Intro to Electronics

Week 4

Make an LED blink

TODAY'S PROJECT

Timers

- Useful for all kinds of things
  - Wait a certain length of time
  - Turn things on and off repeatedly

555

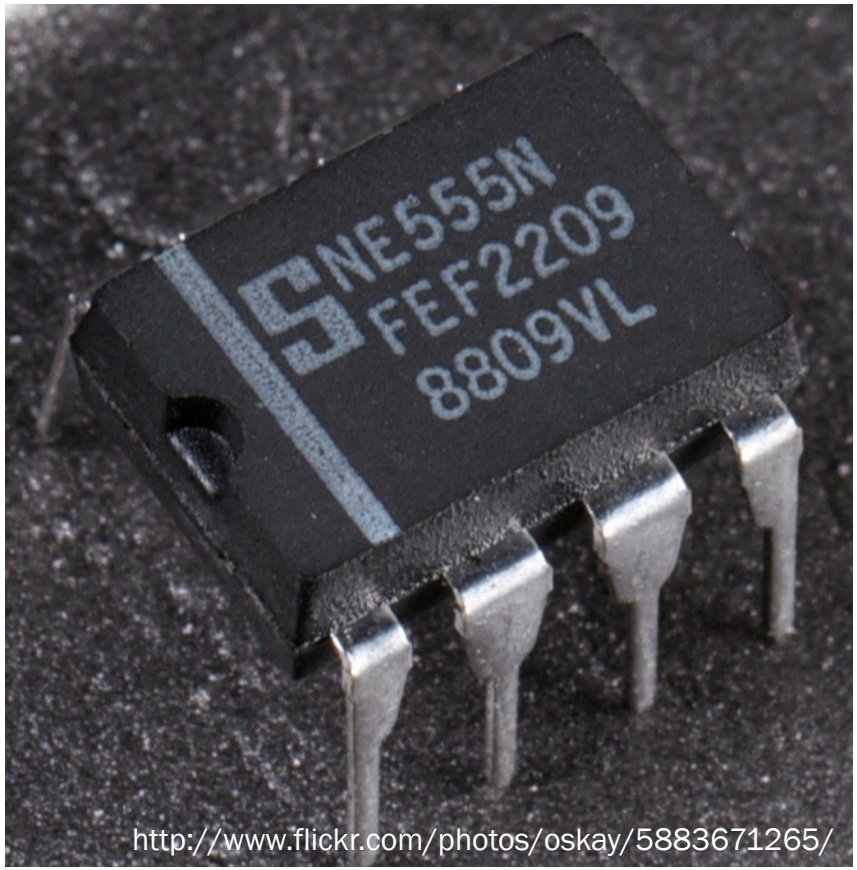
- Probably the most famous timer IC ever
- Used for all kinds of crazy things
  - People have even built full games with it
    - Whack-a-Mole
    - Dodgeball (reverse Pong)
  - Or used it to make an AM radio

555

- We're going to keep it simple, though
- Just making it turn on and off for a set length of time at a set frequency
  - "Astable multivibrator"
  - All kinds of other neat circuit building blocks in the datasheet

DIP

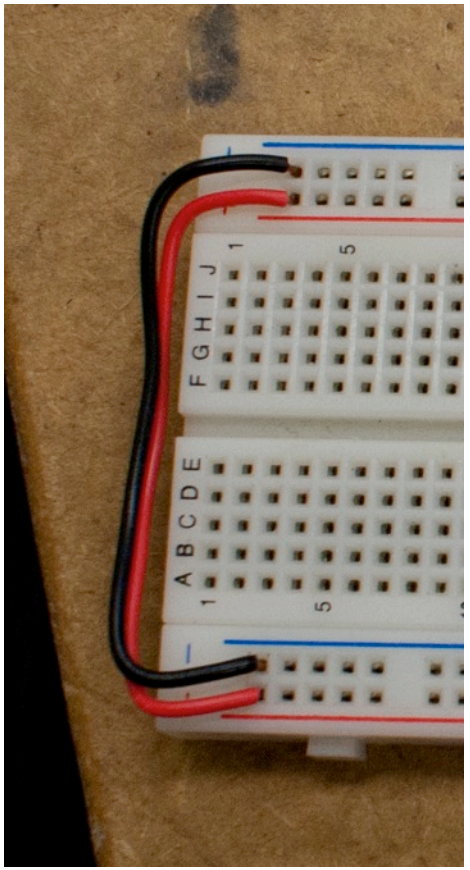
- Dual inline package
  - Very common package for ICs (especially older ones)
- Can have a few pins or a couple dozen



