

Paper, Ink & Electronics



1. Introduction to Electronics
Clemens Wegener
October, 25th 2021

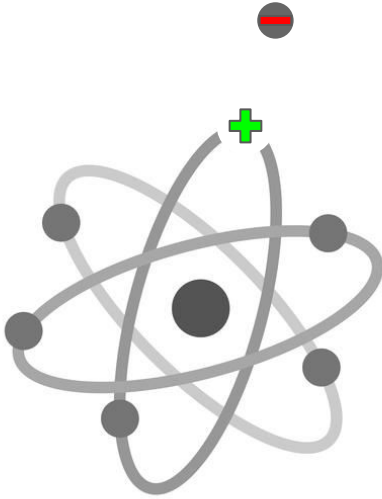
Bauhaus-Universität Weimar

How does current flow?



Josef Beuys - Capri Battey. Source [1]

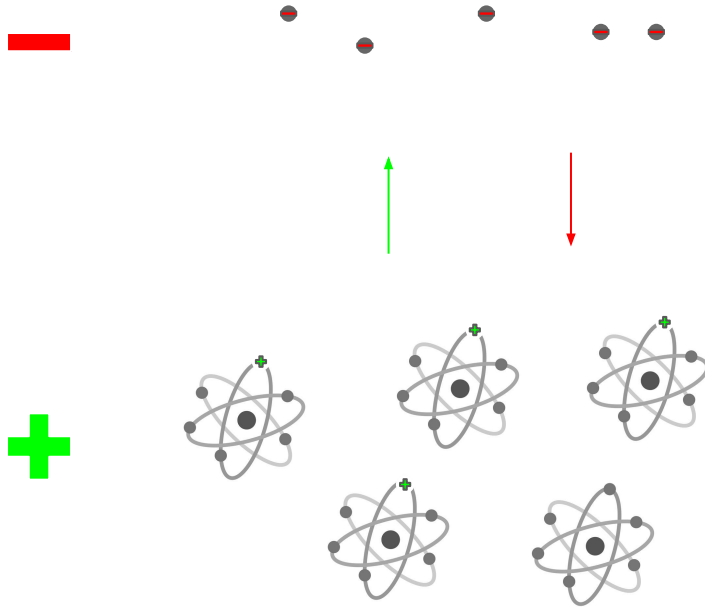
Current flow



Electrons around atom core.

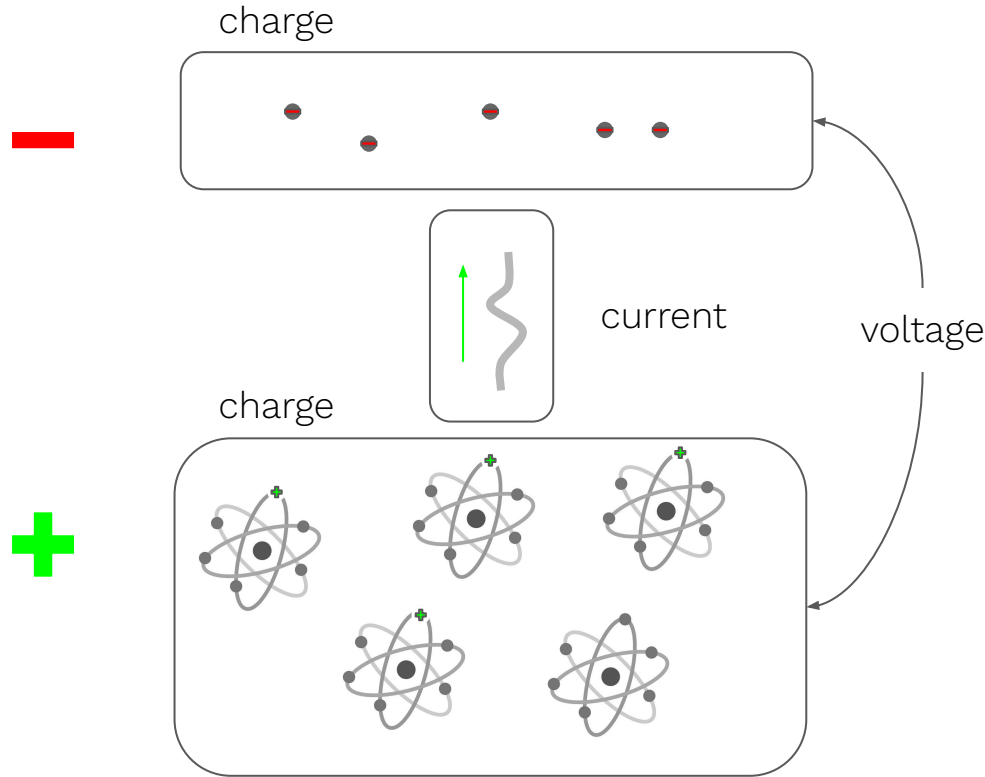
- Current flow is caused by electromagnetic forces between electrons and atom cores
- Atom Core: positive charge
- Electron: negative charge

