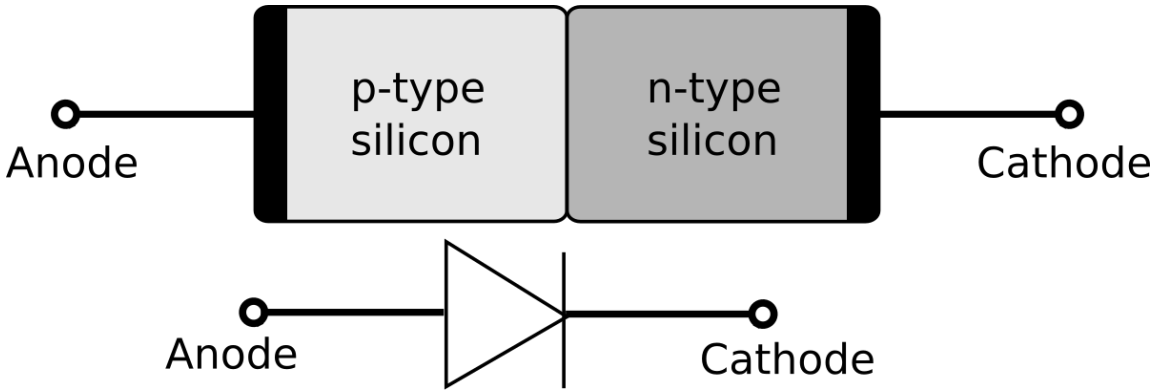
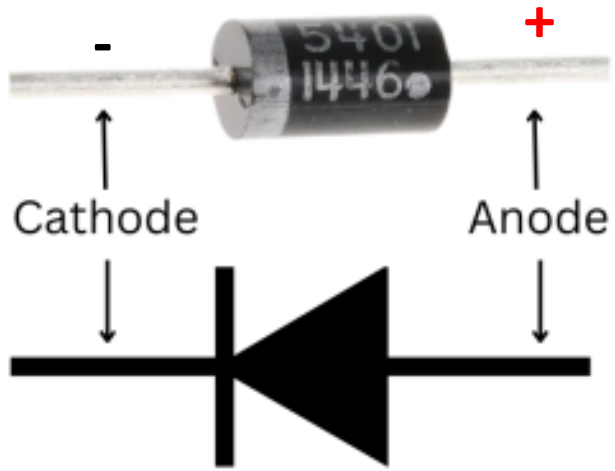
Semiconductor Devices

Junction Diode

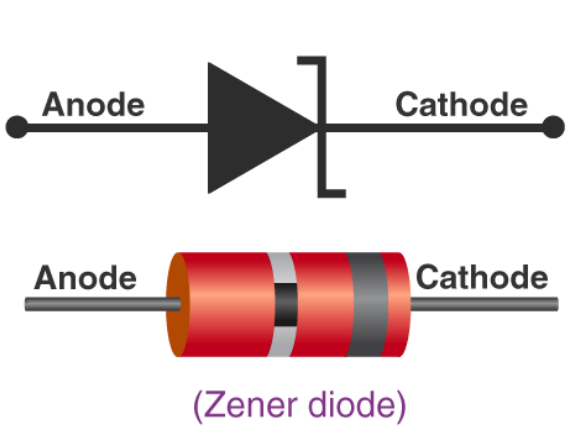
- A junction diode is just a basic PN junction
- This means its one way and blocks flow in the opposite direction
- In forward bias it allows current to flow normally
- In reverse bias it blocks current flow until a breakdown voltage is reached at which point current flows, but it permanently damages the diode

