Breadboards and Voltage Regulation

ECE 401 Senior Design I

Week #6

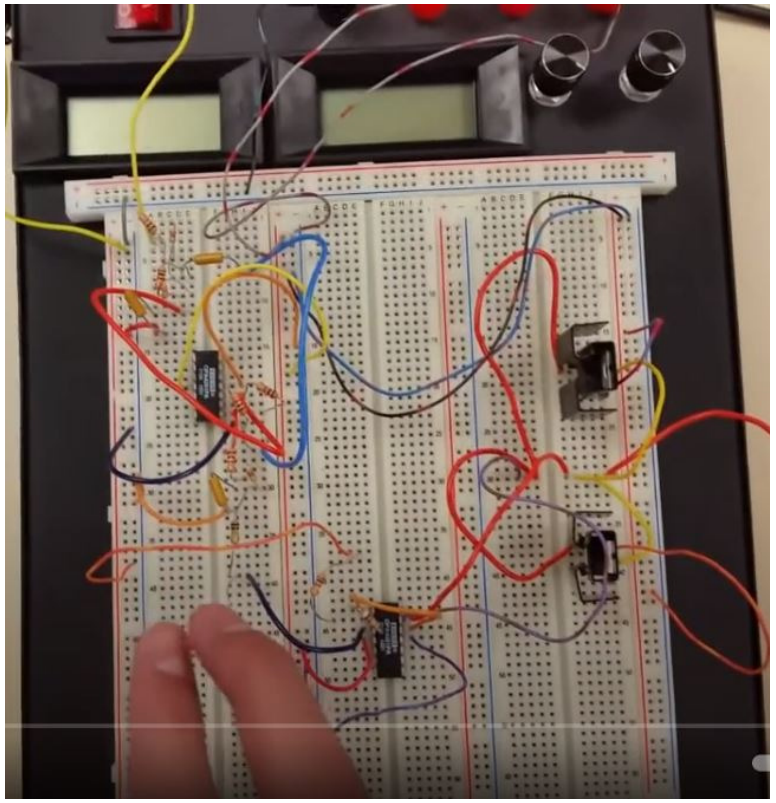
Please visit Bison Academy for corresponding lecture notes,
homework sets, and videos
www.BisonAcademy.com

Breadboards:

Once you have your circuit

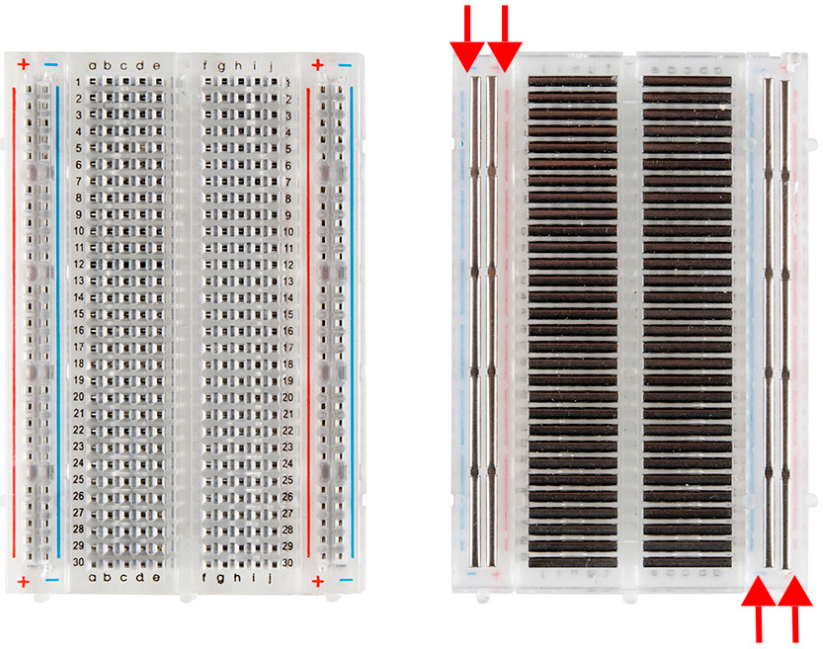
- Designed on paper, and
- Tested in simulation (CircuitLab)

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.



