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# **PICDEM™ 17 DEMONSTRATION BOARD USER'S GUIDE**

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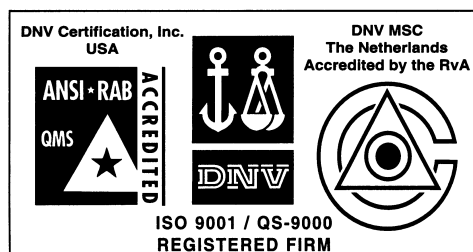
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## PREFACE

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### Welcome

Thank you for purchasing the PICDEM 17 product demonstration board for the PIC17C7XX family of microcontrollers from Microchip Technology Incorporated. The PICDEM 17 demonstration board allows you to quickly and easily become familiar with both the PIC17C7XX products and the MPLAB® ICE in-circuit emulator. The PICDEM 17 demonstration board currently supports all 68-pin and 84-pin PLCC products.

The software provided with the PICDEM 17 demonstration board for the PIC17C7XX Monitor runs under Microsoft® Windows® 95 only.

### Documentation Layout

This document describes the PICDEM 17 demonstration board. A detailed description of the demonstration software is also provided to give the user an overview of the PIC17C7XX series of PICmicro® MCUs. Detailed usage of the microcontrollers, MPLAB IDE, or MPLAB ICE in-circuit emulator are deferred to the individual product data sheets and user's manuals, respectively.

**Chapter 1: Introduction** – This chapter introduces the PICDEM 17 demonstration board and provides a brief description of the hardware.

**Chapter 2: Using the PICDEM 17 Monitor** – This chapter discusses how to use the PICDEM 17 Monitor PC program and the pre-programmed PIC17C756A device.

**Chapter 3: Hardware Description** – This chapter describes in detail the hardware of the PICDEM 17 demonstration board.

**Chapter 4: Using MPLAB C17 C compiler with PICDEM 17 demonstration board** – This chapter provides a description of how to write and compile code for execution on the PICDEM 17 demonstration board. Some special files are required for use with the MPLAB C17 C compiler to correctly compile programs to run in the external FLASH program memory.

**Chapter 5: LCD . C Description** – This chapter provides a detailed description of the demonstration program for the PIC17C756A that interfaces to an external LCD panel using an Hitachi HD44780 display controller or equivalent.

**Chapter 6: USART . C Description** – This chapter provides a detailed description of the demonstration program for the PIC17C756A that displays data to the USART.

**Chapter 7: ANALOG . C Description** – This chapter provides a detailed description of the demonstration program for the PIC17C756A that reads an A/D channel and displays the results in the Monitor program window.



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**Chapter 8: SWITCH.C Description** – This chapter provides a detailed description of the memory mapping of the PIC17C756A and provides source code to interface to the memory mapped switches and LEDs.

**Chapter 9: I2C.C Description** – This chapter provides a detailed description of the demonstration program for the PIC17C756A that reads and writes data from a 24LC01B Serial EEPROM.

**Appendix A: PICDEM 17 Demonstration Board Schematics** – This appendix provides the PICDEM 17 demonstration board parts layout diagram and the board schematics.

**Appendix B: RS-232 Communication Protocol** – This appendix provides the protocol for the PIC17C756A Monitor firmware to communicate to the PC based software.

**Appendix C: Floppy Disk Contents** – This appendix contains a listing of all files on the included 3.5-inch floppy disk. There is also a description as to the use of each file when compiling programs for the PICDEM 17 demonstration board and the PIC17C7XX microcontrollers.

**Appendix D: On-line Support** – This appendix provides information on Microchip's electronic support services.

**Worldwide Sales & Service** – This reference gives the address, telephone, and fax numbers for Microchip Technology Incorporated sales and service locations throughout the world.

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**Chapter 1. About PICDEM 17 Demonstration Board**

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## 1.1 Introduction

This chapter describes the features of the PICDEM 17 demonstration board.

## 1.2 Highlights

This chapter covers the following topics:

- **Processor Sockets**
- **External FLASH Memory**
- **Memory Mapping**
- **Power Supply**
- **Prototyping Areas**
- **Oscillator Options**
- **RS-232 Serial Ports**
- **Push-button Switches**
- **LEDs**
- **Analog Circuitry**
- **External LCD Interface**
- **CAN Bus Interface**
- **24LC01B Serial EEPROM**
- **Modular Connectors**
- **Pre-programmed Sample**

**Note:** All following part references can be found in Figure A.1.1 in *Appendix A: PICDEM 17 Demonstration Board Schematics*. For example, the 68-pin PLCC socket for the PIC17C75X microcontrollers is located at U1 on the Parts Layout.