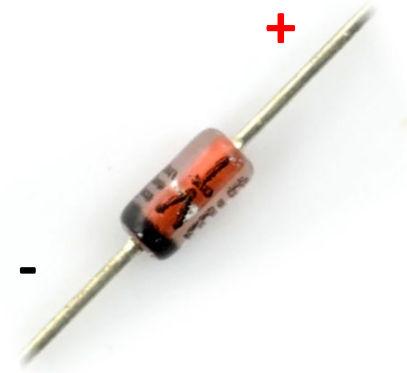




Zener Diode

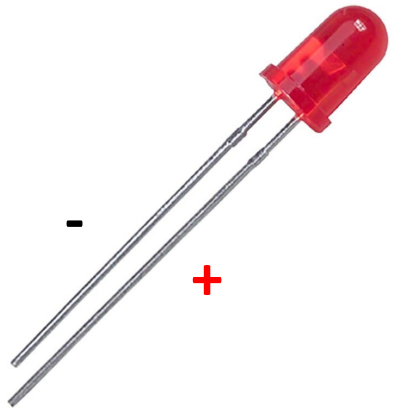
- A Zener diode is just a PN junction which is specially doped to make it able to work in reverse
- Current can usually only flow one way unless a breakdown voltage is applied to in reverse
- In forward bias it allows current to flow normally
- In reverse bias it blocks current flow until a breakdown voltage is reached at which point current flows without damaging the diode
- Zener diodes output a constant voltage when plugged in in reverse.





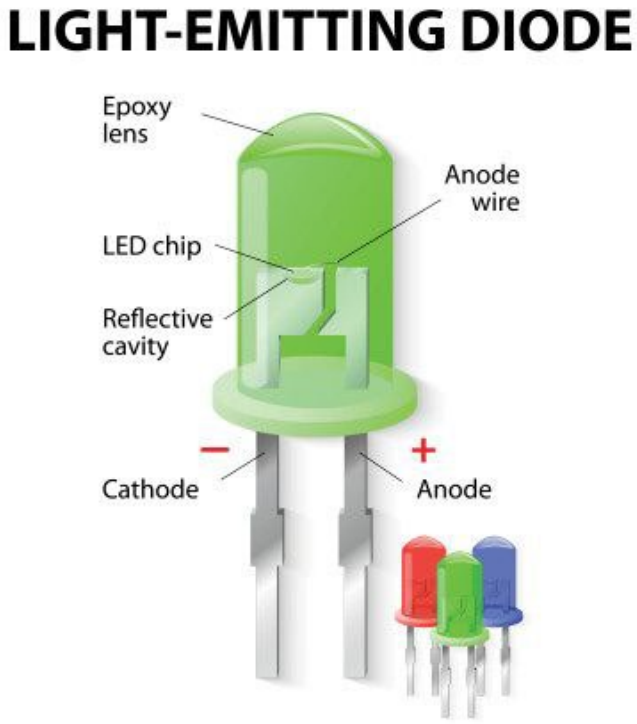
Light Emitting Diode (LED)

- An LED is a diode made of a compound of semiconductors which emits light
- Light is only emitted when current is flowing the right way, if reversed no light is emitted
- We can tell which is the anode and cathode of the LED based on the length of the leg, the longer leg is the anode and the shorter is the cathode



