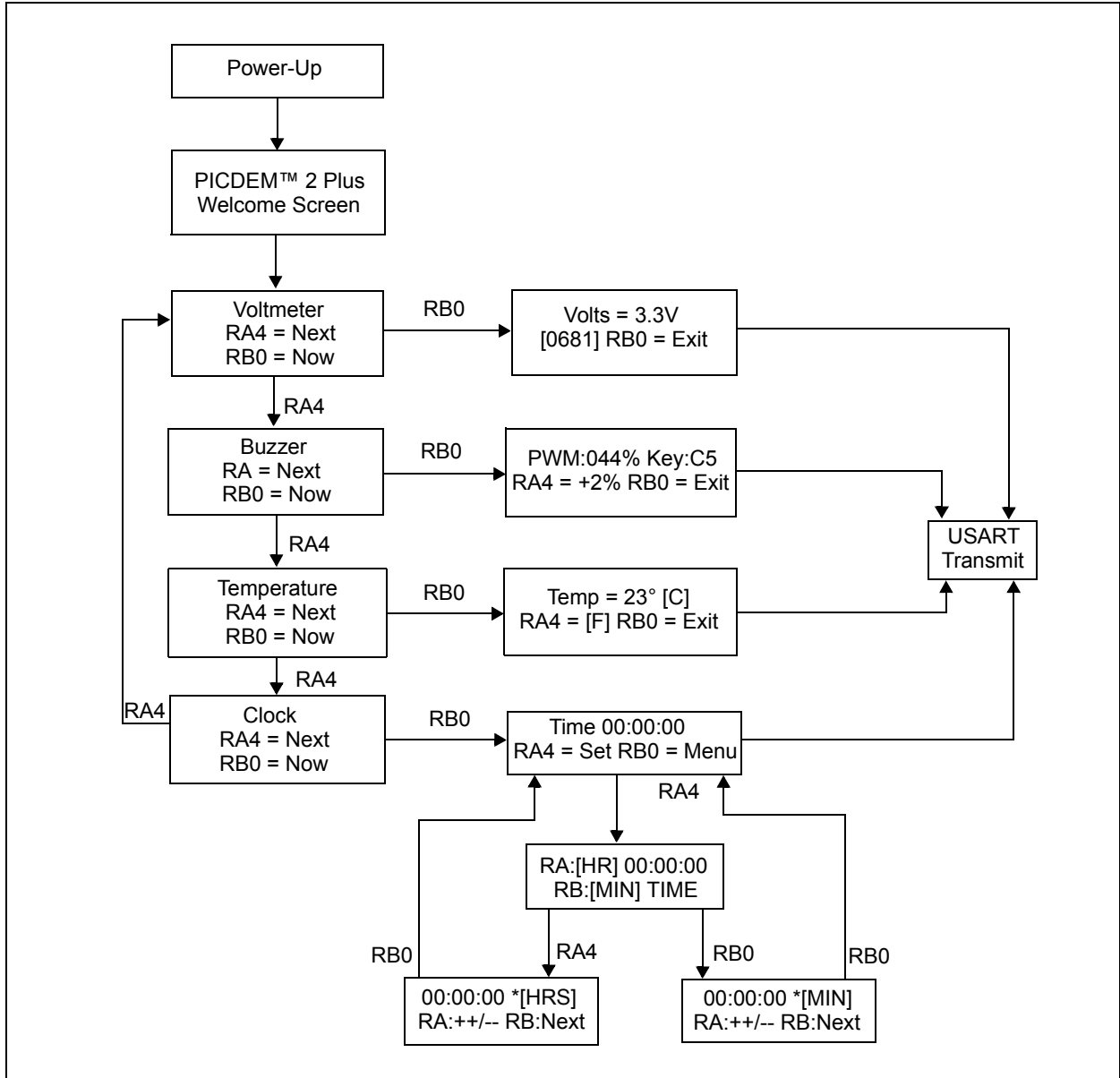
## 3.2 SOURCE CODE AND APPLICATION NOTES

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

A digital guide is also included with the installer.

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”](#).

**FIGURE 3-12: TUTORIAL PROGRAM FLOWCHART**



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## Appendix A. Hardware Detail

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The PICDEM™ 2 Plus Demonstration Board hardware is extremely simple and illustrates the ease-of-use of various PIC® MCUs. This section describes the PICDEM 2 Plus Demonstration Board 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 green LEDs are connected to PORTB of each processor type.
- PORTB pins are set high to light the LEDs. These LEDs may be disconnected from PORTB by removing jumper J6.
- One red LED is provided to indicate whether there is power to the PICDEM 2 Plus Demonstration Board.
- LED On = Powered. LED Off = Not Powered

### A.3 POWER SUPPLY

There are multiple 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.