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,

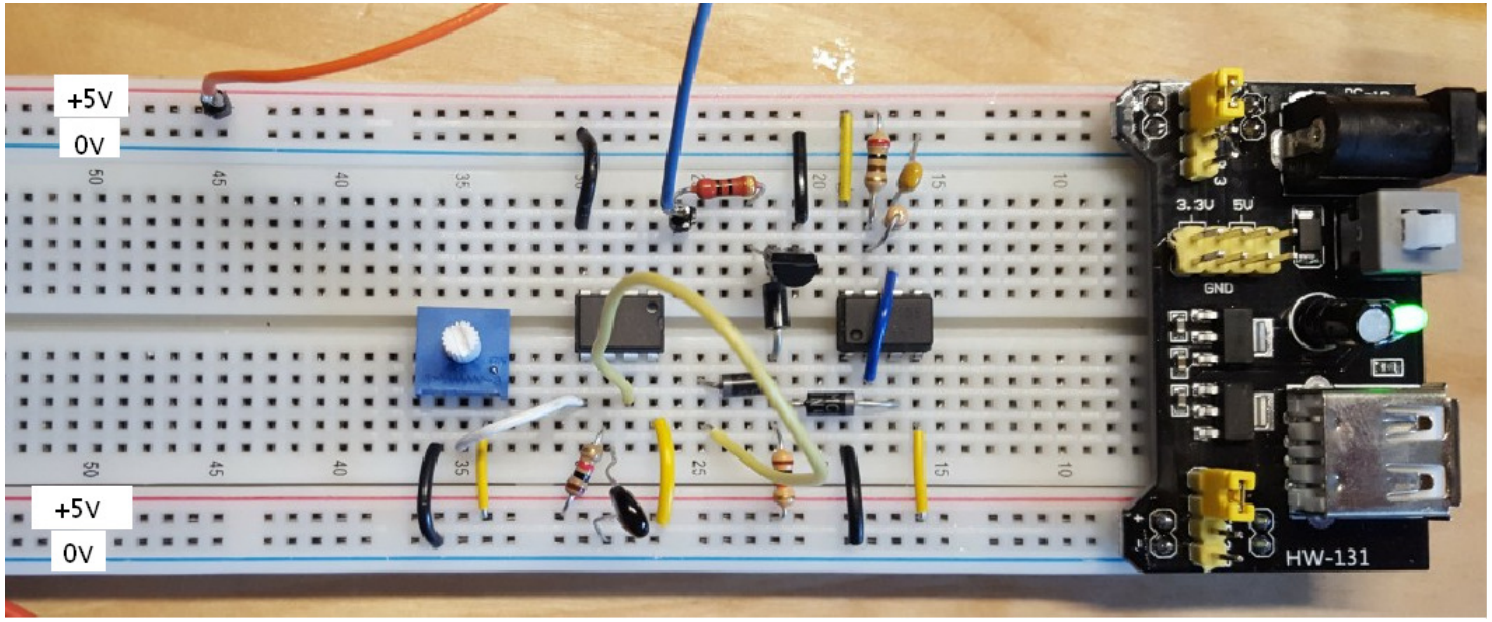


Breadboard Top (left) and back side (right)