## 1.3 Processor Sockets

The PICDEM 17 demonstration board supports the following devices:

- 68-pin PLCC socket for the PIC17C75X microcontrollers (U1)
- 84-pin PLCC socket for the PIC17C76X microcontrollers (U7)

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## 1.4 External FLASH Memory

The PICDEM 17 demonstration board supports all operating modes of the PIC17C7XX PICmicro® microcontroller. However, the Monitor program uses the extended microcontroller mode of operation. The FLASH is the AM29F100T device from AMD configured as 64K x 16. The monitor program supports downloading code into the FLASH and then running the program.

## 1.5 Memory Mapping

Since the PIC17C756A is in the extended microcontroller mode, there are several memory mapped peripherals available to the user. The first is the eight push-button switches mapped at address FFFCh. The eight LEDs are mapped at address FFFDh. There are also two signals that provide decoding for an address of 8 (LE\_1) and an address of 16 (LE\_2). These signals are located in the digital prototyping area in the upper right-hand corner of the board.

## 1.6 Power Supply

The PICDEM 17 demonstration board provides a different power supply structure to the user. The only power input capable of powering the entire board is at the connector J1. Any power supply with a 2.1 mm plug capable of delivering +9V, up to 1A, unregulated Alternating Current (AC) or Direct Current (DC) can be used. The digital components on the board are powered from a LM2940T-5.0 that is capable of supplying 1A of current. This digital +5V is available in the digital prototyping area in the upper right-hand corner of the board.

The analog section of the PICDEM 17 demonstration board has a separate power source and voltage reference. A LM78L05 +5V regulator provides 150 mA at +5V for the analog circuits. It is also available in the analog prototyping area in the lower left-hand corner of the board. There is also a precision +4.096V reference that is connected to the (Analog-to-Digital) A/D as well as the analog prototyping area.

## 1.7 Prototyping Areas

The PICDEM 17 demonstration board provides two prototyping areas, one for analog and one for digital. The PICDEM 17 demonstration board was designed to fully demonstrate the capabilities of the on-chip A/D converter. In addition to the separate analog power supply and voltage reference, the printed circuit board has four layers with two signal layers and a power and ground layer. The analog prototyping area has all A/D channels, analog VDD and VSS, as well as the voltage reference available to the user. The digital prototyping area has all other I/O pins, complete 16-bit address bus, digital VDD and VSS, and additional memory mapped peripheral signals.

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# About PICDEM 17 Demonstration Board

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## 1.8 Oscillator Options

The PICDEM 17 demonstration board layout will only accept a canned oscillator. The use of a crystal or ceramic resonator requires that the user modify the board.

## 1.9 RS-232 Serial Ports

The PICDEM 17 demonstration board supports both USARTs on the PIC17C7XX devices. A level shifting IC is used to convert from the TTL/CMOS levels out of the PIC17C7XX to the RS-232 voltages. USART2 also has the capability to function in a hardware handshaking mode using RTS and CTS. These signals are level shifted and connected to PORTB pins 4 (CTS) and 5 (RTS).

## 1.10 Push-button Switches

The PICDEM 17 demonstration board has 8 general purpose push-button switches that are available to the user. These switches are not connected directly to I/O pins on the microcontroller but are memory mapped into the address space. The switches are available at address FFFCh.

## 1.11 LEDs

The PICDEM 17 demonstration board also has 8 LEDs which are also memory mapped. These LEDs may be accessed at address FFFDh. There is no read capability for the LEDs, so the user must have a shadow register in the PIC17C7XX device to keep track of the value on the latch.

## 1.12 Analog Circuitry

In addition to the power and ground planes on the PICDEM 17 demonstration board, it also has separate analog and digital power supplies. Both of these voltage regulators use connector J1 as the source. If the user desires to power the board from the test points in the prototyping areas, then both sets of test points in the analog and digital must be used. Otherwise one portion of the board will not be operational.

## 1.13 External LCD Interface

The PICDEM 17 demonstration board provides an interface to an external LCD display that uses the Hitachi HD4478 LCD controller or equivalent device. The LCD is used in the 4-bit interface mode. Four data lines and three control lines are required to operate the LCD. These LCD signals are multiplexed with some of the A/D converter channels. It is therefore important that the A/D is properly initialized before the LCD can be used (refer to Chapter 4). The board layout provides space for the Optrex DMC-50448N 8x2 character display which is available from DigiKey.

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## 1.14 CAN Bus Interface

The PICDEM 17 demonstration board provides a simple interface to a CAN Bus. The Microchip Technology MCP2510 CAN Interface peripheral device with the Phillips PCA82C250 device provide a complete CAN Interface solution. The two modular connectors J4 and J5 allow easy interface to the bus. The canned oscillator socket O2 provides the clock source for the MCP2510 which in turn can also provide the clock source for the PIC17C7XX.

