Electric Systems

Presented by Michael Haines and Andrew Wintenberg

What is an electricity?

- Is it electric shock?
- Is it like a static from from a balloon on your hair?
- Is it in the power lines and appliances?
- What comes from power plants?
- Can you hold electricity? like a battery?
- Is it dangerous?
- How can we protect ourselves?
- What does this have to do with robotics?

What is an electricity?

Electricity is actually a poorly defined term.
Generally it refers to the presence of an electric current.
- An electric current is the movement of electric charge
- An electric charge is the presence of charged particles

It also refers to the power of an electric current
- The movement of charged particles can provide power to appliances
- This power is often observed in the visible sparks of static electricity

This leads to the question:

What is a charged particle?

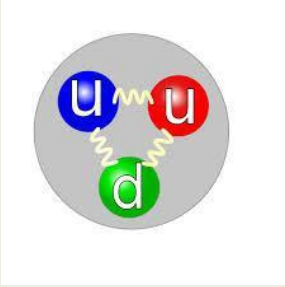
What is an electricity?

Charge is a property of matter just like mass
Charge is visualized at the subatomic level

- Protons have a positive charge
- Neutrons have a neutral charge
- Electrons have a negative charge

Based on its definition, current is actually the organized movement of the these particles.

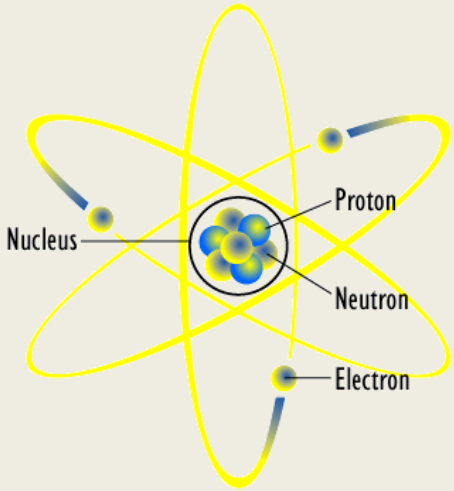
Which of these particles actually moves in what we think of electricity?



What is an electricity?

You probably know that electrons move in a current.
In the atom, electrons can be removed more easily than a proton
However, one could also use protons to create a current as well

We use conductors to “carry” our currents.
This means that our charged particles can easily move within a material
Metals are great conductors because the metallic bond allows for free electrons



How does electricity work?

Okay so electricity is electrons flowing through a wire.

Wait but why does that happen?
What makes the electrons move?

Maybe a battery has something to do with it.

How does electricity work?

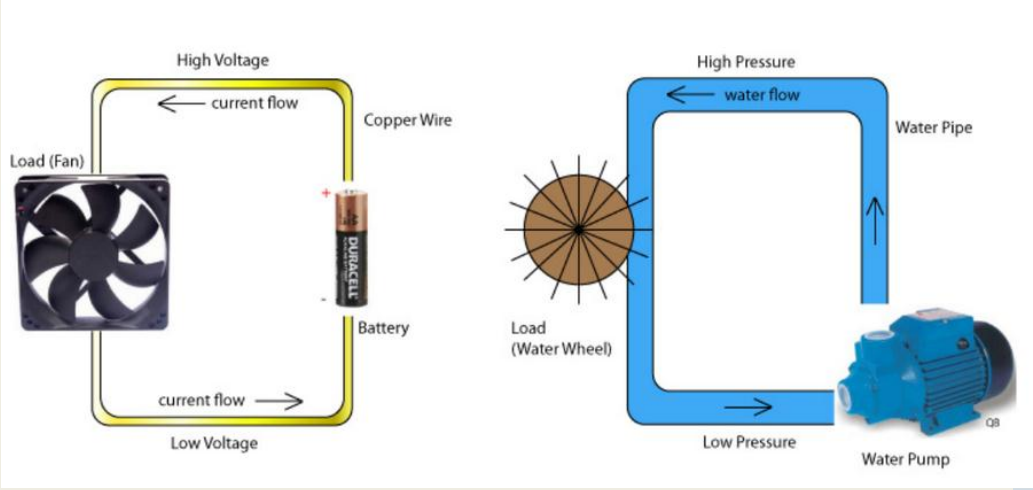
A battery provides a quantity called voltage.
Voltage provides a force that moves the electrons through.
An electron going through the battery gains electricity

It can help to think of electricity like water in a pipe.

