PICDEM.net™ 2 Internet/Ethernet Development Board 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 website (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 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.net™ 2 Development Board. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

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

- **Chapter 1. "Introduction to the PICDEM.net 2 Development Board"** – Describes what the PICDEM.net 2 Development Board is and the features available on the board.
- **Chapter 2. "Getting Started with the PICDEM.net 2 Development Board"** – Describes how to connect and begin to use the PICDEM.net 2 Development Board.
- **Chapter 3. "Reconfiguring the PICDEM.net 2 Development Board"** – Provides instructions on changing hardware configuration and reconfiguring the network settings.
- **Chapter 4. "Troubleshooting"** – Provides information on solving common problems.
- **Appendix A. "PICDEM.net 2 Development Board Schematics, Rev. 6"** – Provides the schematic diagrams of the Development Board.

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
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	

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 on the Microchip website.

RECOMMENDED READING

This user's guide describes how to use the PICDEM.net 2 Development 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® X IDE installation directory. The Readme files contain updated information and known issues that may not be included in this user's guide.

PIC18F97J60 Family Data Sheet (DS39762)

Consult this document for detailed information on Microchip's first family of 8-bit microcontrollers with on-chip Ethernet capability. The reference information found in this data sheet includes:

- Device pinout and packaging details
- Device electrical specifications
- Device memory map
- List of peripherals included on the device
- Practical information on using the Ethernet interface module in connectivity solutions

ENC28J60 Data Sheet (DS39662)

Consult this document for detailed information on the non-microcontroller Ethernet interface. The reference information found in this data sheet includes:

- Device pinout and packaging details
- Device electrical specifications
- Device memory map
- Practical information on using the Ethernet interface module in connectivity solutions

Microchip Lightweight TCP/IP Stack for 8-Bit Microcontrollers (DS00001921)

This document describes the structure and the interface for the Microchip Lightweight TCP/IP stack library. It also provides a description of some of the codes used for the demo application. This application note is available at http://ww1.microchip.com/downloads/en/AppNotes/00001921A.pdf.

THE MICROCHIP WEBSITE

Microchip provides online support via our website at www.microchip.com. This website is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the website 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, listing of Microchip sales offices, distributors and factory representatives

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 website at: http://support.microchip.com.

DOCUMENT REVISION HISTORY

Revision A (September 2006)

Initial Release of this Document.

Revision B (June 2007)

Edits to **Section 1.3 “The Development Kit: What’s In The Box”**.

Revision C (April 2008)

Revised to refer to the Microchip TCP/IP Stack Help for software-specific documentation.

Revision D (April 2011)

Revised schematic and text references for the latest hardware version (v6), which adds auto-polarity detection circuitry and an EMI filter. (Refer to the latest version of “*PIC18F97J60 Family Data Sheet*” (DS39762) for more information on these hardware additions.)

- Deleted L1 1.5A, 60 Ohm Ferrite Bead
- Added L1, L3 300 mA, 120 Ohm Ferrite Beads
- Changed U3 to PIC18F97J60-I/PT (12x12x1 mm package)
- Added C53, C54 56 pF Capacitors
- Added U6, U7 Switches
- Added R53, R54 100K Resistors
- Change C19, C25, C30, C35 to 27 pF 5% Capacitors
- Changed the incorrect value of C34. The correct value is 1 μF.

Removed references to the accompanying software CD (not available with the latest version of the Development Board) and replaced with references to the product-specific area of the Microchip corporate website.

Revision E (October 2015)

Updated the document to refer to the new TCP/IP stack for XC8; Updated the Recommended Reading section; Updated sections in Chapter 1 and 2; Other minor corrections.

NOTES:

Chapter 1. Introduction to the PICDEM.net 2 Development Board

1.1 INTRODUCTION

The PICDEM.net 2 Development Board was created to allow developers to examine Microchip's latest available technology in embedded Ethernet and Internet solutions. Using the free Microchip TCP/IP Stack source code, developers can experiment with the preprogrammed Microchip TCP/IP Demo Application and learn how to integrate connectivity into their applications.

1.2 HIGHLIGHTS

This chapter covers the following:

- The Development Kit: What's In The Box
- The PICDEM.net 2 Development Board
- Development Kit Firmware

1.3 THE DEVELOPMENT KIT: WHAT'S IN THE BOX

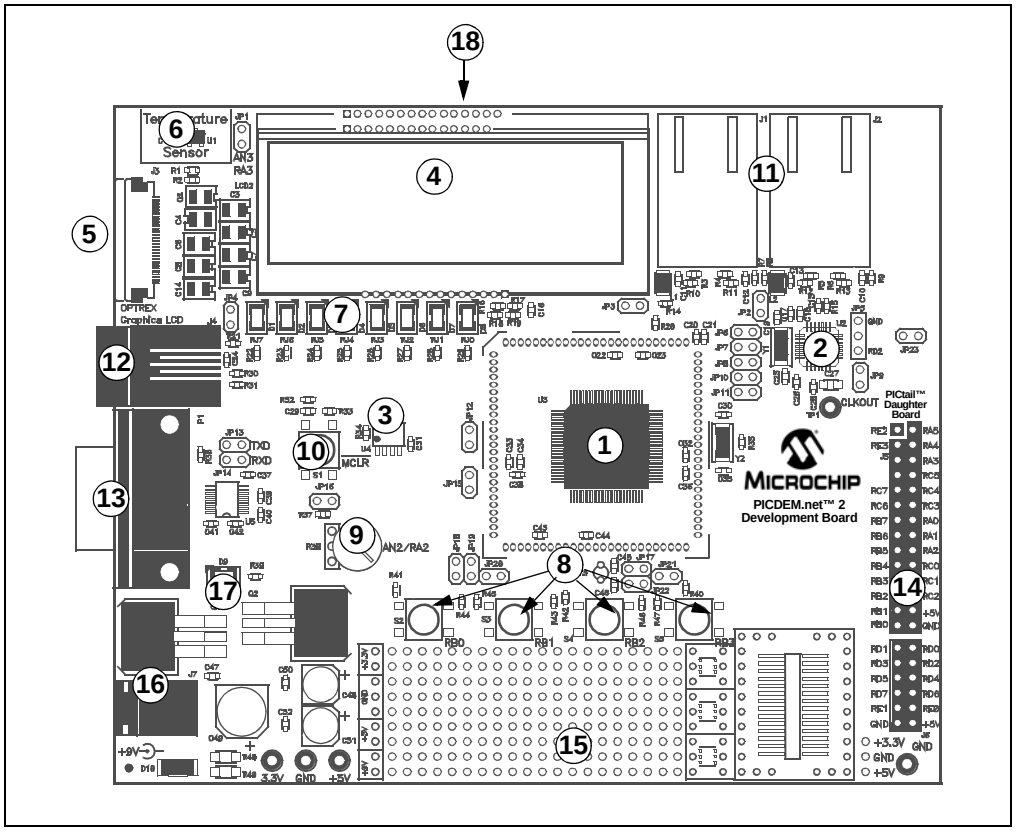
Your Development Kit contains the following items:

1. The PICDEM.net 2 Development Board
2. A standard CAT5 "straight-through" network cable for networking the board
3. A CAT5 "crossover" network cable for networking the board directly to a computer
4. An "Important Information" card
5. A warranty registration card

1.4 THE PICDEM.net 2 DEVELOPMENT BOARD

The PICDEM.net 2 Development Board has all the features to begin developing Internet connectivity applications over an Ethernet connection. The preprogrammed firmware allows users to begin evaluating the board right out of the box, with no additional programming or configuration. All that is required to begin exploring the board is a network-enabled computer with an Ethernet adapter and a DHCP server. (See **Chapter 2. "Getting Started with the PICDEM.net 2 Development Board"** for more specific information.)

FIGURE 1-1: PICDEM.net™ 2 DEVELOPMENT BOARD LAYOUT



Features on the PICDEM.net 2 Development Board include:

1. **Microcontroller:** A Microchip PIC18F97J60 microcontroller with built-in Ethernet controller and transceiver is directly installed on the board (U3). The device is clocked at 41.67 MHz and has been preprogrammed with demonstration firmware from the Microchip TCP/IP Stack. Jumpers, JP15 and JP3, can be used to measure the current consumption of the microcontroller.
2. **ETHERNET Controller:** In addition to the PIC18F97J60, the PICDEM.net 2 Development Board also features a Microchip ENC28J60 stand-alone Ethernet controller. This device provides Ethernet connectivity for microcontroller-based applications using a standard SPI interface.
3. **Memory:** A Microchip 25LC256 serial EEPROM (U4) provides 256 Kbits (32 Kbytes) of storage for both web pages and nonvolatile configuration options. The 25LC256 is programmable via an SPI interface.
4. **LCD Display:** A two-line by 16-character dot matrix display shows diagnostic and error messages with the factory programmed firmware. It may be used for other applications with appropriate reprogramming.

5. **Optional External LCD Connector:** Space is provided on the board for the installation of a 30-pin, bottom contact FFC edge connector (Hirose FH12-30S-0.5SH or equivalent). This will allow the use of an external LCD character display module (such as one of the Optrex™ F-51320 series) to the board via a ribbon cable. Note that using an external LCD module will require appropriate changes to the application code, as well as the use of a ribbon cable compatible with the connector.
6. **Temperature Sensor:** This analog temperature sensor, a Microchip TC1047 (U1), is connected to an analog I/O pin of the microcontroller. It can be disconnected by a jumper.
7. **User-defined LEDs:** Eight LEDs are driven by digital I/O pins of the controller (PORTJ) and may be used to simulate a digital output to an embedded device. They may also be enabled or disabled by jumper selection on the board.
8. **User-defined Push Buttons:** These switches are connected to digital I/O pins on the microcontroller (PORTB<3:0>) and may be used to simulate a digital input in an embedded application.
9. **User-defined Potentiometer:** One 5 kΩ potentiometer is connected to an analog I/O pin of the microcontroller. It can be used to simulate an analog input in an embedded application.
10. **Reset Push Button:** This switch is tied to the $\overline{\text{MCLR}}$ pin on the controller, and is used to reset the board.
11. **RJ-45 (10Base-T) Modular Connectors:** The PICDEM.net 2 Development Board is outfitted with two Integrated Connector Modules (ICMs), one each for the PIC18F97J60 and ENC28J60. These ICMs provide the modular jack, as well as the necessary transformers, EMI suppression and status LEDs, for Ethernet connectivity.