## 1.15 24LC01B Serial EEPROM

The PICDEM 17 demonstration board has a 24LC01B Serial EEPROM capable of holding 128 bytes of data. This device uses the I<sup>2</sup>C™ interface on the PIC17C7XX PICmicro MCU. The modular connectors J4 and J5 can also be used to create an I<sup>2</sup>C interface to a peripheral not located on the board.

## 1.16 Modular Connectors

The modular connectors J4 and J5 are used to connect to external busses. The DIP switch S14 is used to determine if the CAN Bus interface is used or the I<sup>2</sup>C interface. If the CAN Bus is the desired interface, the user will have to populate the board with the MCP2510 CAN Bus peripheral from Microchip Technology and the PCA82C250 CAN Bus interface device from Philips Semiconductor. Since the MCP2510 uses the SPI™ interface, DIP switch S13 must be configured for SPI (SCK,SDO,SDI,CS).

## 1.17 Pre-programmed Sample

A pre-programmed PIC17C756 or PIC17C756A sample is included with the PICDEM 17 demonstration board. It has been programmed with the Monitor firmware to communicate with the Monitor program on the PC. This device should be used with the 16 MHz canned oscillator in the socket labeled O1.

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## Chapter 2. Using the PICDEM 17 Monitor

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### 2.1 Introduction

This chapter discusses how to use the Monitor program to interact with the PIC17C7XX device on the PICDEM 17 demonstration board.

### 2.2 Highlights

This chapter includes:

- **Installing the PICDEM 17 Monitor Program**
- **Running the PICDEM 17 Monitor Program**
- **Resetting the PICDEM 17 Demonstration Board**
- **Erasing the FLASH on the PICDEM 17 Demonstration Board**
- **Downloading HEX Files to PICDEM 17 Demonstration Board**
- **Running HEX Files from the PICDEM 17 Demonstration Board**
- **Running Diagnostics on the PICDEM 17 Demonstration Board**
- **Modifying Memory Contents**

### 2.3 Installing the PICDEM 17 Monitor Program

The PICDEM 17 Monitor program setup routine installs the monitor program, PC monitor source code and the PIC17C756A monitor source code into the MPLAB® IDE directory. Microsoft® Windows® 95 must be running to execute the Monitor Setup program. The files can be installed under the default MPLAB IDE directory, C:\Program Files\MPLAB\756MON, or in another directory.

1. Insert the PICDEM 17 Monitor installation disk in drive A:.
2. From the Program Manager Run option, type **A:SETUP**  
The PICDEM 17 Monitor Setup program displays a Welcome! message box with options to continue or exit. Click **OK** to continue.
3. Setup next displays a dialog to select the directory to install the executable and source code files. If directory other than the default is desired, enter the name and click **OK**.
4. After copying the PICDEM 17 Monitor files, Setup displays a message box with the caption "The PICDEM 17 Monitor installation has completed." Click **OK**.

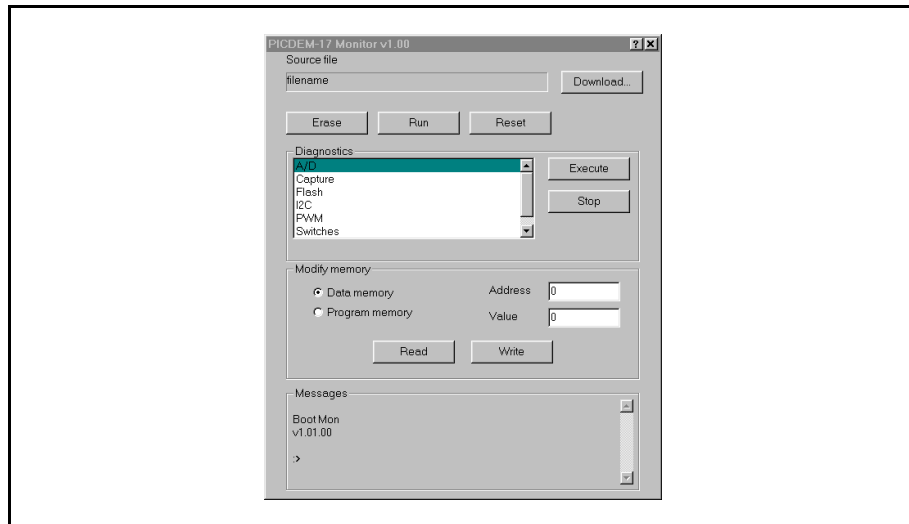
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## 2.4 Using the PICDEM 17 Monitor Program

The Monitor program uses a serial port on the Host PC. It currently supports COM1 through COM4. The command line to execute the Monitor program should be:

**756MON.EXE COM?**

where ? is the desired COM port 1, 2, 3, or 4. The PICDEM 17 Monitor program should look like Figure 2.1.