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



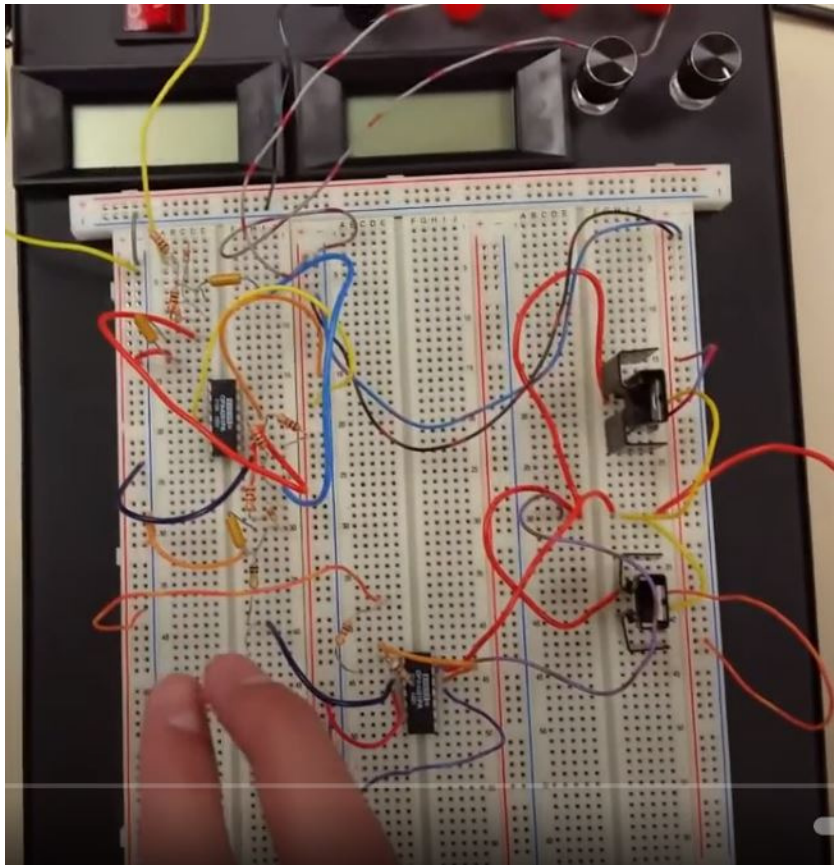
Purpose of Breadboarding:

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

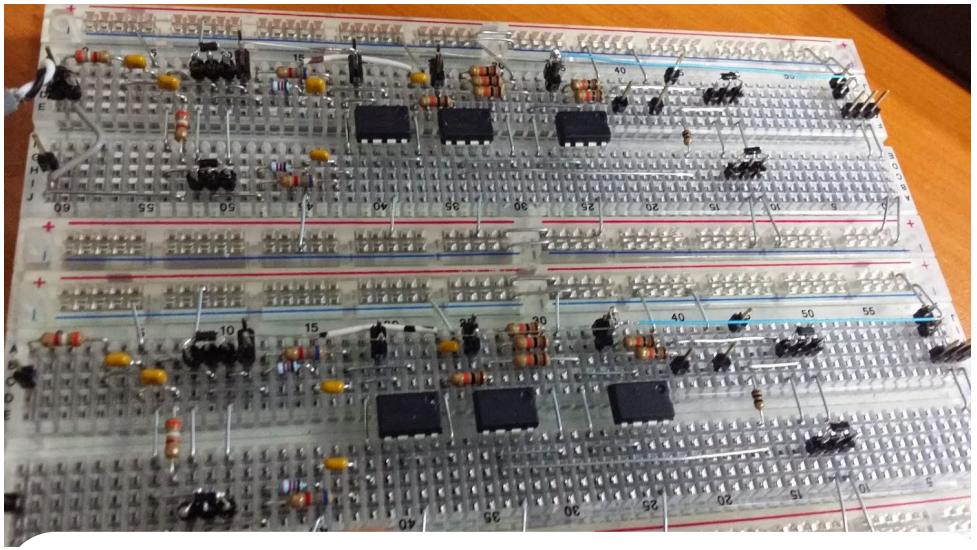
- Changes are fairly easy to implement
- Components & values can be changed pretty easily



