SIGPwny

Embedded FA 2025 • 2025-09-29

Embedded 103: Breadboarding and Hardware

Jake and Swetha

Jake Mayer

- SIGPwny Admin & Embedded co-lead for '24 & '25
- CS, Math major
- Fun fact: I was rejected from UIUC

Swetha Karthikeyan

- Helper & embedded lead in SIGPwny
- Junior in Computer Engineering
- Fun fact: I play the violin and used to be in the university orchestra

Announcements

- CSAW Embedded Security Challenge
  - Using AI and LLMs for hardware security
  - We have two teams that qualified for the final round!
  - Team 1: Minh, Shovan, Krishnan, Cygnus
  - Team 2: Jake, Swetha, Nikhil, Ryan

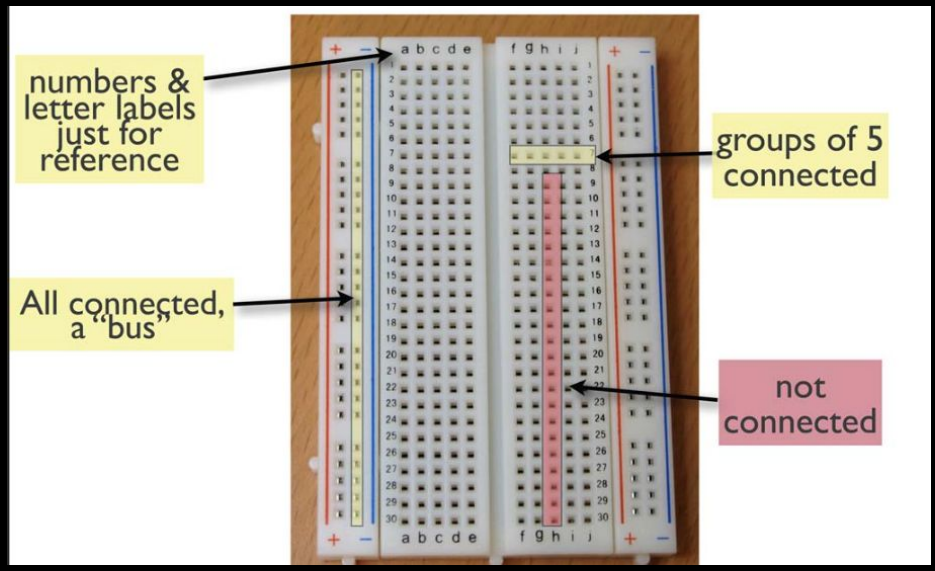
Meeting content can be found at sigpwny.com/meetings.

SIGPwny

What is breadboarding?

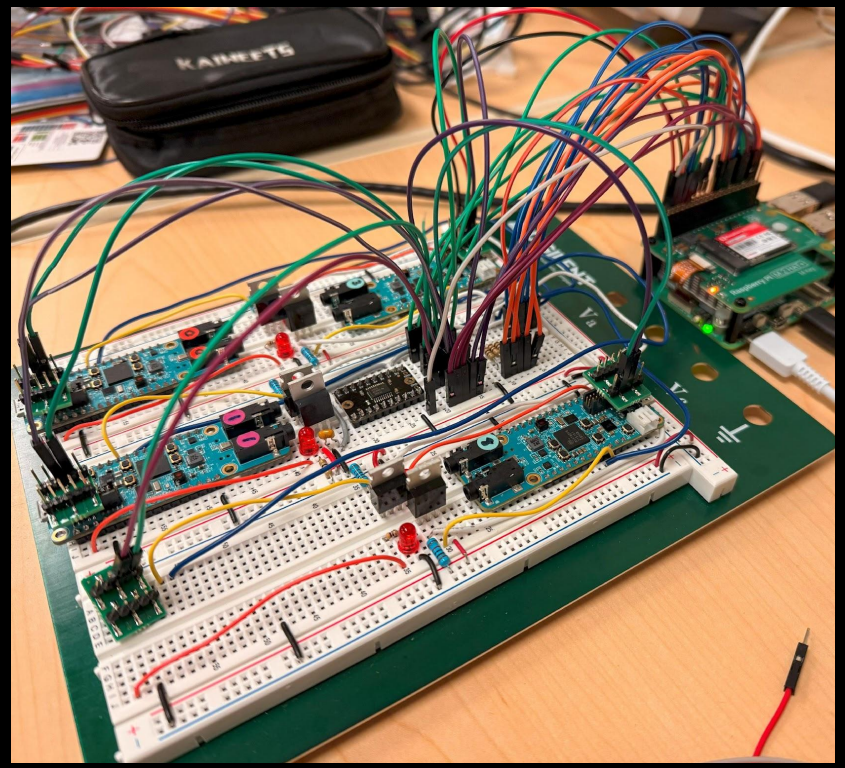
- Process of building and testing circuits on a breadboard (as opposed to soldering)
- Allows us to observe circuit behavior and debug in real time
- Circuits used to be prototyped on wooden boards used to cut bread

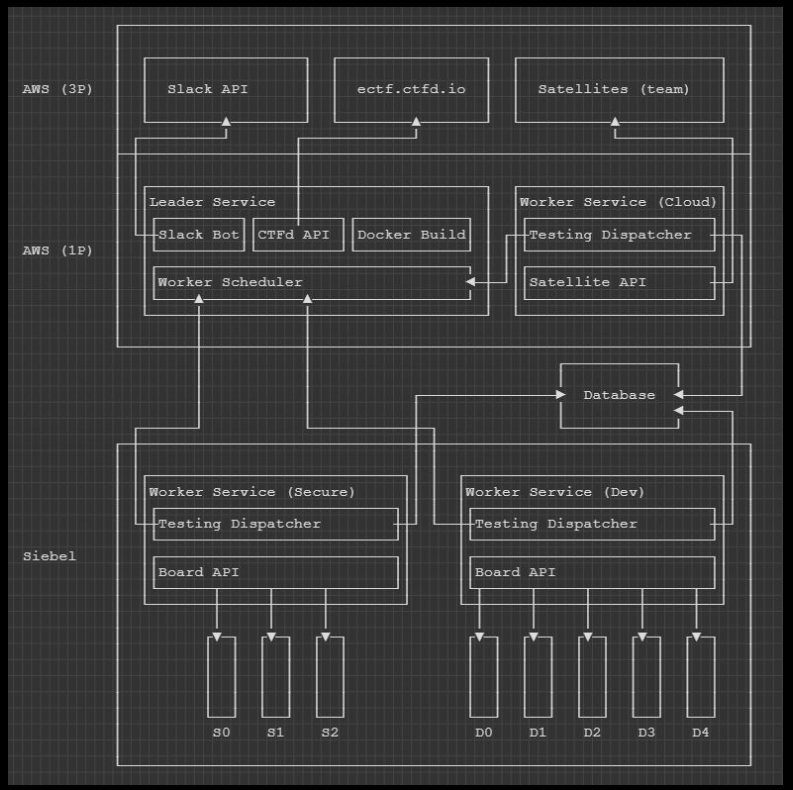
- **Breadboard** - plastic board with metal sockets
  - Power rail, ground rail, horizontal rails



How is breadboarding relevant?