MPLAB ICD or PICKIT™ programmer users may use the programmer to power the target board to 5V, up to 200 mA, if the MPLAB programmer is connected to the PC.

### A.4 RS-232 SERIAL PORT

An RS-232, level-shifting IC has been provided with all the 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 debounced capacitors, where as S2 does not, allowing the user to investigate debounced techniques.

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

## A.6 OSCILLATOR OPTIONS

- 32.768 kHz (watch-type) crystal for Timer1.
- Space for a user defined canned crystal oscillator.
- Space for a user defined oscillator crystal.

## A.7 ANALOG INPUT

A 5 $\Omega$  potentiometer is connected through a series 470 $\Omega$  resistor to AN0.

The pot can be adjusted from VDD to GND to provide an analog input to the parts with an A/D module.

## A.8 ICD CONNECTOR

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

## A.9 PICKIT™ CONNECTOR

By way of the header connector (J11), the MPLAB PICKit can be connected for low-cost debugging.

## A.10 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<sup>2</sup>C™ compatible serial port. This device has an address of '0b1001101'.

## A.11 SERIAL EEPROM

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

## A.12 LCD

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

# PICDEM™ 2 Plus Demonstration Board User's Guide

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## A.13 SAMPLE DEVICES

A sample part programmed with a simple program is included in the PICDEM 2 Plus Demonstration Board kit. [Table A-1](#) lists the I/O features and port connections for each processor type.

**TABLE A-1: PORT CONNECTIONS**

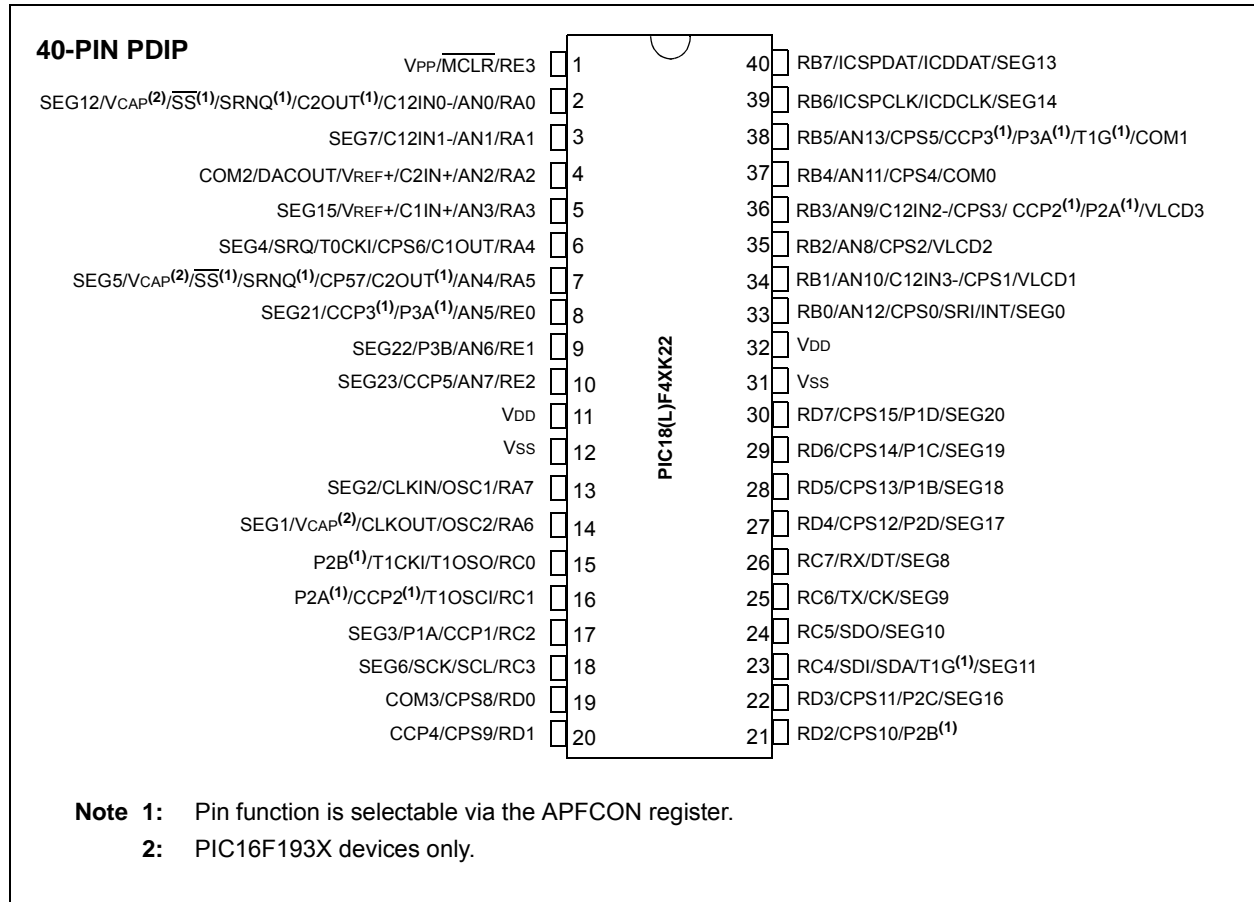
Device	LEDs	RS-232	S1	S2	S3	Pot R16	LCD	EEPROM	Buzzer	ICD	Temp Sensor	Y1/Y2
18-pin	RB3:RB0	N/A	$\overline{\text{MCLR}}$	RA4	RB0	RA0	N/A	N/A	N/A	RB6/RB7	N/A	Yes
28-pin	RB3:RB0	RC6/RC7	$\overline{\text{MCLR}}$	RA4	RB0	RA0	N/A	RC3/RC4	RC2	RB6/RB7	RC3/RC4	Yes
40-pin	RB3:RB0	RC6/RC7	$\overline{\text{MCLR}}$	RA4	RB0	RA0	RD6:RD4 RD3:RD0	RC3/RC4	RC2	RB6/RB7	RC3/RC4	Yes







