Electronics and Robotics I Week 19
Programming PIC Microcontrollers in PicBasic Pro – LCD Lesson 2

- **Administration:**
  - Prayer
- **PicBasic Pro Programs Used in This Lesson:**
  - General PicBasic Pro Program Listing: http://www.cornerstonerobotics.org/picbasic.php
  - Lab 1 lcd3 as .pdf file: http://www.cornerstonerobotics.org/code/LCD3.pdf
  - Lab 4 lcd1 as .pdf file: http://www.cornerstonerobotics.org/code/LCD1.pdf
- **LCD PicBasic Pro Review:**
  - Perform LCD2 LAB 1 – LED Status on LCD
- **Defining LCD Pins:**
  - PicBasic Pro permits changing of LCD pin connections by using DEFINE statements. The LCD default pin connections are shown in Figure 2:

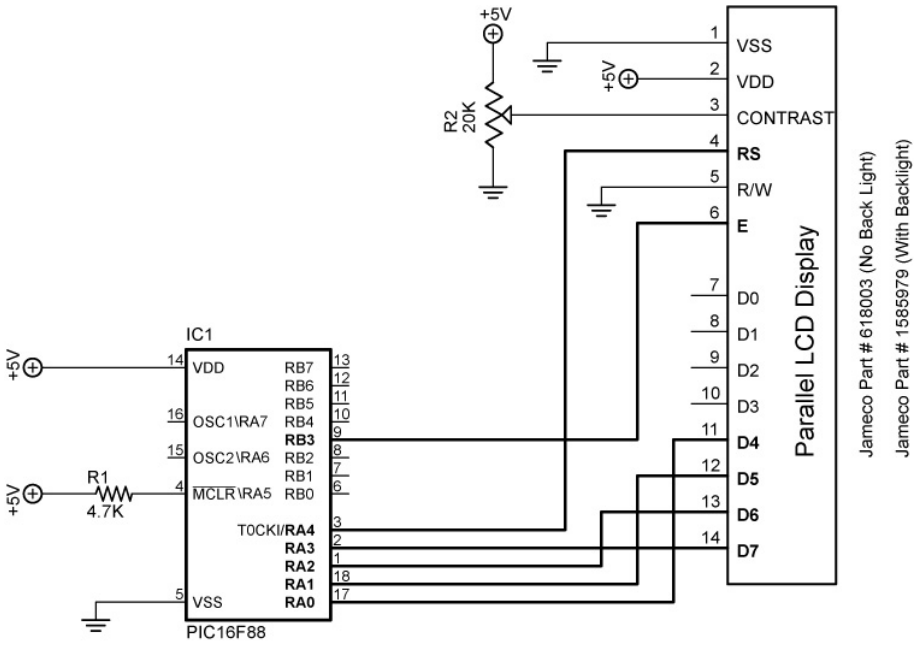


Figure 2, LCD Default Connections

  - To move the data connections, use the following DEFINE statements:
    - **DEFINE LCD_DREG** sets the LCD **data port**.
      - Examples:
        - DEFINE LCD_DREG PORTA 'Sets PORTA as LCD data port
        - DEFINE LCD_DREG PORTB 'Sets PORTB as LCD data port
      - If an 8-bit data bus is used, all 8 bits must be in one port
      - If a 4-bit data bus is used, the top 4 LCD data bits (DB4-DB7) must be either wired to the bottom 4 or top 4 bits of the port selected. For example, if DEFINE LCD_DREG PORTB is declared, then the top LCD bits DB4-DB7 must be connected to either RB0-RB3 or RB4-RB7 (see DEFINE LCD_DBIT immediately below).
      - PicBasic Pro assumes the data lines DB4-DB7 are connected to PORTA.0-PORTA.3 (RA0-RA3).