Tricks of Breadboarding

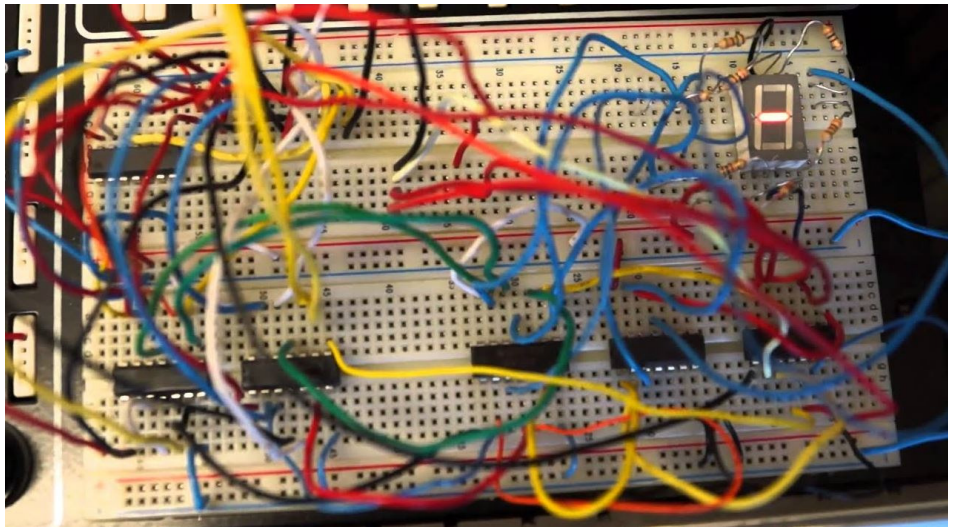
1) Keep Your Circuit Neat

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



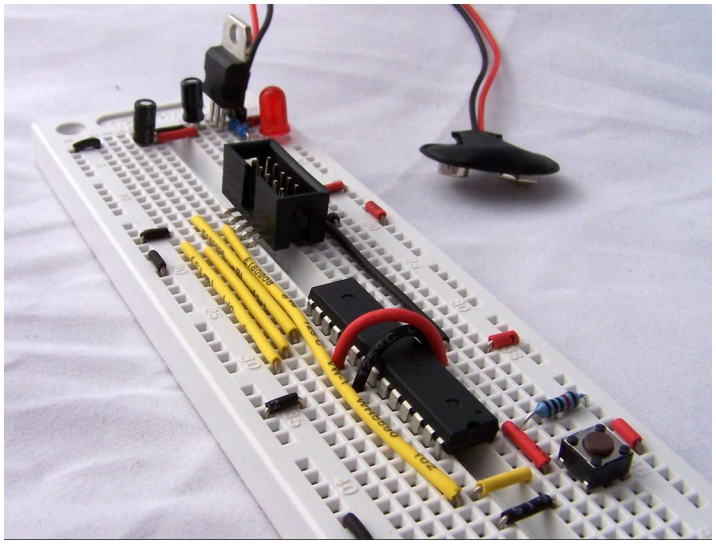
Keeping your wires short

- 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.



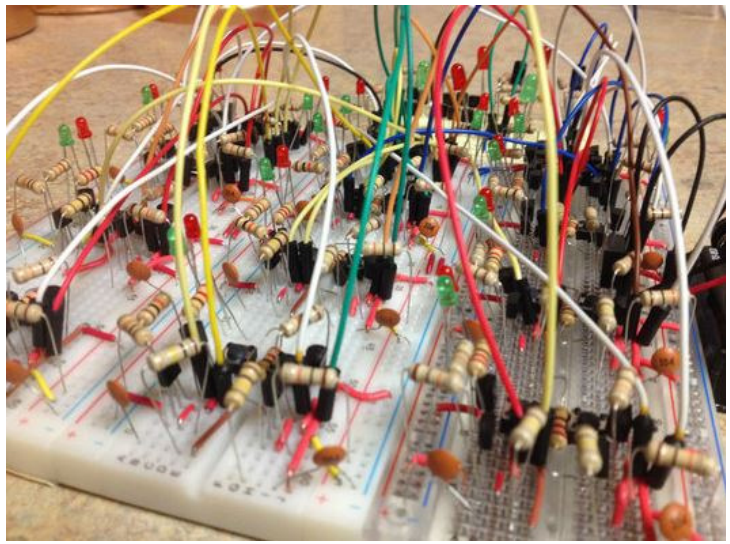
2. Color Code your Wires

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



By color coding your wires,

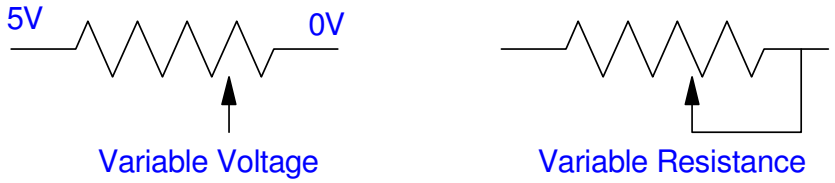
- You can quickly spot if a chip is missing power and/or ground.
- You can quickly see if a signal wire is missing between two ICs