    Each ICM has its own ACTIVITY and LINK LEDs on the left and right sides of the ICM. These show if an Ethernet application is transmitting or receiving a packet, and if the Ethernet connection is active. The LEDs for the PIC18F97J60 (on J1) can be disconnected by jumpers if the I/O ports, RA0 and RA1, are to be used for another purpose.
12. **RJ-11 (SIX-WIRE) Modular Connector:** This allows the Development Board to be connected to Microchip MPLAB® ICD 2, MPLAB® ICD 3 or MPLAB REAL ICE™ in-circuit emulator for in-system programming, as well as advanced application debugging.
13. **Serial Port:** The PICDEM.net 2 Development Board includes an RS-232 port with a DB9 connector (P1) and appropriate level-shifting hardware (U5). This can be used for debugging or application development purposes, as needed.
14. **I/O and PICtail™ Daughter Board Access**: A pair of female risers (J5 and J6) allow direct access to five of the microcontroller's I/O ports (PORTA through PORTE). The even pins of J5 also serve as a standard interface between the PICDEM.net 2 Development Board and Microchip's PICtail daughter board series.
15. **Prototype Area:** A 9x20 grid with through-holes is provided for users to breadboard additional circuitry for development. Three SOT-23 pads and a SOIC-28 footprint are also provided for surface mounting common components. Connections are provided for +3.3 VDC, +5 VDC, +9 VDC and ground.
16. **On-board Power:** Two on-board regulators provide separate 5 VDC and 3.3 VDC at 500 mA common current from the 9 VDC supplied at J7.
17. **Power-on LED:** This LED (D9) shows the board is powered up.

18. **ETHERNET ID Stickers (back side):** The numbers on the two stickers are used to form the unique Media Access Control (MAC) addresses used by the Ethernet transceivers to identify and filter packets. The number is the base 10 version of the last six hexadecimal digits of the 12-digit MAC address. The board's full address is formed by appending the number on the sticker to the hex prefix "00:04:A3" (Microchip's MAC address prefix). For example, the sticker number, "12345", represents 003039h; the full MAC address for the board is thus "00:04:A3:00:30:39".
    One of these is assigned to the PIC18F97J60 and the other to the ENC28J60. These MAC addresses are provided for evaluation purposes; both addresses can be changed in software. The default MAC address used in the firmware is 00:DE:AD:00:BE:EF.

1.5 DEVELOPMENT KIT FIRMWARE

The firmware used in this Development Board is the Microchip Lightweight TCP/IP Stack for 8-bit microcontrollers, which is available on the Microchip website:

http://www.microchip.com//wwwAppNotes/AppNotes.aspx?appnote=en573940

This firmware includes:

- The complete source code, hex files and libraries for the free Microchip TCP/IP Stack Demo Application
- Example applications for use with PIC18F97J60 and ENC28J60 devices: TCP Client and Server implementation, and UDP Client and Server implementation.
- The Demo GUI Java application used to communicate with the board

Chapter 2. Getting Started with the PICDEM.net 2 Development Board

2.1 HIGHLIGHTS

This chapter will cover the following topics:

- Network Precautions: Before You Start
- Connecting the PICDEM.net 2 Development Board
- Running the TCP/IP Stack Demos

2.2 NETWORK PRECAUTIONS: BEFORE YOU START

The PICDEM.net 2 Development Board, provided in your kit, is designed to demonstrate the possibilities of networking with embedded Microchip controllers over Ethernet and the Internet. As with any experimental system, however, some precautions are in order before you start.

Whenever new hardware or software is added to a network, it is always advisable to create a separate test network that is isolated from your LAN. This allows testing the new system in a controlled environment and minimizes the possibilities of network interference from the new equipment. The major sources of potential interference include:

- **Addressing** – Each device on the network must have a unique address. If Dynamic Host Configuration Protocol (DHCP) is in use, the PICDEM.net 2 Development Board will automatically acquire a valid IP address. If DHCP is not used, or a fixed address is required, adding the board to the network without assigning an address may create network conflicts.
- **Traffic Levels** – While the on-board Ethernet controller will filter out unwanted messages, a highly loaded network with many broadcast messages may place a sizable burden on the Development Board.
- **Data Security** – Although it is unlikely that the addition of a single device will compromise the integrity or privacy of sensitive information, it is always a good idea to perform extensive testing with new equipment before adding it to a secure network.
- **Experimentation** – Even as a simple microcontroller-based device, the Development Board is capable of generating a high volume of network traffic which may severely disrupt normal network operations.

2.3 CONNECTING THE PICDEM.net 2 DEVELOPMENT BOARD

There are two basic network configurations for the PICDEM.net 2 Development Board: direct connection to a network and a connection to a host computer through a crossover cable.

If you are connecting the Development Board to a DHCP-enabled network, follow the steps in **Section 2.3.1 "Connecting to a Network"**.

If you are connecting the board directly to a host computer, follow the steps in **Section 2.3.2 "Connecting Directly to a Host System"**.

All of this assumes that the Development Board is running the preprogrammed Demo Application firmware. The general principles for hardware discussed in the following sections still apply for other applications and may be used as a guideline.

Note: This section assumes that an Ethernet card has already been installed in the host system and is working properly, and that the TCP/IP protocol has been installed and bound to the card. If this has not been done, or if you are uncertain if this has been done, please contact your Information Systems support person for further assistance.

2.3.1 Connecting to a Network

This configuration is the basic method of networking the PICDEM.net 2 Development Board. This assumes there is a stable Ethernet network using TCP/IP for communications and that at least one DHCP server is present on the network.

To set up the board for direct networking (see Figure 2-1):

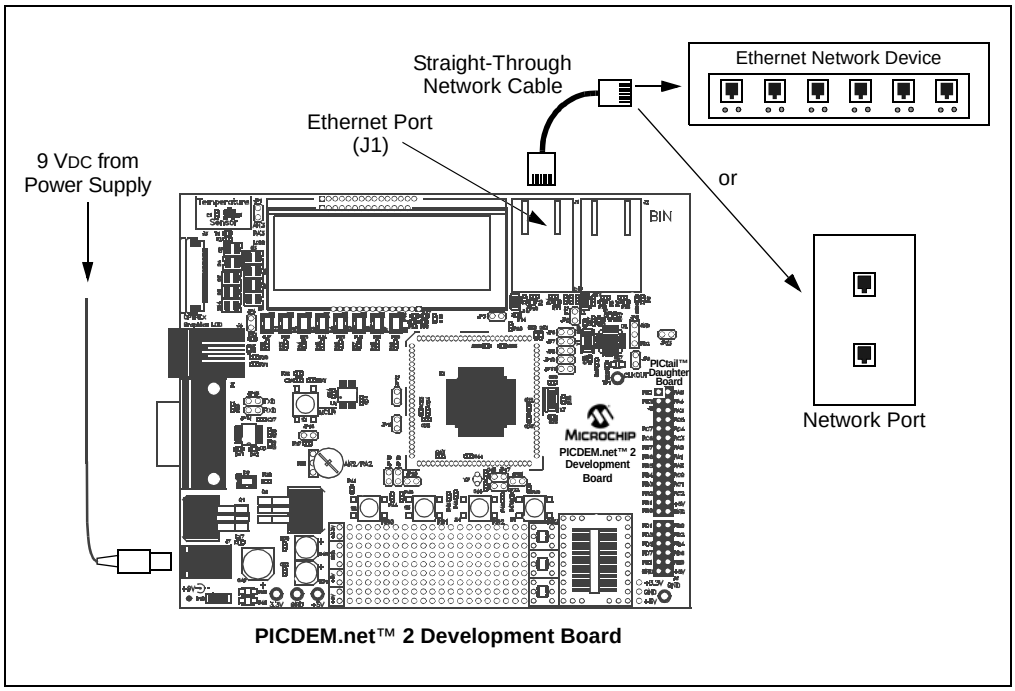
1. Unbox and unwrap the board, and set it on a non-conductive surface near the host computer.
2. Connect the straight-through Ethernet cable to the board at Ethernet connector, J1, then to the Ethernet network. This can be at a network port or an available port on a network device (such as a hub, switch or router).

Note: Do NOT use the provided crossover cable if you are directly connecting the board to a network or network device. The crossover cable is intended only for connecting the board directly to a computer.

3. Apply power to the board (9 VDC) at J7.

Note: The Development Kit does not include a power supply. An unregulated 2.5 mm center-positive DC supply of 7V to 12V (preferably 9V) with a current capability of 500 mA is sufficient. If an external supply is needed, use either Microchip part number AC002014 or AC162039.

FIGURE 2-1: CONNECTING THE PICDEM.net 2™ DEVELOPMENT BOARD TO A NETWORK



2.3.2 Connecting Directly to a Host System

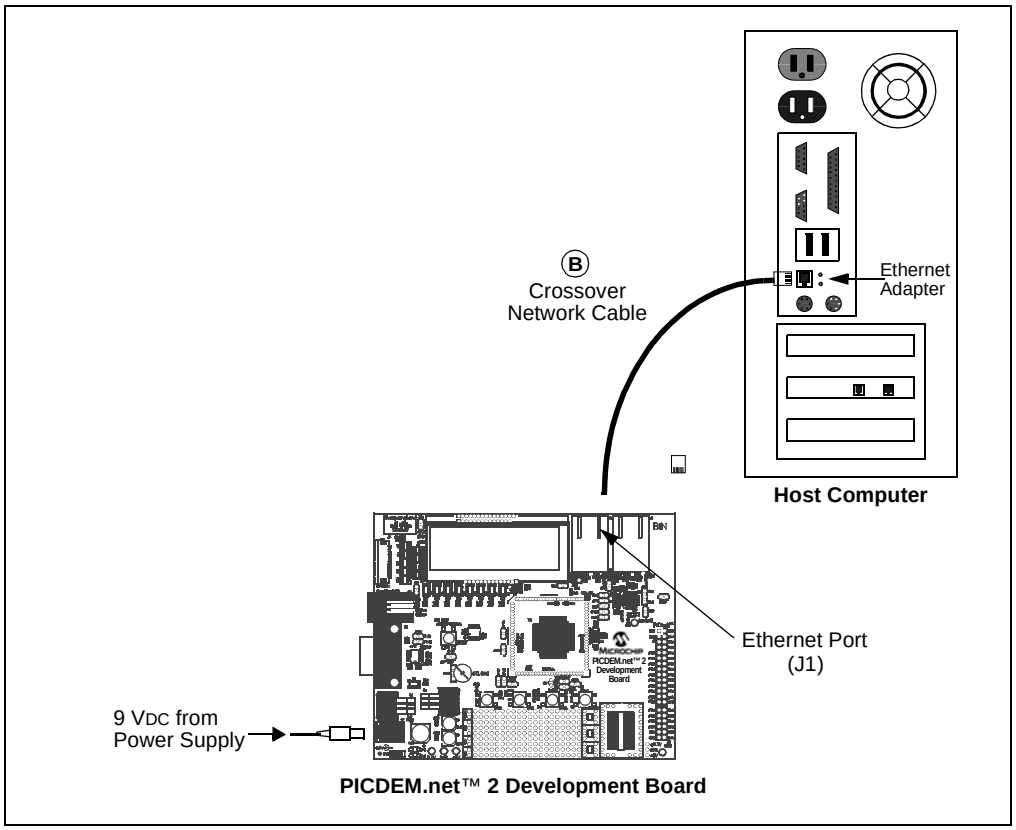
This option is used under the following situation:

- Operation on an isolated network is desired or
- Connection to a deployed network is not possible.

