



# Chapter 6: Digital Display

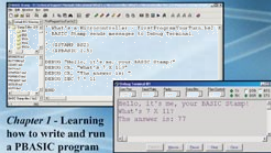
# PARALLAX

## What's a Microcontroller?

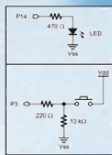
by Andy Lindsay

Introductory BASIC Stamp programming with simple circuits including LEDs and pushbuttons.

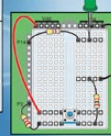
Hours to completion: 40  
Level of Difficulty (out of 10): 3



Chapter 1 - Learning how to write and run a PBASIC program



Chapter 3 - Wiring a pushbutton and LED circuit



Learn electronics with the world's most popular microcontroller, the BASIC Stamp 2.

Presentation developed by:  
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Southern Illinois University Carbondale  
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9/10/03



What's a Microcontroller?



# Presentation Index

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# Use and Copyright

What's a Microcontroller?

This presentation supplements "**What's a Microcontroller**" by Andy Lindsay. ([Link to text](#) at Parallax)

- ✓ This presentation is not a replacement for the text.
- ✓ Important concepts of the text are highlighted.
- ✓ In some cases, additional material has been added to augment the text. Denoted by titles colored **gold**.
- ✓ Full program listings are generally not provided in the presentation.

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# Every-Day Digital Display

Digital displays are found on many devices, one being a microwave oven timer. Each of the 3 digits is a 7-segment display controlled by a microcontroller.



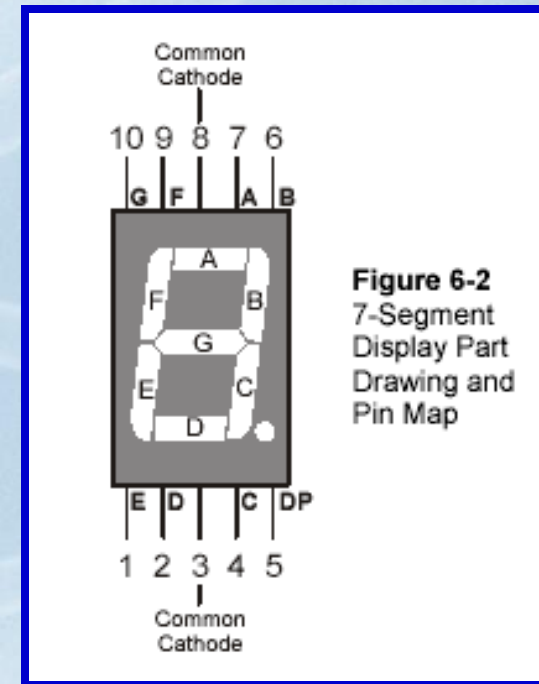
What's a Microcontroller?



# What's A 7-Segment Display?

A 7-segment display is a package with 7 bar-shaped LEDs arranged to allow the display of many useful digits and some letters.

Each segment (labeled A-G) contains an LED which may be individually controlled. DP is an eighth LED, the decimal point.



What's a Microcontroller?



# What's a Microcontroller?

Common cathode means that each segment's cathode is connected to common pins - 3 & 8, allowing the anode of each to be connected to the controller.