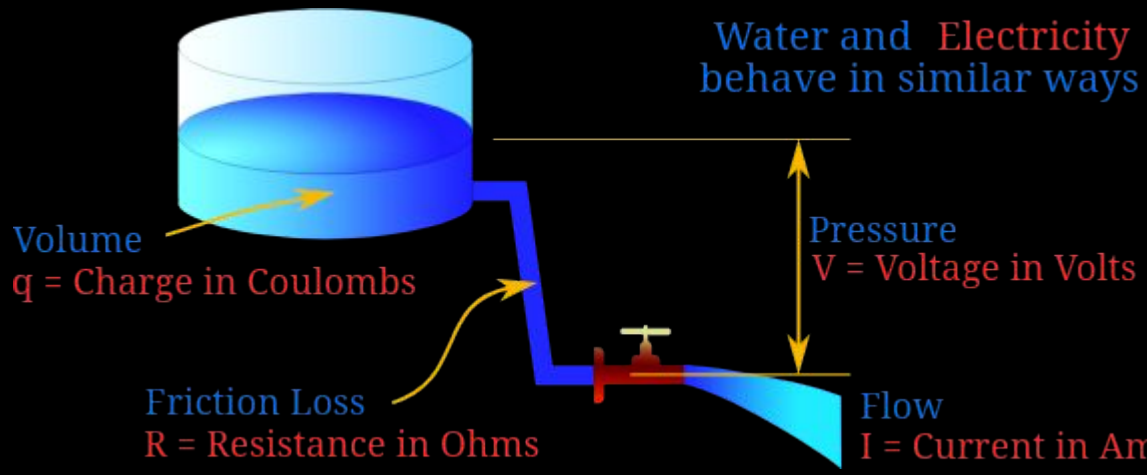
- Understanding how circuits work is important for understanding voltage glitching and fault injection
- Helps with quick prototyping, debugging, instrumenting boards





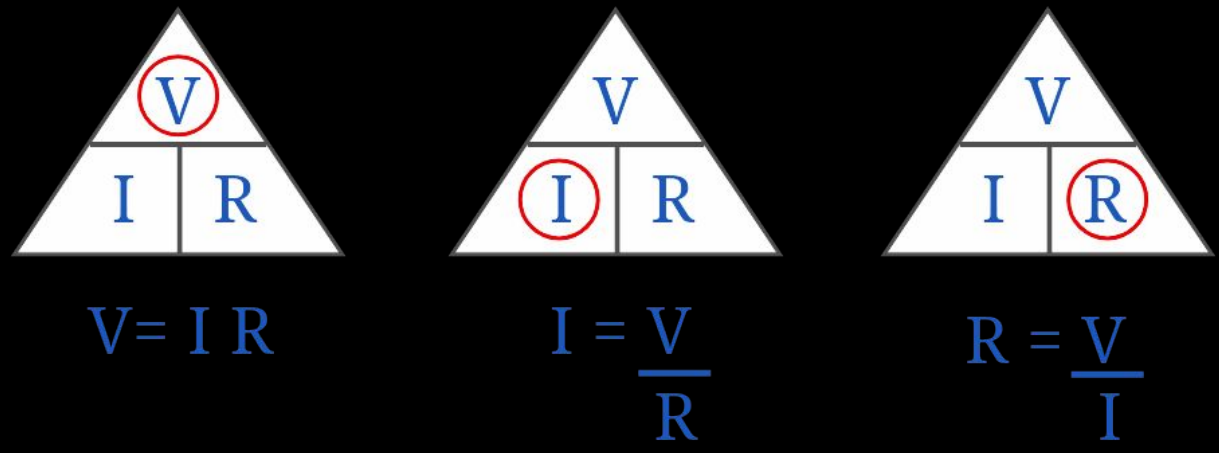
What is electricity?

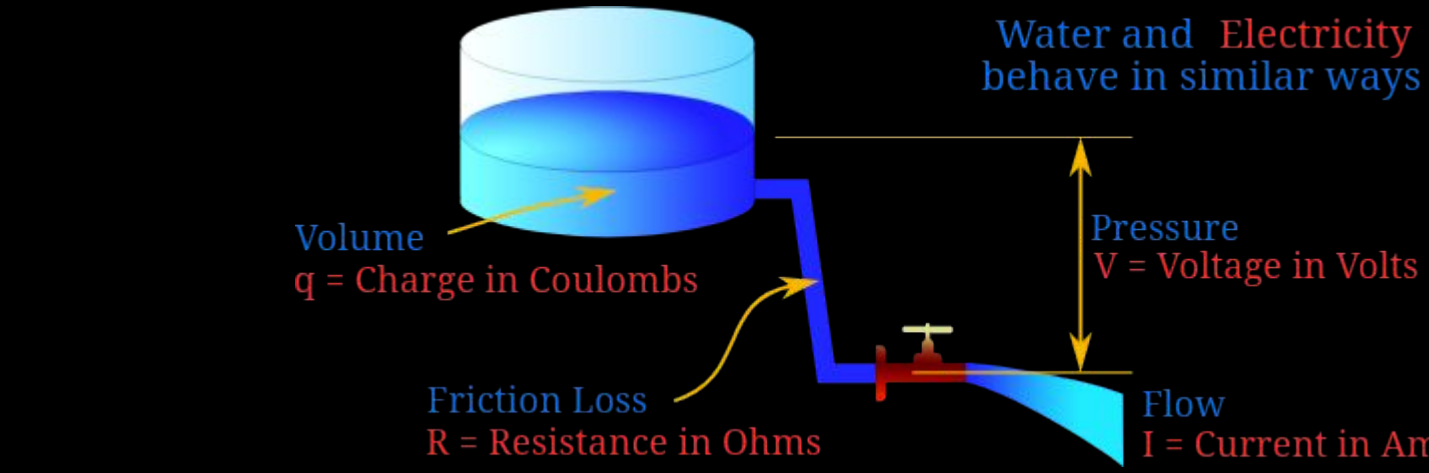
- Current (amperage)
  - Electrons over time
  - Think: Flow of water through a pipe
- Voltage
  - Potential energy per electron (kinda)
  - Flows from high to low, like potential energy due to gravity
  - Think: Pressure of water in a pipe
- Resistance
  - Voltage drop per amp
  - Think: "loss" pressure due to long or narrow pipes



