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# **Breadboards and Test Points**

## **ECE 403 Senior Design II**

### **Week #5**

Please visit Bison Academy for corresponding lecture notes,  
homework sets, and videos  
[www.BisonAcademy.com](http://www.BisonAcademy.com)

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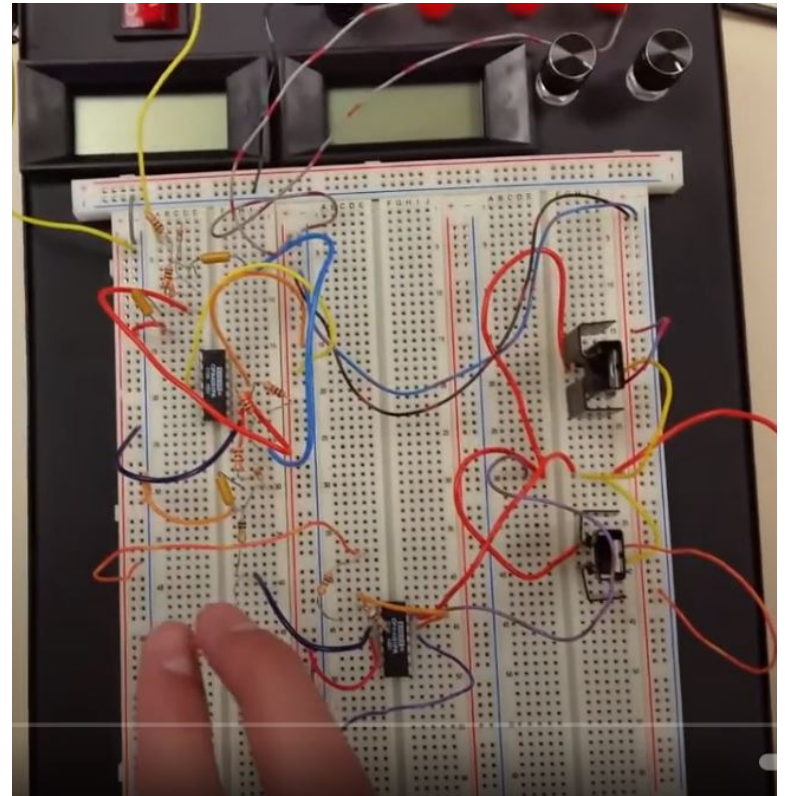
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## Breadboards:

Once you have your circuit

- Designed on paper, and
- Tested in simulation (CircuitLab)

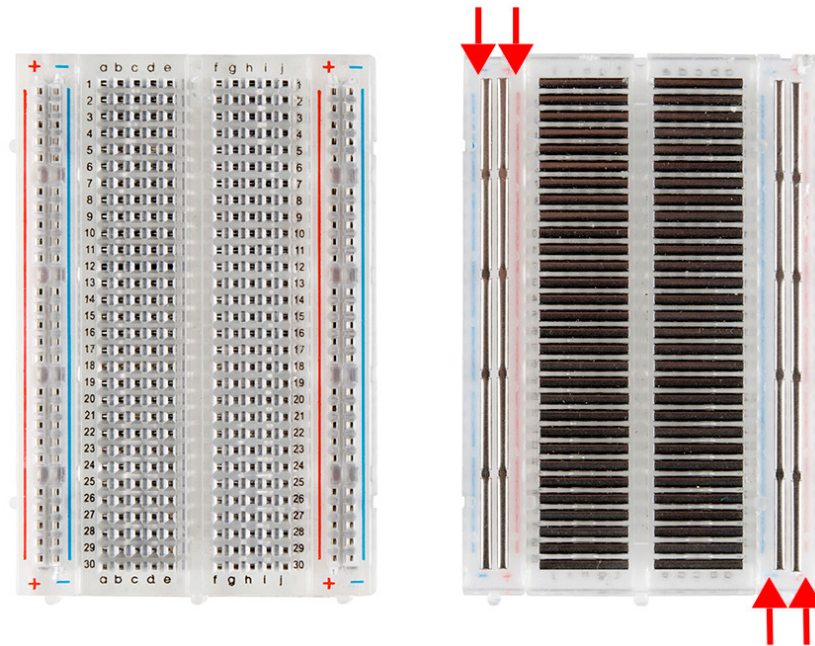
you're ready to test your design in hardware. Breadboards are an easy way to build your circuit and test your design. They're also easy to modify and change: components can be easily added and removed from a breadboard.