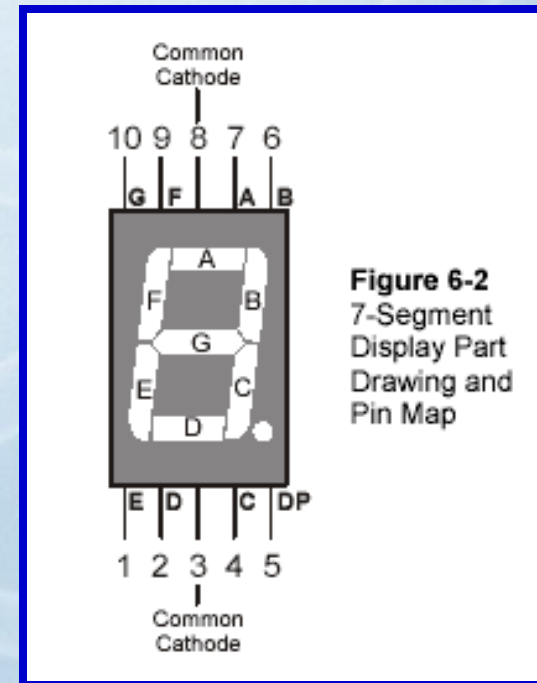


Figure 6-2  
7-Segment Display Part Drawing and Pin Map

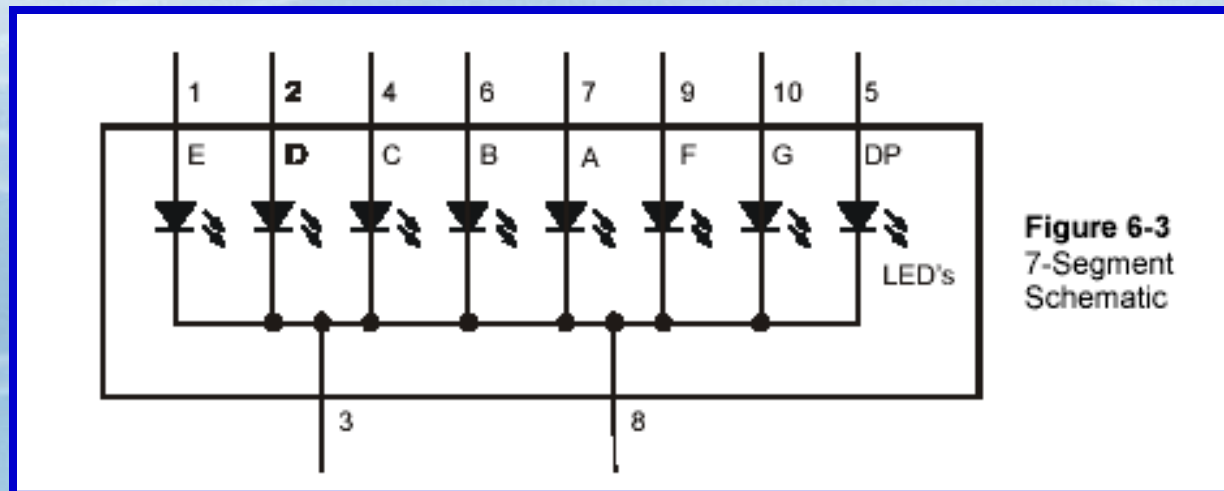


Figure 6-3  
7-Segment Schematic

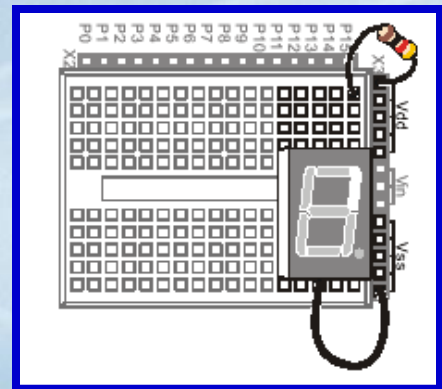
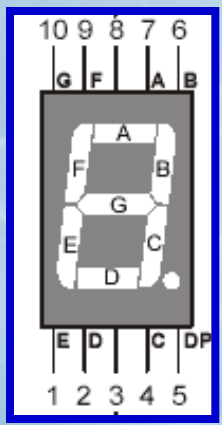
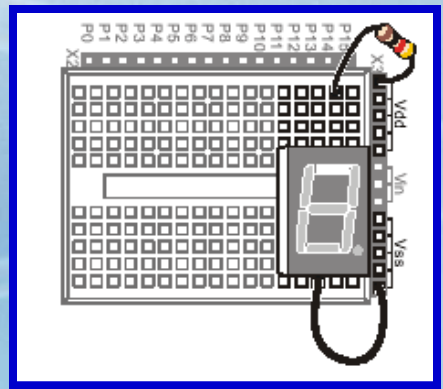
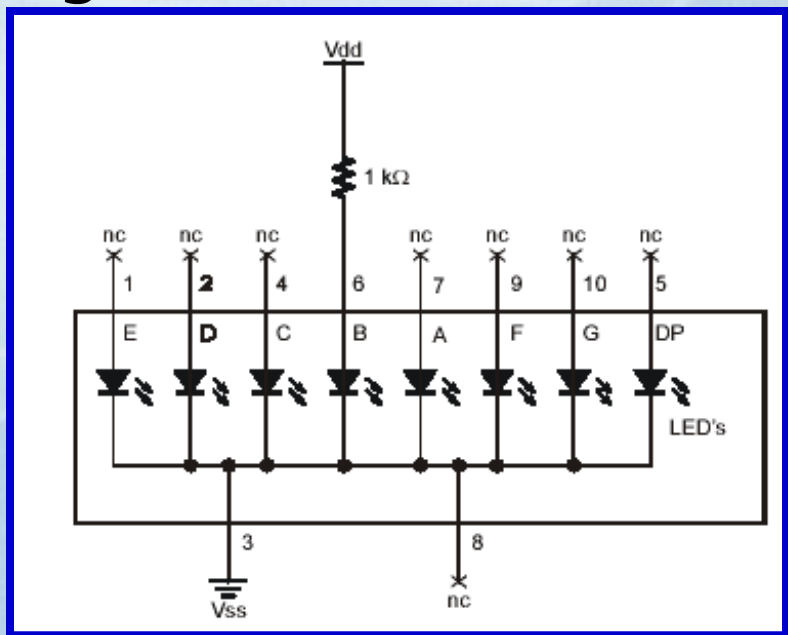
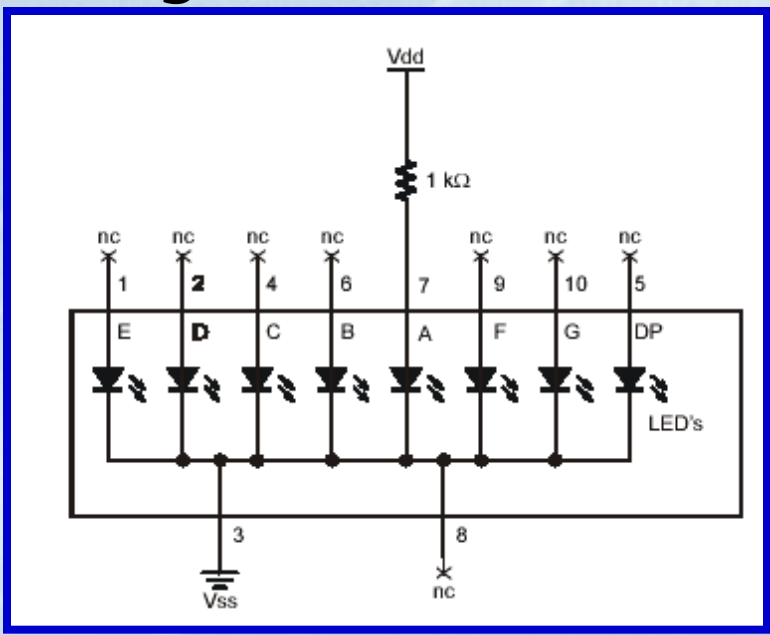