Ohm's Law

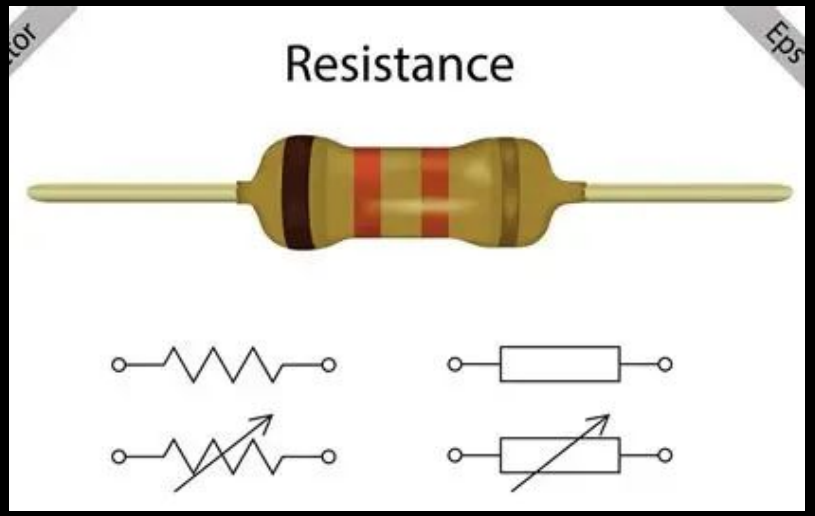
Resistance is a proportional voltage drop proportional to current



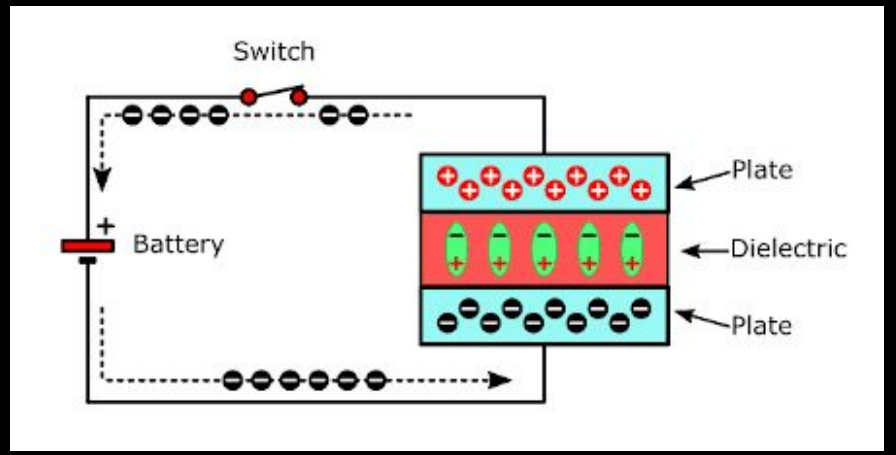


Circuit Elements

- **Resistor** - introduces resistance to current in a circuit
  - Serves to control current flow and therefore the functionality of a circuit
  - Think: a narrow pipe that water flows through



- **Capacitor** - stores electrical energy in the form of an electric field
  - Parallel plates accumulate opposite charges, forming electric field
  - Think: a water tank/buffer

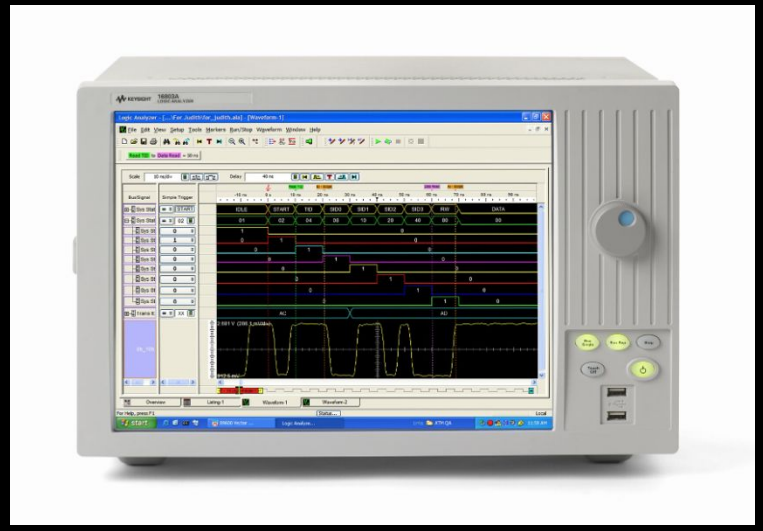


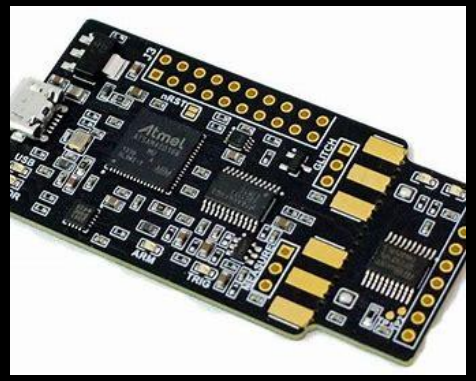
Measurement & Analysis Tools

- **Oscilloscope** - instrument used to measure analog quantities from a circuit as chosen/defined by the user
- Probes can be connected to any parts of a circuit to measure voltage, current, etc. between 2 points