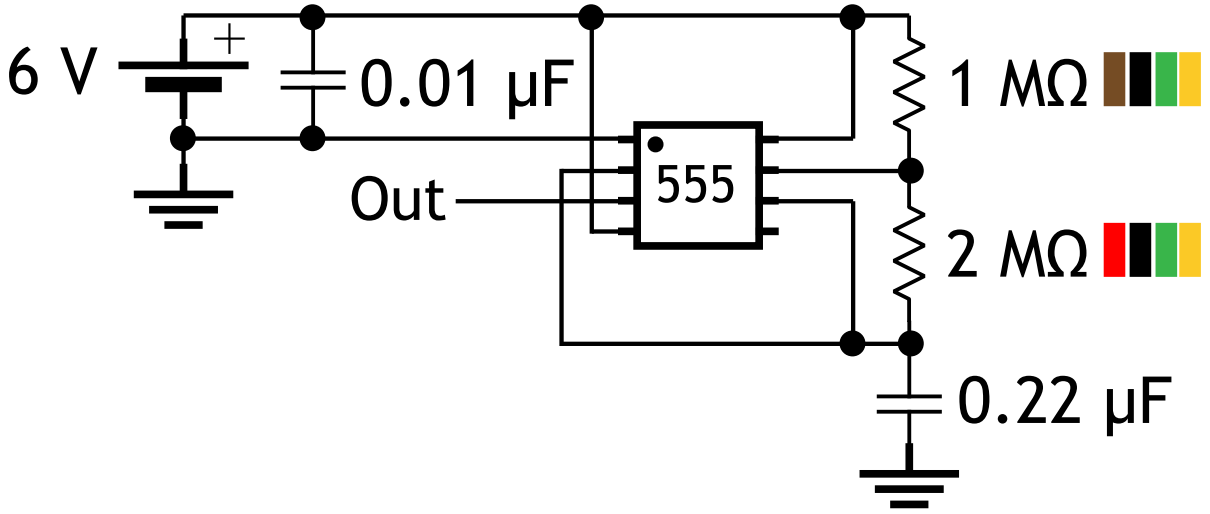
http://www.flickr.com/photos/oskay/5883671265/

With great pins…

- …come great confusion.
- Useful breadboard trick: Wire both sides' supply rails together
  - Positive to positive
  - Negative to negative
- Makes it easier to assemble larger circuits