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Most of the breadboard used in ECE are 830 tie breadboards. These have

- Four edge connectors that are shorted along the length of the breadboard
  - two left side, two right side. Usually used for power and ground
- Two sets of connectors in the middle
  - one left and one right of the center bar.
- Across the middle is an insulator
  - this separates the middle connectors by 300 mils: the width of a typical IC,



Breadboard Top (left) and back side (right)

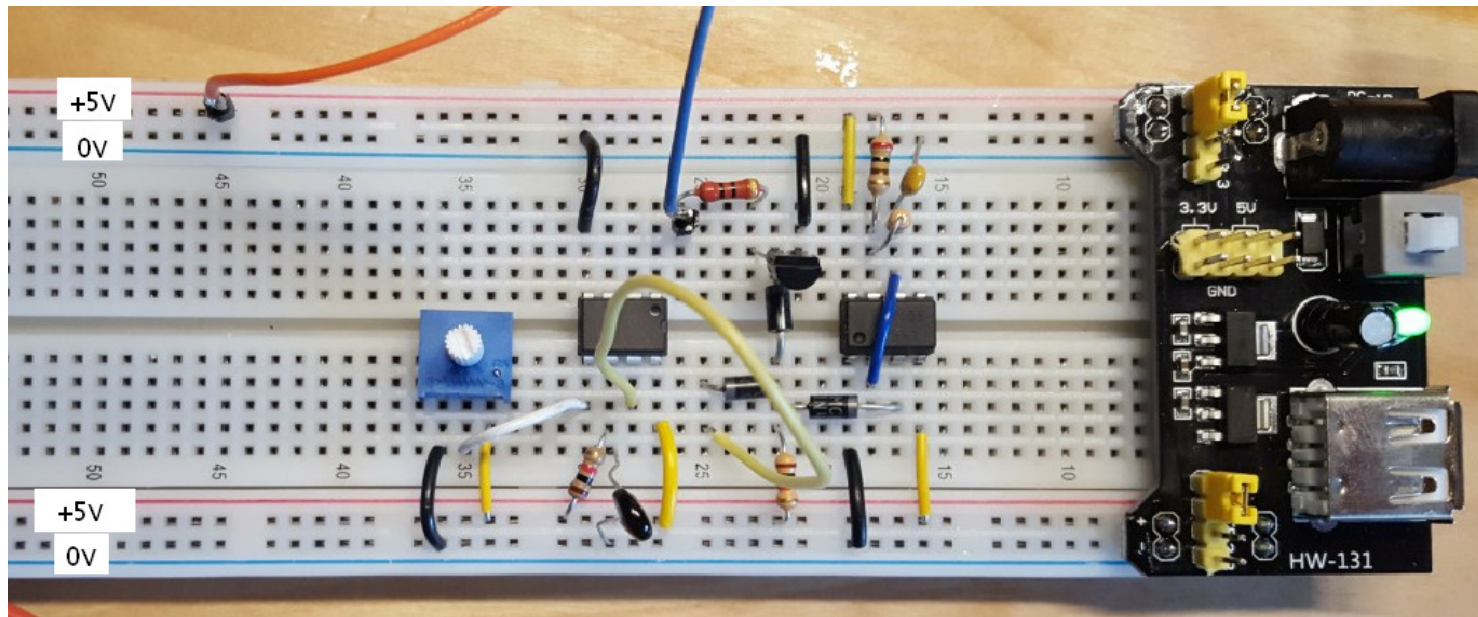
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For example, the following breadboard circuit uses

- The red trace along the top and bottom as +5V
- The blue trace along the top and bottom as 0V
- Two IC's go across the middle divider.