- **DEFINE LCD_DBIT** sets starting **data bit** for 4-bit bus.
  - Examples:
    - DEFINE LCD_DBIT 0 ‘Set starting data bit to 0
    - DEFINE LCD_DBIT 4 ‘Set starting data bit to 4
  - PicBasic Pro default starting bit is bit 0 of PORTA or PORTA.0
- **Example:** Move the data port AN0-AN3 to PORTB and the starting data bit to bit 4. Let Register Select and Enable connections remain unchanged.
  - DEFINE Statements:
    - DEFINE LCD_DREG PORTB ‘Sets PORTB as LCD data port
    - DEFINE LCD_DBIT 4 ‘Set starting data bit to 4
  - The schematic in Figure 3 shows relocated the data port connections:

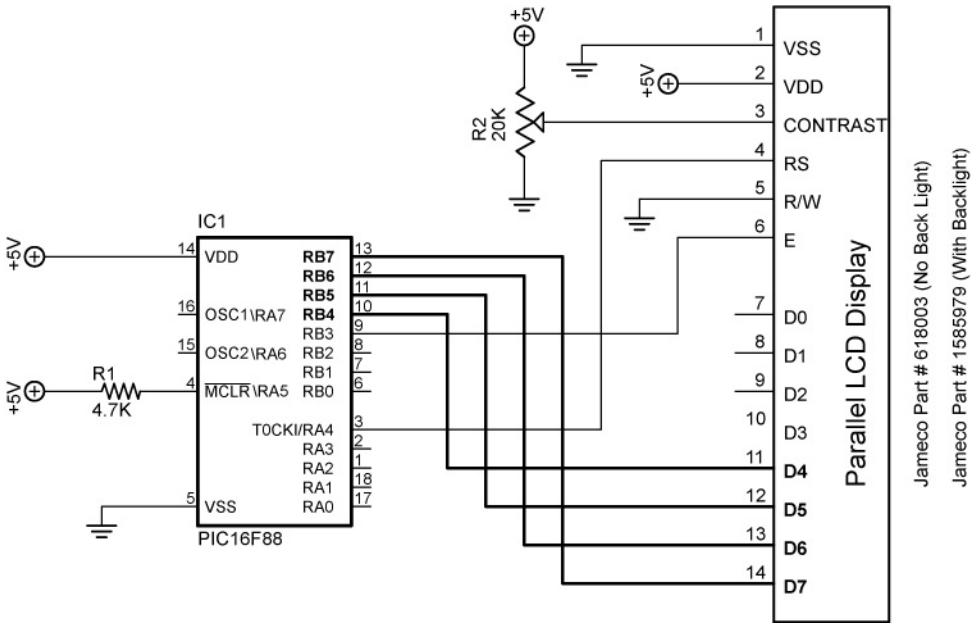


Figure 3, Revised Data Port Connections

- To move the Register Select and Enable connections, use the following DEFINE statements:
  - **DEFINE LCD_RSREG** sets the **Register Select (RS) port**.
    - Examples:
      - DEFINE LCD_RSREG PORTB ‘Sets PORTB as the RS port
      - DEFINE LCD_RSREG PORTE ‘Sets PORTE as the RS port
    - Register Select may be connected to any port pin.
    - PicBasic Pro default setting for Register Select is PORTA.
  - **DEFINE LCD_RSBIT** sets the **Register Select (RS) bit**.
    - Examples:
      - DEFINE LCD_RSBIT 2 ‘Sets bit 2 as RS bit
      - DEFINE LCD_RSBIT 6 ‘Sets bit 6 as RS bit
    - Register Select may be connected to any port pin.
    - PicBasic Pro default setting for Register Select is bit 4 of PORTA or PORTA.4.
  - **DEFINE LCD_EREG** sets the **Enable (E) port**.
    - Examples:
      - DEFINE LCD_EREG PORTB ‘Sets PORTB as Enable port
      - DEFINE LCD_EREG PORTD ‘Sets PORTD as Enable port
    - Enable may be connected to any port pin.
    - PicBasic Pro default setting for Enable is PORTB.
  - **DEFINE LCD_EBIT** sets the **Enable (E) bit**.
    - Examples:
      - DEFINE LCD_EBIT 3 ‘Sets bit 3 as the Enable bit
      - DEFINE LCD_EBIT 7 ‘Sets bit 7 as the Enable bit
    - Enable may be connected to any port pin.
    - PicBasic Pro default setting for Enable is bit 3 of PORTB or PORTB.3.
  - **Example:** Move the Register Select from AN4 to RB0 and the Enable from RB3 to RB1. Leave the data port connections in their default configuration.
    - DEFINE Register Select Statements:
      - DEFINE LCD_RSREG PORTB ‘Sets PORTB as the RS port
      - DEFINE LCD_RSBIT 0 ‘Sets bit 0 as RS bit
    - DEFINE Enable Statements:
      - DEFINE LCD_EREG PORTB ‘Sets PORTB as Enable port
      - DEFINE LCD_EBIT 1 ‘Sets bit 1 as the Enable bit
    - The schematic in Figure 4 on the next page shows the relocated Register Select and Enable connections:

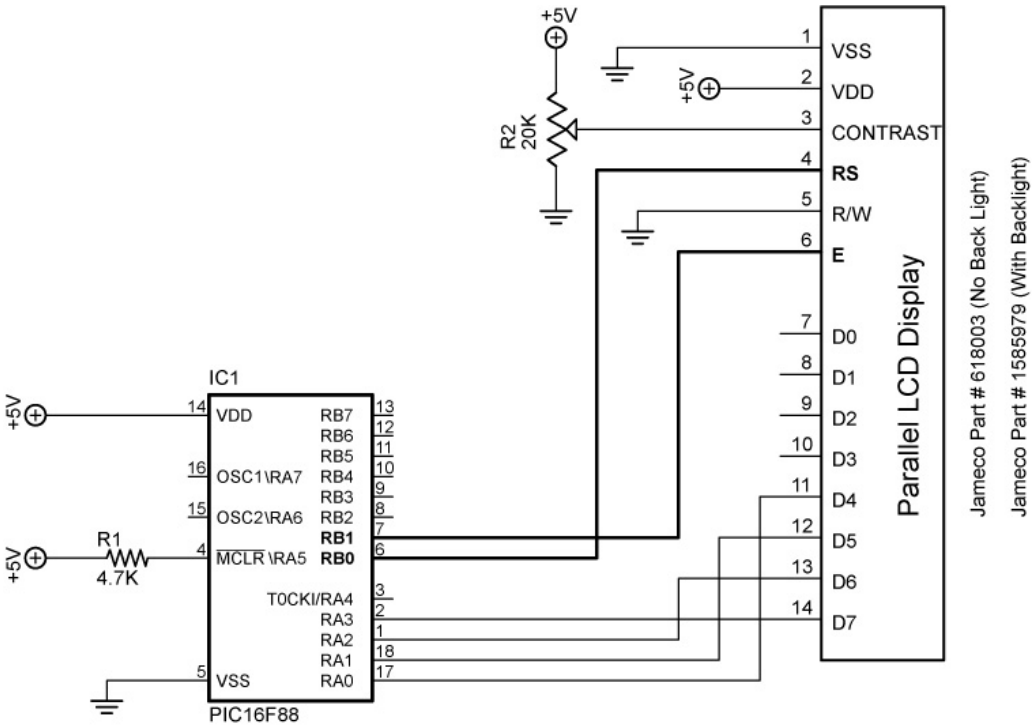


Figure 4, Revised Register Select and Enable Connections

- **DEFINE LCD_BITS** sets the **bus size** (4-bits or 8-bits).
  - Examples:
    - DEFINE LCD_BITS 4 ‘Sets 4-bit bus
    - DEFINE LCD_BITS 8 ‘Sets 8-bit bus
  - PicBasic Pro default setting for bus size is a 4-bit bus.
- **DEFINE LCD_LINES** sets the **number of lines** on the LCD.
  - Examples:
    - DEFINE LCD_LINES 4 ‘Sets LCD to display 4 lines
    - DEFINE LCD_LINES 2 ‘Sets LCD to display 2 lines
  - PicBasic Pro default setting is for the number of lines on the LCD is a 2 line LCD display.