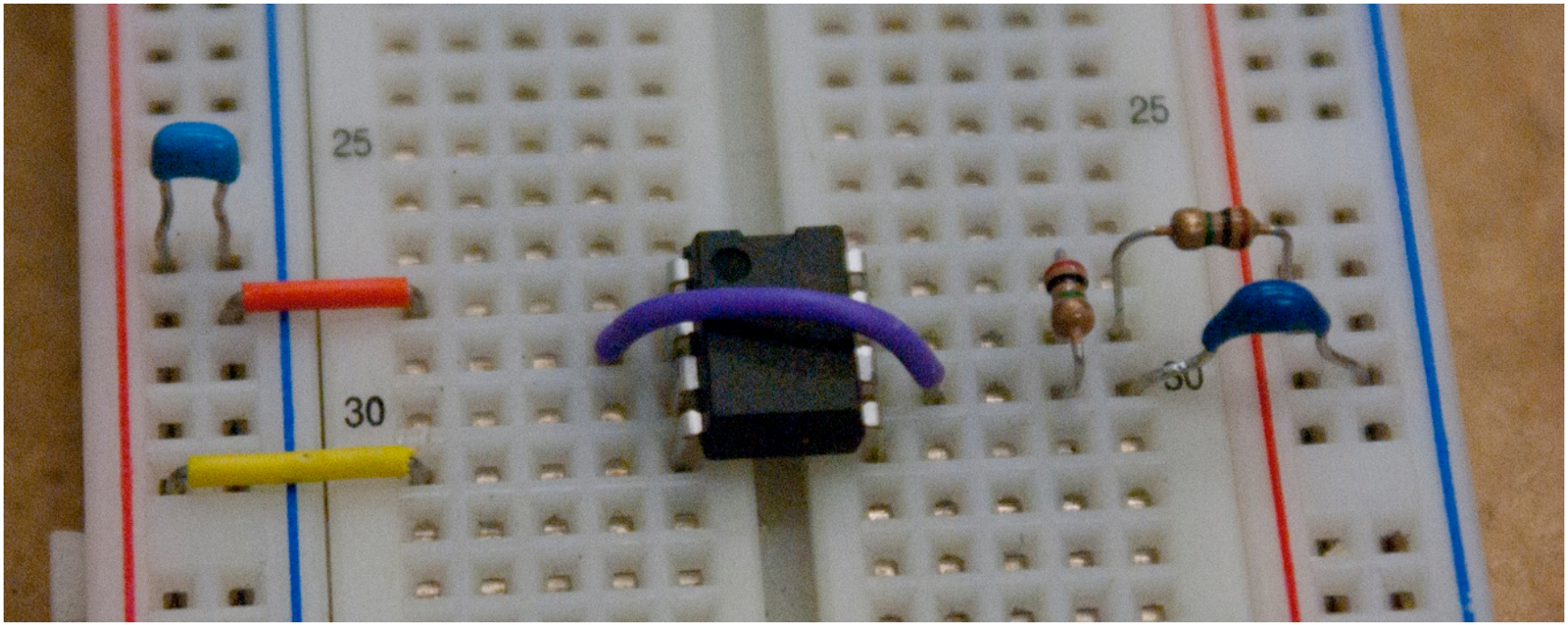


Hook one up



Connect this	to this.	Connect this	to this.
555 pin 1	– supply	One end of 1 MΩ	555 pin 7
555 pin 2	555 pin 6	One end of 2 MΩ	555 pin 7
555 pin 4	+ supply	Other end of 2 MΩ	555 pin 6
555 pin 8	+ supply	555 pin 6	One end of 0.22 µF

Hook one up

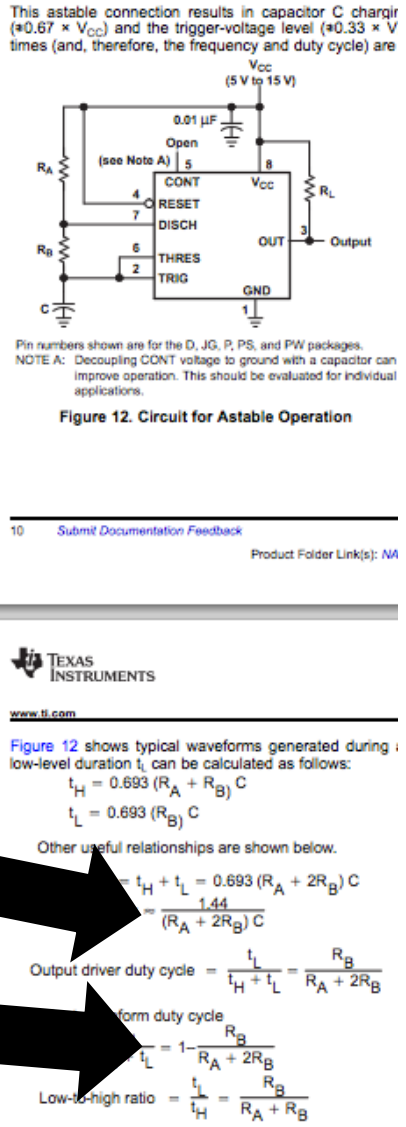


Math time!

