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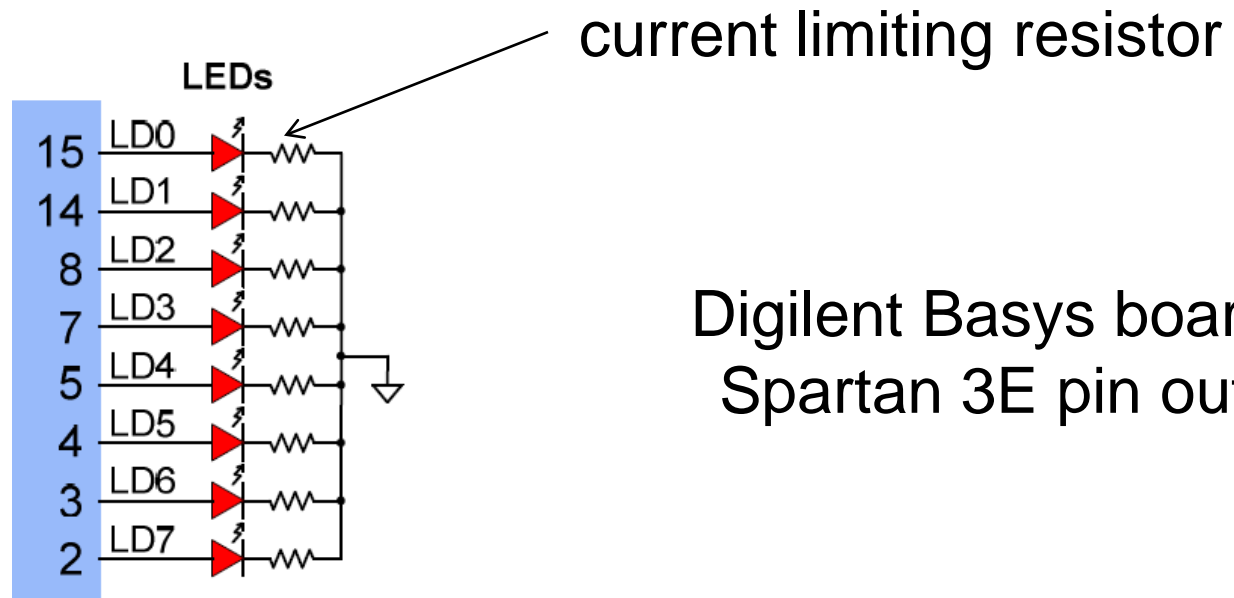
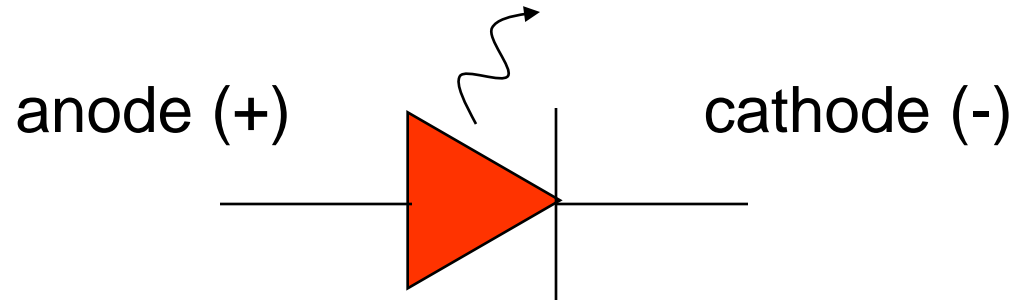
## CSE 20221: Logic Design

# Using the 4-Digit 7-Segment Display on the Digilent Basys Board

[http://www.digilentinc.com/Data/Products/BASYS/BASYS\\_E\\_RM.pdf](http://www.digilentinc.com/Data/Products/BASYS/BASYS_E_RM.pdf)