To set up the board for connection to a local host (see Figure 2-2):

1. Unbox and unwrap the board, and set it on a non-conductive surface near the host computer.
2. Connect the Ethernet crossover cable (supplied in the kit) to the board, then to the computer.
3. Apply power to the board (9 VDC) at J7. (See **Section 2.3.1 "Connecting to a Network"** for power supply requirements.)
4. On the host computer, go to *Start > Control Panel > Network and Internet > Network and Sharing Center* and then click the **Change adapter settings** on the left side of the window.
5. Right-click the adapter connected to the Internet and click **Properties**.
6. Go to **Sharing** tab and then select the **Allow other network users to connect through this computer's Internet connection** checkbox.
7. In the Home networking connection section, click the **Select a private network connection** combo box and select the Local Area Connection where the PICDEM.net 2 Board is connected.
8. Click **OK**.

FIGURE 2-2: CONNECTING TO A HOST SYSTEM THROUGH A DIRECT CONNECTION



2.3.3 Confirming Operation

Once the PICDEM.net 2 Development Board is properly connected and powered up, you should see all of the following:

- The Power-on LED (D9) is lit
- The green LINK LED on J1 is lit
- The LCD display shows the IP address:

  X.X.X.X

  where "**X.X.X.X**" is the IP address currently in use by the board. This address is assigned automatically by the DHCP server.

If your board does not show all of these things, check all connections with the power supply and the board. For additional assistance, refer to **Chapter 4. "Troubleshooting"**.

2.4 RUNNING THE TCP/IP STACK DEMOS

2.4.1 Required Hardware and Software

The following hardware and software are needed to run the TCP/IP stack demo code:

1. PICDEM.net™ 2 Board
2. External 9V Power Supply
3. Lightweight Microchip TCP/IP Stack Demo Code
4. Microchip TCP/IP Demo GUI Java Application
5. MPLAB® X v2.35 or later
6. MPLAB® XC8 Compiler v1.33 or later
7. Microchip Debugger/Programmer (e.g., MPLAB ICD 3, MPLAB REAL ICE)
8. Windows®, Linux®, or Mac OS® computer
9. DHCP Server
10. Ethernet Cables:
    - Straight-through – if the board is connected directly to a network (router/ switch)
    - Crossover – if the board is connected directly to a computer

2.4.2 Setting up the Hardware

1. Connect the PICDEM.net 2 Board (via J1 connector) on an Ethernet network using an Ethernet cable.
2. Connect the external power supply to the PICDEM.net 2 Board via J7 connector.
3. Connect the Microchip Debugger/Programmer to the PICDEM.net 2 Board via J4 connector
4. For the next steps, refer to the succeeding sections for each demo code.

2.4.3 Running the Demo Applications

2.4.3.1 TCP SERVER IMPLEMENTATION

This demo starts a TCP echo server on the PICDEM.net 2 Board and will wait for any incoming connections on port 7. The server will echo back all the received data once the connection on the client is established.

1. Load the `tcpServerDEMO.X` project in MPLAB® X.
2. Program the PICDEM.net 2 Board.
3. An IP address will appear on the LCD of the board (See Figure 2-3). This address will be used by the client to connect on the server running on the board.
4. Start the `TCPIP_Demo.jar` application on the computer.
5. Go to the **TCP Client Demo** tab.
6. Type the IP address shown on the PICDEM.net 2 Board's LCD to the Server IP Address and set the Port to 7.
7. Click the **Connect** button and a message in the Status window will appear confirming that the board is connected (See Figure 2-4).
8. Type a message in the Send window and press the **Send** button. Both sent data (in green) and received data (in blue) will appear in the Sent/Received Data window (See Figure 2-4).
9. To enable the generation of TCP traffic to the board, click the **ECHO Back Received Message** button. Type a text in the Send window and press the **Send** button to start the data exchange (See Figure 2-5). Click again the **ECHO Back Received Message** button to stop the TCP traffic.
10. Click the **Disconnect** button to close the TCP connection. A Connection Closed message will appear in the Status window (See Figure 2-6).