3. Use Potentiometers (2 max)

Potentiometers allow you to

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

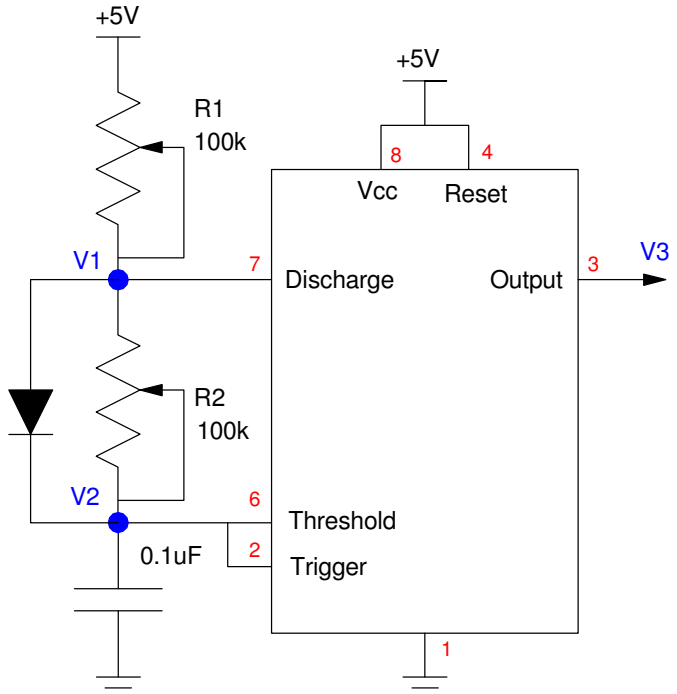


Replacing a resistor with a potentiometer allows you to tune your circuit without having to replace components

- Really useful when you get to PCB's

But...

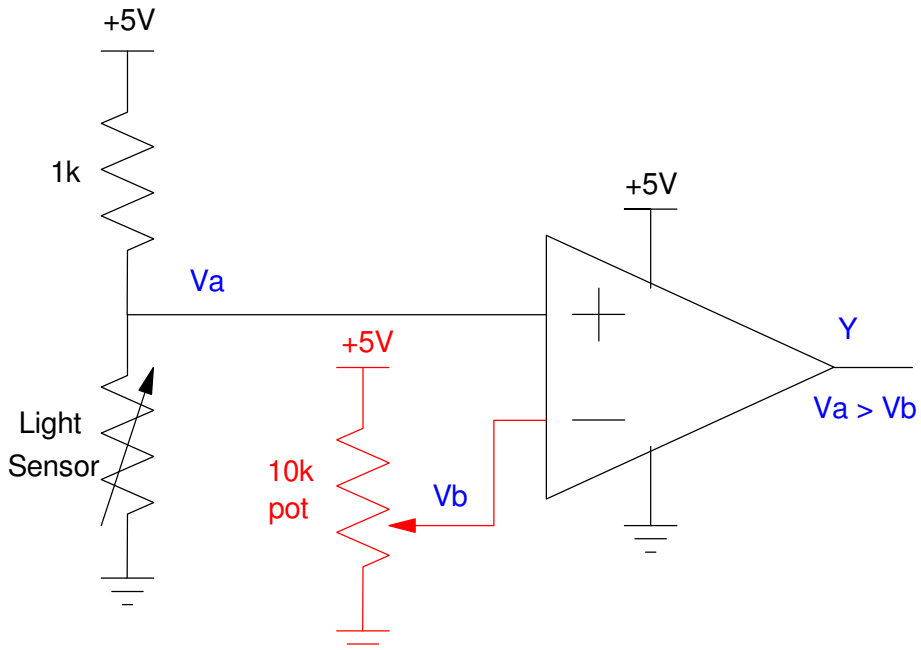
- A resistor costs $0.02
- Potentiometers cost $1.55



Use Potentiometers (cont'd)

Example: Variable voltage

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



Pots allow you to adjust a voltage

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.