listed under links in course web site

# LEDs



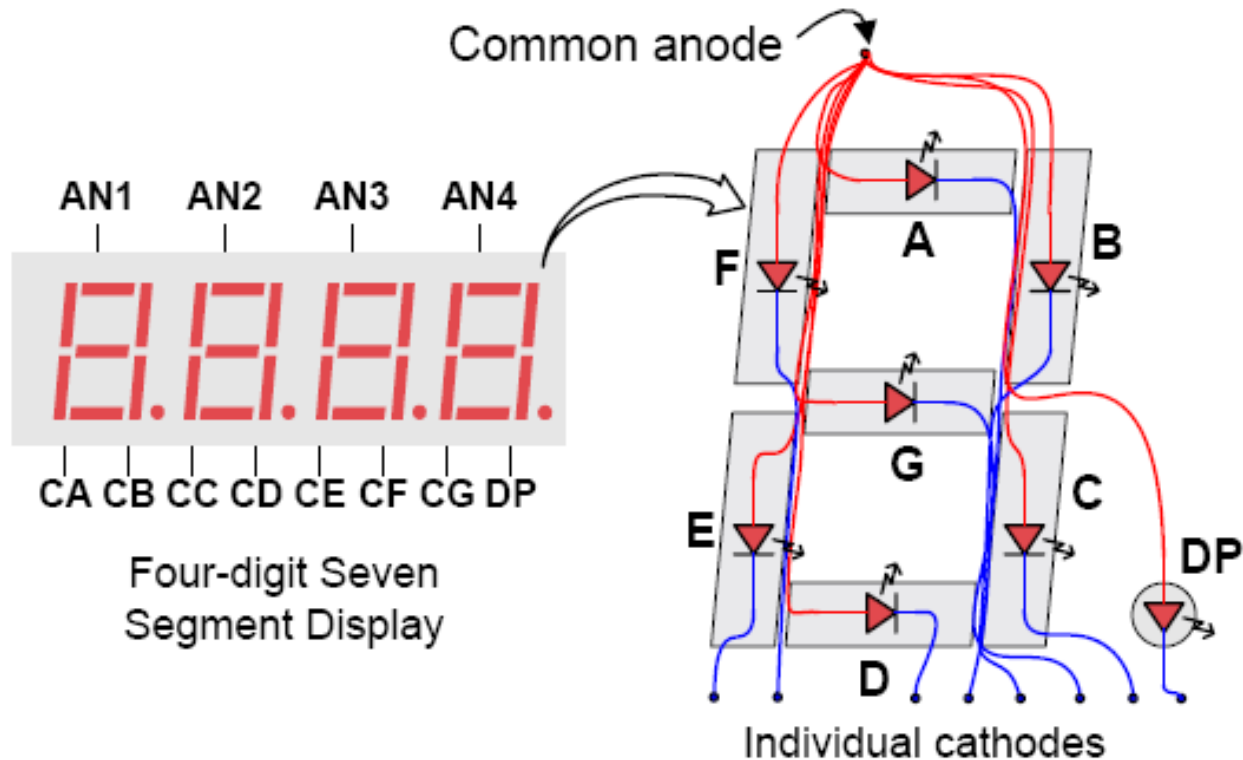
Digilent Basys board  
Spartan 3E pin out

# Current limiting resistor calculation

- $R > (V_{cc} - V_d) / I_{d_{max}}$
- Assume:
  - the led voltage drop,  $V_d = 1.3 \text{ V}$
  - the maximum diode current,  $I_{d_{max}} = 10 \text{ mA}$
  - the supply voltage,  $V_{cc} = 3.3 \text{ V}$

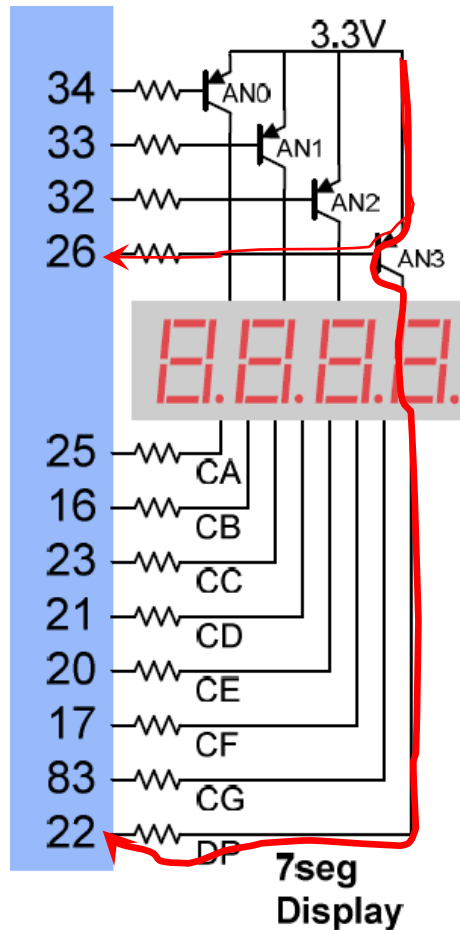
$$R > 200 \Omega$$

# Seven-Segment Display



- Apply low voltage to cathodes (CA-CG) to select segments (logic 0 = low voltage on Basys board)
- Apply high voltage to anodes (AN1-AN4) to select digit

# Seven-Segment Display Basys Pin Out



- transistor switches are “p-type”, assert “0” (low voltage) to turn them on
- assert “0” on pins P26,32,33,34 to select appropriate digit
- assert “0” on pins P16,17,20,21,23,25,83 to select appropriate segments
- Need to multiplex cathode data (more on that in a later lab)

# The Design Process

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- Interpret the problem statement
- Identify inputs and outputs
- Assign assertion voltage levels
- Develop a high level representation, e.g., block diagram
- Transform the high level information into applicable design representation, e.g., truth table, Boolean equation, schematic, high-level language
- Simulate, verify and validate behavior
- Download design to target device

# Lab Design Problem Statement

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- Design a circuit that will display a digit on a 7-segment LED display. The digit corresponds to its binary equivalent value represented by the position of four switches.
- Consider the numbers 0000 thru 1001 as the only valid numbers, i.e., binary coded decimal (BCD). Numbers greater than 1001 can be considered as “don’t care” conditions.