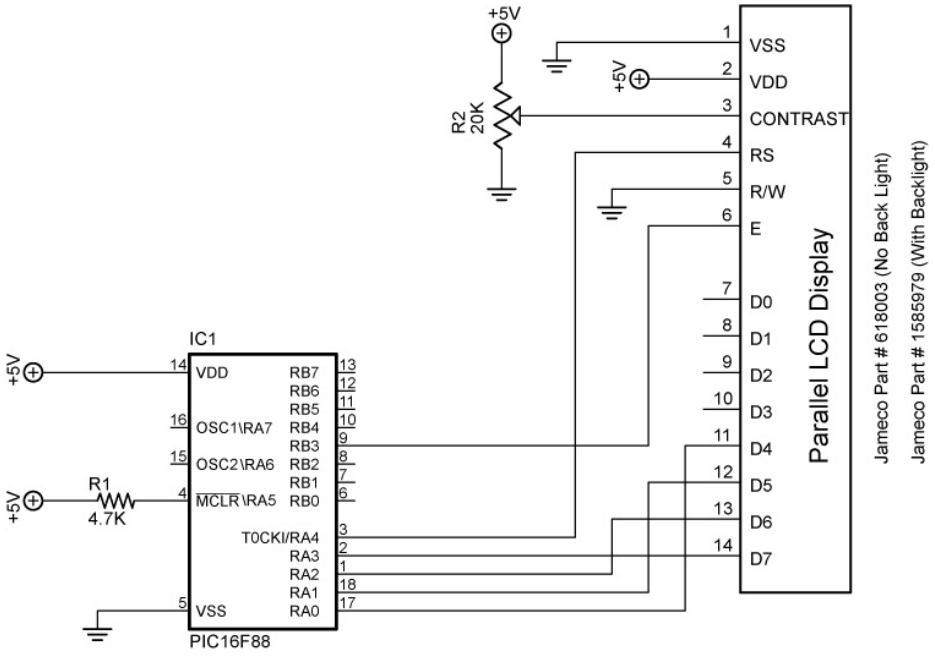
- In summary, LCD connections to PICs can be changed from their PIC default settings by using the DEFINE statements listed above.
- We will need use these features in our lesson on analog-to-digital conversion.
- Perform LCD2 LAB 2 – Changing LCD Pins on a PIC

Electronics and Robotics I Week 19
LCD Lesson 2 LAB 1 – LED Status on LCD

- **Purpose:** The purpose of this lab is to show the student how to use an LCD to display the state of an output.

- **Apparatus and Materials:**
  - Analog/Digital Trainer or Breadboard w/ 5VDC Supply
  - PIC 16F88 Microcontroller
  - Hantronix HDM16216H-5-300S 16x2 LCD, Jameco #618003
  - 1 – 4.7K Resistor
  - 2 – 220 Ohm Resistors
  - 20 K Potentiometer
  - 2 – LEDs

- **Procedure:**
  - Wire the following circuit lcd1.
  - Open **LCD1.pbp** from your folder and run the program to check your connections.



lcd1 and lcd2

- **Challenges**:
  - Connect one LED (LED1) with a 220 ohm resistor to PORTB.1 and program it to blink on and off every second. Display "LED1" and its state (0 or 1) as a variable on the LCD. Save the program as **lcd16.pbp**. Don't forget to set the proper bits in the TRISB register to outputs as needed and insert "ANSEL = 0" into your initializations. To display your variable "x", your command should be:

    LCDOUT $FE,1," LED1 = ", #x
  - Connect a second 220 ohm resistor and LED (LED2) to PORTB.2 and program it to blink opposite LED1. Display "LED1" on the first line and "LED2" on the second line along with their respective states as variables. Save the program as **lcd17.pbp**.