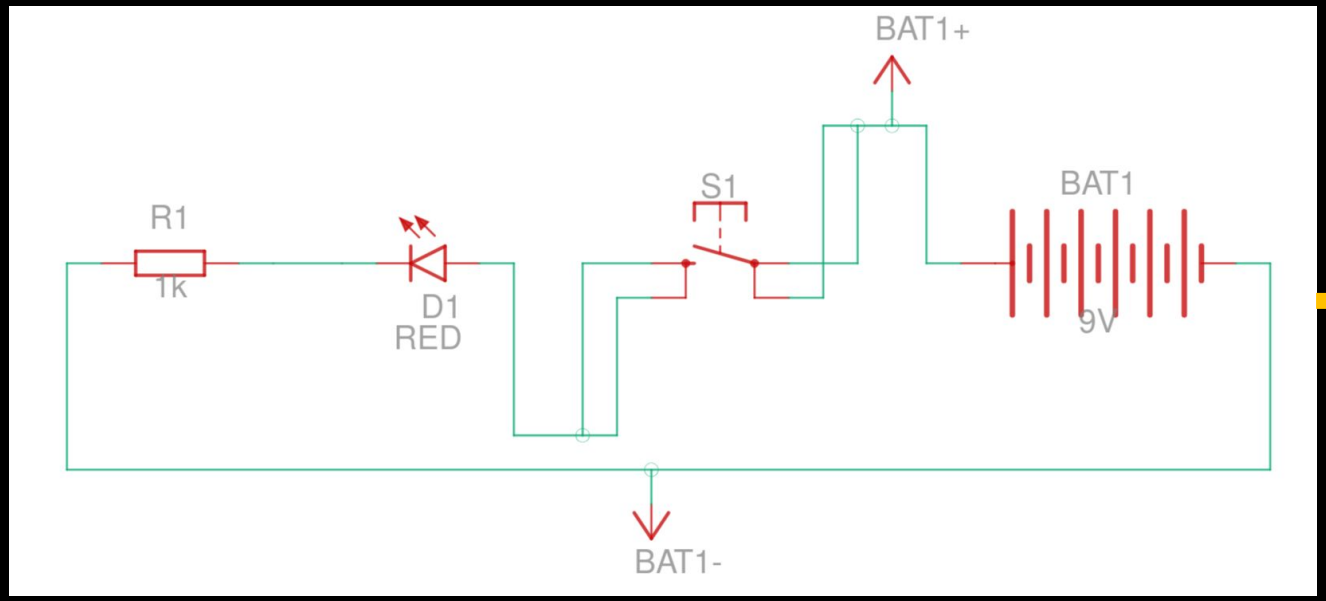
- **Logic analyzer** - instrument used to measure digital signals for circuits (logic 1 and 0)
- Voltage above certain threshold considered “high” and below certain threshold considered “low”

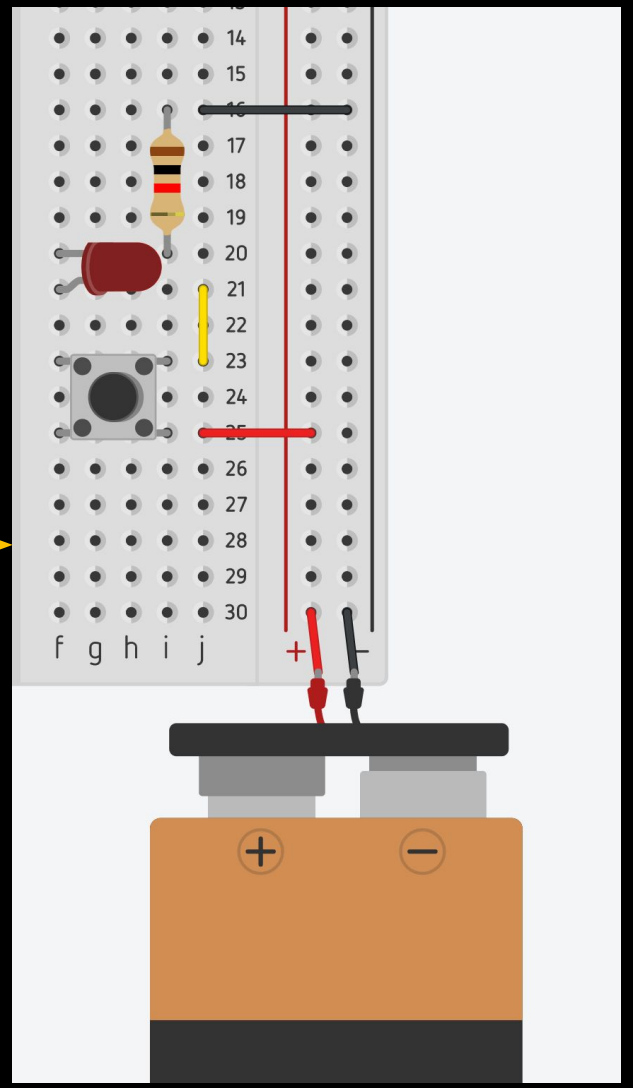
- **ChipWhisperer** - board used to read power traces and perform side channel analysis and fault injection on other devices





Reading a circuit diagram





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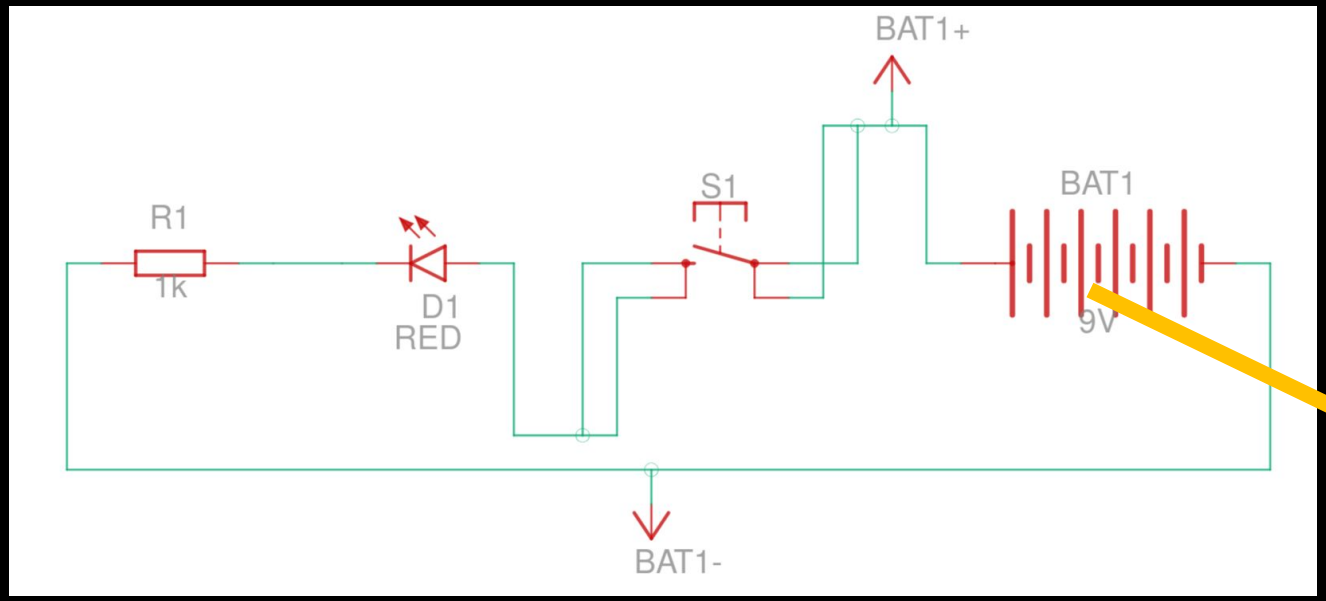

