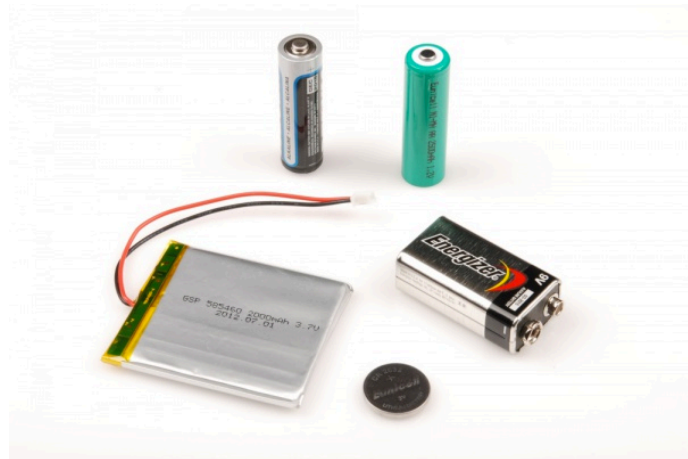


Battery & Power Technologies



Types of batteries

Rechargeable

Lead-acid



Nickel-Cadmium;
Nickel-metal-
hydride



Lithium-ion;
Lithium-polymer



Single-use

Alkaline



Lithium



Battery Terminology



Voltage – What level does the battery charge and discharge at?

Capacity – how much energy can it hold?

Output Current – how fast can it put out energy?

Cycle Life– how many times can it be charged & discharged before it wears out?

Battery Terminology

- **Nominal Cell Voltage** - The average voltage a cell outputs when charged. The nominal voltage of a battery depends on the chemical reaction behind it. (E.g: LiPo's nominal voltage = 3.7V...however, a fully charged LiPo battery will produce about 4.23V, while when discharged its voltage may be closer to 2.7V)
- **Capacity** - Batteries have different ratings for the amount of power a given battery can store. When a battery is fully charged, the capacity is the amount of power it contains. Batteries of the same type will often be rated by the amount of current they can output over time. (mAH)
- **Output Current** (output power) – Batteries have a maximum current they can put out---maximum flow of power out of the battery. Check that this is enough current for the system.

Battery Terminology con'td...

- **Cycle Life** – Rechargeable batteries don't last forever: each time they are charged and discharged they get damaged a little bit. Will the battery last for 100 cycles? 1000?

Note that cycle life and output current are related: for lower current = longer cycle life.

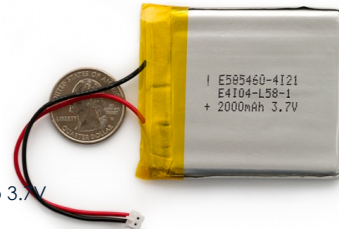
- **Shape** - Batteries come in many sizes and shapes. The term 'AA' references a specific shape and style of a cell.
- **Energy Density** - Measure of how much energy the battery holds for the battery's size. For example, lithium batteries typically hold more energy in a small space a given volume than alkaline or coin cell batteries.
- **Internal Discharge Rate** - Batteries discharge when sitting on the shelf or when unused. This is a measure of how fast the energy leaks out.

Safety Concerns

- Because batteries store power, they are basically very tiny explosives. Batteries release the energy more slowly than explosives and are designed to be as safe as possible.
- If you hook up an alkaline battery incorrectly, it may get hot to the touch but should not catch fire. Most Lithium Polymer batteries have safety circuits built-in to prevent damage to battery and prevent it from unsafe usage.

Lithium Polymer - LiPo

- Most widely used for embedded electronics.
- Highest density readily available on the market.
- Nominal Voltage : 3.7V
 - When fully charged you will see nearly 4.3V on the cell but it will quickly drop to 3.7V under normal use. When depleted, the cell will be around 3V.
- Charging and Discharging
 - Low-cost USB chargers available to charge LiPo batteries. **Do not** attempt to charge a LiPo without a charger. A LiPo battery can be harmed by overcharging, so use a specifically designed LiPo charger.
 - LiPo batteries can also be harmed by being discharged too far. To protect against this, almost all LiPo batteries have a small safety circuit built into the top of the cell that will shut off the battery if the voltage drops below a certain threshold (usually 3V).
- LiPo batteries have a **very low internal discharge rate**.



Nickel Metal Hydride - NiMH

- Proven rechargeable technology.
- Lower cost but suffer from lower densities than LiPo.
- NiMH batteries require less stringent charging curves, which lower the cost of the chargers. NiMH are often found in lower cost electronic devices such as toothbrushes and cordless shavers where output voltage is less of a concern.
- Nominal Voltage: **1.2V**.
- Because of their similarity to regular consumer batteries, charging NiMH batteries is often done with chargers that plug into the wall.
- Ideal for a device already been designed to use AA type batteries.



Lithium Coin Cell

- Coin cell batteries are great for very small, low power projects.
- **Not** rechargeable in most cases.
- Nominal voltage of 3V.
- Capacity : 190mAh to 240mAh



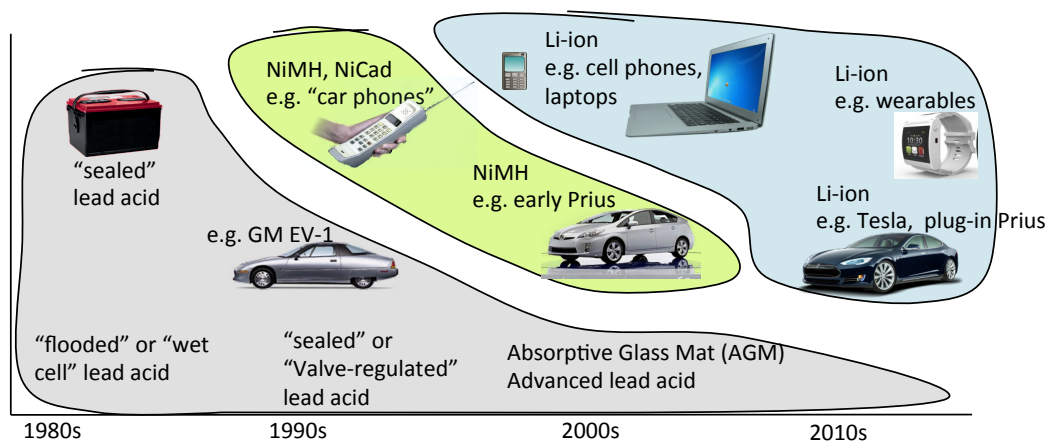
Coin cell batteries come in a few different sizes, each with a specially coded name to indicate the size and chemistry. **Alkaline coin cells** all start with an “L”, while **lithium coin cells** are all prefixed with a “C”. The popular **CR2032**, for example, is a lithium battery measuring 20mm in diameter and 3.2mm tall.

Alkaline

- Around for many decades!
- Cheap, safe to use, and available everywhere, but sadly, they **are not** rechargeable.
- AAs and AAAs are the most common alkaline batteries and output **1.2V nominally** (but are around 1.5V when first used). 9V batteries are obviously 9V nominally.
- A 9V battery is a great way to make a project portable, but don't expect the battery to last very long! While it outputs 9 volts, the capacity of a 9V battery is pretty low.



Types of batteries



**For Everything you ever want to know
about batteries**

<http://batteryuniversity.com/>