Test Point Example: Schmitt Trigger Circuit

TP1: 5V

TP2: 0V

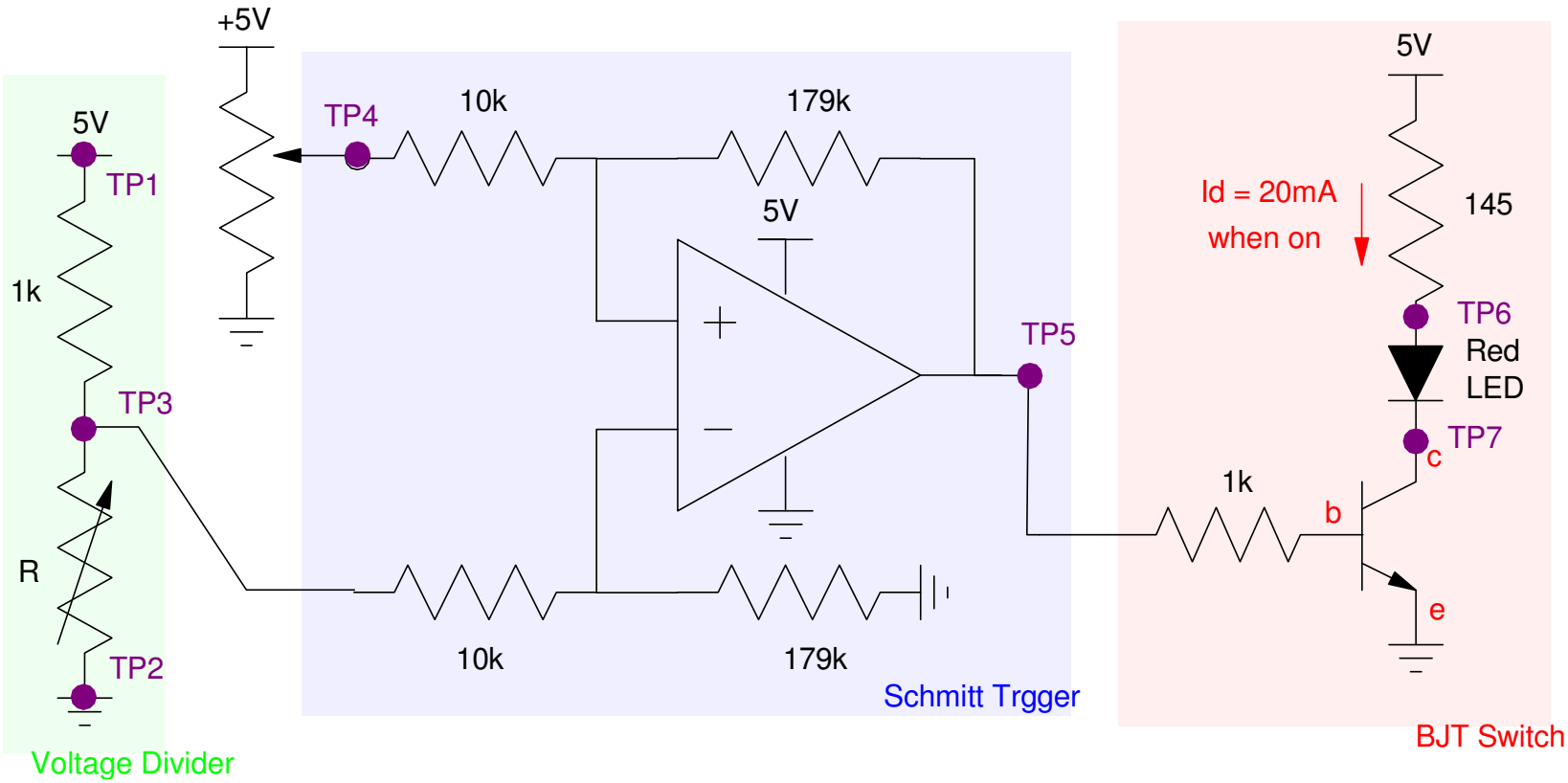
TP3: V(sensor)

TP4: V(on)

TP5: 0V=off, 5V=on

TP6: Measure Id = (5V - V6)/145

TP7: 0.2V means saturated



5. 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 401

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

That's OK.