- Datasheet says frequency and duty cycle are set with the resistors and capacitor

$$f = \frac{1.44}{(R_A + 2R_B) * C}$$

$$D = 1 - \frac{R_B}{R_A + 2R_B}$$



This astable connection results in capacitor C chargir
(⇒0.67 × V_{CC}) and the trigger-voltage level (⇒0.33 × V
times (and, therefore, the frequency and duty cycle) are

Pin numbers shown are for the D, JG, P, PS, and PW packages.
NOTE A: Decoupling CONT voltage to ground with a capacitor can improve operation. This should be evaluated for individual applications.

Figure 12. Circuit for Astable Operation

10 *Submit Documentation Feedback*

Product Folder Link(s): *NA*

TEXAS INSTRUMENTS

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Figure 12 shows typical waveforms generated during
low-level duration t_L can be calculated as follows:

$t_H = 0.693 (R_A + R_B) C$

$t_L = 0.693 (R_B) C$

Other useful relationships are shown below.

$= t_H + t_L = 0.693 (R_A + 2R_B) C$

$= \frac{1.44}{(R_A + 2R_B) C}$

Output driver duty cycle $= \frac{t_L}{t_H + t_L} = \frac{R_B}{R_A + 2R_B}$

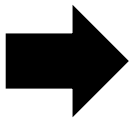
form duty cycle

$\frac{}{t_L} = 1 - \frac{R_B}{R_A + 2R_B}$

Low-to-high ratio $= \frac{t_L}{t_H} = \frac{R_B}{R_A + R_B}$

Math time!

- R_A = 1 MΩ = 1,000,000 Ω
- R_B = 2 MΩ = 2,000,000 Ω
- C = 0.22 μF = 0.00000022 F



- f = 1.3 Hz
- D = 60%

$$f = \frac{1.44}{(R_A + 2R_B) * C}$$

$$D = 1 - \frac{R_B}{R_A + 2R_B}$$

Let's watch

- Add an LED to the output

Mix it up

- We've used a red LED quite a bit though
  - Already know an appropriate resistor to use
  - Done this several times already

Blue LED

- Assume 6 V output
- Blue LED has forward voltage of 3.2 V
- Limit current to 20 mA

Blue LED

- Assume 6 V output
- Blue LED has forward voltage of 3.2 V
- Limit current to 20 mA

- What resistor do we need?
  - Remember, V = IR, so R = V/I

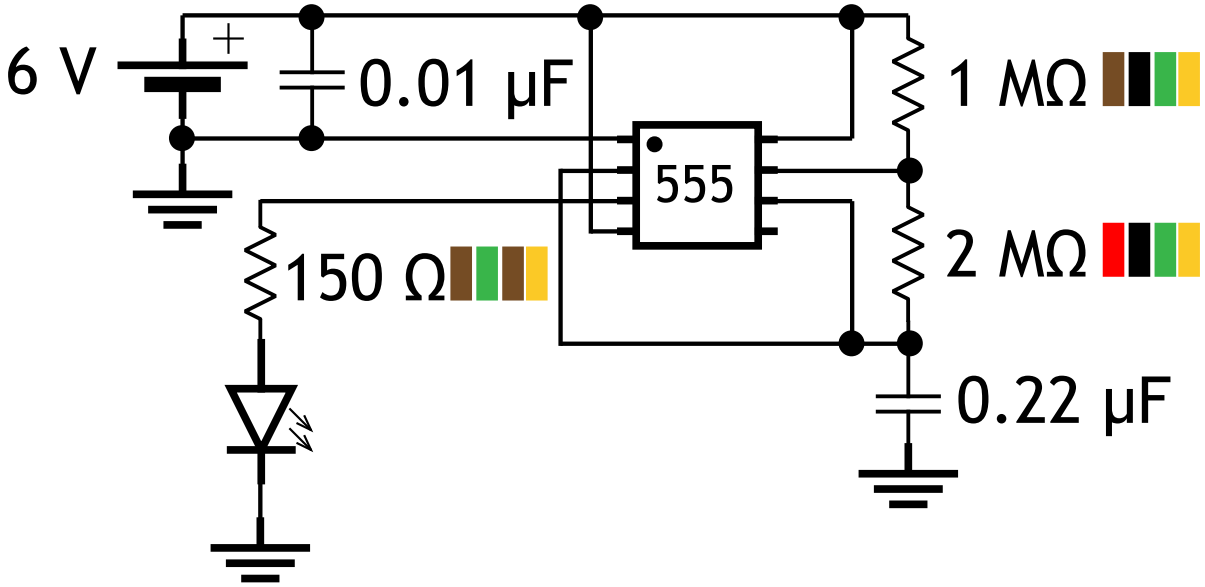
Blue LED

- Assume 6 V output
- Blue LED has forward voltage of 3.2 V
- Limit current to 20 mA