# Activity #1: Building and Testing 7-Segment Display

By supplying anodes with Vdd, individual segments can be energized.

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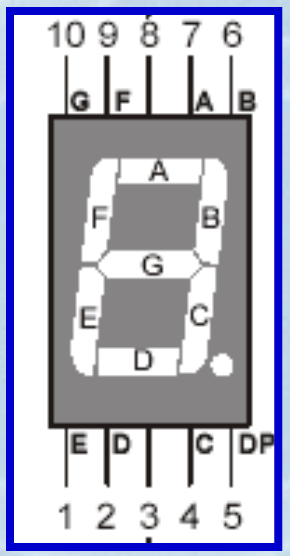
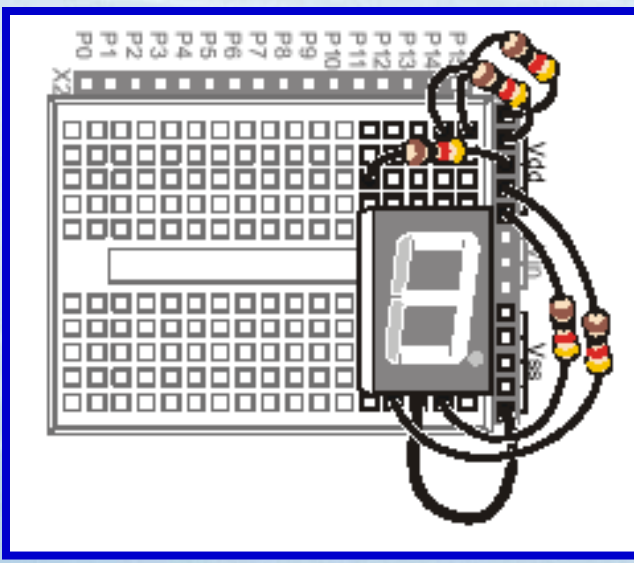
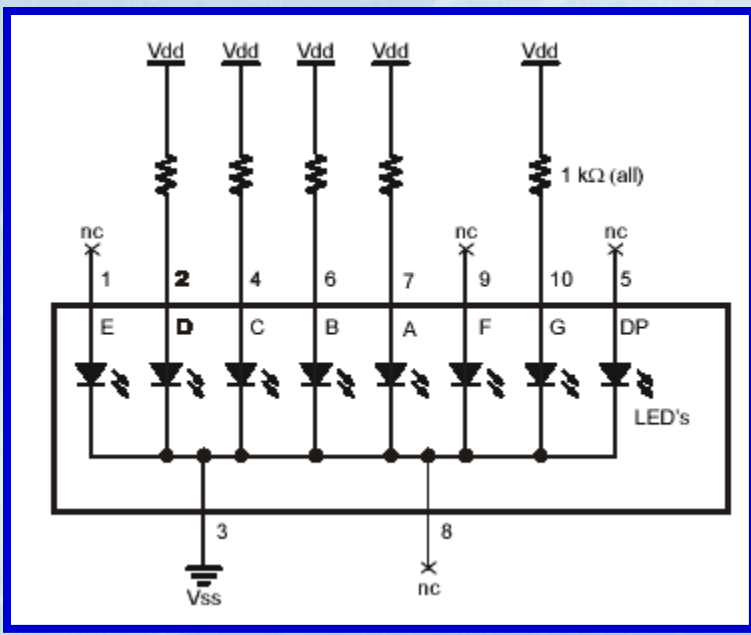






What's a Microcontroller?