A current is the flowing of water like electricity.
A voltage is like a pressure forcing the water through
A battery is thus like a pump for electrons

How does electricity work?

Just like moving water, this current can do work called a load.
Water can turn a water wheel while electricity can do many things
The more pressure applied to the wheel, the faster it turns.
The same is true for electricity.
How are pressure and work related?

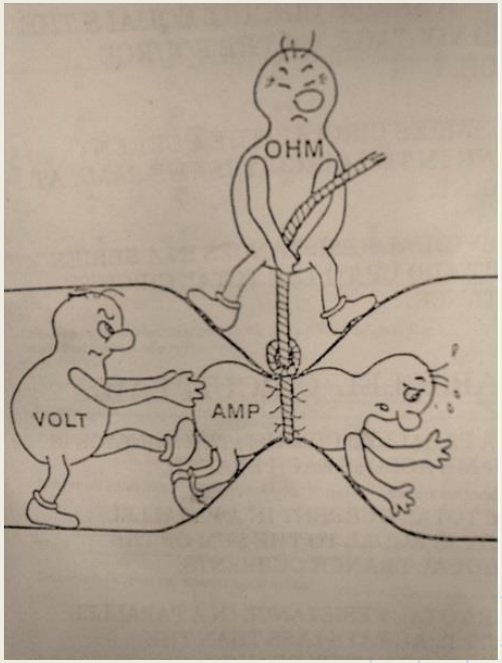


How does electricity work?

Every load requires a different amount of “work”, called resistance
All electrical components have a resistance, whether a wire or light bulb
There is an equation that relates voltage, current, and resistance

This is called Ohm’s law

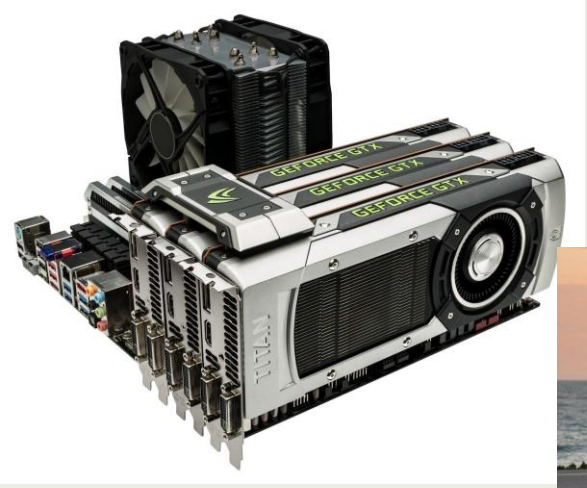
Voltage = Current * Resistance

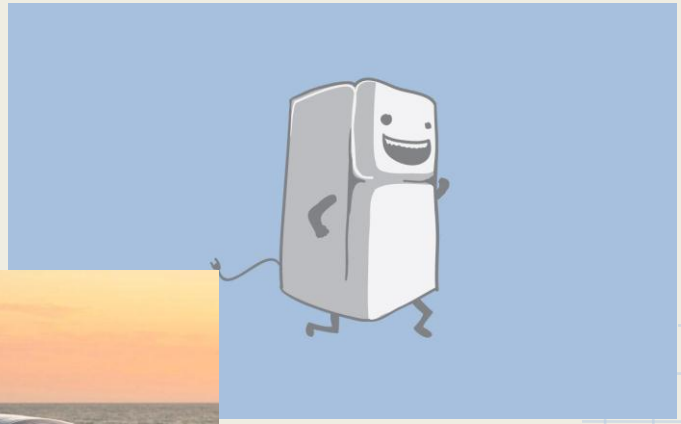


Application

Now that you know how electricity works,

- How can we use it to power our robot?
- How do we control electricity?
- What parts are used to control electricity?
- How do these parts affect electricity?