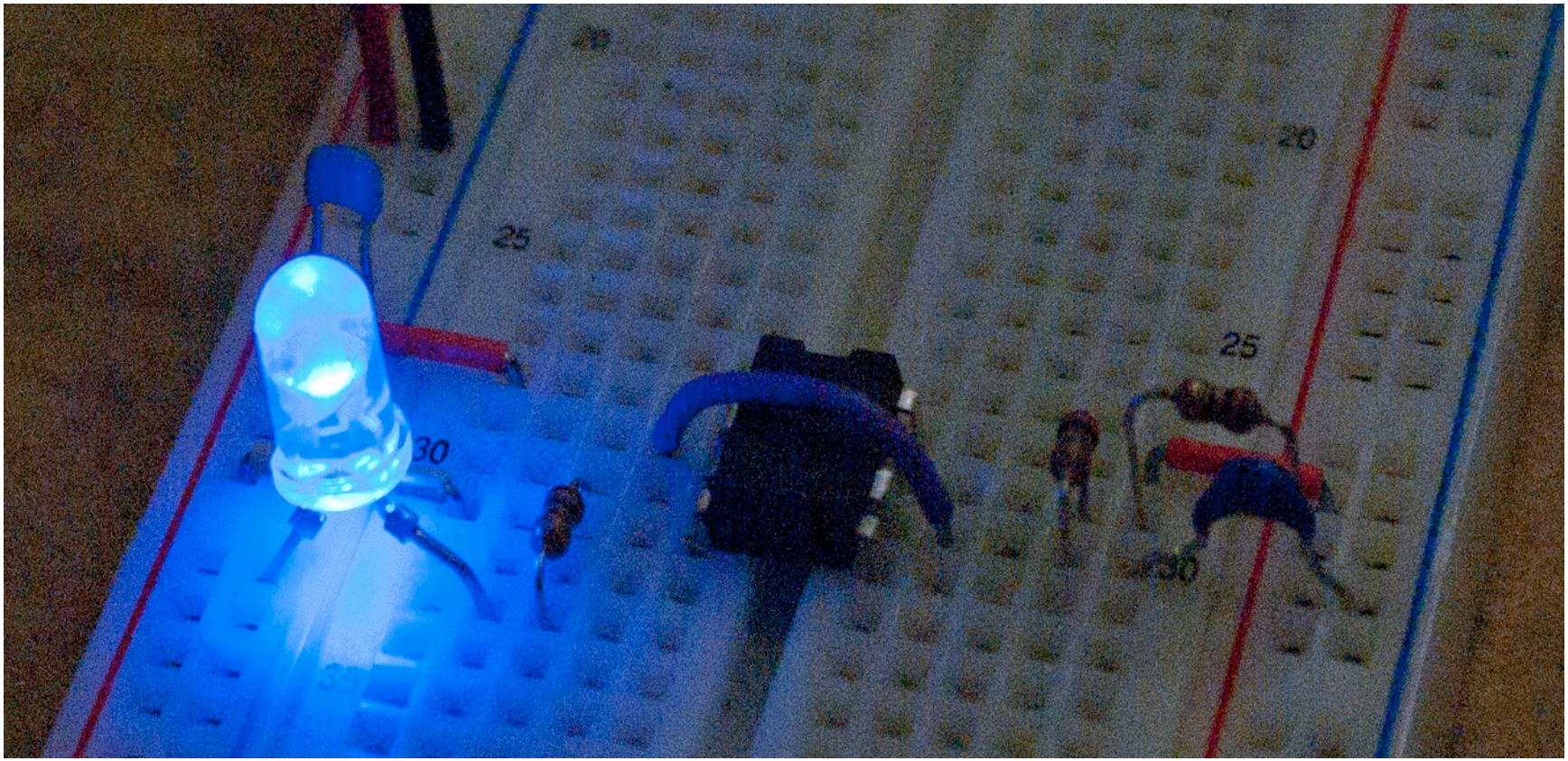
$$\frac{6\ V - 3.2\ V}{20\ mA} = 140\ \Omega$$