FIGURE 2-3: PICDEM.net™ 2 IP ADDRESS

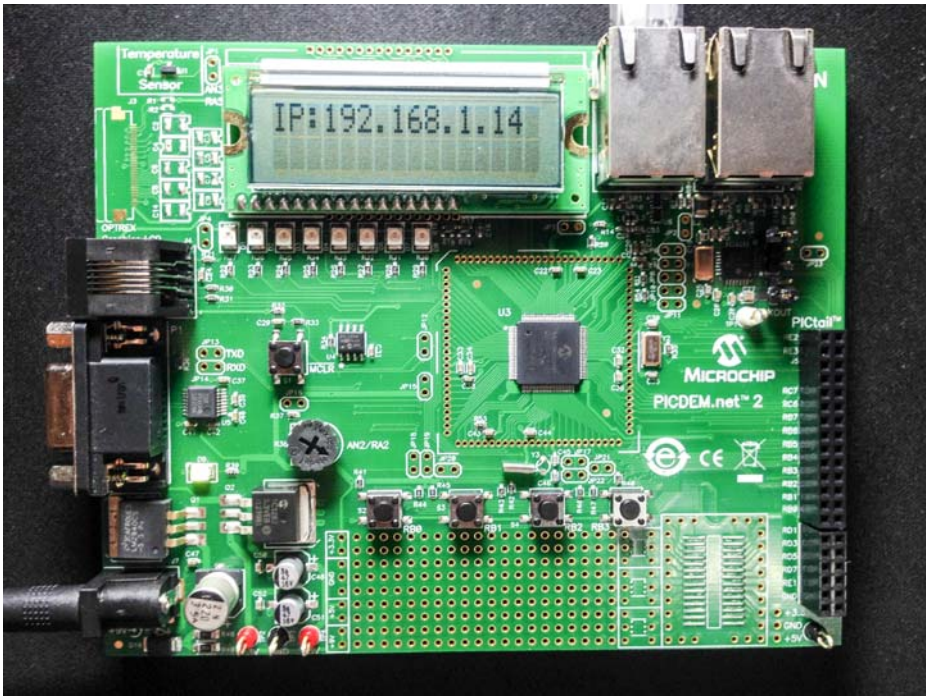


FIGURE 2-4: CONNECTION STATUS AND SENT/RECEIVED DATA

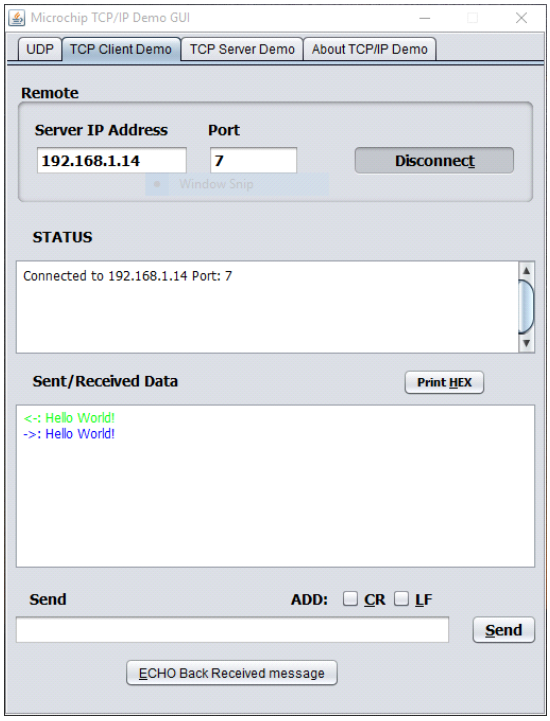


FIGURE 2-5: GENERATING TCP TRAFFIC

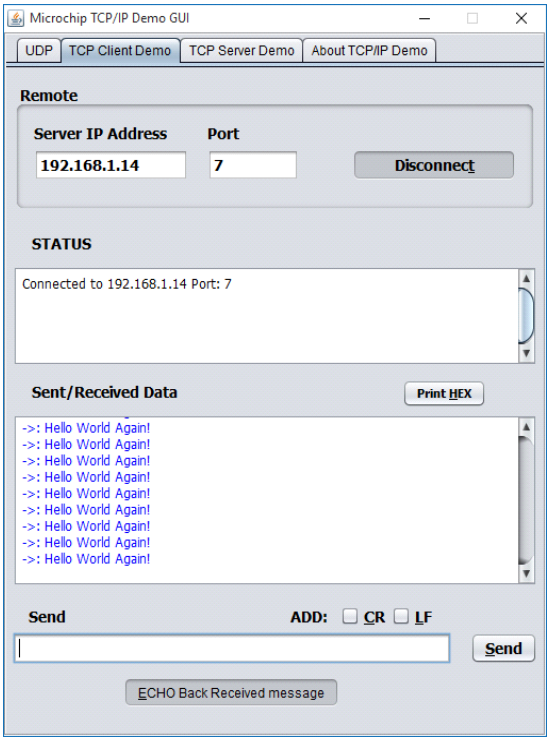
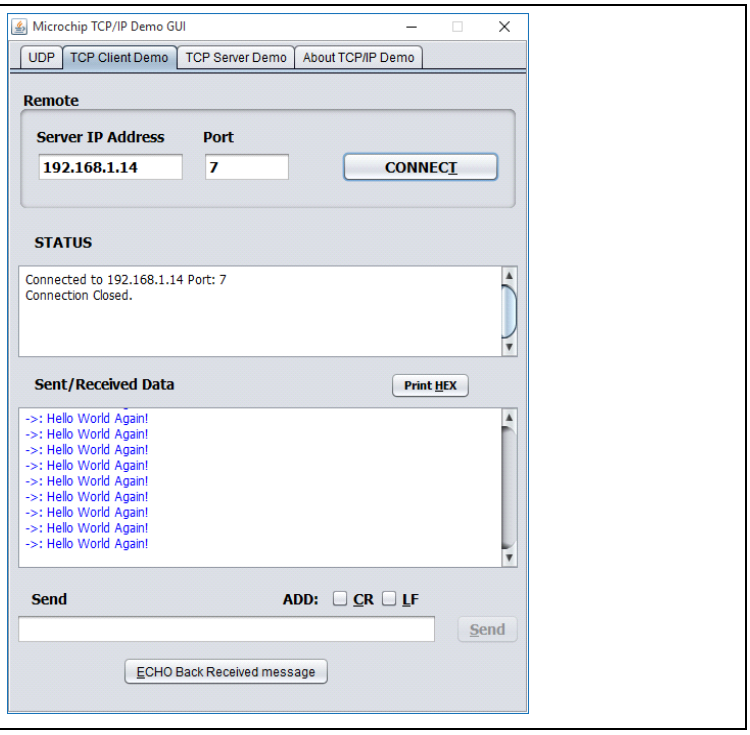


FIGURE 2-6: CONNECTION CLOSED



2.4.3.2 TCP CLIENT IMPLEMENTATION

This demo implements a TCP client on the PICDEM.net 2 Board that will connect to a server running on a computer on port 60. The client will begin sending packets to the server every two seconds once a connection is established. These packets contain temperature reading, potentiometer value, buttons and LED status. Using the Java application on the server, the user can send messages that will be printed on the second line of the PICDEM.net 2 Board's LCD, and control the LEDs on the board using the buttons on the LED Control Window.

1. Find the IP address of the computer where the `TCPIP_Demo.jar` application is running.
2. Load the `tcpClientDEMO.X` project in MPLAB® X.
3. Open the `main.c` source file and go to the line with the code `remoteSocket.addr.s_addr = MAKE_IPV4_ADDRESS(192,168,1,9);`
4. Change the parameter of `MAKE_IPV4_ADDRESS()` with the IP address found in Step 1.
5. Program the PICDEM.net 2 Board.
6. An IP address will appear on the LCD of the board. This address will be used by the client to connect to the server running on the board.
7. Start the `TCPIP_Demo.jar` application on the computer.
8. Go to the **TCP Server Demo** tab.
9. Go to the Server window and change the Local Port to 60.
10. Click the **Listen** button and a message in the Status window will appear confirming that the board is connected (See Figure 2-7).
11. Data from the board such as temperature reading, potentiometer value, buttons and LED status are automatically shown in the Sent/Received Data window (See Figure 2-7). These values are in hexadecimal format.

12. Type anything in the Send window and press the **Send** button. The sent data (in green) will appear in the Sent/Received Data window and will also be displayed on the board's LCD (See Figure 2-8).
13. Click different LED buttons in the LED Control window to turn on and off the LEDs on the board (See Figure 2-8).
14. Press the **Disconnect** button to close the TCP connection. A Server Closed and Client Disconnected message will appear in the Status window. (See Figure 2-9).

FIGURE 2-7: CONNECTION STATUS AND SENT/RECEIVED DATA

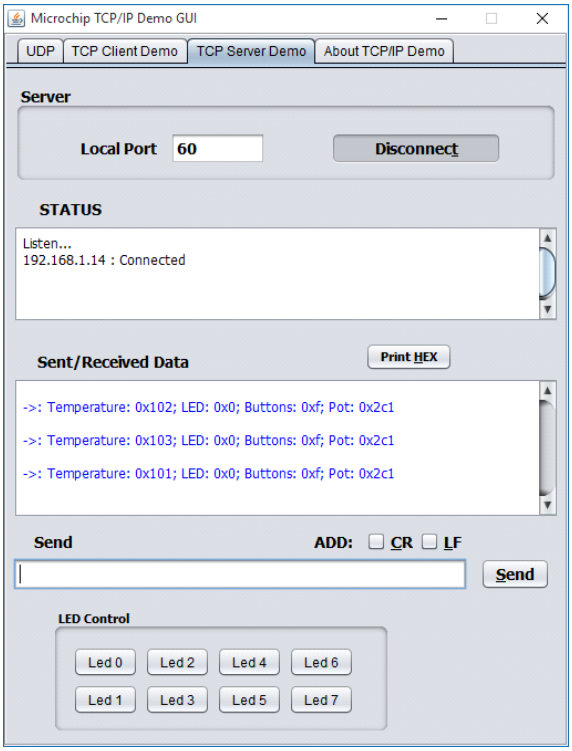


FIGURE 2-8: SENDING DATA AND CONTROLLING THE LEDs

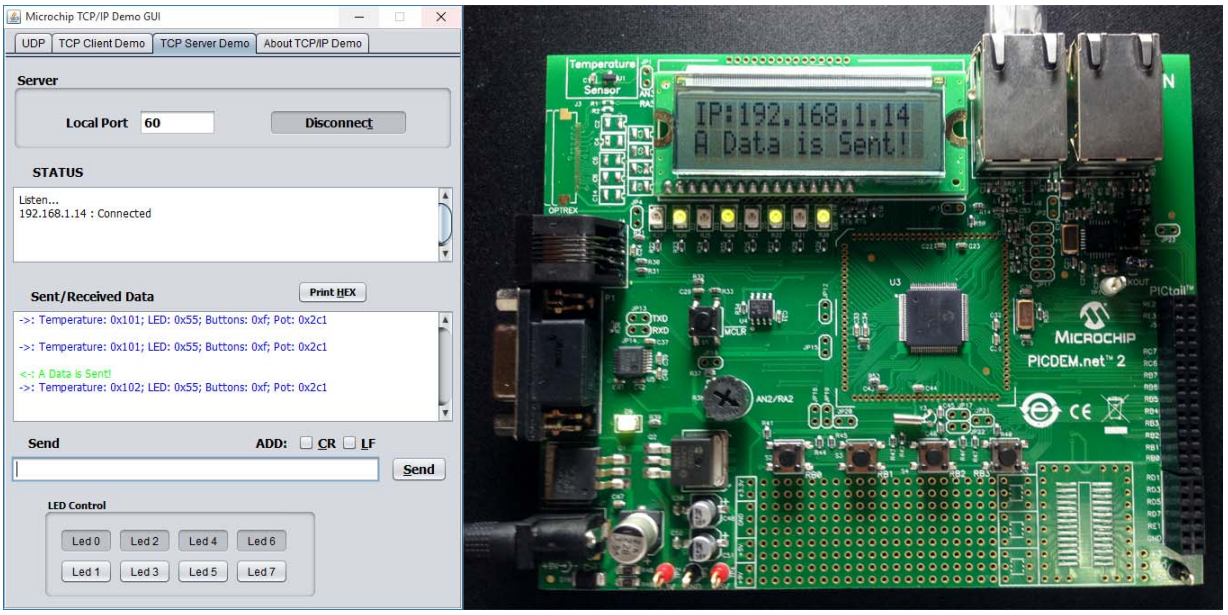
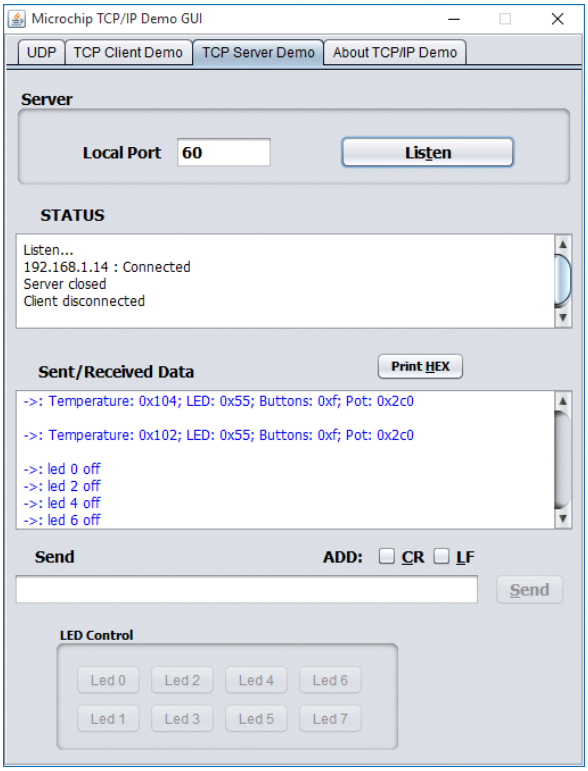


FIGURE 2-9: SERVER CLOSED, CLIENT DISCONNECTED



2.4.3.3 UDP SERVER AND CLIENT IMPLEMENTATION

This demo consists of UDP Send (UDP Client) and UDP Receive (UDP Server) implementations. As UDP Send, the PICDEM.net 2 Board sends the potentiometer value and temperature readings as UDP packets. As UDP Receive, the PICDEM.net 2 Board listens to any incoming UDP packets, such as toggle LEDs and display data on LCD on port 65531. The port numbers can be anything between 49152 and 65535.

1. Load the `udpDEMO.X` project in MPLAB X.
2. Program the PICDEM.net 2 Board.
3. Start the `TCPIP_Demo.jar` application on the computer.
4. Go to the **UDP** tab.
5. Set the Port number to 65531 and click the **Listen** button to start a UDP connection on port 65531.

Note: Make sure the `DEST_PORT` in the `udp_demo.h` file and the port number entered in the Microchip TCP/IP Demo GUI are the same.