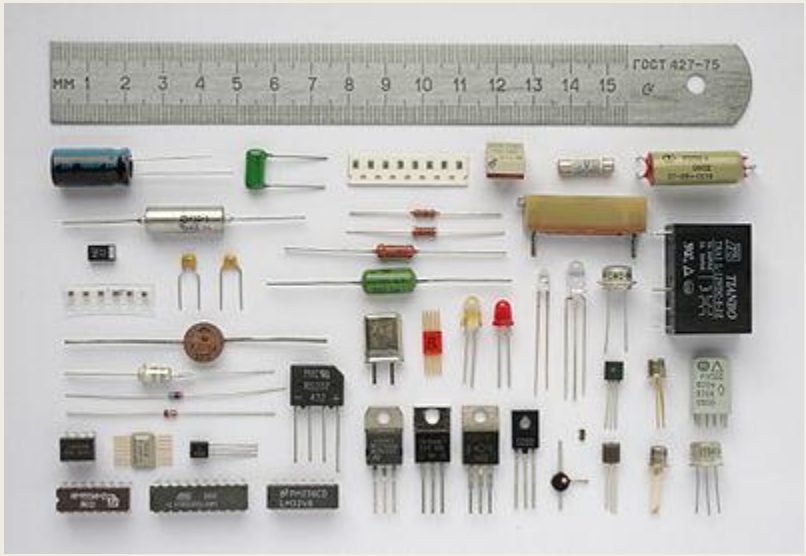
Electronic parts

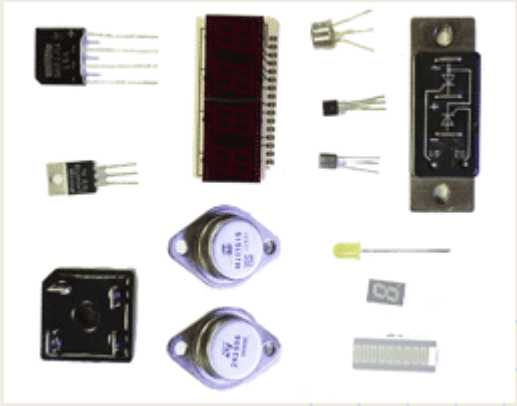
Passive:

- Resistors
- Capacitors
- Magnetic (Induction) devices
- Transducers, Sensors, and detectors

Active Components:

- Semiconductors
  - Transistors
  - diodes
  - integrated circuits
- power sources
- vacuum tubes