Current flow



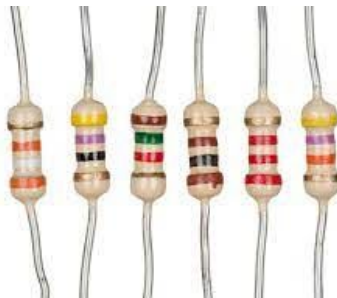
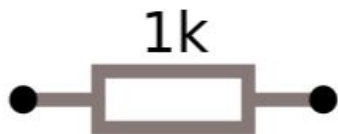
- Current flow is defined to flow from + to - for positive charge
- Negative particles (electrons) flow the other way around
- In electrical circuits, mostly electrons move through pieces of metal
- The more particles flow, the bigger the current

Elementary Notions



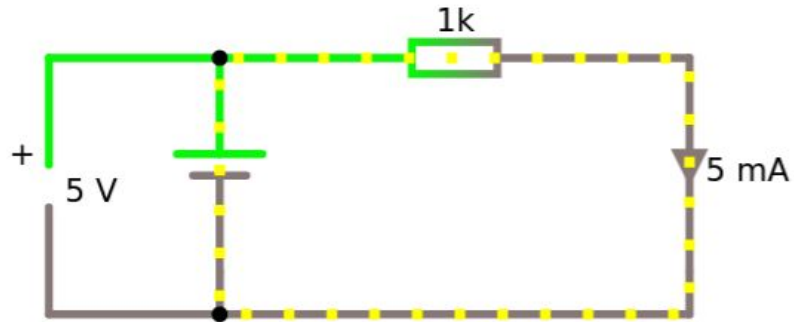
- **Charge:** amount of positive or negative particles
- **Current:** charge that travels per second through a wire
- **Resistance:** how hard is it for charge to travel through the wire
- **Voltage** is proportional to difference in charge. It is a measure of with how much pressure the charge can be pushed through the wire

Resistors



- Resistors resist a current.
- How much they resist a current is given in Ohms [Ω].
- Everything around us has some resistance against current.
- Copper wires have very low resistance.
- For electronic circuits we can buy resistors in many defined resistances.