LCD Command Table

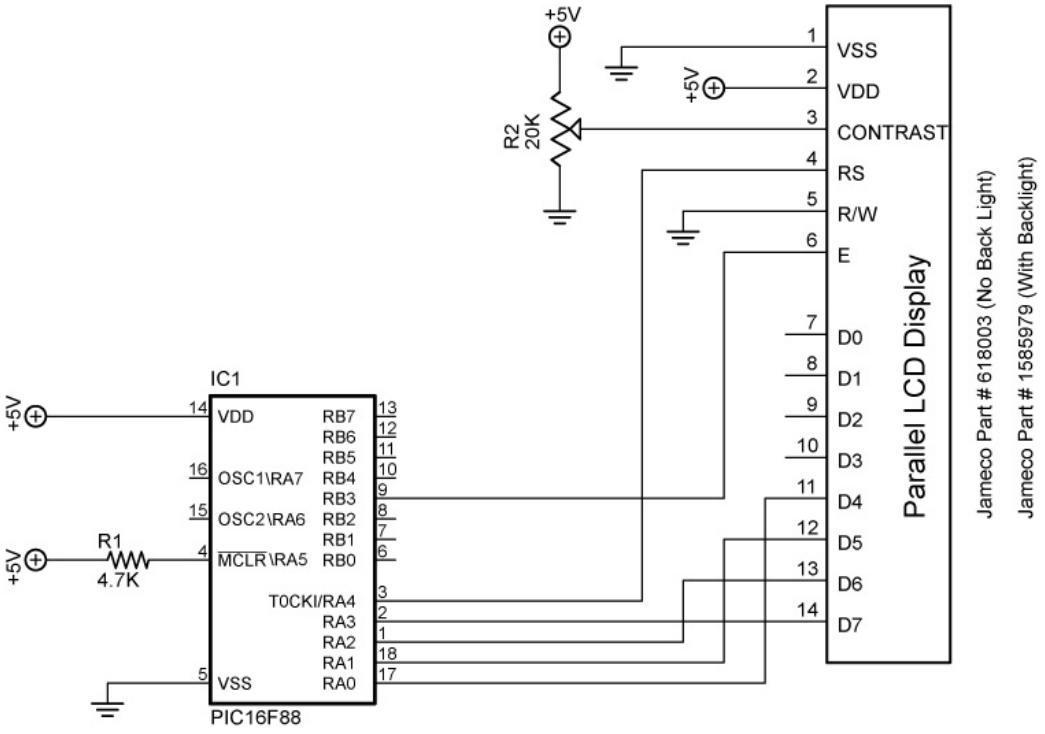
Command	Operation
$FE, 1	Clear display
$FE, 2	Return home
$FE, $0C	Cursor off
$FE, $0E	Underline cursor on
$FE, $0F	Blinking cursor on
$FE, $10	Move cursor left one position
$FE, $14	Move cursor right one position
$FE, $18	Display shift left
$FE, $1C	Display shift right
$FE, $80	Move cursor to beginning of first line
$FE, $C0	Move cursor to beginning of second line
$FE, $94	Move cursor to beginning of third line
$FE, $D4	Move cursor to beginning of fourth line

Electronics and Robotics I Week 19
LCD Lesson 2 LAB 2 – Changing LCD Pins on a PIC

- **Purpose:** The purpose of this lab is to acquaint the student with changing the default connections of an LCD to a PIC chip.

- **Apparatus and Materials:**
  - Analog/Digital Trainer or Breadboard w/ 5VDC Supply
  - PIC 16F88 Microcontroller
  - Hantronix HDM16216H-5-300S 16x2 LCD, Jameco #618003
  - 1 – 4.7K Resistor
  - 1 – 20 K Potentiometer

- **Procedure:**
  - Wire the following circuit lcd1.
  - Download **lcd1.pbp** into the PIC16F88
  - Change the LCD pin connections from their default settings to:
    - Data port: PORTB (replace PORTA)
    - Starting data bit: 0 (replace RA0 with RB0)
    - Register Select port: PORTB (replace PORTA)
    - Register Select bit: 4 (replace RA4 with RB4)
    - Enable port: PORTB (same PORTB)
    - Enable bit: 5 (replace RB3 with RB5)
  - Save the revised **lcd1.pbp** as **lcd18.pbp**
  - Rewire the circuit below to reflect the change in LCD pin connections.



lcd1 and lcd2

Schematic Showing LCD Default Connections to a PIC16F88