**Figure 2.1: PICDEM 17 Monitor Program**

Once the Monitor program has been started, connect the serial cable to P2 on the PICDEM 17 demonstration board. Then apply power to the PICDEM 17 demonstration board. The PICDEM 17 demonstration board should display the following message in the message window on the Monitor Program:

```
Boot Mon  
V???.???.??  
:->
```

where **???.???.??** is the version of the Monitor firmware in the PIC17C756A. The Monitor program has many features including:

- Resetting the PIC17C756A on the PICDEM 17 demonstration board
- Erasing the FLASH on the PICDEM 17 demonstration board
- Downloading HEX files to the PICDEM 17 demonstration board
- Running and halting the operation of programs
- Running diagnostics on the various PIC17C756A peripherals
- Reading and writing to Data Memory and external FLASH program memory
- Displaying USART2 activity in message window

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# Using the PICDEM 17 Monitor

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## 2.5 Resetting the PICDEM 17 Demonstration Board

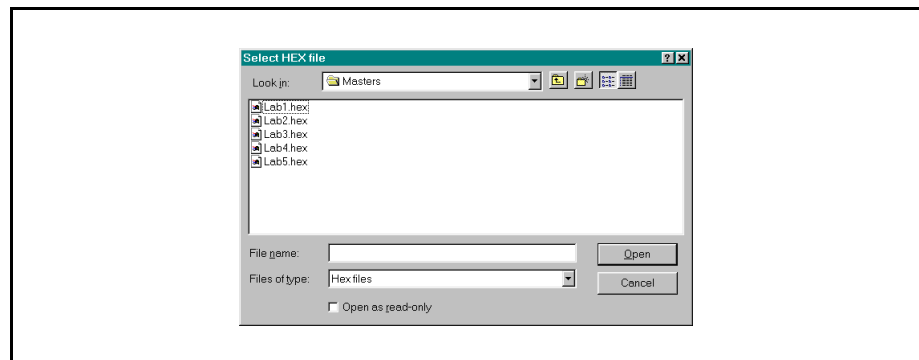
One unique feature of USART2 is the ability to reset the PICmicro<sup>®</sup> MCU. This is accomplished by connecting the DTR signal from P2 to the MCLR pin of the PICmicro MCU using the circuit in Figure 2.4. Jumper J3 is also provided to disable this feature. To reset the microcontroller, simply click on **Reset** in the Monitor window. The boot message should display on the message area.

## 2.6 Erasing the FLASH on the PICDEM 17 Demonstration Board

The Monitor program allows the external FLASH program memory device to be erased by clicking on the **Erase** button. This simply erases the FLASH memory. When a download is requested, the PIC17C756A automatically erases the FLASH. Therefore, it is not required that the FLASH be erased using the **Erase** button before a download is initiated.

## 2.7 Downloading HEX Files to the PICDEM 17 Demonstration Board

To download a HEX file to the PICDEM 17 demonstration board, first click on **Download...** This will open a Select HEX file window that allows the selection of the desired HEX file to load into the external FLASH program memory on the PICDEM 17.



**Figure 2.2: Select HEX file Window**

Once a HEX file has been selected for downloading to the PICDEM 17 demonstration board, the Monitor will show a **Downloading...** status window that has a bar graph display of percentage download of the file. Initially, there will be a slight pause allowing the PIC17C756A to erase the FLASH memory.



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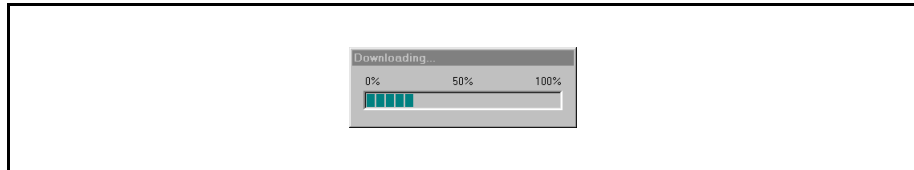


Figure 2.3: Downloading... Window

At the completion of the download, the Monitor status window will have displayed a **Erase Complete and Download Complete** message. When the message window shows a **:>**, it is ready to process the next command.

## 2.8 Running HEX files from the PICDEM 17 Demonstration Board

The Monitor program has a Run button that starts the execution of code from the external FLASH program memory. Once a program has been downloaded into the FLASH memory, click the **Run** button to start execution. Control of the PIC17C756A is released by the Monitor firmware by simply writing 4000h to the PCLATH:PCL registers. Refer to Chapter 4, *Using the MPLAB® C17 C Compiler* for more information.