The four pins above and below each IC then allow you to connect to that pin



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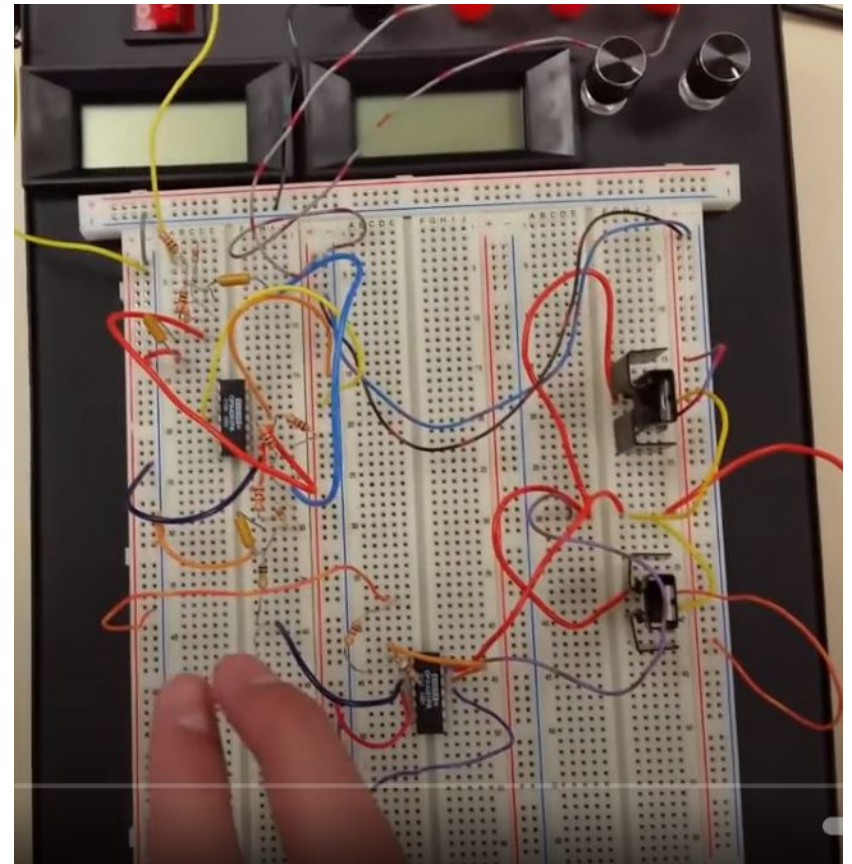
## Purpose of Breadboarding:

Verify your design works in practice

- Step 1) Paper Design
  - In theory it works...
- Step 2) Simulation (CircuitLab)
  - Check your design with nonlinear models
- Step 3) Breadboard
  - Check your actual design
- Step 4) PCB
  - More permanent & abuse tolerant
  - Less noise sensitive
  - Smaller, easier to package

Notes: With a breadboard

- Changes are fairly easy to implement
- Components & values can be changed pretty easily