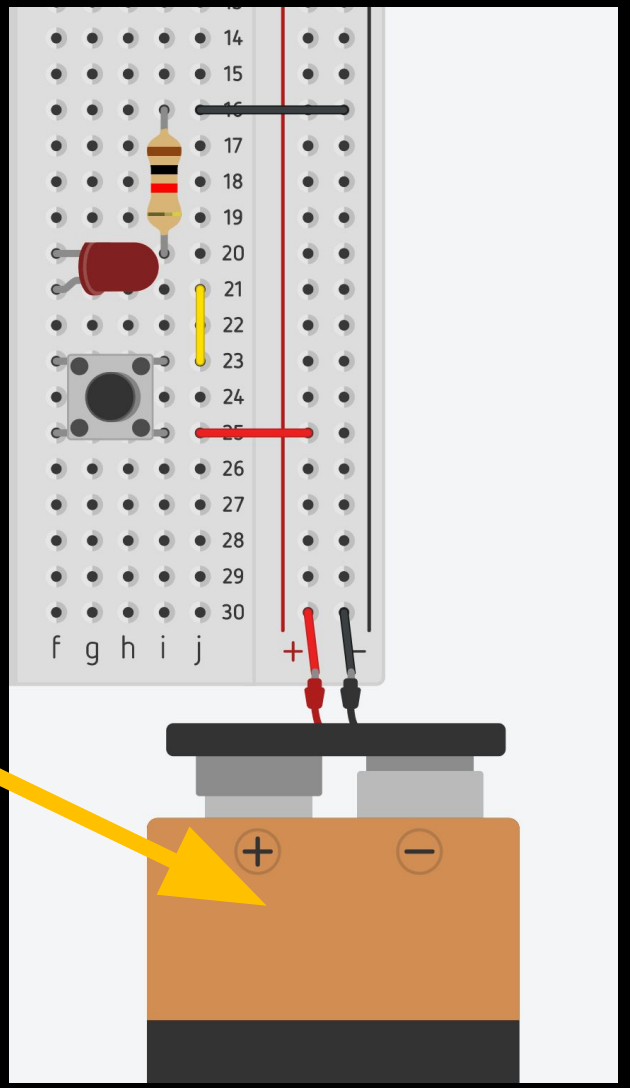

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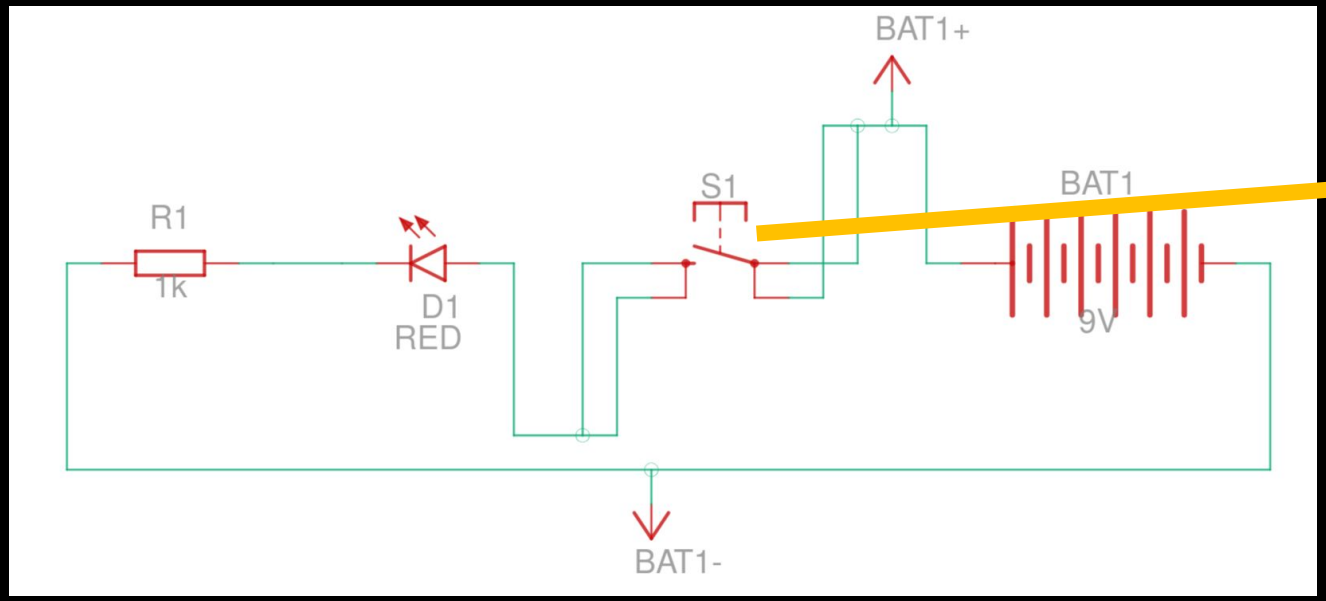