Breadboards with a PIC18F2620

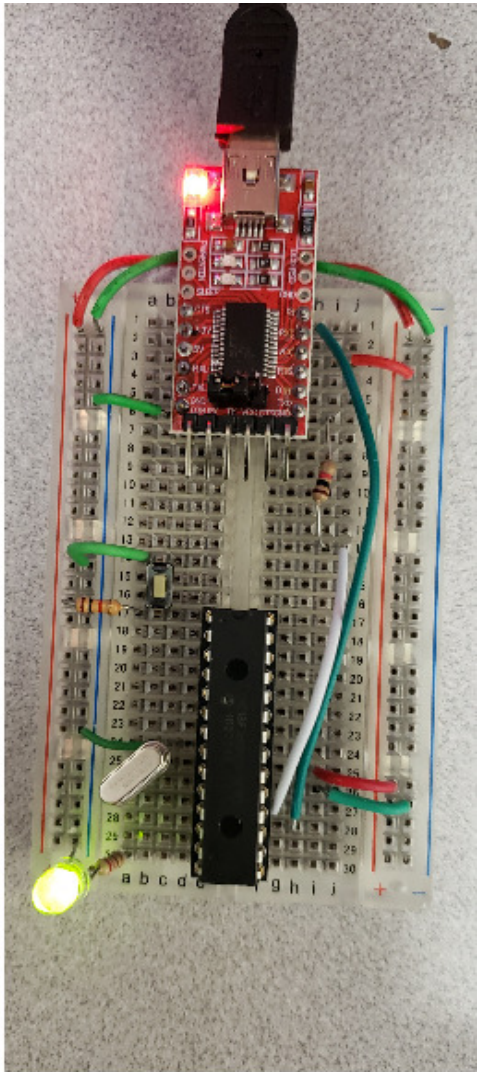
Microcontrollers can simplify some circuits

In ECE 401, use the PIC18F2620

- We have a boot-loader for this chip
  - same as used in ECE 376
- We have experience using this chip
  - same as ECE 376
- We have a C compiler for this chip
  - same as ECE 376

The only difference between this chip and the one used in ECE 376 is it has 21 I/O pins on a 28-pin package

- PORTA (5 I/O pins)
- PORTB (8 I/O pins)
- PORTC (8 I/O pins)