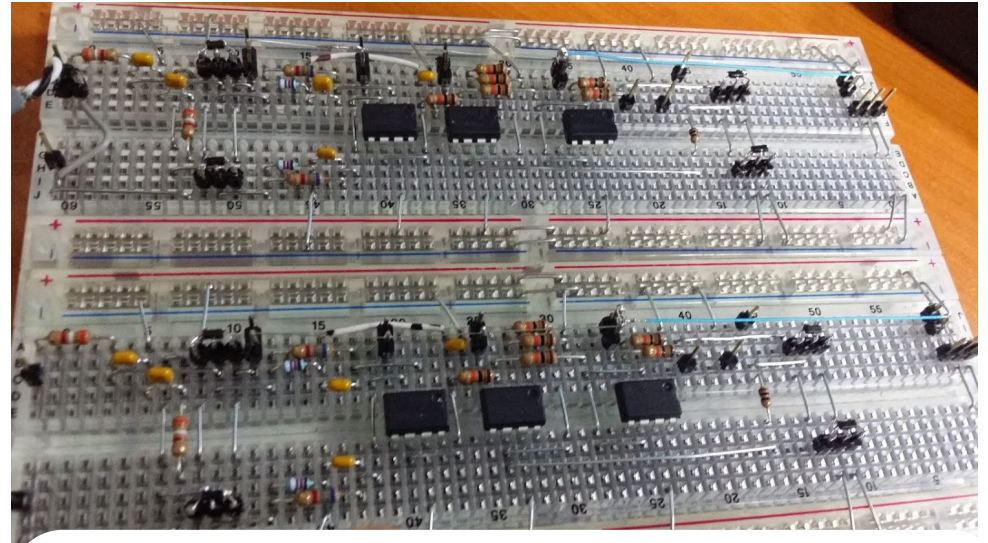


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# Tricks of Breadboarding

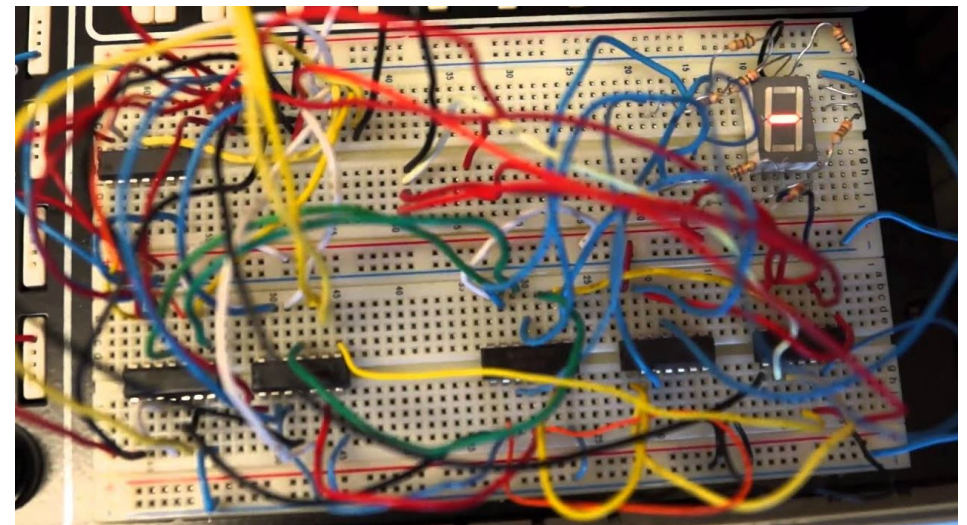
## 1) Keep Your Circuit Neat

- Use short wires
- Use short component leads
- Organize your breadboard into sections



### Keeping your wires short

- Reduces the noise picked up by your wires
- Reduces the chance of a wire falling out
- Helps you see the wiring in your board
- Helps when you need to modify your breadboard circuit.



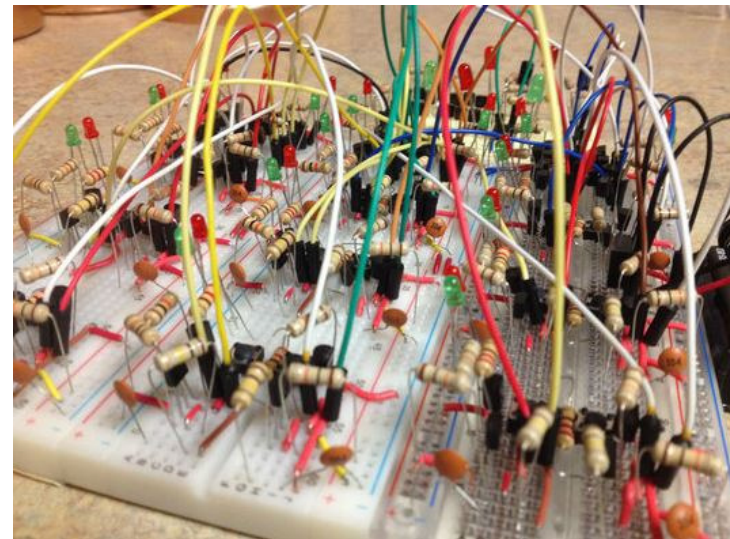
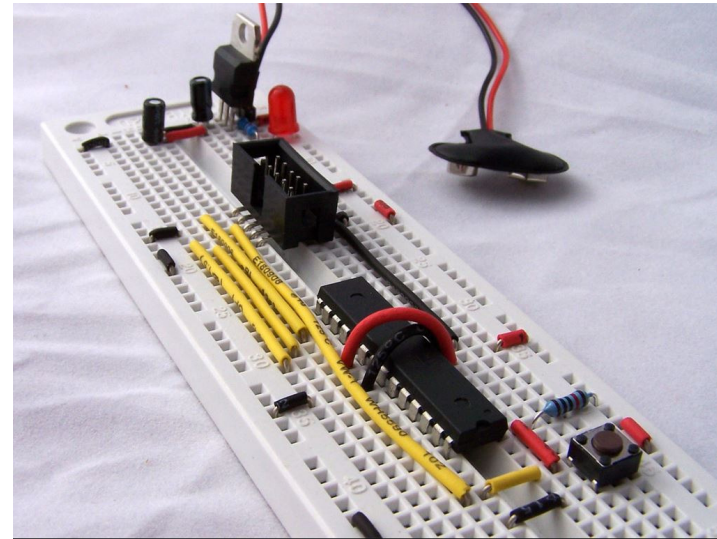
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## 2. Color Code your Wires