6. The TCP/IP Demo application will start listening for UDP packets on port 65531. The IP addresses of the devices which are on the network are displayed in the Destination IP Address window.
7. Select an IP address in the Destination IP Address window and click the **Connect** button.
8. Click the **Connect** button and a message in the Status window will appear confirming that the board is connected (See Figure 2-10).
9. Turn the potentiometer on the board. This allows the board to send UDP packets to display the potentiometer value (See Figure 2-10).
10. Click the **Temperature** button to allow the board to send UDP packets to display the ambient temperature reading in Fahrenheit (See Figure 2-10).
11. Click on any of the **LED buttons** and type a message in the text box then press the Send button. This allows the board to receive UDP packets from the PC (See Figure 2-11).
12. Click the **Disconnect** button to close the UDP connection.

FIGURE 2-10: PICDEM.net™ 2 BOARD SENDING UDP PACKETS

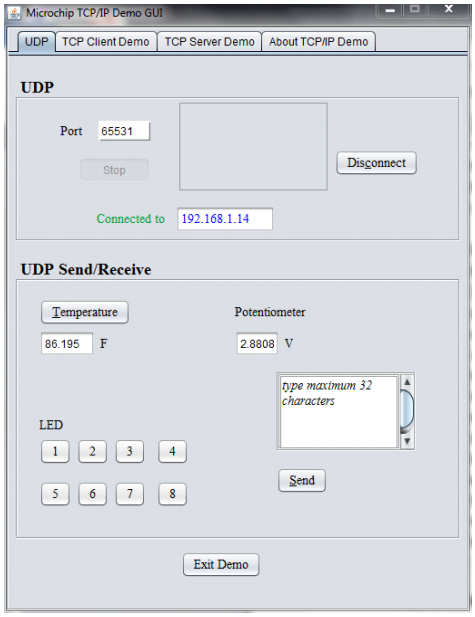
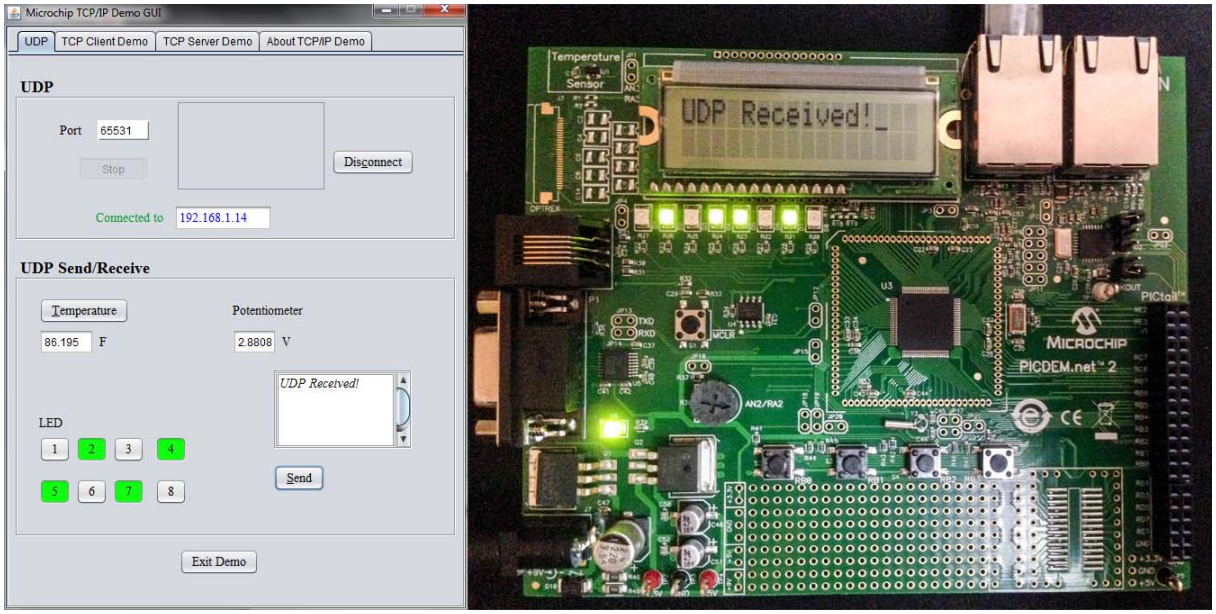


FIGURE 2-11: PICDEM.net™ 2 BOARD RECEIVING UDP PACKETS



Chapter 3. Reconfiguring the PICDEM.net 2 Development Board

3.1 HIGHLIGHTS

This chapter covers the following:

- Reconfiguring the PICDEM.net 2 Development Board Hardware

3.2 RECONFIGURING THE PICDEM.net 2 DEVELOPMENT BOARD HARDWARE

The PICDEM.net 2 Development Board is provided with a range of hardware features for manual interaction, as well as a choice of two Ethernet interfaces. In its original state, the main port (J1) is active and all interactive options are enabled. To allow the greatest amount of hardware flexibility in developing new applications, users can change any or all of these configuration options to suit the needs of their application.

3.2.1 Configuring the Hardware Options

The Development Board can be configured to enable or disable its various hardware features. A total of 23 jumper locations are provided in various places around the board. As shipped from the factory, all of the locations are bridged by circuit traces, and all of the features are enabled (with the exception of JP9, discussed below). To change this, the user will need to cut the traces, and install pins and block jumpers. Afterwards, the features can be enabled or disabled easily by installing or removing the jumpers.

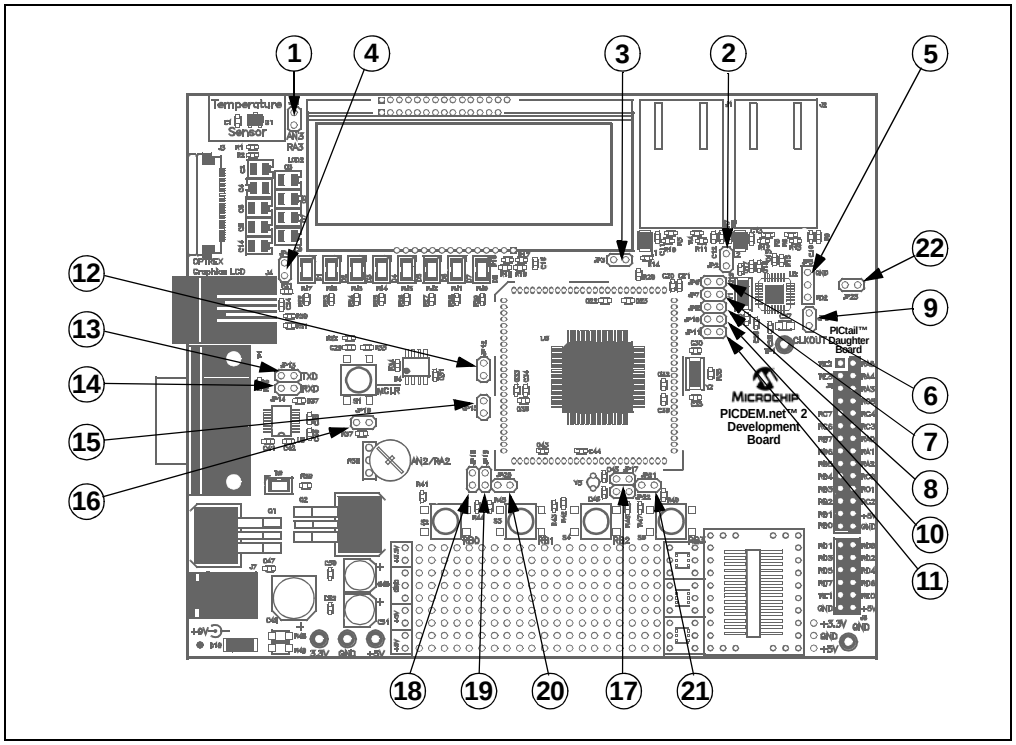
In some instances, a single function (such as the USART) is connected to the rest of the board through more than one jumper. This allows selective tailoring of the controller's I/O ports to any application that the user may develop. Specific cases are discussed in the following sections.

The functions of the jumpers are listed in Table 3-1; their locations are shown in Figure 3-1.

TABLE 3-1: JUMPER DESCRIPTIONS

Number	Board ID(s)	Type	Description
1	JP1	Bridge	U1 (temperature sensor) to RA3
2	JP2	Bridge	J2 Power (ENC28J60 Ethernet jack)
3	JP3	Bridge	J1 Power (PIC18F97J60 Ethernet jack)
4	JP4	Bridge	LED Bank (D1 through D8)
5	JP5	2-Way	Select ENC28J60 Reset Control (RD2) or Device Disable
6	JP6	Bridge	J1 Ethernet Activity LED Enable (LEDA)
7	JP7	Bridge	RA0/LEDA to PICtail™ Daughter Board Header
8	JP8	Bridge	J1 Ethernet Link LED Enable (LEDB)
9	JP9	Bridge	ENC28J60 $\overline{INT}$ to RB0 (**normally open**)
10	JP10	Bridge	RA1/LEDB to PICtail Daughter Board Header (LEDB)
11	JP11	Bridge	ENC28J60 Power
12	JP12	Bridge	U4 (EEPROM) SPI Chip Select to RD7
13	JP13	Bridge	USART Transmit (microcontroller perspective)
14	JP14	Bridge	USART Receive (microcontroller perspective)
15	JP15	Bridge	PIC18F97J60 Power
16	JP16	Bridge	R38 (potentiometer) to RA2
17	JP17, JP22	Bridge	Y3 (Timer1 oscillator)
18	JP18	Bridge	S2 (RB0 user-defined push button)
19	JP19	Bridge	S3 (RB1 user-defined push button)
20	JP20	Bridge	S4 (RB2 user-defined push button)
21	JP21	Bridge	S5 (RB3 user-defined push button)
22	JP23	Bridge	ENC28J60 SPI Chip Select to RD3

FIGURE 3-1: JUMPER LOCATIONS ON THE DEVELOPMENT BOARD



3.2.1.1 USER-DEFINED CONTROLS AND THE LED BANK

The potentiometer and the user-defined push buttons are each connected to the PIC18F97J60 through their own individual jumpers. They may be selectively disabled to allow individual ports to become available for general I/O purposes.