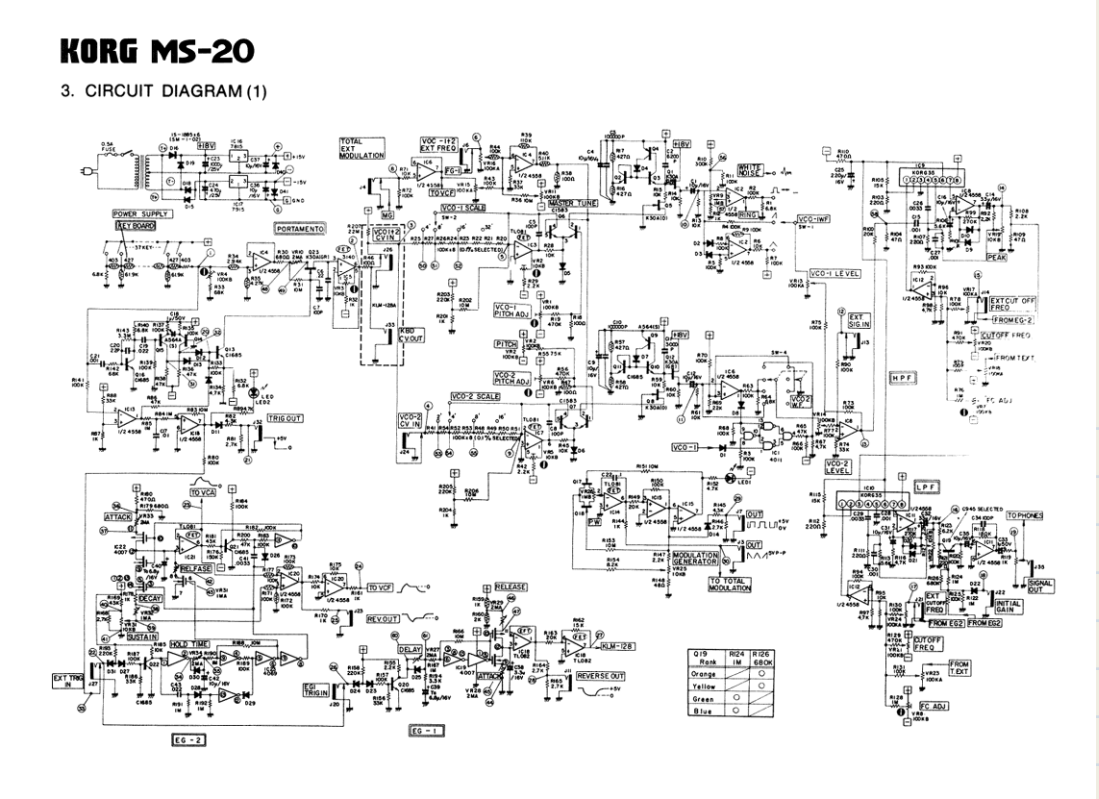


Circ - What?

A circuit is a combination of electrical components. It is a loop that allows the electricity to flow from one end of the powersource and back in on the other side. i.e think of a battery and a light bulb.

Circuit conditions

- open circuit
- closed circuit
- short circuit



Backwards Electricity?

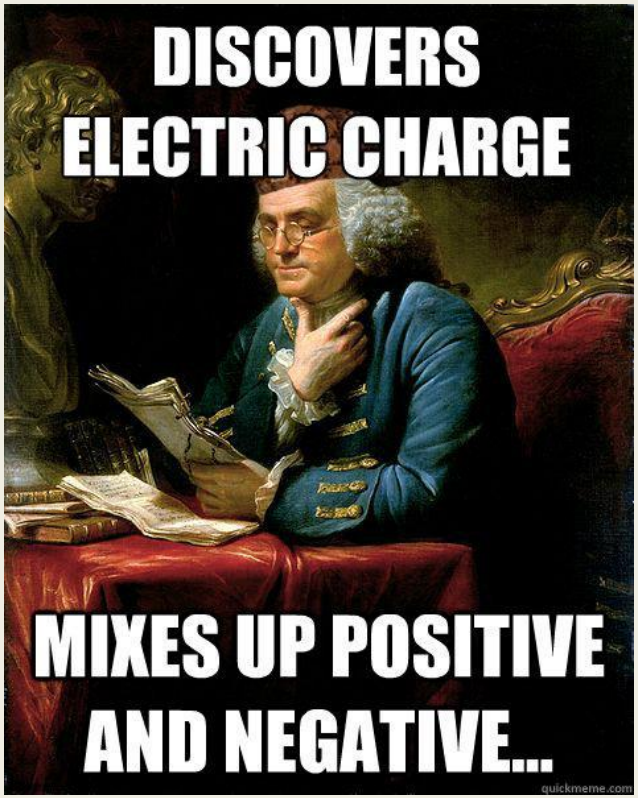
The conventional positive current is in the direction a positive particle flows.

- This means that electrons actually leave the battery from the negative terminal and return in the positive one.
- The conventional current leaves the positive terminal but enters the negative one

It seems like applications should work in the direction of the electrons.
Who can we blame for this weird, backwards convention?

Dangit Ben

None other than our founding father, Benjamin Franklin



Safety

Electricity poses a hazard for both you and the robot.
It can cause severe burns and can destroy components of the robot
In addition to the electricity, the battery contains corrosive chemicals
Knowing the science behind electricity should help with safe practices.

Robot Safety

Every part on the robot can get fried like a turkey on Thanksgiving if you don't watch out.