- Use red wires for +5V
- Use black wires for ground
- Use different colors for different types of signals.

By color coding your wires,

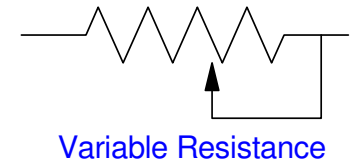
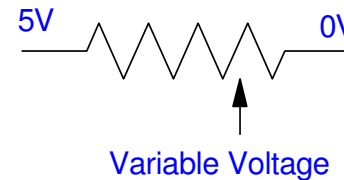
- You can quickly spot if a chip is missing power and/or ground.
- You can quickly see if a signal wire is missing between two ICs



### 3. Use Potentiometers (2 max)

Potentiometers allow you to

- Adjust voltages (0..5V)
- Adjust resistors (0% to 100%)

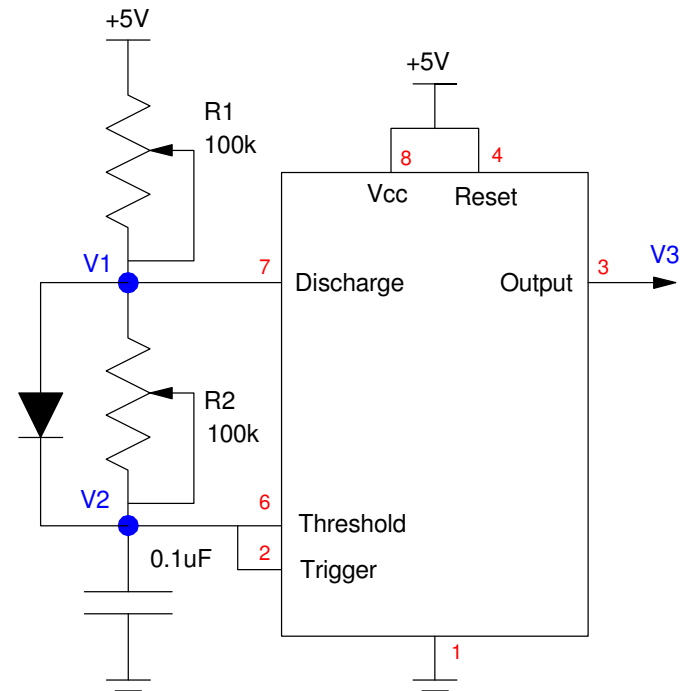


Replacing a resistor with a potentiometer allows you to tune your circuit without having to replace components

- Really useful when you get to PCB's

But...