Ohm's Law



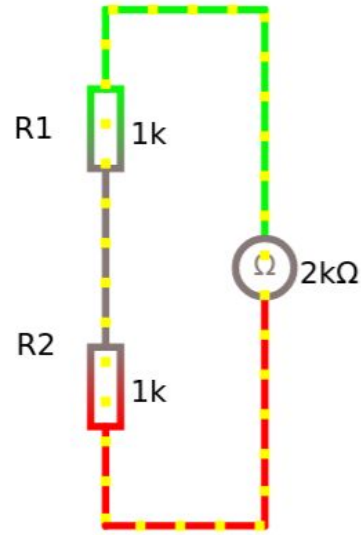
$$U = R * I$$

U ... Voltage

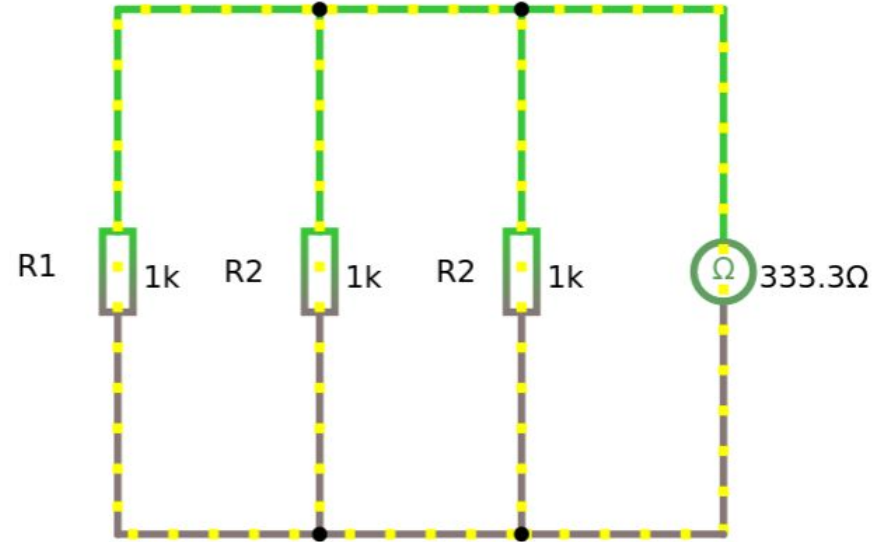
R ... Resistance

I ... Current

Series & Parallel Resistance

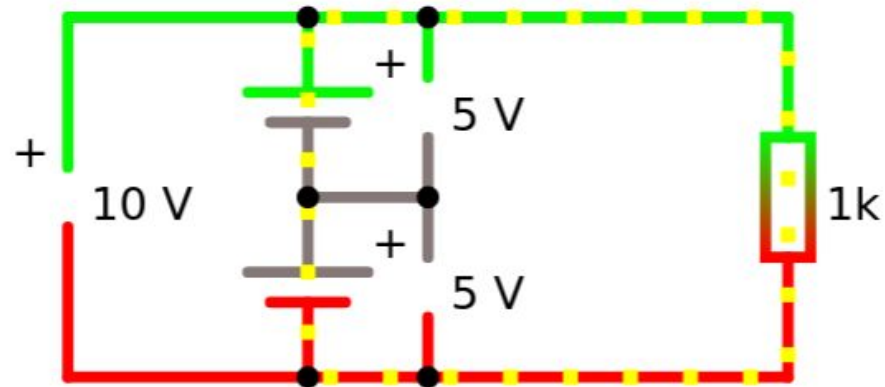


$$R_{\text{series}} = R1 + R2 + \dots$$



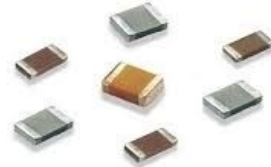
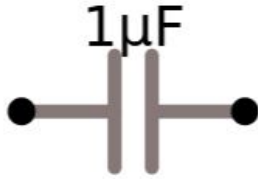
$$1/R_{\text{parallel}} = 1/R1 + 1/R2 + 1/R3 + \dots$$

Voltage Law



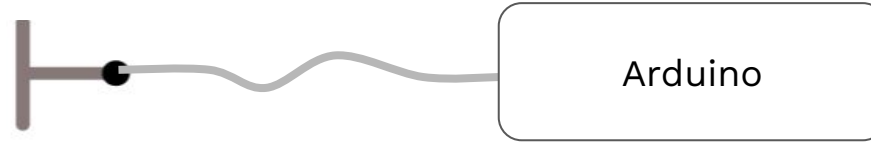
$$U_{\text{total}} = U_1 + U_2 + \dots$$

Capacitors



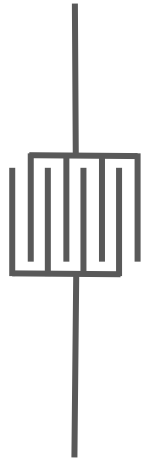
- Capacitors store charge over a certain time span.
- The amount of charge, they can hold, depends on their size given in Farads (F).
- The bigger their capacity (F), the longer they need to charge or discharge.
- In a real-world scenario they will always discharge because of leakage.
- In a circuit their charge and discharge times are controlled with a series or parallel resistor.

Capacitive Sensor



- Capacitive sensing is used to detect the presence of a finger touch on input devices
- A voltage measurement device (e.g. Arduino) is connected to half a plate of a capacitor.
- When a finger is near the plate, the capacitance changes.
- This capacitance change can be detected by the measurement device.

Humidity Sensor



- A moisture sensor is a pattern of wires that does not connect
- Within the pattern the conductors are very close to each other, allowing a finger touch to connect them
- When the finger connects the conductors, a small current is flow through the moist skin of the finger. The circuit is closed by the finger.
- The moist skin acts as a resistor - the more skin touches the sensor, the smaller is the resistance.
- To use this sensor, we have to apply the concept of the [voltage divider](#) and use our humidity sensor instead of one of the resistors ([full circuit](#))

Sources

[1] <https://pinakothek-beuys-multiples.de/product/capri-batterie/>, access 2021-10-17.