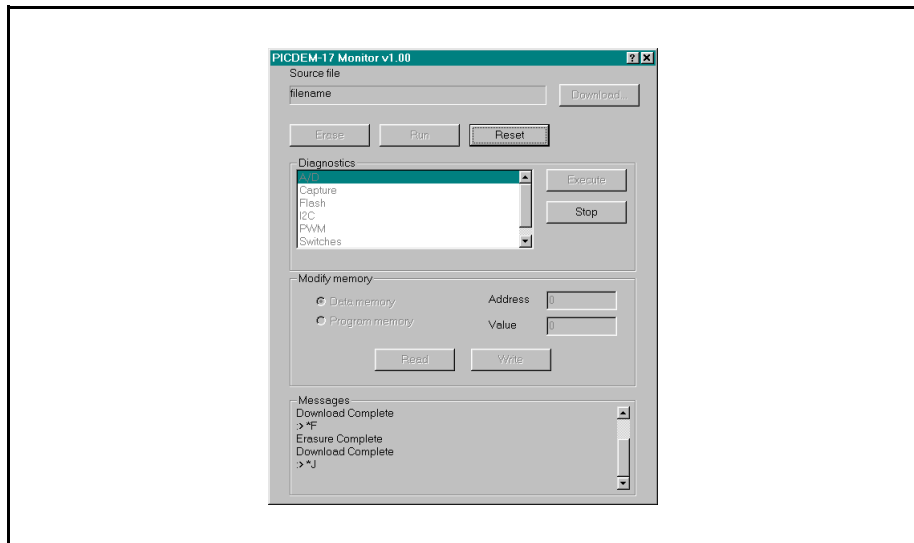


Figure 2.4: Program Running on PICDEM 17 Demonstration Board

The only way to stop the program from running is to click on the **Reset** button in the Monitor window. This resets the PIC17C756A and restores operation to the Monitor firmware. This method allows for all Data memory, interrupt vectors, and stack locations to be available to the user for the target application.

## 2.9 Running Diagnostics on the PICDEM 17 Demonstration Board

The Monitor firmware on the PIC17C756A provides several diagnostic routines that allow the user to run pretested code on a peripheral. The diagnostics include:

- **A/D** – The A/D diagnostic allows the user to configure the A/D channel, clock source, justification, and reference. The A/D results are displayed in the Monitor message window.

During A/C Diagnostics, the switches and LEDs take on the following functions:

S5	Increment channel number, 0 – 11 only
S9	Toggle between internal and external voltage references
S10	Toggle between right and left justify
S12	The clock source (FOSC/8, FOSC/32, FOSC/B4, FRC)
D1, D6 – D8	Channel number in HEX format
D9	Internal (OFF) or External (ON) voltage references
D10	Left (OFF) or Right (ON) justify
D11 – D12	A/D clock source

The diagnostic ends when **Halt** is clicked

- **Capture** – The capture diagnostic allows the user to configure the capture channel and mode. The capture results are displayed in the Monitor message window.

During Capture Diagnostics, the switches and LEDs take on the following functions:

S5	Increment capture channel, 1 – 4 only
S9	Increment toggle mode
D1, D6	Capture channel
D9, D10	Capture mode

The diagnostic ends when **Halt** is clicked

- **FLASH** – The external FLASH memory diagnostic simply writes all zero's, all one's, checkerboard, and inverse checkerboard to a portion of memory and checks to make sure that the values were properly written. This diagnostic does not require any user interaction.
- **I<sup>2</sup>C** – This diagnostic writes an incrementing count to the 24LC01B Serial EEPROM on the PICDEM 17 demonstration board and verifies that each location has been properly programmed. This diagnostic does not require any interaction from the user.

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- **LCD** – This diagnostic configures I/O pins and writes a message to the external LCD panel in 4-bit mode.

```
portF<0:3>  data lines
portG<1>     E
portG<0>     R/W
portF<7>     RS
```

If this diagnostic is selected and these I/O pins are not connected to the LCD panel, then the message will not be displayed correctly. Provided the connections are correct, the diagnostic does not require any interaction from the user.

- **PWM** – This diagnostic allows the user to select the PWM channel and increment or decrement the period and duty cycle of that channel.