# Displaying the number 3.



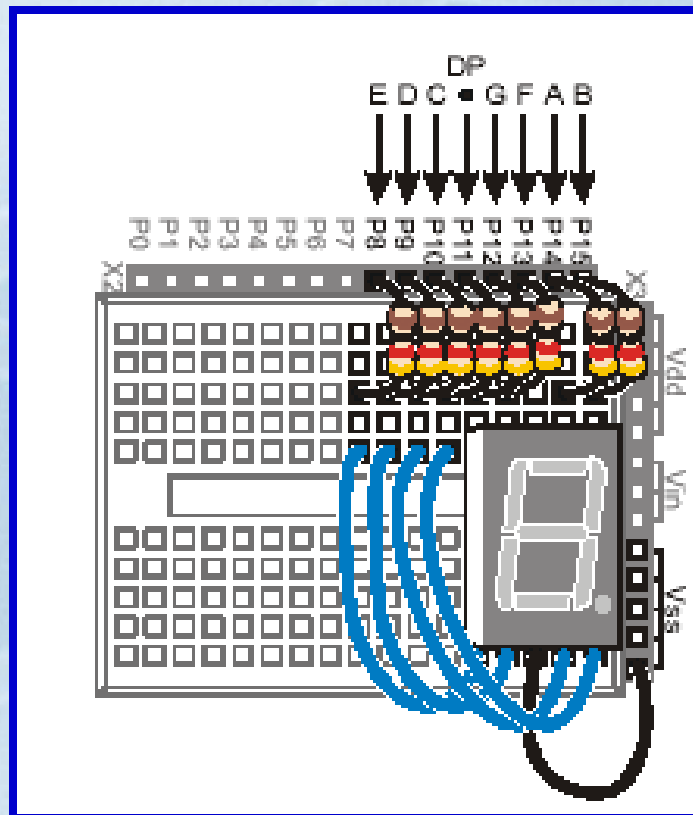
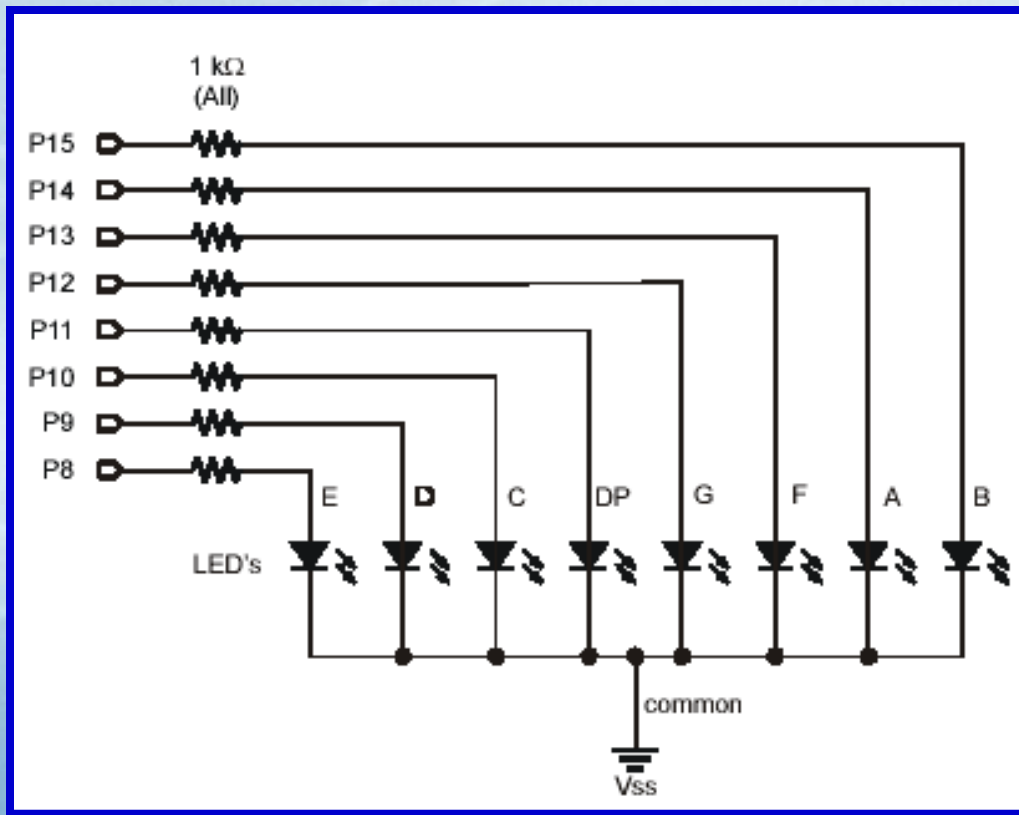
What segments would be lit to display the number 2 and the letter A?