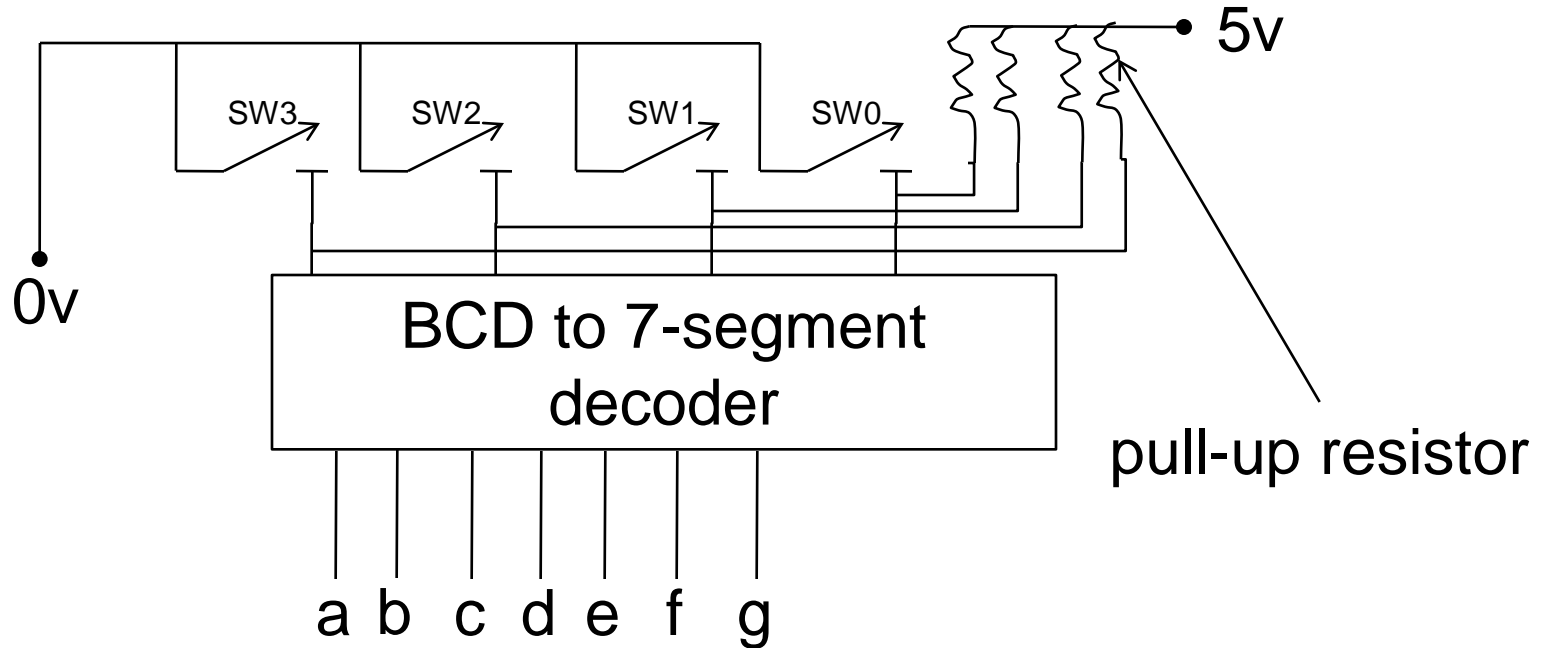
# Identify Inputs and Outputs

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- Inputs: sw0, sw1, sw2, sw3
- Outputs: a, b, c, d, e, f, g, anode1



# Block Diagram



A pull-up resistor forces the voltage at the input to equal 5 v when the switch is open. The input shouldn't be left to "float", which can cause erratic values.

# Translate to Design Format

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- Truth table
- Karnaugh map
- Schematic

# Simulation

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- Verification – does the circuit simulate according to its intended design?
- Validation – does the circuit function according to what the customer wanted?
- Make any necessary design changes to correct any invalid behavior

# Prototype

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- Download design to prototype board
- Verify correct functionality
- Repeat necessary design steps to correct any problems

# Design: An Iterative Process

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- The design process is presented as a sequence of well organized steps
- In reality, design is an iterative process:
  - cyclic, i.e., revisit the different steps:
    - analysis
    - design
    - testing: verification and validation
- A product “evolves” over several design and product iterations

# Homework

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- None for this lecture