- Closest we've got is 150 Ω

Let's add that

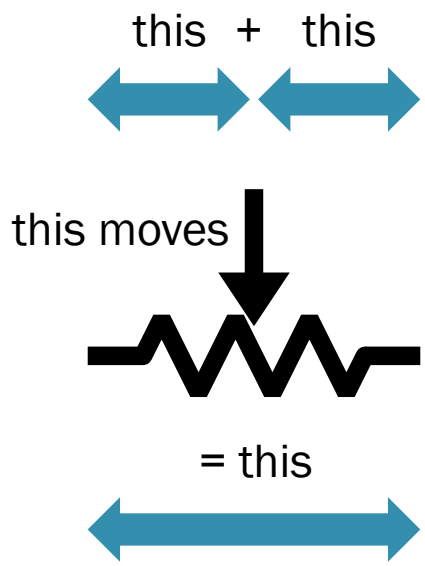


Let's add that



Potentiometer

- Frequently used as a variable resistor
- Like a resistor but with an extra terminal



Potentiometer

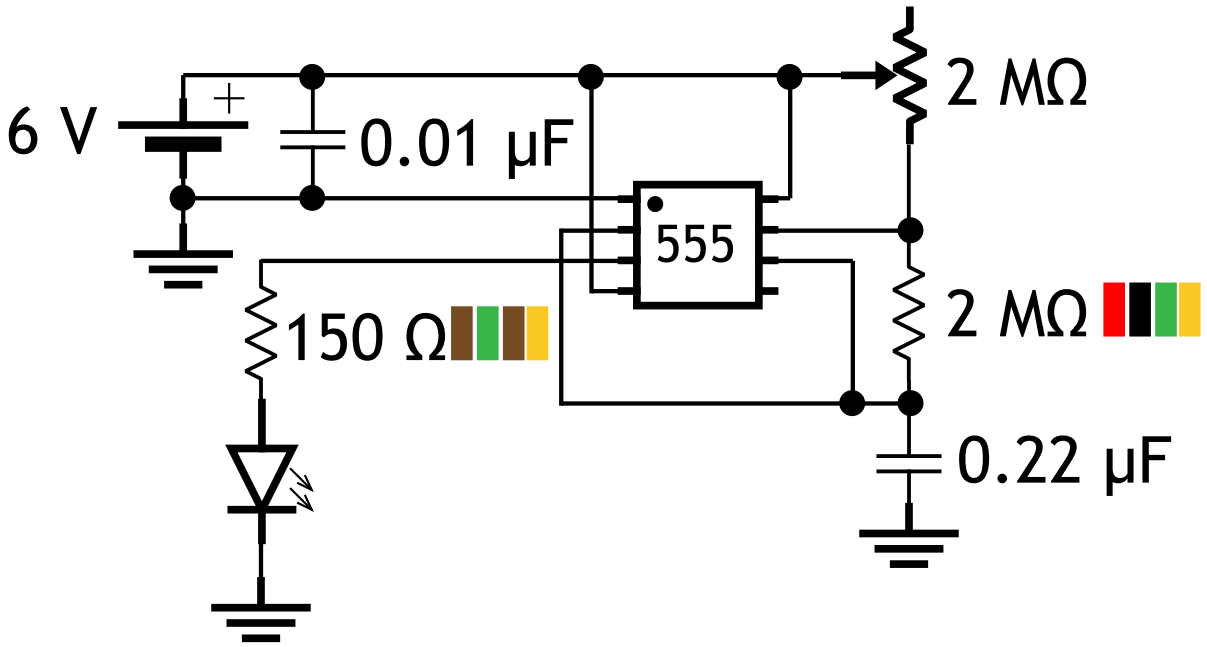
- All kinds of ways to move that center terminal