The LED bank (D1 through D8) is enabled as a group with one jumper (JP4).

3.2.1.2 TIMER1 OSCILLATOR (Y3)

By default, ports, RC0 and RC1, are configured for use by the Timer1 oscillator. An appropriate oscillator circuit, including Y3, C45 and C46, is connected across these pins. Removing jumpers, JP17 and/or JP22, disconnects the circuit and makes one or both pins available as I/O ports.

3.2.1.3 ETHERNET LEDs

As shipped, the PICDEM.net 2 Development Board uses pins, RA0 and RA1, of the microcontroller to drive the Ethernet LEDs in J1, generically known as LEDA (the Activity LED) and LEDB (the Link LED). These signals are also present on RA0 and RA1 of the PICtail Daughter Board header. Jumpers, JP6, JP7, JP8 and JP10, are used to connect or disconnect the microcontroller from either the LEDs or the header, or from both. This is useful in situations when RA0 and RA1 are being used as general I/O pins and are not needed for network indication.

3.2.1.4 ENC28J60 OPERATION

The Reset state of the ENC28J60 controller is determined by jumper, JP5. There are three possible configurations:

- RD4 (1-2 bridged): The $\overline{\text{RESET}}$ pin is tied to RD4 of the PIC18F97J60. This allows the microcontroller to execute hardware Resets of the ENC28J60 and use it as an external Ethernet transceiver.
- Disabled (2-3 bridged): The $\overline{\text{RESET}}$ pin is tied to ground, holding the ENC28J60 in permanent Reset and effectively disabling it.
- Open (no jumper): The $\overline{\text{RESET}}$ pin is disconnected, preventing hardware Resets but still allowing software device Resets from the SPI bus. This setting also allows the PIC18F97J60 to use the ENC28J60 as an Ethernet transceiver.

By default, JP5 is configured as “Open” (no jumper).

3.2.2 Using the ENC28J60 as the Ethernet Interface

As shipped, the Development Board uses the Ethernet interface module on the PIC18F97J60 controller for network connectivity. In this state, J1 is the only active Ethernet port; J2 is not functional.

It is possible to configure the board to bypass the microcontroller’s on-chip Ethernet module and use the ENC28J60 interface for connectivity. All of the necessary circuit connections on the board have already been made. The main factor preventing the ENC28J60 from being used is that the preprogrammed Microchip TCP/IP Demo Application has been designed to use the microcontroller’s on-chip Ethernet module.

To use the ENC28J60, do the following steps:

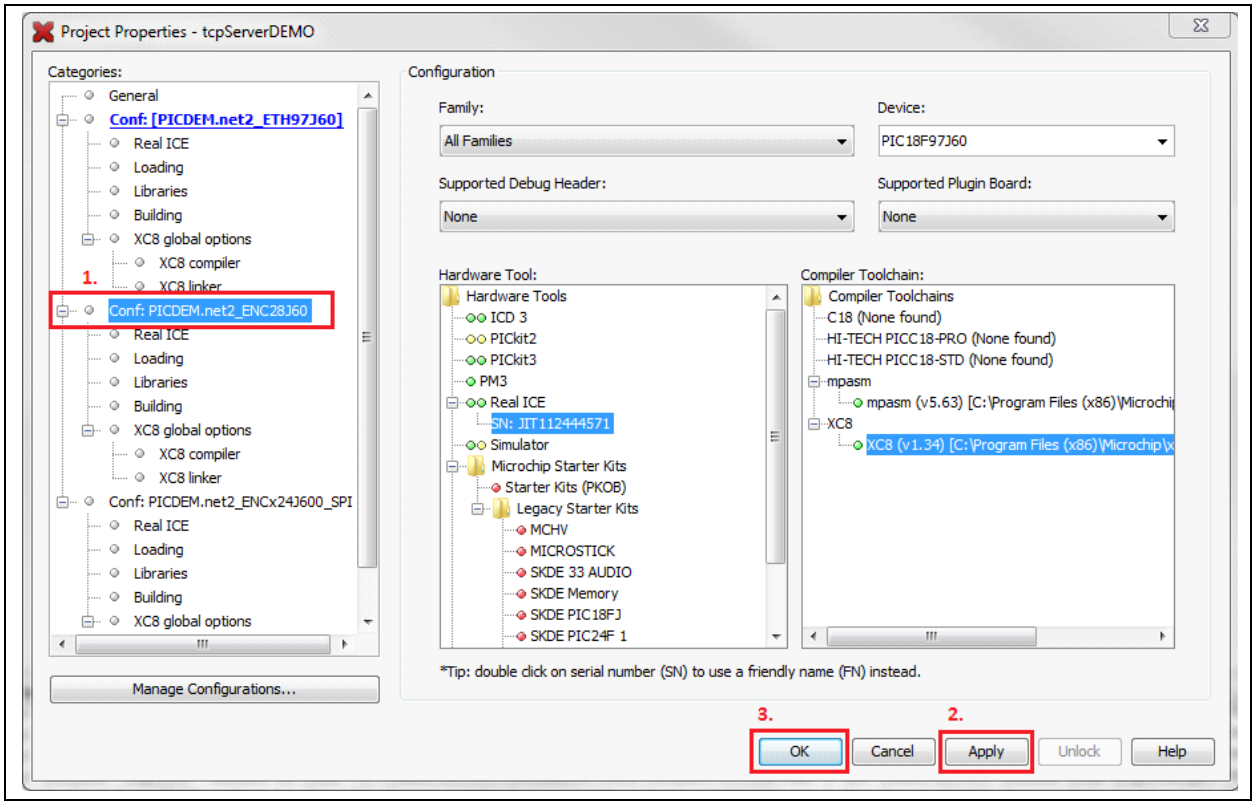
3.2.2.1 HARDWARE SETUP

1. Connect the Ethernet cable on J2 (the RJ45 socket on the right side of the board).
2. Close JP9 by using a jumper.
3. Apply an external 9V power source to the board via J7.

3.2.2.2 SOFTWARE SETUP

1. Load one of the projects in MPLAB® X.
2. Right click on the project name then choose Properties.
3. In the Project Properties window, select Conf: PICDEM.net2_ENC28J60. Click **Apply** and then **OK** (See Figure 3-2).

FIGURE 3-2: USING ENC28J60 AS THE ETHERNET INTERFACE



Chapter 4. Troubleshooting

4.1 HIGHLIGHTS

This chapter will cover the following operational issues and how to resolve them:

- Common Issues

4.2 COMMON ISSUES

1. **The Link LED on the active Ethernet ICM is not lit or only lights intermittently.**

   Check the board for power:

   - Verify that the power supply is plugged in and the wall outlet has power.
   - Check that voltage is available (9 V_{DC}) at the barrel plug.
   - Check that the regulated voltages (3.3 V_{DC} and 5 V_{DC}) are available at the connectors at the prototype area of the board.

   Make sure that the microcontroller is programmed correctly.

   Verify that the Ethernet cable is connected to the proper ICM for the firmware being used.

   Verify the connection between the board and the network or local host.

   Verify that the correct Ethernet cable is being used:

   - When the Development Board is directly connected to the host system, a crossover cable must be used.
   - When the Development Board is connected to the host system through a network device (such as a hub or switch), a "straight-through" cable must be used.

   Note: If you suspect that one of the Ethernet cables supplied with the kit is damaged, be certain to replace it with the same type of cable (either straight-through or crossover). An Ethernet straight-through cable may not work if the Development Board is directly connected to a host system.

2. **The LCD does not display a message when power is applied to the PICDEM.net 2 Development Board.**

   Check the board for power (see Issue 1, above).

   If the board functions normally otherwise (including connectivity to the host system), the LCD display itself may be faulty. Contact Customer Service for additional assistance.

3. **The PICDEM.net 2 Development Board does not communicate with the host system.**

   Verify that the correct Ethernet cable is being used:

   - When the Development Board is directly connected to the host system, a crossover cable must be used.
   - When the Development Board is connected to the host system through a network device (such as a hub or switch), a "straight-through" cable must be used.

   Verify that the Ethernet cable is connected and undamaged.

   Verify that the IP address as displayed on the LCD is used to communicate.

   If the board fails when connected through a network device, verify that the device is working properly. If it is, try connecting the host system directly to the Ethernet board, as described in **Chapter 2. "Getting Started with the PICDEM.net 2 Development Board"**. Also, check that the proper cable is being used (see above).

   Check TCP/IP connectivity with the `ping` command:

   1. Launch a DOS (or Command Prompt) window.
   2. Type `ping x.x.x.x`, where "`x.x.x.x`" is the IP address of the Development Board.

   If `ping` returns the message "Request timed out", check the Activity LED on the active Ethernet ICM:

   - If the LED blinks during attempted communications, the IP addressing may be wrong (i.e., the board and the host are not in the same subnet).
   - If the LED does NOT blink, the Ethernet cable is defective, or the wrong type, or the host system has not been properly configured for TCP/IP.

   Verify the operation of the Ethernet card. In Microsoft® Windows® operating systems, this is done through the System or Network applet in the Control Panel (the exact applet and method of getting there varies from version to version). Other operating systems may use different methods. Consult the documentation for your operating system to get detailed information:

   Check the Development Board for power (see Issue 1, above).

   If all else fails, reconfigure the Development Board's network settings using the default Ethernet ID and IP address.

4. **The PICDEM.net 2 Development Board shows `0.0.0.0` as the IP address when connected directly to a host system**

   Verify that the correct Ethernet cable is being used.

   Verify that the Ethernet cable is connected and undamaged.

   Verify that the host computer is connected to the Internet.

   Check if Internet Connection Sharing (ICS) is enabled on the host system. If ICS is enabled, verify that the private network connection selected is correct. (See **Section 2.3.2 "Connecting Directly to a Host System"**.)

5. **The demo application does not build/compile.**

   Check the version of the XC8 Compiler that you're using. If you're using XC8 v1.35, the Peripheral Libraries are included by default.

6. **The board does not communicate with the host system after changing the IP address and/or Ethernet ID.**

   Check the Development Board and host system as in Issue 4, above.

   Verify that the host system is set up correctly.

   Clear the host system's ARP cache. For Windows operating systems, open a Command window, type `arp -d *` and hit <ENTER>.

   If these steps do not work, restore the Development Board's default network configuration to see if communications can be re-established.