During PWM Diagnostics, the switches and LEDs take on the following functions:

S5	Increments the channel, 1 – 3 only
S7	Decrement the duty cycle down to 0
S8	Increment the duty cycle, no upper limit
S9	Decrement the period down to 0
S10	Increment the period, no upper limit
S12	Selects clock source, Timer1 or Timer2
D1, D6	PWM channel
D12	Timer source Timer1 (OFF) or Timer2 (ON)

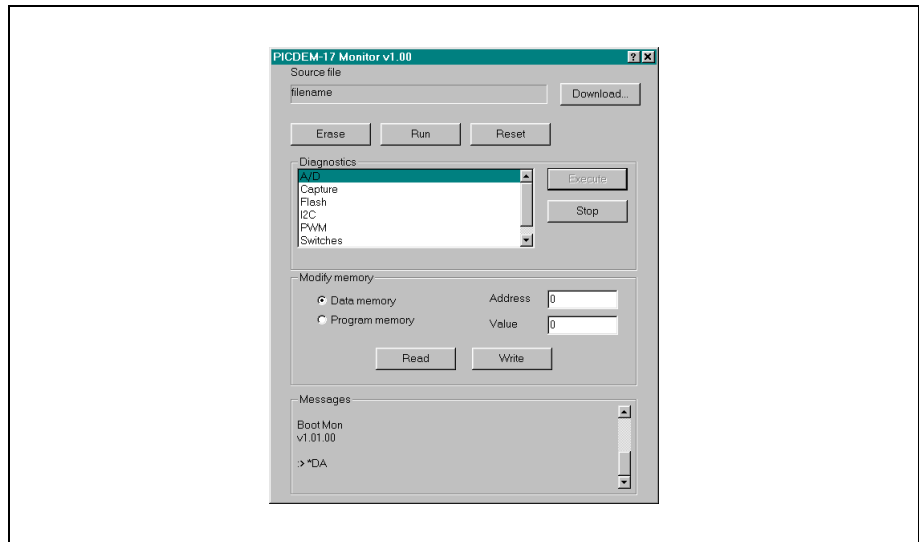
The diagnostic ends when **Halt** is clicked

- **Switches** – This diagnostic tests the functionality of the memory mapped switches and LEDs. Each time a switch is pressed the corresponding LED is turned OFF. This diagnostic ends when all LEDs have been turned OFF.
- **USART2** – This diagnostic writes a message to the Monitor program running on the PC Host. This diagnostic does not require any interaction from the user.

To run a diagnostic, highlight the desired test in the Diagnostics window of the Monitor program. Then click the **Execute** button to start the test. Those tests that do not automatically terminate can be stopped using the **Stop** button.

# Using the PICDEM 17 Monitor

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**Figure 2.5: Running Diagnostics**

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## 2.10 Modifying Memory Contents

The PICDEM 17 Monitor program has the capability to read from any Data memory location or internal/external Program memory location. It can also write to any Data memory location and any external FLASH program memory location. Writes to internal program memory are not allowed because this memory is EPROM based.

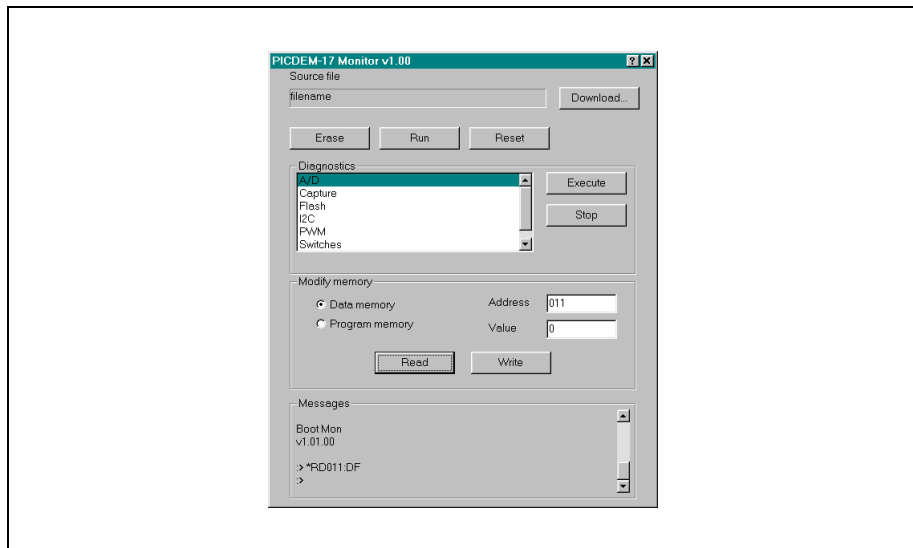
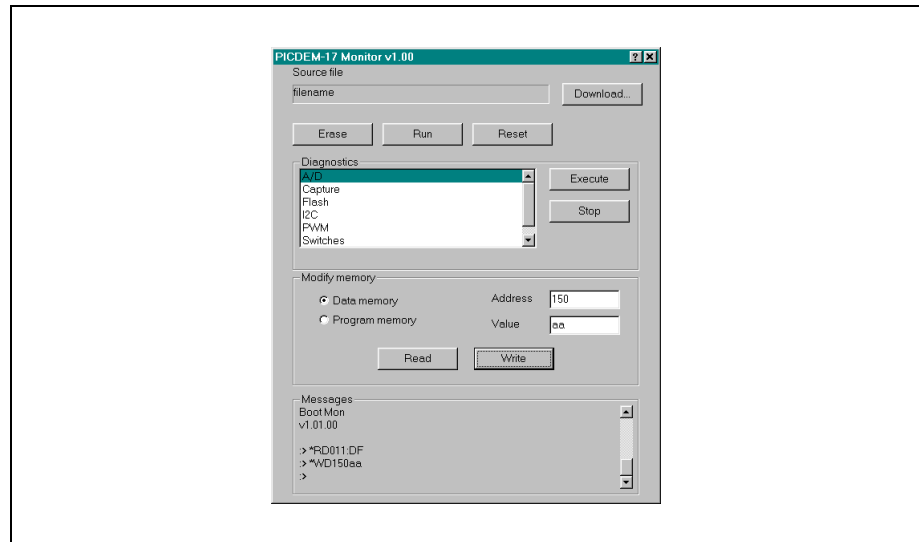