- A resistor costs \$0.02
- Potentiometers cost \$1.55



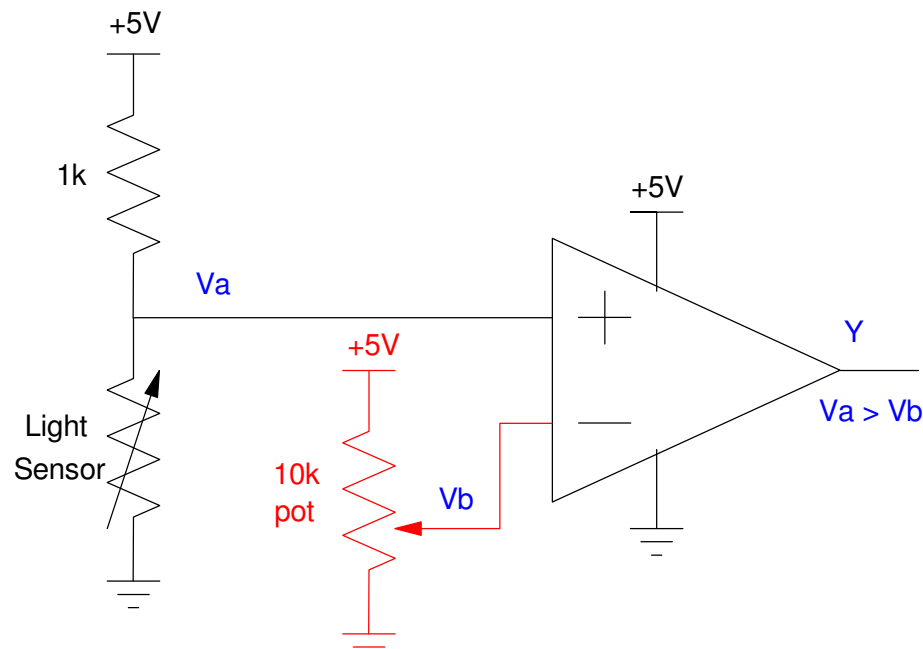


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## Use Potentiometers (cont'd)

Example: Variable voltage

- Allows you to adjust the voltage the comparator switches
- Allows you to adjust the light level where you turn on



Pots allow you to adjust a voltage

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## 4. Breadboards & Test Points

Some things to think about when using a breadboard are:

- How do you test your circuit?
- What signal do you look at?
- What should the signals look like?
- What procedures do you use?

Note what signals you look at and record what you read. This affects your upcoming PCB layout:

- These same signals should be measured in simulation and on your PCB
  - Test points should be added to your PCB so that you have access to these signals.
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## Test Point Example: Schmitt Trigger Circuit

TP1: 5V

TP4: V(on)