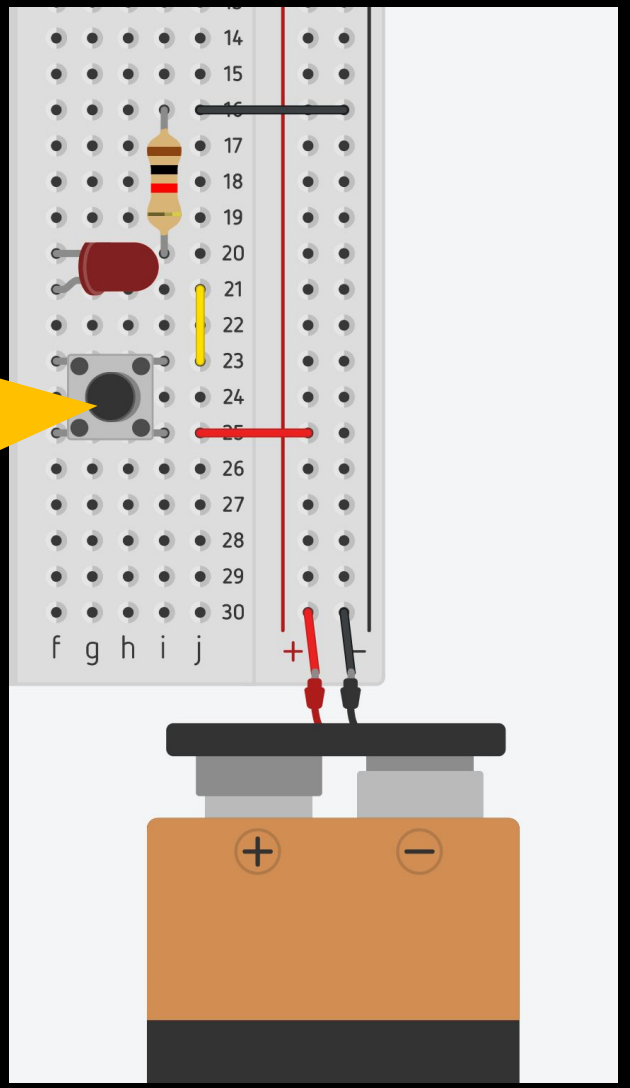

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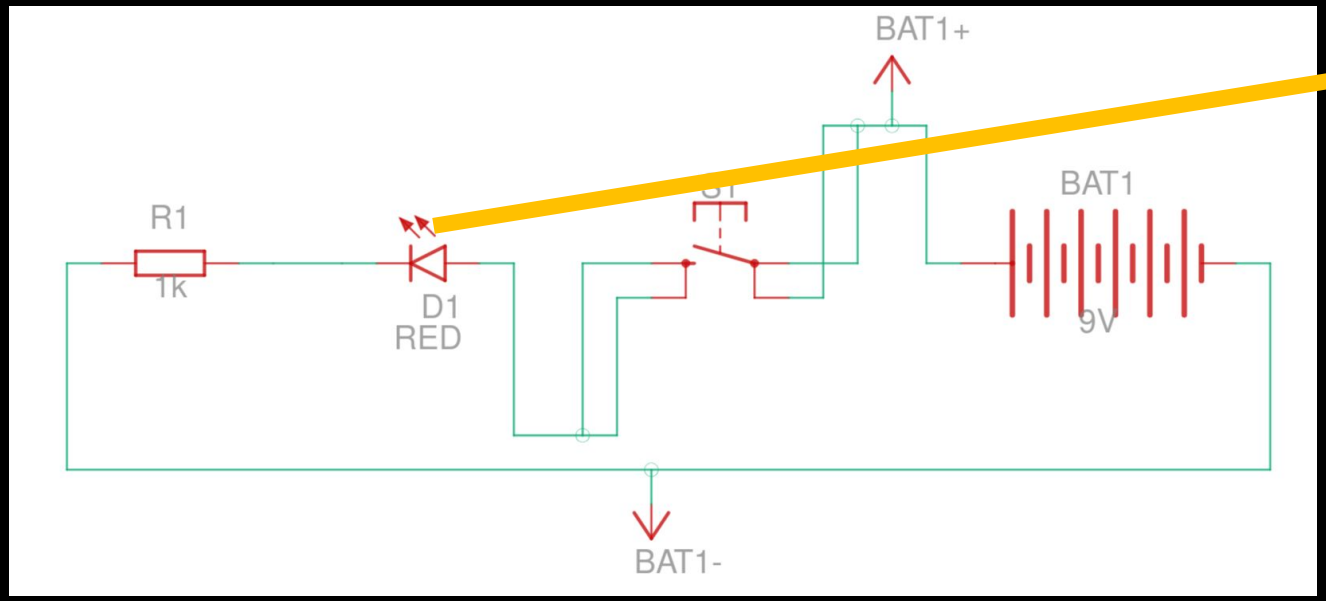