PIC Limitations

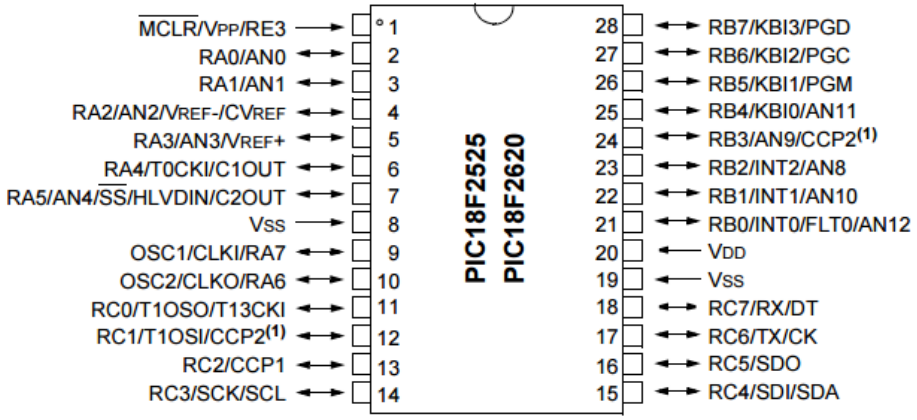
Binary I/O

- 0V = logic 0
- 5V = logic 1
- Capable of sourcing / sinking up to 25mA

Analog Inputs

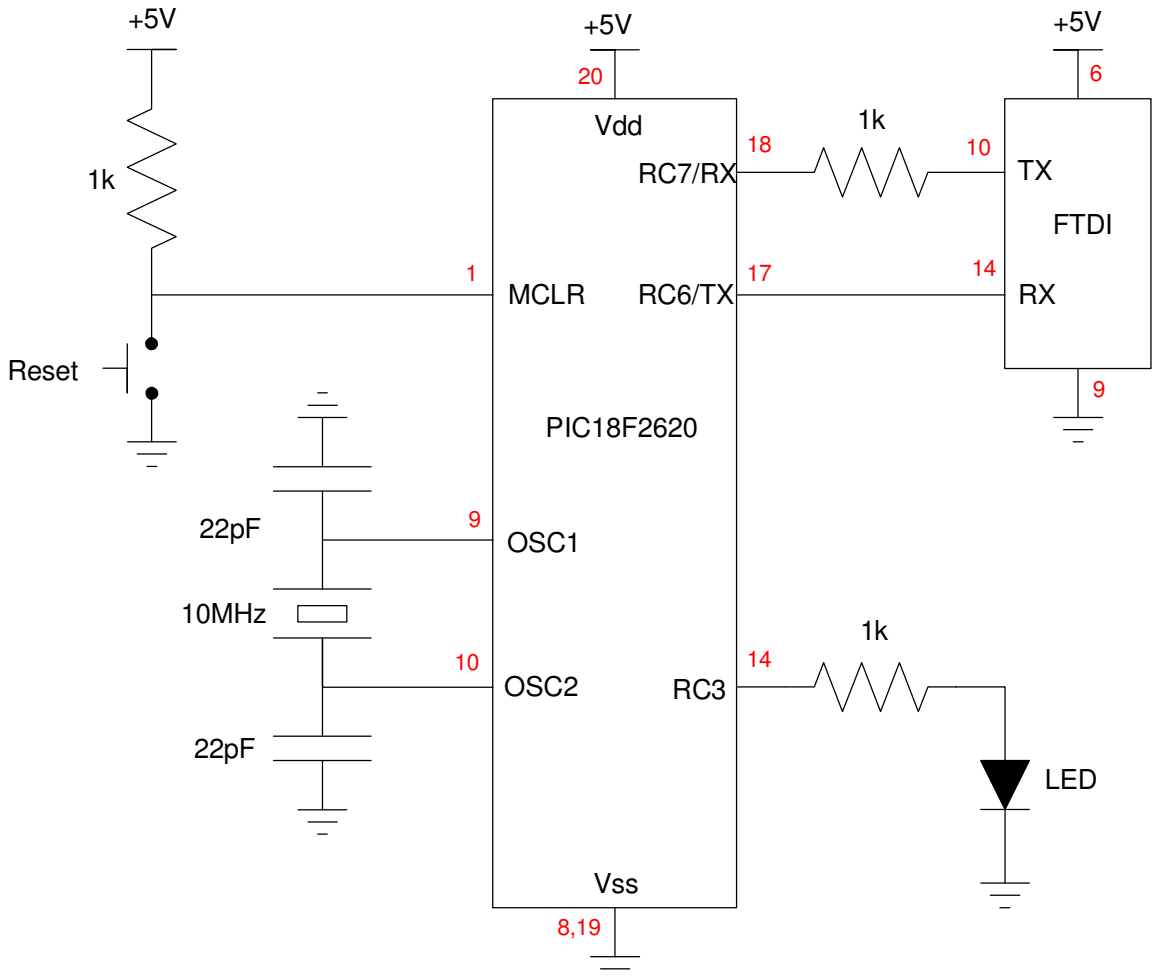
- 10-bit A/D
- 0V to 5V
- 4.88mV resolution

28-Pin SPDIP, SOIC



PIC Schematic

Minimum hardware to blink an LED



Homework #5: Breadboard & Test Points

ECE 401 Circuit Requirements

- Must operate off of 5VDC
- Must include at least one integrated circuit
- Must include at least one LED with Id = 20mA +/- 2mA
  - Design for 100mA on paper
  - Change Rc to set the current to 20mA for your actual circuit
- Must include at least one NPN and one PNP transistor
- Power supply = 9V battery (mark +/- polarity)
  - use a LM7805 regulator to drop 9V to 5V
- Must have a reverse-polarity protection diode
- Must have a 1/4 Watt 1-Ohm resistor in series with the power supply

Homework #5:

1. Build your circuit on a breadboard
   - Power comes from a 9V battery
   - Include a photo in your OneNote document
2. Take measurements to verify your circuit works
   - Voltages
   - Currents (usually calculated by measuring voltages)
   - Frequencies
   - Total current draw from the 9V battery
     - measure the voltage across the 1 Ohm resistor and compute current
   - Include these measurements in your OneNote document
   - Note where you these are recorded on your schematic
     - These are your test points for the PCB
3) Parts List
   - Parts used in your breadboard
   - Vendor & Vendor number
   - Description & Price