Figure 2.6: Reading Data Memory

To read from a Data memory location, the user must first select the **Data Memory** radio button in the Modify Memory window of the Monitor program. Then the Data memory address must be written into the Address edit box. The format of this value is **bx**, where **b** is a valid bank number in HEX format, and **xx** is a value from 00h to FFh that indicates the desired address within the bank to read. Then click the **Read** button. The message window will reply with the following message: **\*RDbxx:dd**. **bx** represents the bank and address and **dd** represents the data found at that address in HEX format. For this operation the first three digits in the Address edit box are used when the command is sent to the PICDEM 17 demonstration board. Any additional digits are ignored.

# Using the PICDEM 17 Monitor

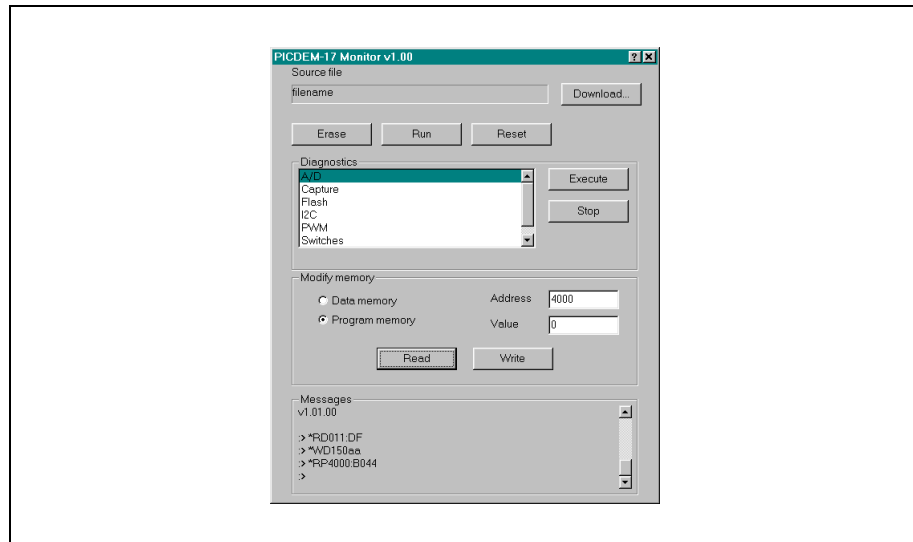


**Figure 2.7: Writing Data Memory**

To write to a Data memory location, the user must first select the **Data Memory** radio button in the Modify Memory window of the Monitor program. Then the Data memory address must be written into the Address edit box. The format of this value is **bxx**, where **b** is a valid bank number in HEX format, and **xx** is a value from 00h to FFh that indicates the desired address within the bank to write. The user must also enter the value to be written to the Data register in the **Value** edit box. Then click the **Write** button. The message window will reply with the following message: **\*WDbxxdd**. **bxx** represents the bank and address and **dd** represents the data written to the address in HEX format. For this operation the first three digits in the **Address** edit box and first two digits in the **Value** edit box are used when the command is sent to the PICDEM 17 demonstration board. Any additional digits are ignored.