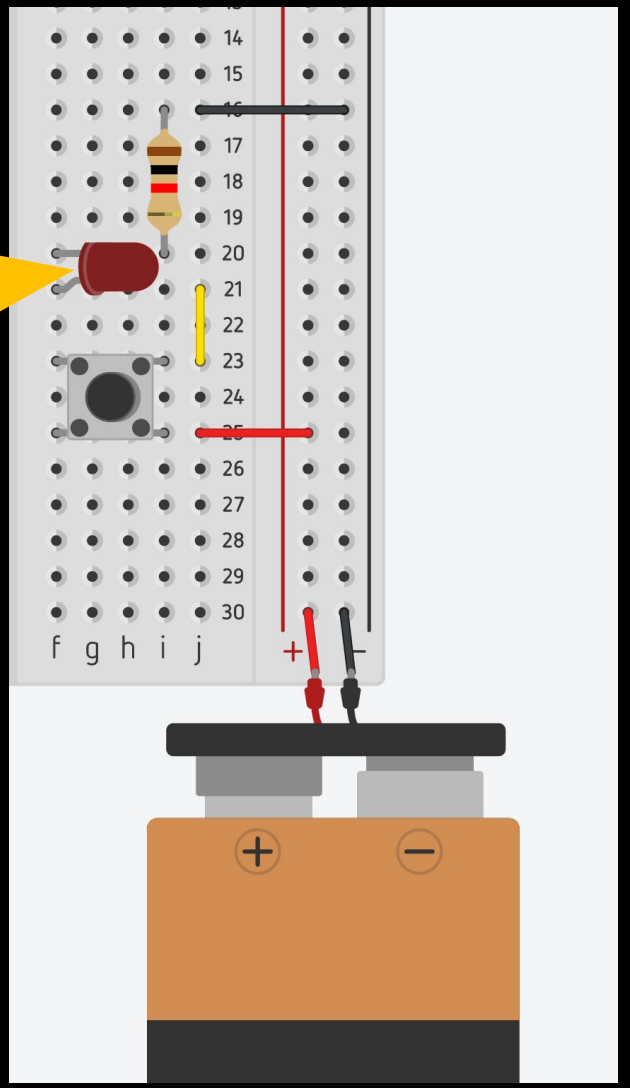

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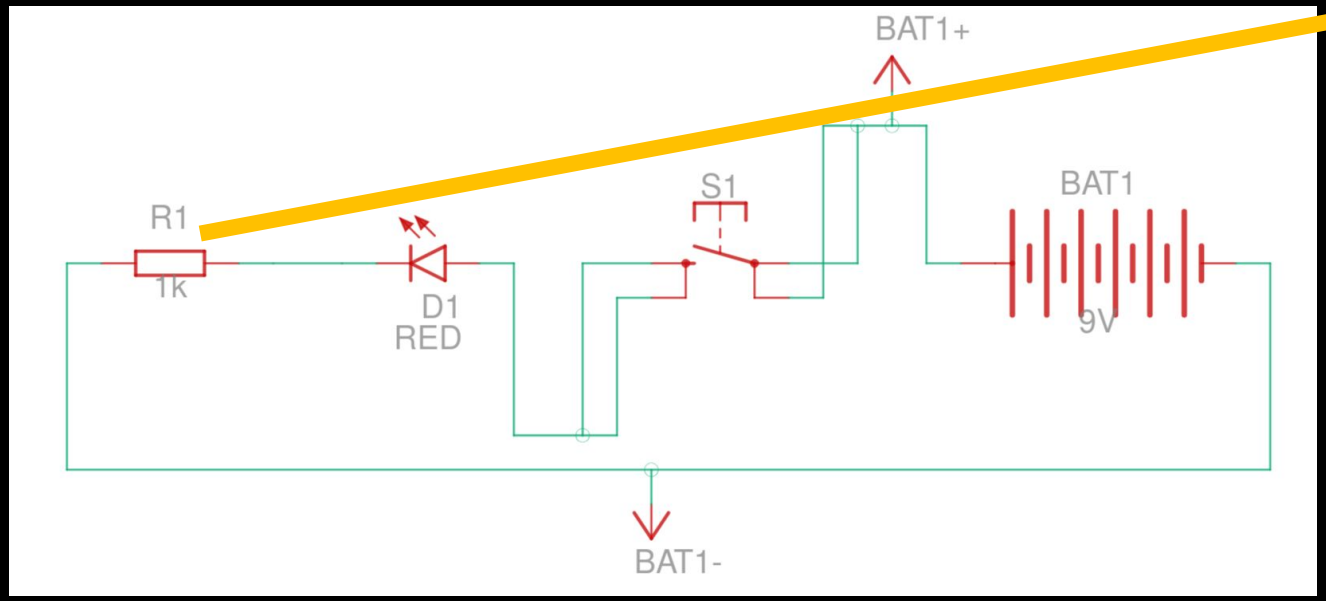
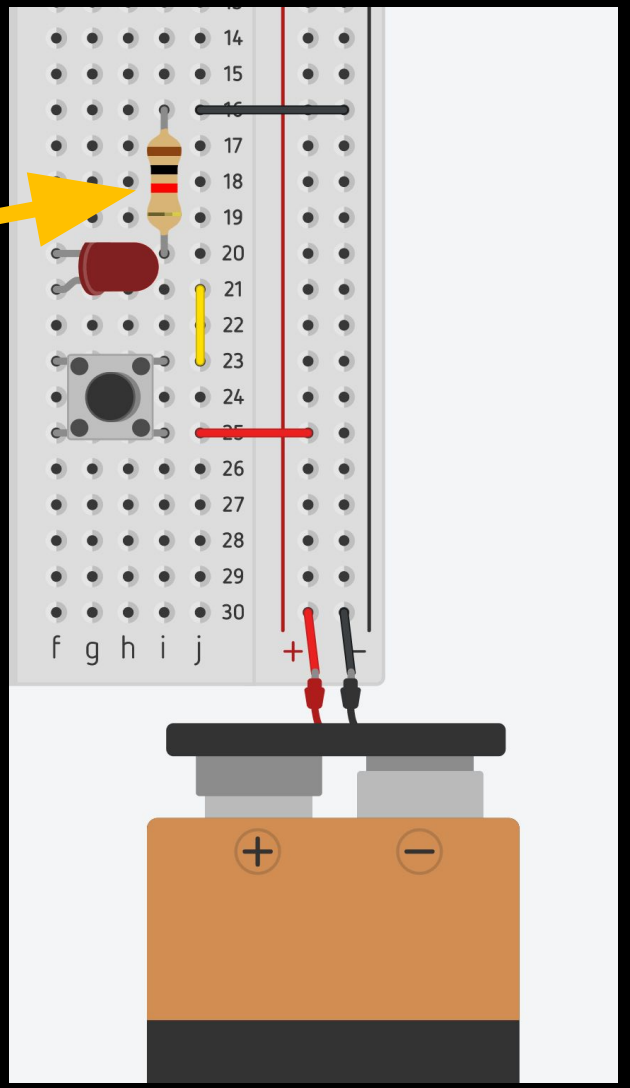
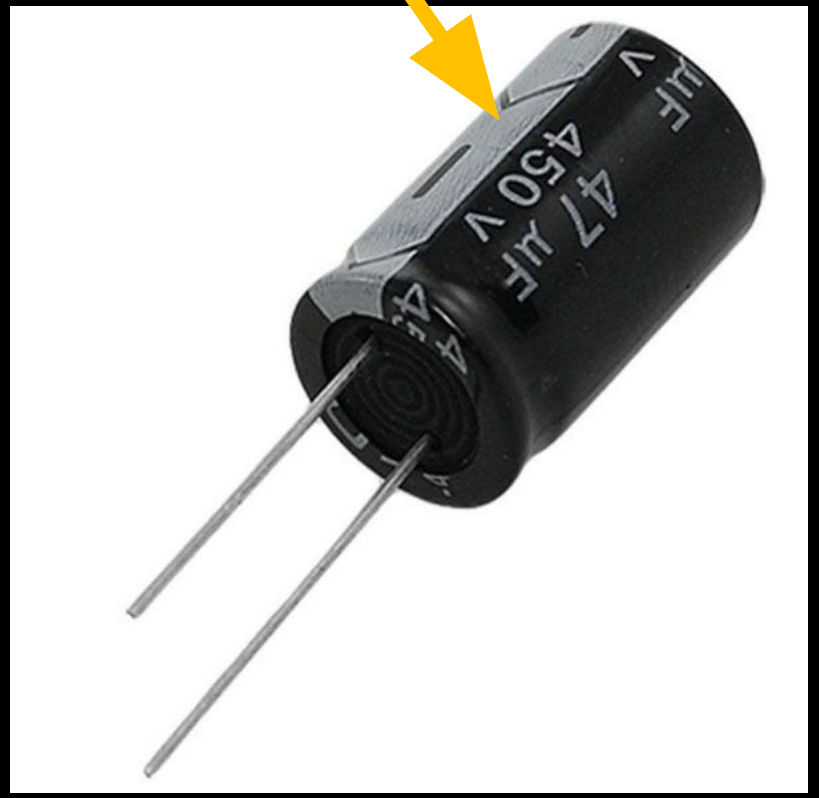