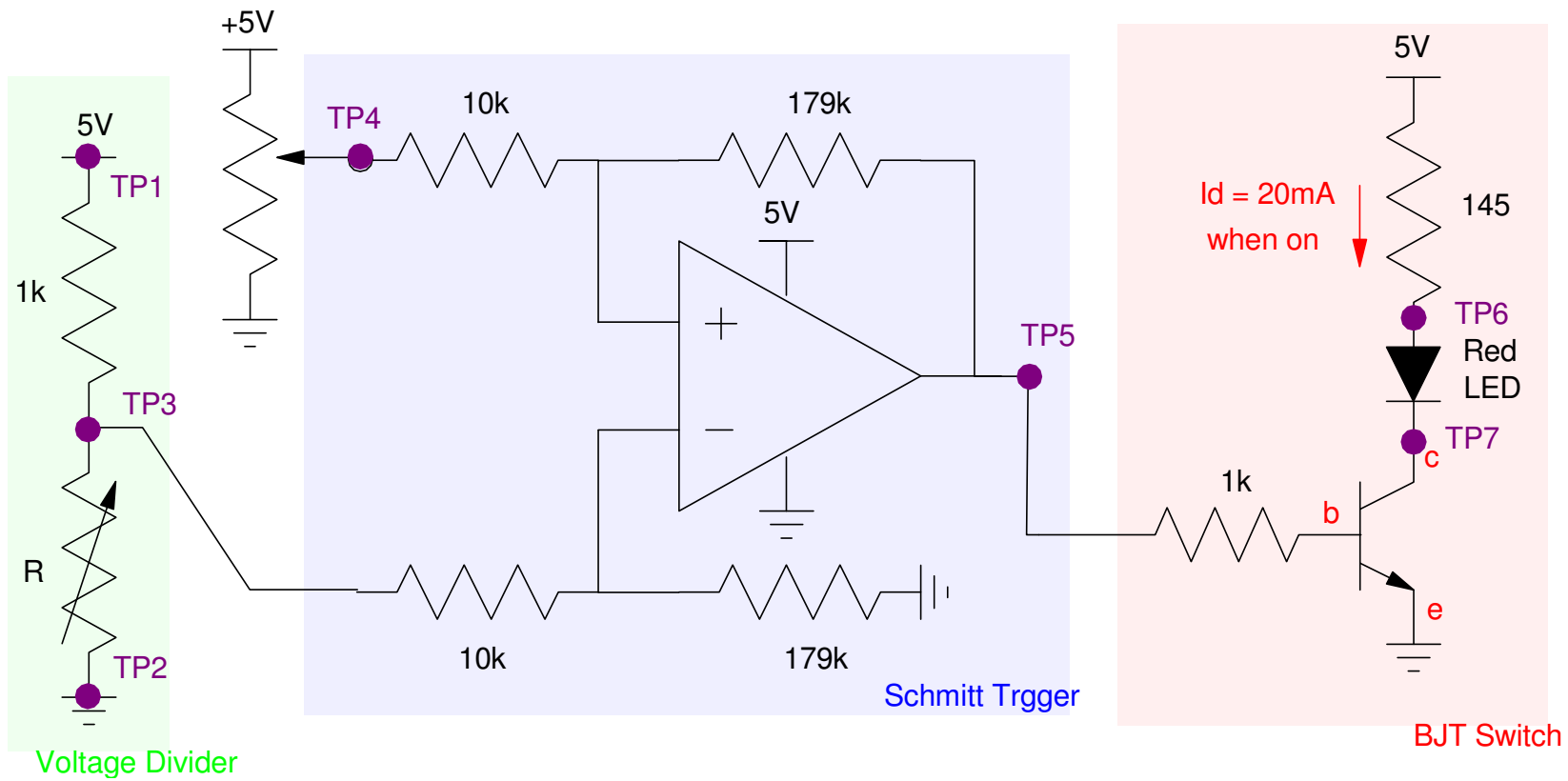
TP7: 0.2V means saturated

TP2: 0V

TP5: 0V=off, 5V=on

TP3: V(sensor)

TP6: Measure  $I_d = (5V - V_6)/145$



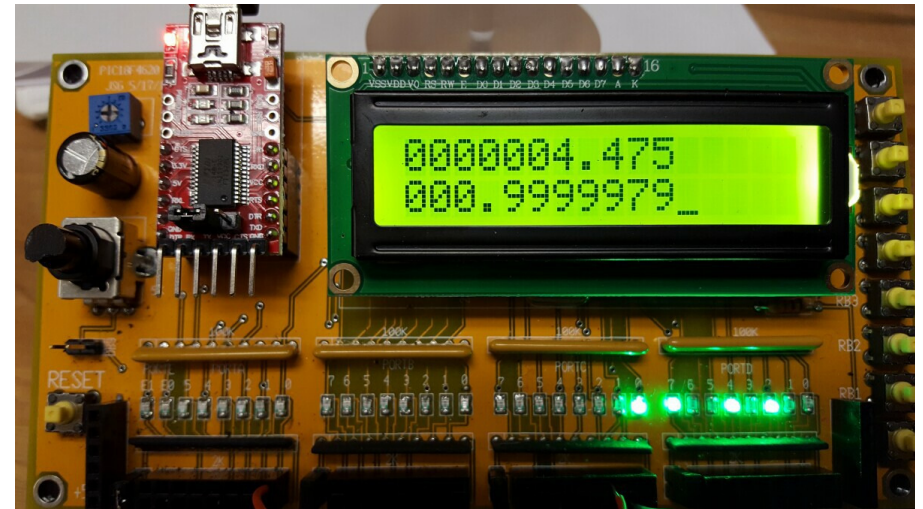
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## 5. Use of Evaluation Boards

- PIC, Arduino, Raspberry Pi, etc.

### In Senior Design II

- Using EVB's is encouraged
- They make it easy to connect hardware to a microcontroller
- They make it easy to test your code as you write it
- It's what evaluation boards are for
- (I have spares if you need a PIC EVB)



### In Senior Design III

- Replace the EVB with a custom PCB
  - Strip out everything you don't need
  - Reduce the package size
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## 6. Keep Your Breadboard

When done testing your breadboard, keep it together, intact (i.e. don't cannibalize it for parts). If your PCB doesn't work properly, your (working) breadboard circuit will be helpful in debugging what part of your PCB works (and has similar signals), and which part does not work.

This means you'll need two of every part in ECE 403

- One for your breadboard circuit, and
- One for your PCB.

That's OK.

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