NOTES:

Appendix A. PICDEM.net 2 Development Board Schematics, Rev. 6

FIGURE A-1: PICDEM.net™ 2 DEVELOPMENT BOARD SCHEMATIC, SHEET 1 OF 5 (PIC18F97J60 MICROCONTROLLER)

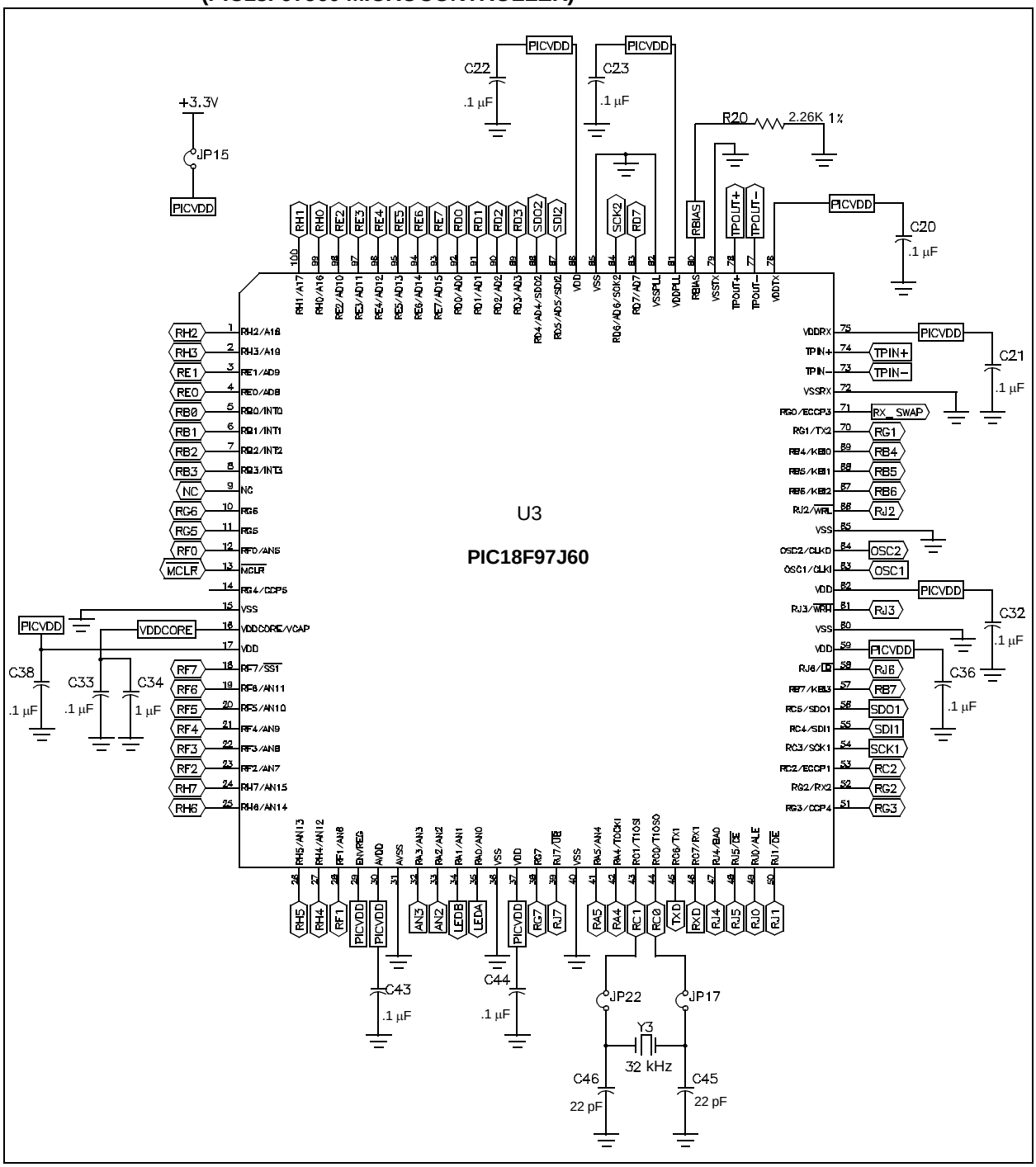


FIGURE A-2: PICDEM.net™ 2 DEVELOPMENT BOARD SCHEMATIC, SHEET 2 OF 5 (PIC18F97J60 MICROCONTROLLER, ASSOCIATED COMPONENTS)

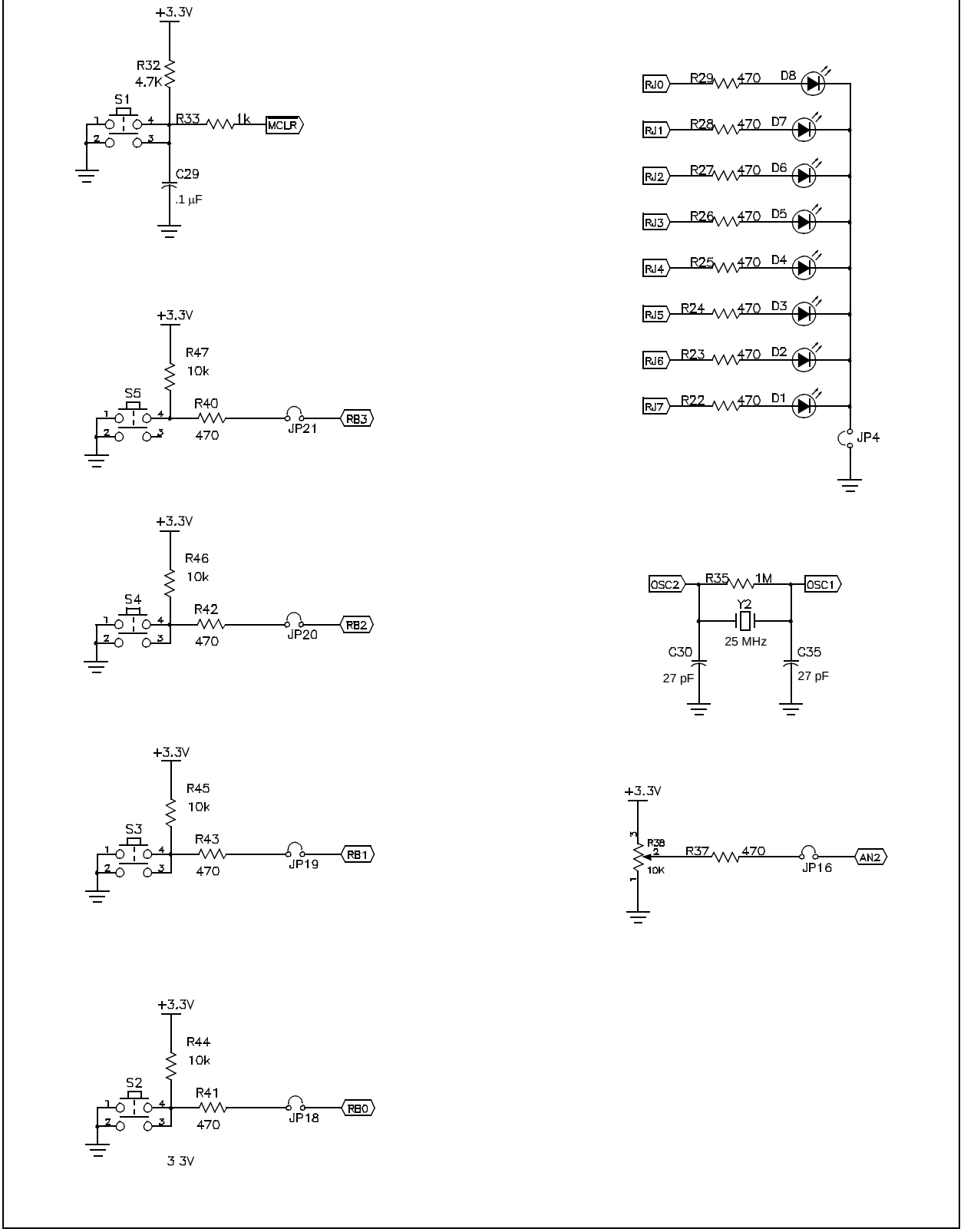


FIGURE A-3: PICDEM.net™ 2 DEVELOPMENT BOARD SCHEMATIC, SHEET 3 OF 5 (ENC28J60 INTERFACE AND ETHERNET MAGNETICS)