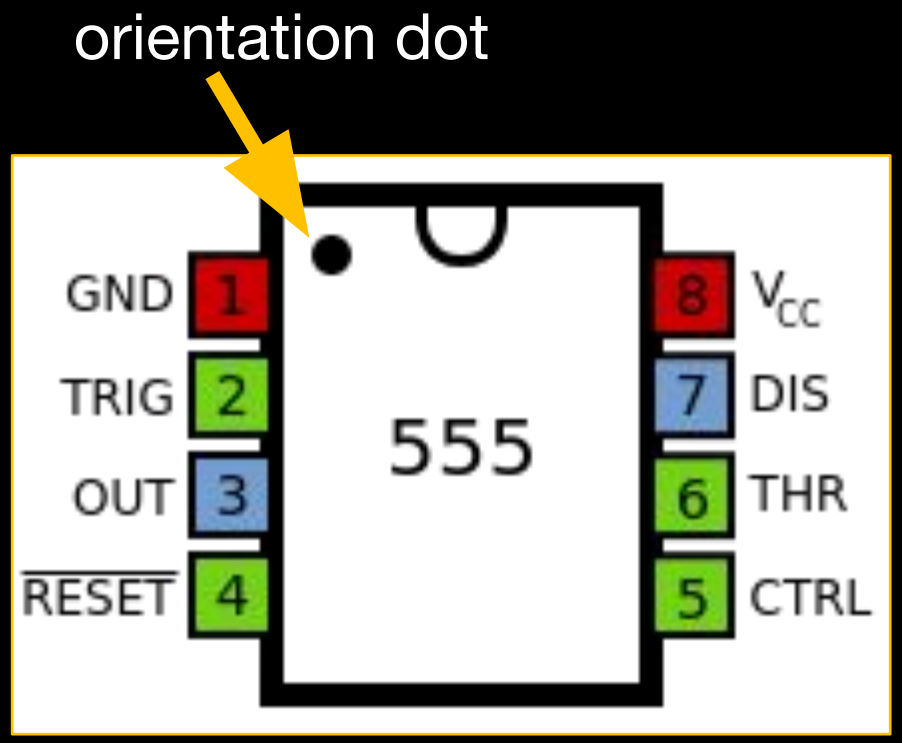
Warning: polarized capacitors

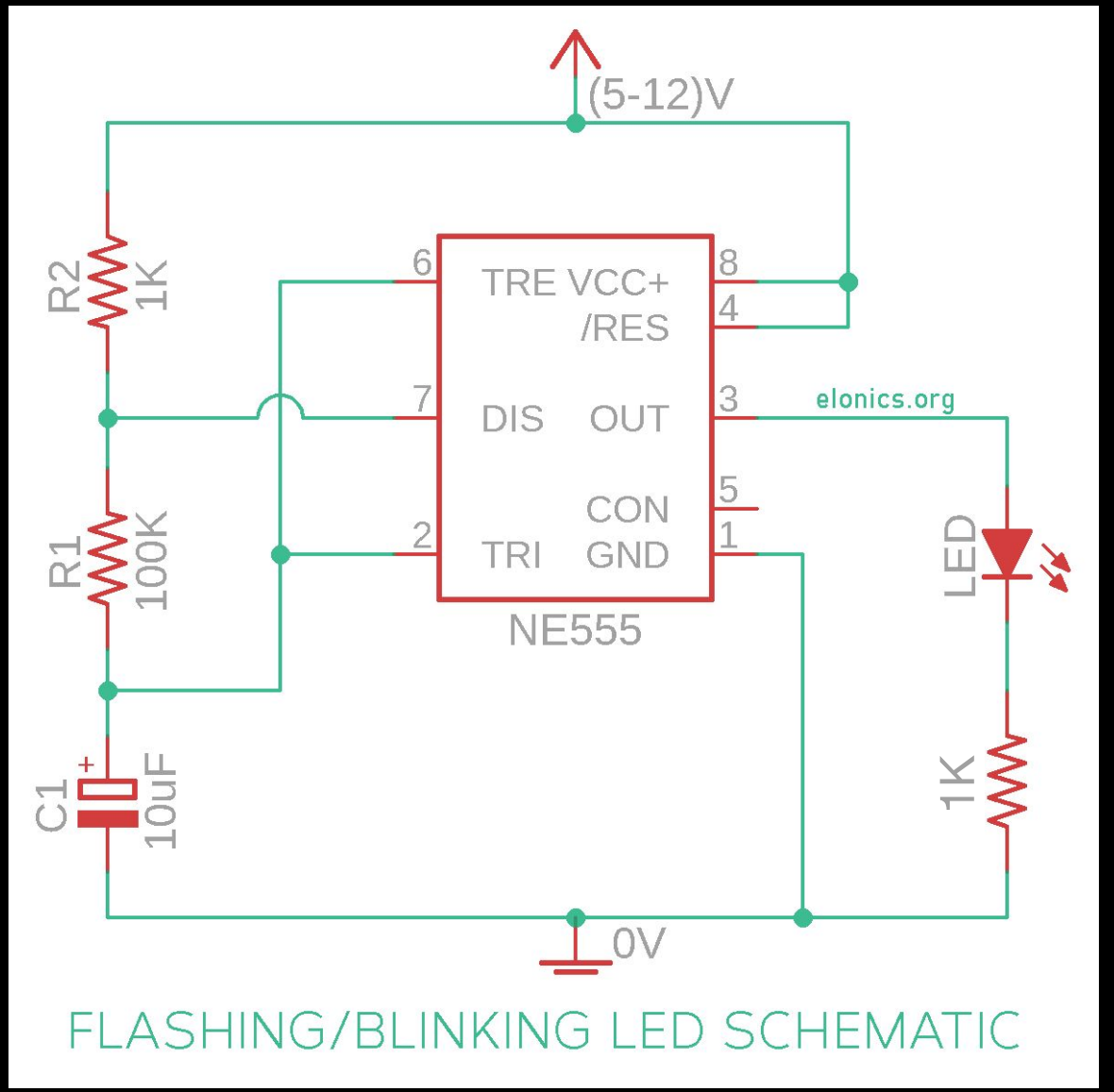
- The **long** end goes to **+**
- **Short** end goes to **-**
- Backwards won't work and may damage the capacitor



Today's Exercise

- Astable 555 Blinker circuit
  - Blinky light





Today's Exercise

- Astable 555 Blinker circuit
  - Blinky light
- 555 IC provides a PWM (pulse-width modulation) signal similar to a clk signal
- The LED will turn on when the signal from the 555 is "high"

Datasheets:

- TLC555CP T106AN datasheet
- 19AHN6M NE555P datasheet

Resources at UIUC

- SIGPwny Embedded Team bench (ACM back room)
  - Ask before taking anything, otherwise, it's free to use for SIGPwny/ACM
- IoT Makerspace (Siebel CS 1109, right across from ACM room)
- OpenLab (ECEB 2024)
- Electronic Services Shop (1st floor ECEB)
  - FREE!!!
  - Self-service, better hours than supply center
- ECE Supply Center (1st floor ECEB)
  - If E-Shop doesn't have what you need, you can buy from here


PURPLE 1.2"
RED 1.5"
ORANGE 3.5"
GREEN 4.5"
GRAY 1.5"
GREEN 5.5"
GRAY 5.5"
PURPLE 3.5"
YELLOW 4.5"
WHITE 1.4"
BLACK 1.5"
RED 2.5"
ORANGE 5.5"
YELLOW 3.5"

Next Meetings

2025-10-06 • **Next Monday**

- Secure Protocol Design
- Learn the basics of applied cryptography and how to design communication protocols

Meeting content can be found at sigpwny.com/meetings.

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