**FIGURE A-3: PICDEM™ 2 PLUS PIC16F1937 PINOUT**



# PICDEM™ 2 Plus Demonstration Board User's Guide

FIGURE A-4: PICDEM™ 2 PLUS PIC18F86K22 PINOUT

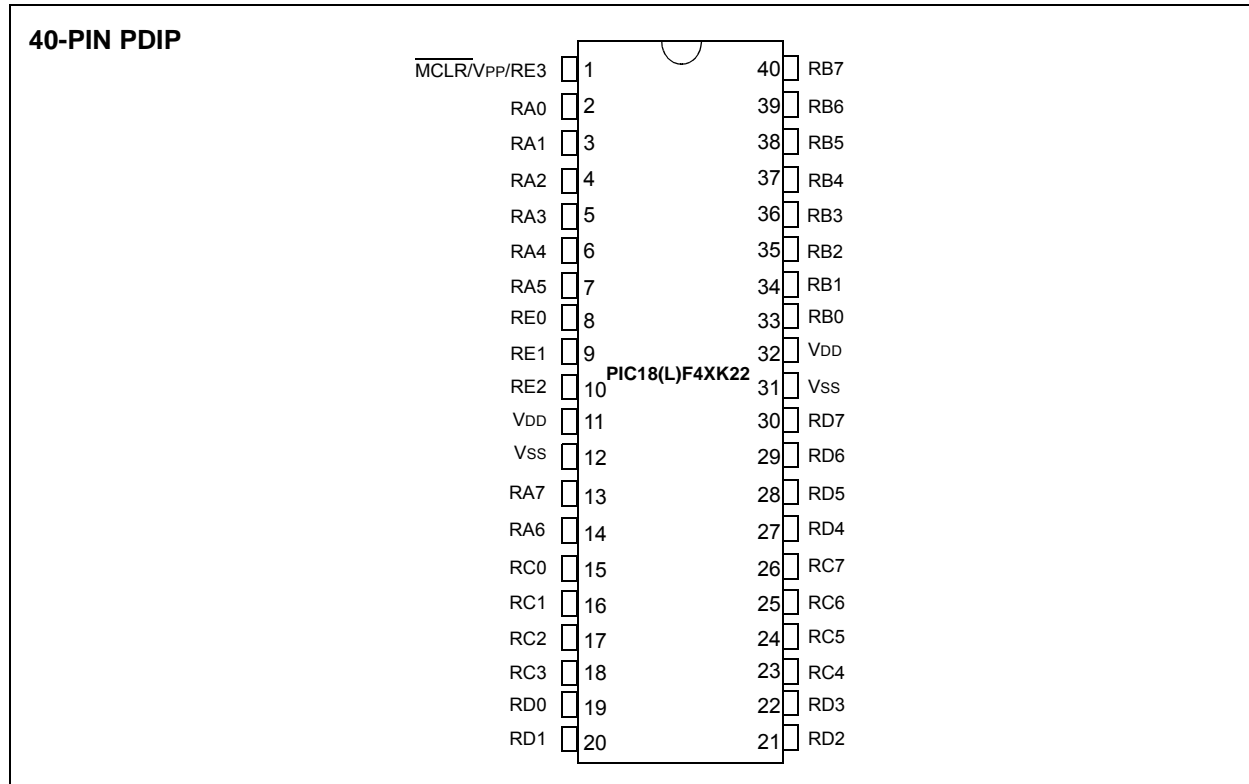
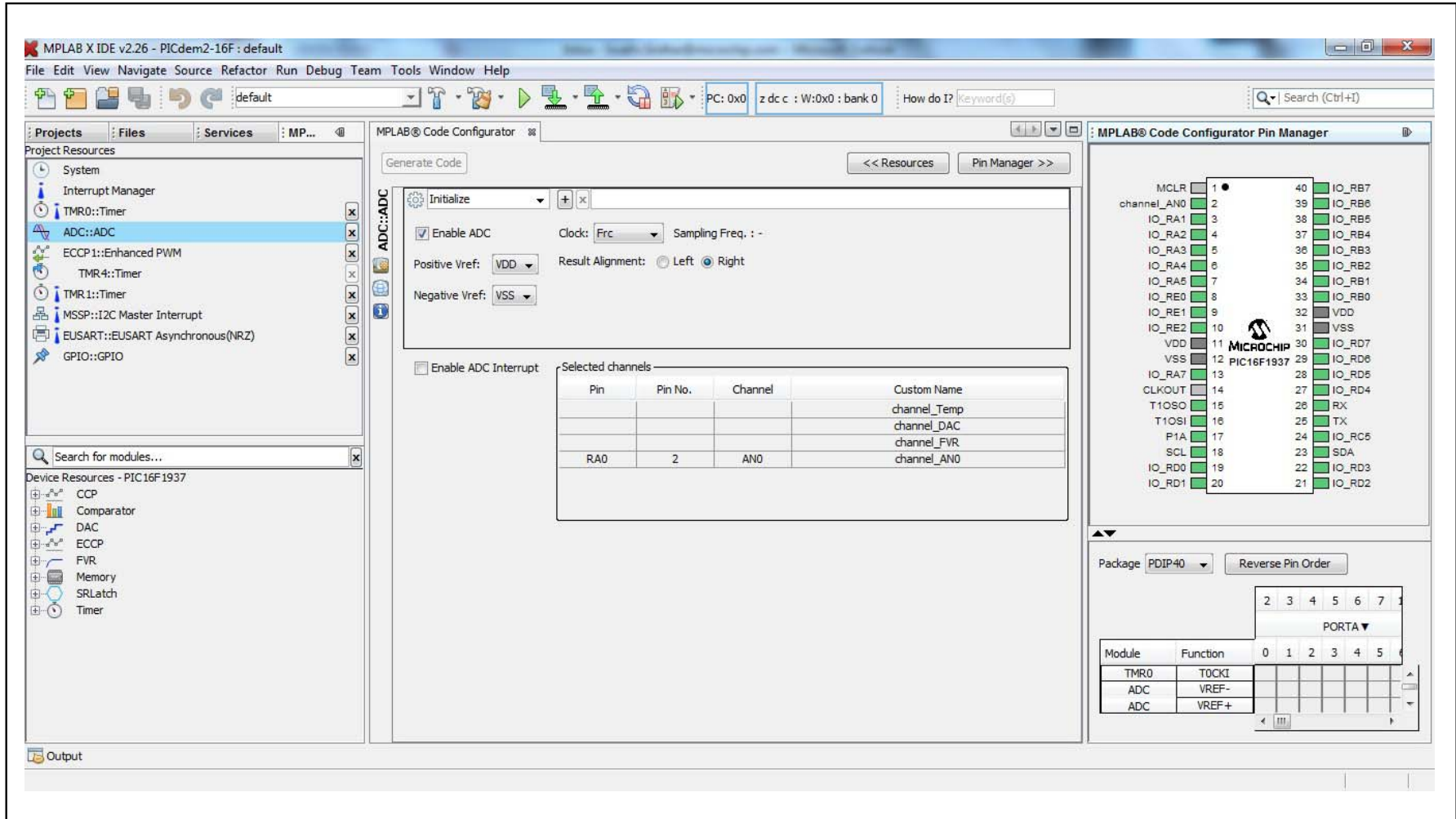


FIGURE A-5: MPLAB® X CODE CONFIGURATOR PLUGIN





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