http://www.flickr.com/photos/ericsbinaryworld/12155374/

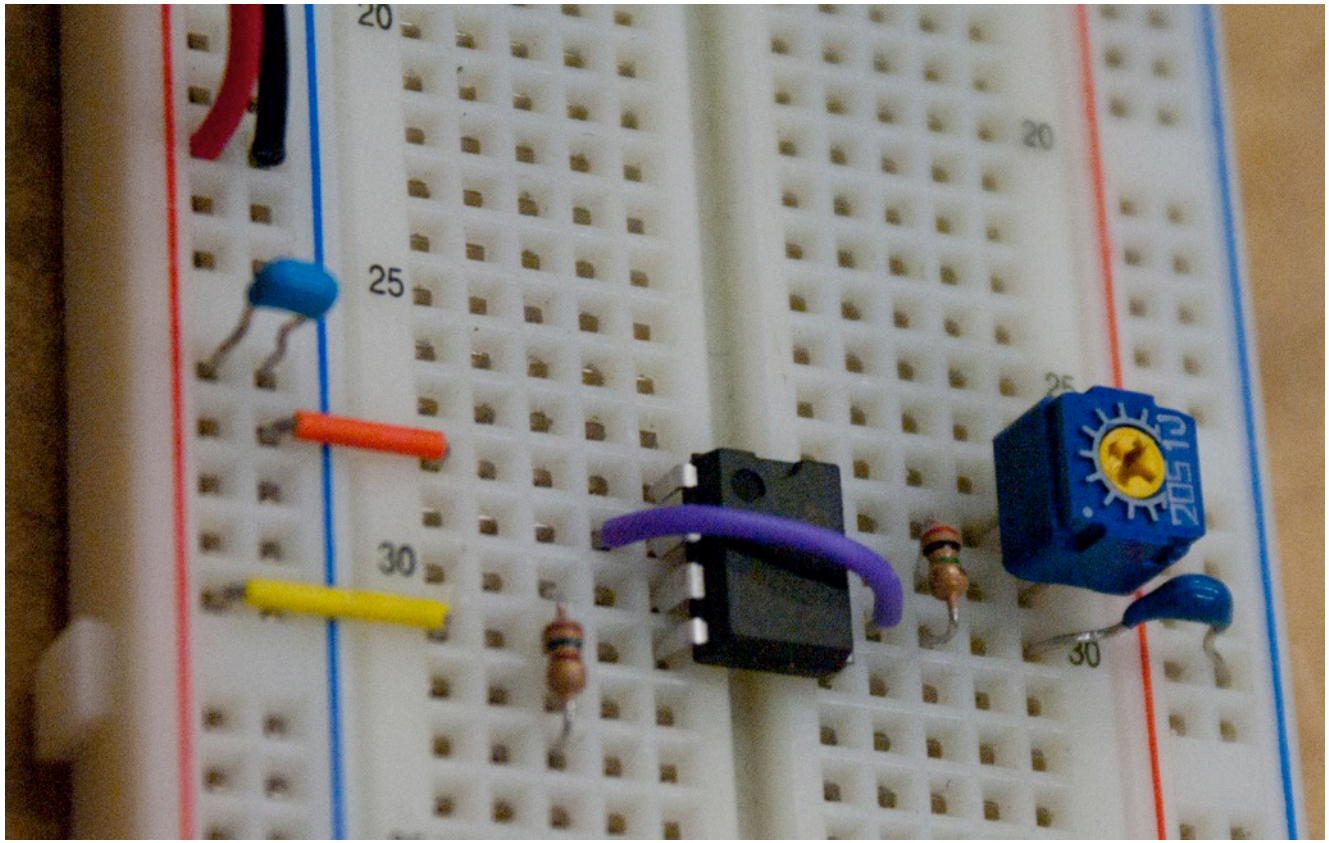
http://www.flickr.com/photos/snazzyguy/3311222006/

http://www.flickr.com/photos/67059785@N03/6103961419/

Let's add one



Let's add one



Turn the pot

- Watch the LED blink at different rates!
- Also could have used this to set the output of Week 2's voltage regulator

That's it for tonight

- Next week
  - More digital logic
    - Using logic gates
    - Counting!
- Keep this project together for next week
  - We'll use it in next week's project