# Activity #2: Controlling the Display

Of course the BASIC Stamp can control Vdd to the segments from the I/O pins.

What's a Microcontroller?







# What's a Microcontroller?

The *SegmentTestWithHighLow* program will energize each segment one at a time.

```
' What's a Microcontroller - SegmentTestWithHighLow.bs2
' Individually test each segment in a 7-Segment LED.
' {$STAMP BS2}
' {$PBASIC 2.5}
pinCounter VAR Nib
DEBUG "I/O Pin", CR,
      "-----", CR
FOR pinCounter = 8 TO 15
  DEBUG DEC2 pinCounter, CR
  HIGH pinCounter
  PAUSE 1000
  LOW pinCounter
NEXT
```

What happens if the "LOW pinCounter" line is commented out?



# Activity #3: Displaying Digits

The HIGH and LOW instructions could be used to control the display for digits 0-9 by energizing the required segments, but it would require a considerable amount of code.

DIR and OUT are two internal variable locations (registers) which can be used to control a single I/O or all I/O simultaneously. This allows a single line of code to display a unique digit.

What's a Microcontroller?







# DIR and OUT

The HIGH and LOW commands really performs 2 functions:

- ✓ Sets the I/O pin to act as an output
- ✓ Sets the state of output: 0 or 5V

DIR and OUT are used to independently set the direction (DIR) and the state of the output (OUT).



The code of **HIGH 5** could be replaced with:

```
DIR5 = 1
```

```
OUT5 = 1
```

If the direction is 1, the I/O is an output.

If 0, the I/O is an input.

If the output is 1, the I/O will be HIGH.

If 0, the I/O will be LOW.

But the true power of DIR and OUT is that a group of bits can be controlled all at once.





For example:

`DIRA = %1100`

The % symbol means the number that follows is a **binary value** where only 1 or 0 can be used and each position is one bit.

DIRA refers to the 1<sup>st</sup> 4 I/O positions:  
P3 to P0

So, putting it together, the code would perform the following:

`DIR3 = 1: DIR2 = 1: DIR1 = 0: DIR0 = 0`



$OUTA = \%1000$  would also set the 1<sup>st</sup> 4 I/O performing:  
 $OUT3 = 1:OUT2 = 0:OUT1 = 0:OUT0 = 1$

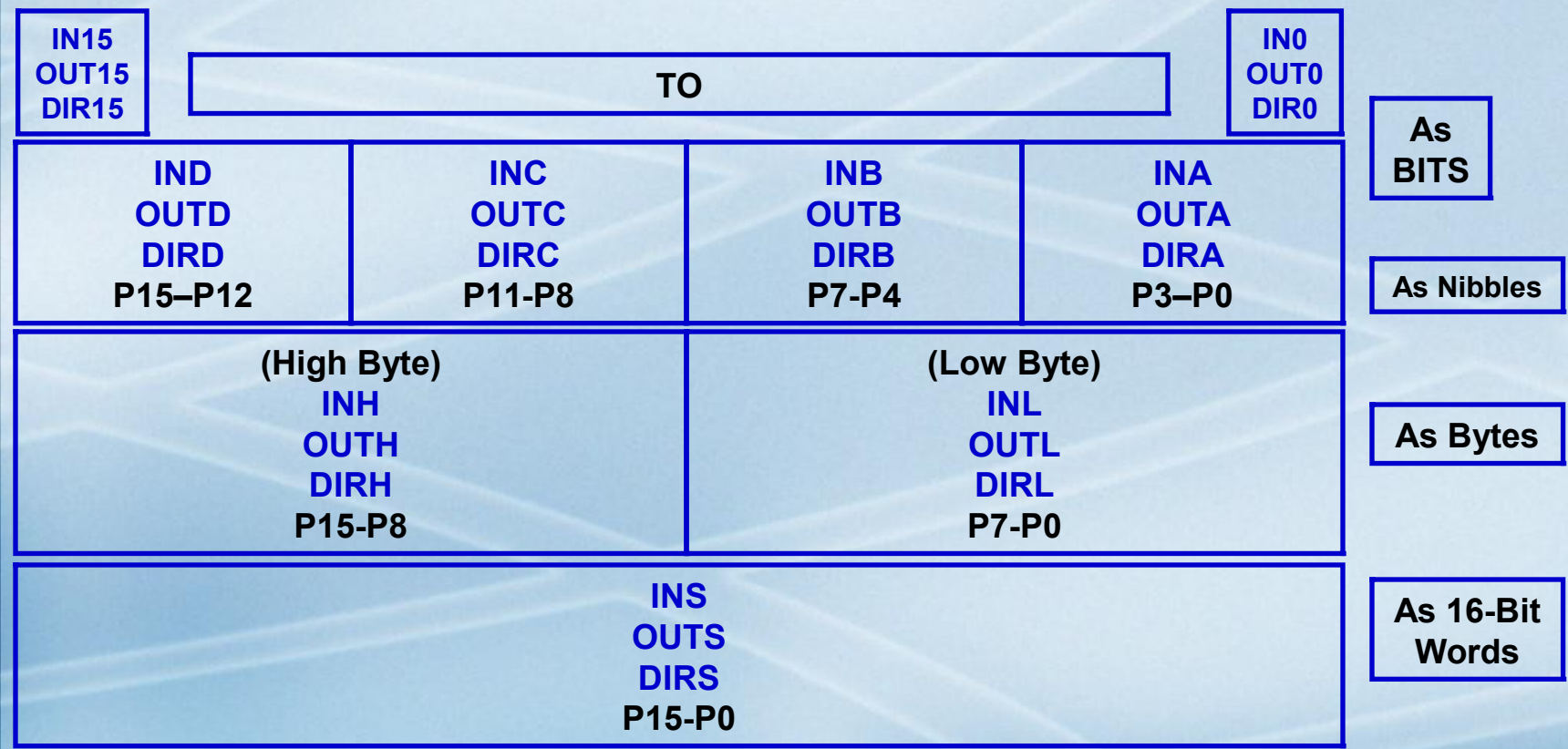
The DIRs and OUTs can be by bit, by nibble (groups of 4), by bytes (groups of 8) or as a word (all 16 I/O at once).