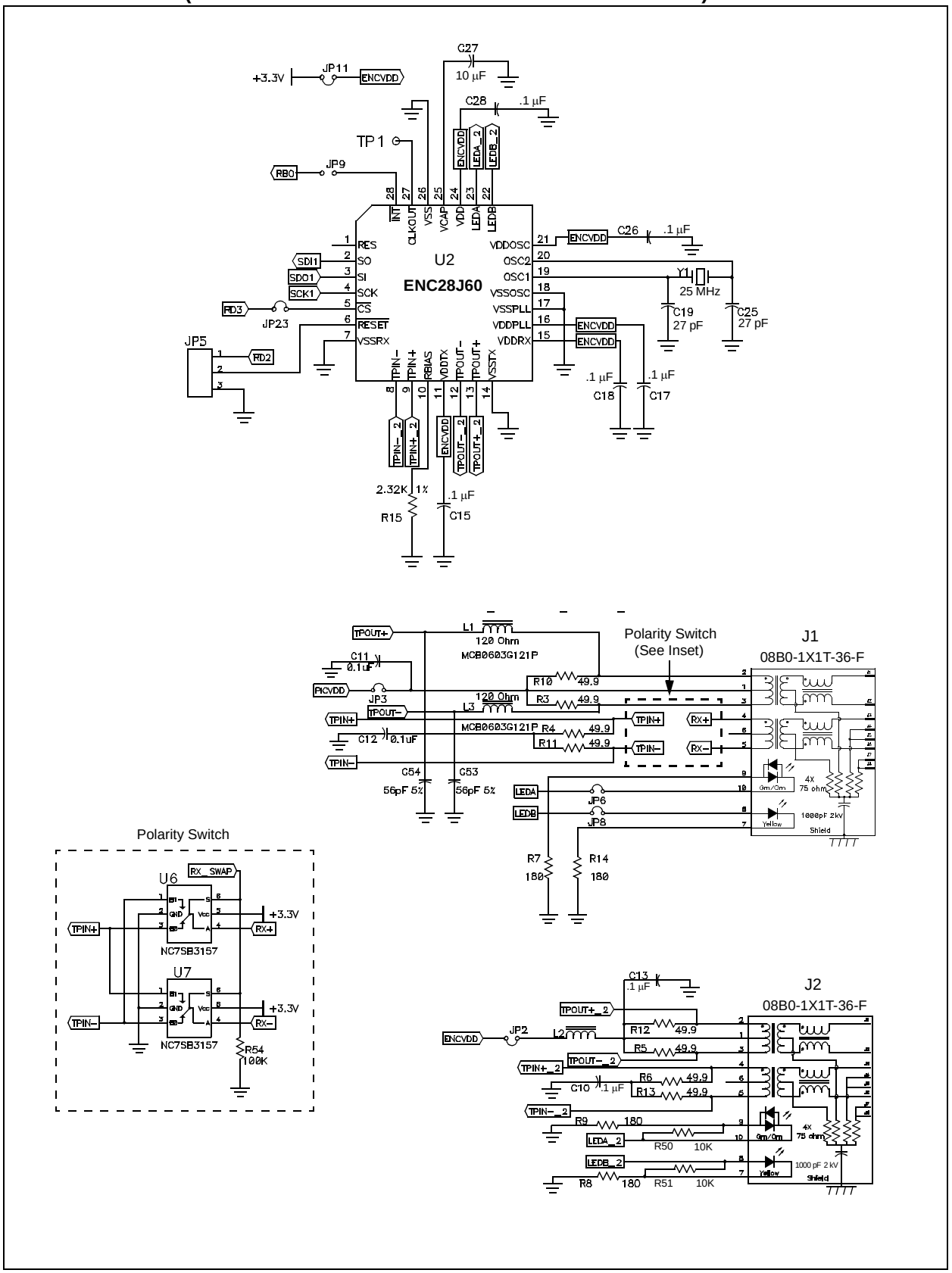


FIGURE A-4: PICDEM.net™ 2 DEVELOPMENT BOARD SCHEMATIC, SHEET 4 OF 5 (RS-232, EEPROM, TEMPERATURE SENSOR, LCD OPTIONS AND POWER SUPPLY)

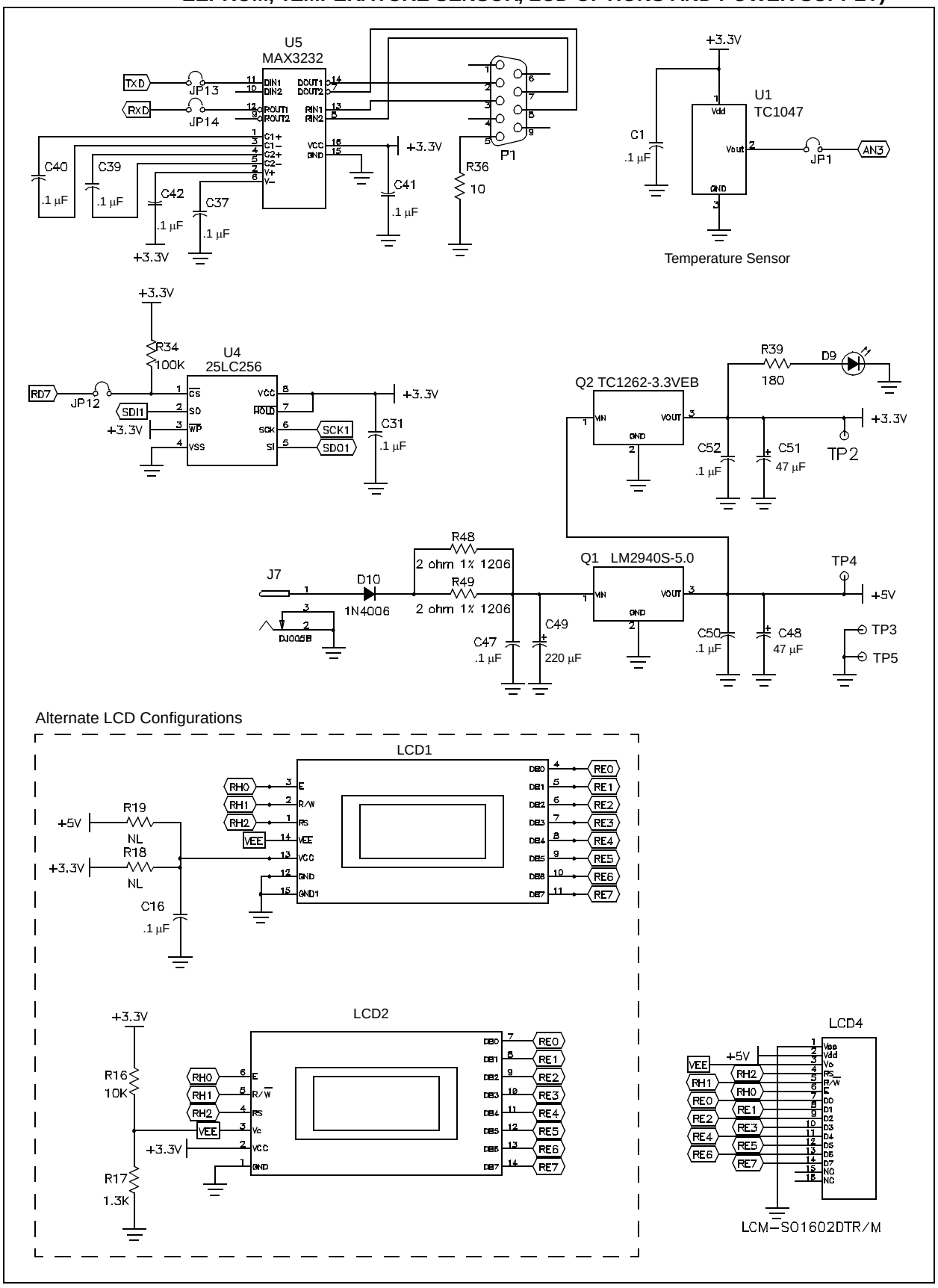
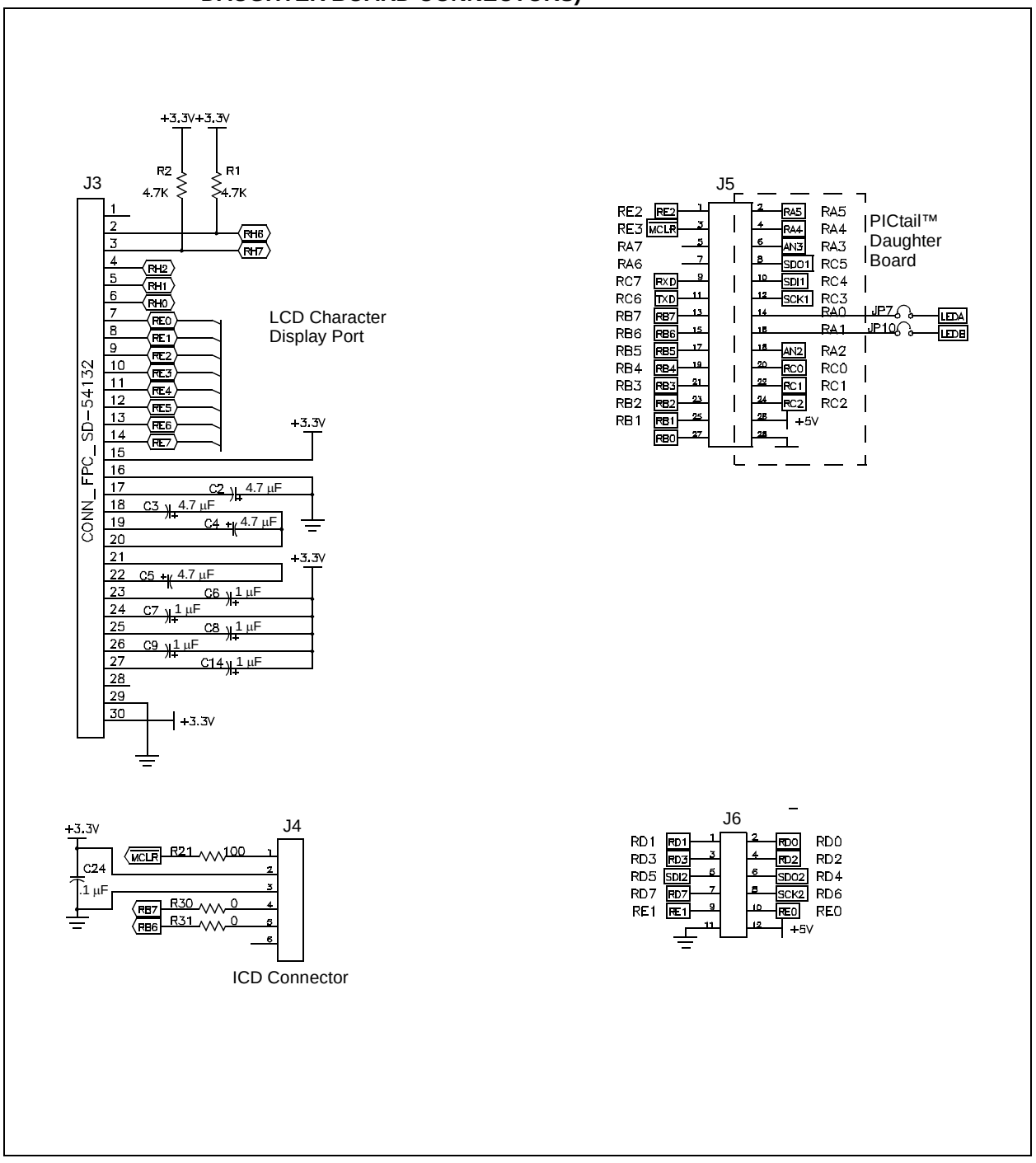


FIGURE A-5: PICDEM.net™ 2 DEVELOPMENT BOARD SCHEMATIC, SHEET 5 OF 5 (ICD, ICSP™, LCD DISPLAY, MICROCONTROLLER HEADER AND PICtail™ DAUGHTER BOARD CONNECTORS)



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