# PICDEM™ 17 Demonstration Board User's Guide

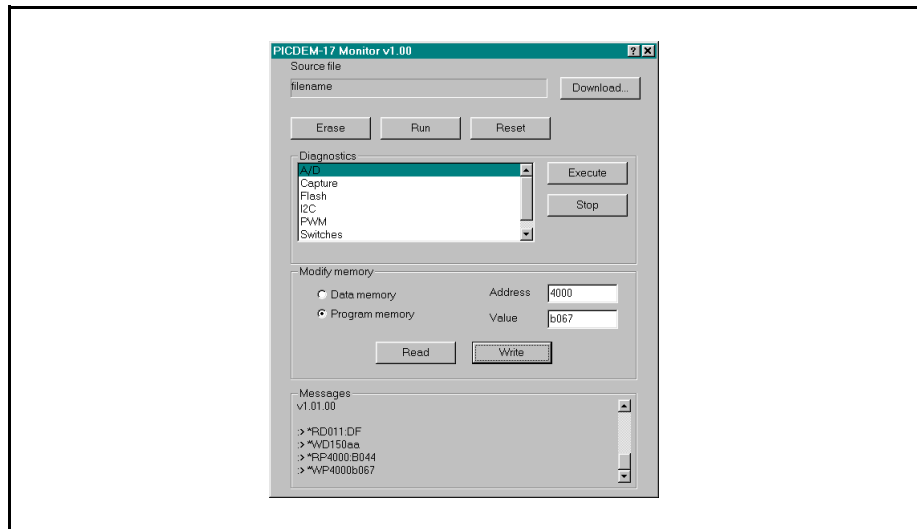
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**Figure 2.8: Reading Program Memory**

To read from a Program memory location, the user must first select the **Program Memory** radio button in the Modify Memory window of the Monitor program. Then the Program memory address must be written into the **Address** edit box. The format of this value is **xxxx**, where **xxxx** is a value from 0000h to FFFFh that indicates the desired address within the 64K address space to read. Then click the **Read** button. The message window will reply with the following message: **\*RPxxxx:dddd**. **xxxx** represents the program memory address and **dddd** represents the data at that address in HEX format. For this operation the first four digits in the Address edit box are used when the command is sent to the PICDEM 17 demonstration board. Any additional digits are ignored.

# Using the PICDEM 17 Monitor



**Figure 2.9: Writing Program Memory**

To write to a Program memory location, the user must first select the **Program Memory** radio button in the Modify Memory window of the Monitor program. Then the Program memory address must be written into the **Address** edit box. The format of this value is **xxxx**, where **xxxx** is a value from 0000h to FFFFh that indicates the desired address within the bank to write. The user must also enter the value to be written to the program memory location in the **Value** edit box. Then click the **Write** button. The message window will reply with the following message: **\*WPxxxxdddd**. **xxxx** represents the program memory address and **dddd** represents the data written to the address in HEX format. For this operation the first four digits of both the **Address** edit box and the **Value** edit box are used when the command is sent to the PICDEM 17 demonstration board. Any additional digits are ignored. The firmware in the PIC17C756A ignores any write program memory commands with an address in the range of 0000h to 3FFFh.



# **PICDEM™ 17 Demonstration Board User's Guide**

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**NOTES:**

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## Chapter 3. Hardware Description

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### 3.1 Introduction

The hardware on the PICDEM 17 demonstration board is simple and is intended to illustrate the ease of use and capabilities of the PIC17C7XX family of devices.

### 3.2 Highlights

This chapter covers the following topics:

- **Port Connections**
- **Push-button Switches**
- **DIP Switches**
- **RS-232 Interface**
- **CAN Bus Interface**
- **Modular Connectors**

### 3.3 Port Connections

The following bullets list the I/O features and port connections for the PIC17C7XX devices.

- PORTA<0:1> not used
- PORTA<2:3> used for SPI™/I<sup>2</sup>C™ interface
- PORTA<4:5> used for USART1 interface
- PORTB<0:3> not used
- PORTB<4:5> used for USART2 handshaking interface (CTS:RTS)
- PORTB<6:7> used for SPI/I<sup>2</sup>C interface
- All of PORTC and PORTD are dedicated to the external memory interface
- PORTE<0:2> are used in the external memory interface as ALE, OE, and WR respectively
- PORTF<0:3> are used as the data lines for the external LCD
- PORTF<4:6> not used
- PORTF<7> used as the register select control line to external LCD
- PORTG<0:1> not used
- PORTG<2> tied to analog ground
- PORTG<3> tied to the +4.096V voltage reference
- PORTG<4:5> not used
- PORTG<6:7> used for USART2 interface
- PORTH<0:7> not used
- PORTJ<0:7> not used
- All V<sub>DD</sub>s tied to digital +5V, all V<sub>SS</sub> tied to digital ground
- AV<sub>DD</sub> tied to analog +5V, AV<sub>SS</sub> tied to analog ground