# What's a Microcontroller?

The chart below illustrates how to access the various locations and sizes. IN is a way of reading multiple inputs simultaneously.







# Displaying a bit pattern on the segments

With our 7-segment LEDs on P8 to P15 code can be written to control all 8 segments at once using DIRH and OUTH since it is the high byte.

**DIRH = %11111111**

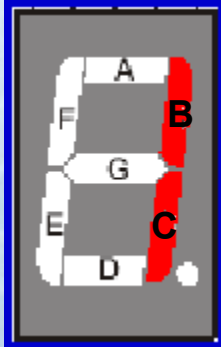
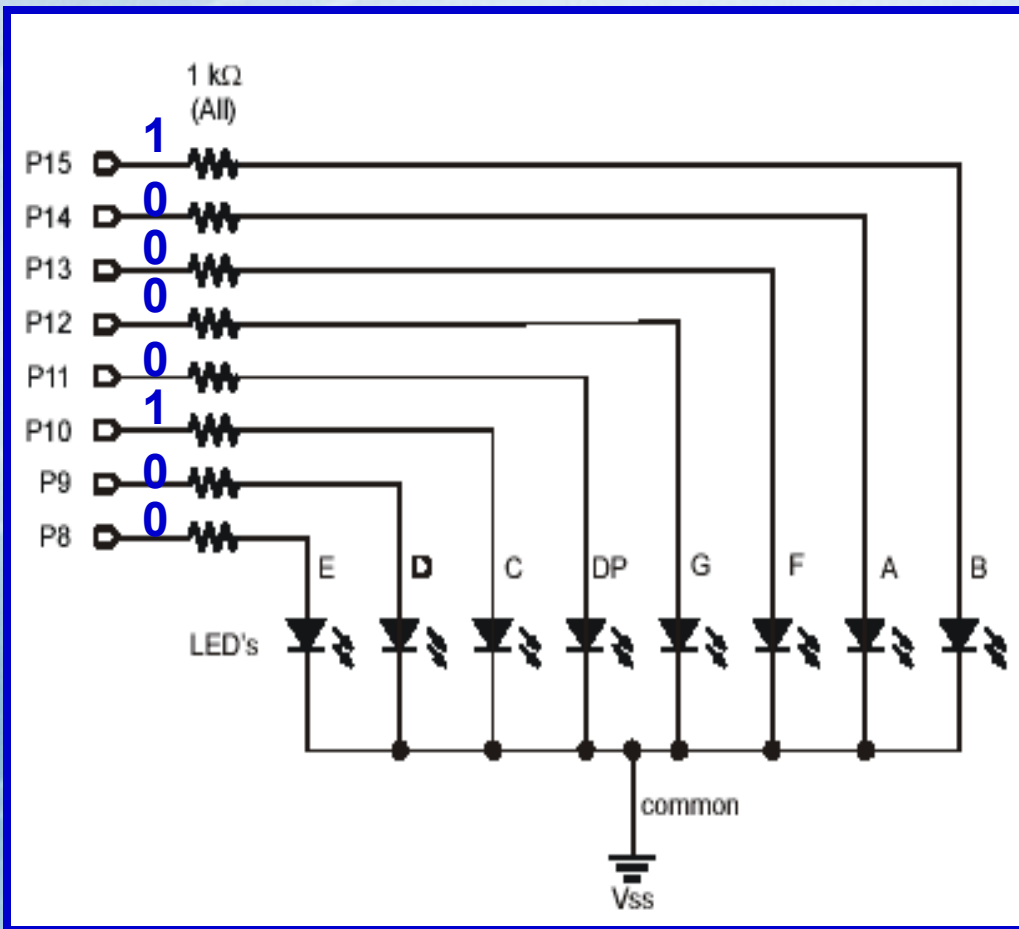
Will set P8 to P15 to be outputs.