Remember:

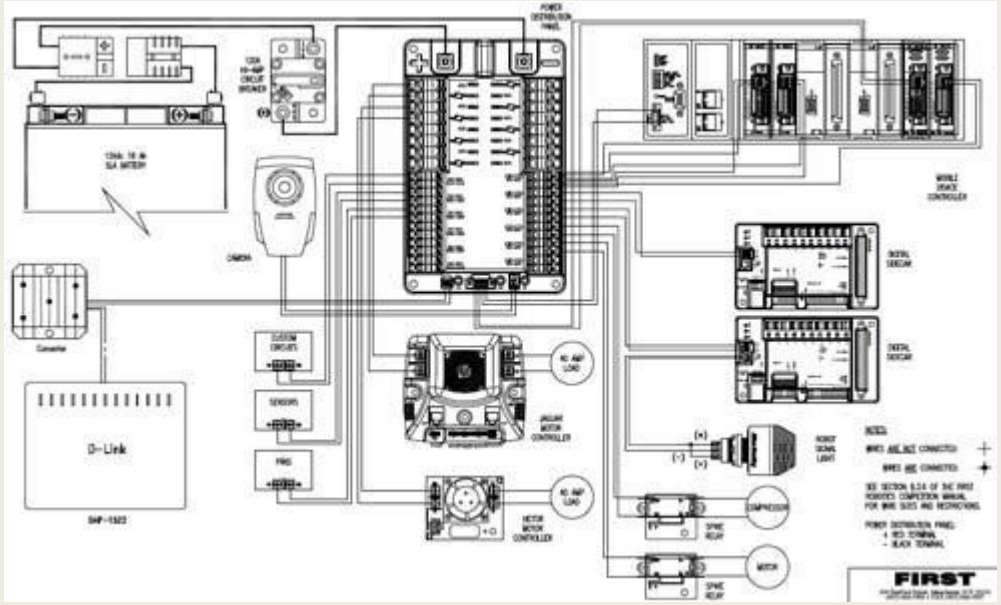
- Do not let wires touch. This can create a short circuit
- If you see exposed wiring, shut of the robot and insulate the wire
- In a short circuit, components will either malfunction or be burnt to a crisp.
- You can identify malfunctioning components by smoke or a burning smell
- Other indicators of malfunction are the various lights on the robot
- Disconnect the power source in case of malfunction
- Batteries themselves are a hazard.
- Never work on the robot when in operation
- No metalwork should be done near sensitive electrical components
- Be careful for the robot's sake

Human Safety

- Electricity poses a real danger for humans
- Although not extremely high, low voltages can cook you
- Do not touch exposed wiring
- Never draw a current directly from the battery
- Use a switch with a fuse to avoid dangerous currents
- Always ensure active components are secured before operating
- Metal tools can heat up in the presence of a current
- Do create a bridge using metal
- Batteries have acid which will damage clothing and skin

Electronics in FRC

Memorize this picture



Electronics in FRC

Just kidding… Maybe

Let’s go learn this from actual components!!!???!!!???!!!

cRIO

- The robot's controller
- Powered by 24v from the power distribution board (PDB)
- All signals are routed through the cRIO
- The cRIO has slots for First modules
- The three modules are the digital, analog and solenoid breakouts
- The cRIO is connected to the wireless router using an ethernet cable

Power Distribution Board (PDB)

- The center of power for the robot
- Connected to the battery in series with the main circuit breaker
- It has various slots with differing voltages and currents
- Each set of main terminals has a slot for a fuse

Circuit Breaker

- The battery's power is channeled through this
- To break the circuit, press the red button
- To reset it, push the lever back into the breaker

Digital Sidecar

- The digital sidecar is connected to the cRIO using a ribbon cable
- It provides expanded digital input and output capabilities
- To transfer signals, PWM cables are used.
- The signal for the signal light is also output

Wireless Router (DLink)

- To communicate with the laptop, a wireless router is used
- It is powered by a specific power supply that is connected to the PDB
- It is connected to the cRIO using an ethernet cable
- The camera is also routed through the DLink

Motor Controller

- Motor controllers are used to adjust power levels according to a digital input
- The motor controller receives power from the PDB
- Based on an input from the digital sidecar, it will output power to an active device
- They are used primarily to power motors
- Motor Controllers in FRC include Jaguars, Victors, Talons, and Spike relays


TI's MDL-BDC24 "Black Jaguar"

Other components

Now we will go over other components not mentioned