What's a Microcontroller?

**OUTH = %10000100**

Sets segments B (P15) and C (P10) to be HIGH (on) and the remainder LOW (off)



**i** The display is a **parallel device** since multiple lines are used to transmit the bit sequence.

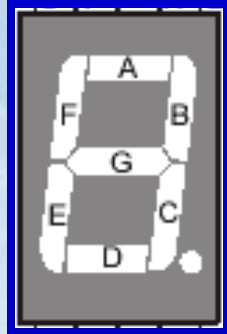




# DisplayDigits Program

The *DisplayDigits* program goes through the bit pattern sequence for the numeric digits 0 to 9.

```
' What's a Microcontroller - DisplayDigits.bs2
' Display the digits 0 through 9 on a 7-segment display.
'{$STAMP BS2}
'{$PBASIC 2.5}
OUTH = %00000000 ' OUTH initialized to low.
DIRH = %11111111 ' Set P8-P15 to all output-low.
' Digit:
' BAFG.CDE
OUTH = %11100111 ' 0
PAUSE 1000
OUTH = %10000100 ' 1
PAUSE 1000
OUTH = %11010011 ' 2
PAUSE 1000
OUTH = %11010110 ' 3
```



What's a Microcontroller?





# Using LOOKUP for Lists

The LOOKUP command allows you to, well, lookup elements in a list.

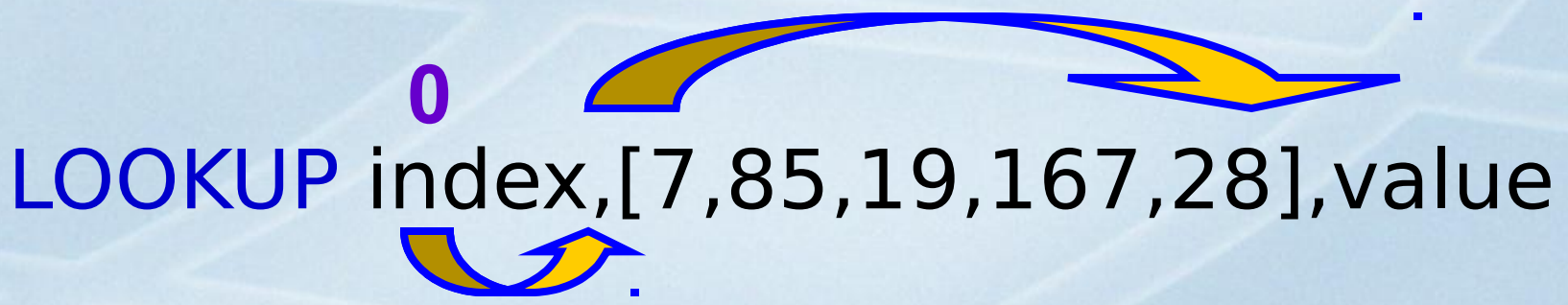
**LOOKUP** index,  
[7,85,19,167,28],value

- ✓ Index is a variable to point to a list position with the 1<sup>st</sup> being the zero position.
- ✓ The values is []'s are the list elements.
- ✓ Value is a variable that will be used to store the value that was indexed.



# What's a Microcontroller?

For example, if the value of index = 0:



0 points to the first position, so the 7 is stored in value.

If the value of index = 3:



3 points to the 4th position, so the 167 is stored in value.



# DisplayDigitsWithLoopup Program

The LOOKUP command can be used to make displaying the 7-segment digits much cleaner and simpler.

```
' What's a Microcontroller - DisplayDigitsWithLookup.bs2
' Use a lookup table to store and display digits with a 7-segment display.
'{$STAMP BS2}
'{$PBASIC 2.5}
index VAR Nib
OUTH = %00000000
DIRH = %11111111
DEBUG "index OUTH ", CR,
"-----", CR
FOR index = 0 TO 9
  LOOKUP index, [ %11100111, %10000100, %11010011,
                 %11010110, %10110100, %01110110,
                 %01110111, %11000100, %11110111, %11110110 ], OUTH

  DEBUG " ", DEC2 index, " ", BIN8 OUTH, CR
  PAUSE 1000
NEXT

DIRH = %00000000
END
```





# Activity #4: Display Dial Position

What's a Microcontroller?

In this activity the segments of the display are lit to indicate the position of a potentiometer dial.

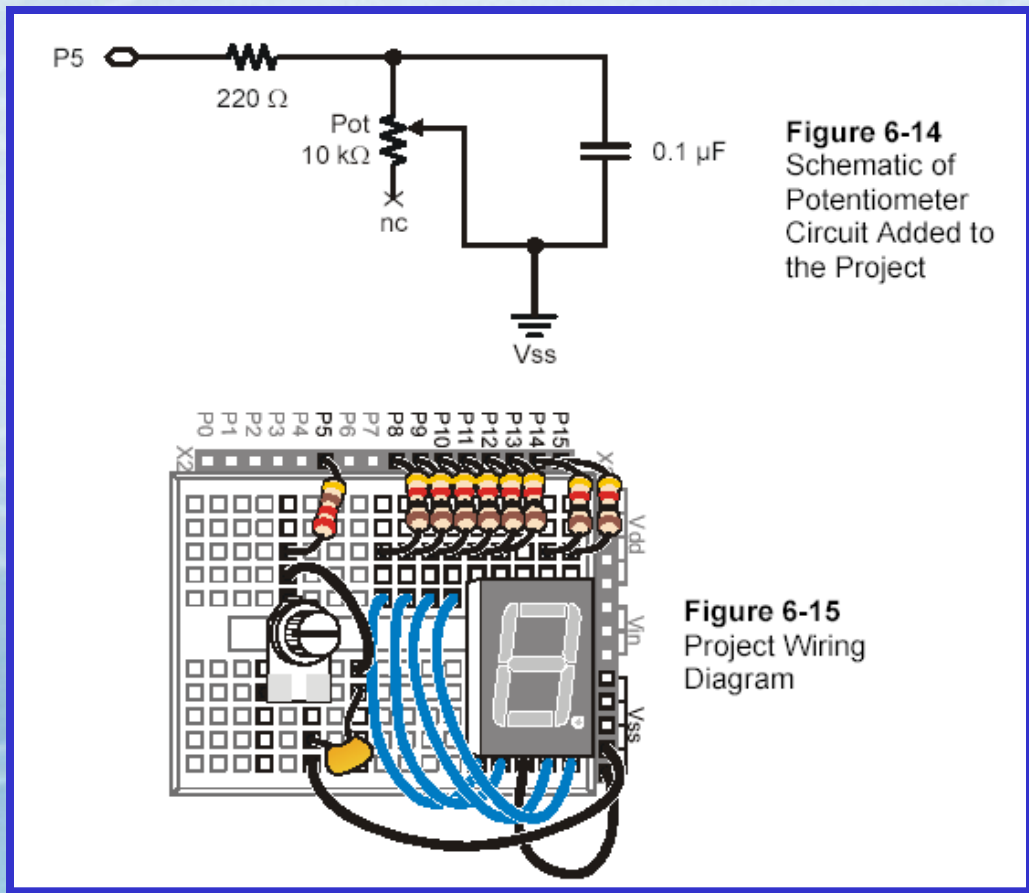


Figure 6-14  
Schematic of  
Potentiometer  
Circuit Added to  
the Project

Figure 6-15  
Project Wiring  
Diagram



# Using LOOKDOWN to Find Index

LOOKDOWN works just opposite of LOOKUP in that where a value lies in a list returns the index for that value.

**LOOKDOWN** value, <=[7,19,28,85,167], index

For example, if value = 15, 19 would be the first choice in the list since value is less than or equal to 19. Since 19 is in the 1-spot in the list, 1 will be stored in index.

=, <=, >= may be used for indexing.

What's a Microcontroller?



In the program:

- ✓ The value of the potentiometer is used to retrieve an index position.
- ✓ The index position retrieved is used to retrieve a bit-pattern for the 7-segment display.

```
HIGH 5
PAUSE 100
RCTIME 5, 1, time
LOOKDOWN time, <= [40, 150, 275, 400, 550, 800], index
LOOKUP index, [ %11100101, %11100001, %01100001,
               %00100001, %00000001, %00000000 ], OUTH
```





# Chapter #6 Review

1. The display discussed had an array of LEDs with common \_\_\_\_\_ for power.
2. To light a 4 on the display, segments \_\_\_\_, \_\_\_\_, \_\_\_\_, \_\_\_\_ would be on.
3. `DIRH=%11111111` sets P\_\_ to P\_\_ to \_\_\_\_\_ (outputs or inputs).
4. The LOOKUP command returns a value based on the \_\_\_\_\_.
5. The LOOKDOWN command returns a \_\_\_\_\_ based on the value.



# Links

- ✓ BASIC Stamp Home
- ✓ Stamps In Class Home
- ✓ BASIC Stamp Software
- ✓ BASIC Stamp Robots
- ✓ BASIC Stamp Yahoo Group
- ✓ Stamps In Class Yahoo Group
- ✓ SIUC EST Degree

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