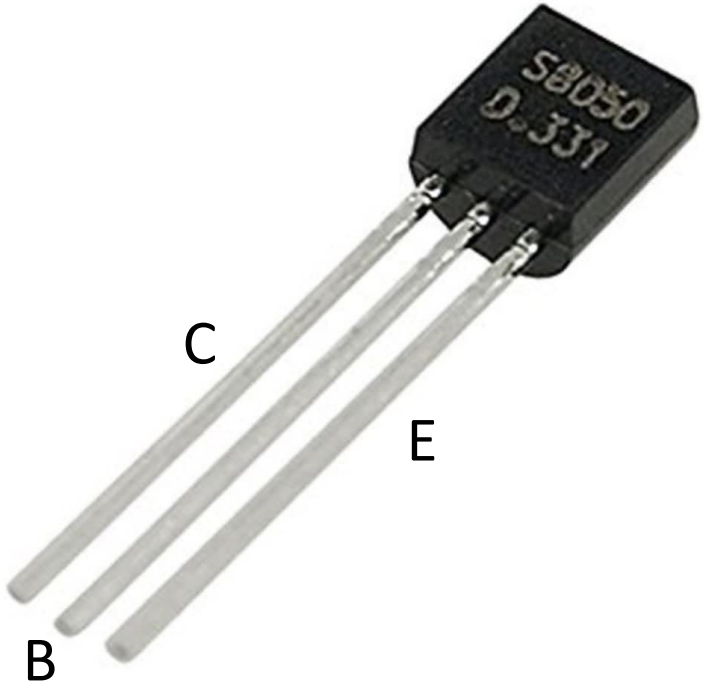
LED Construction

- The diode in an LED is tiny, its located right at the top of the cathode
- The anode and Cathode are constructed out of metal plates allowing them to carry charge easily
- As the LED chip is very small, we need a reflective shield around it to amplify and redirect the light coming off it
- The anode and the LED chip are connected by a tiny wire
- When an LED stops functioning its often because this tiny wire has just melted



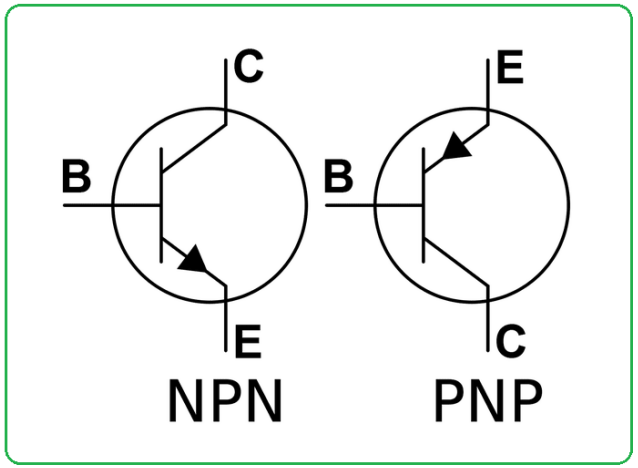
Transistors

- Transistors are another major use of semiconductors. Unlike diodes, they have three terminals instead of two.
- These terminals are the Emitter (E), Collector (C), and Base (B) for BJTs. Or Drain (D), Source (S), Gate (G) for FETs.
- The Emitter is the terminal that releases charge carriers, while the Collector receives them. Their roles depend on the transistor's operation.
- The Base acts as the control input, allowing us to regulate the current flowing between the Collector and Emitter.
- Transistors allow us to control current flow in a circuit using either current (in BJTs) or voltage (in FETs).



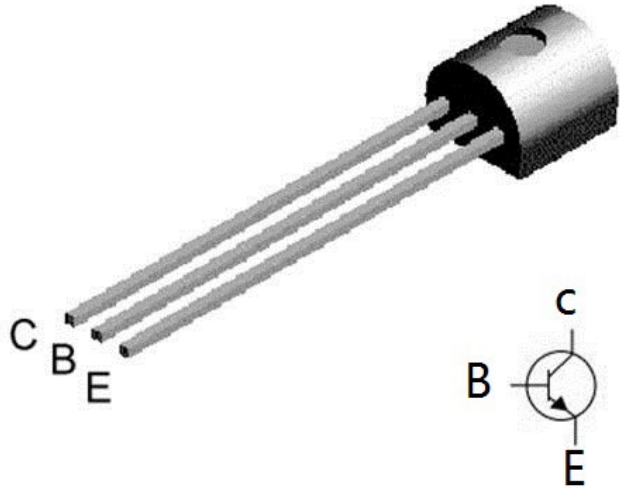
PNP vs NPN Transistors

- Transistors come in two BJT configurations: NPN and PNP.
- NPN is the most common configuration. The current flows from collector to emitter. The transistor only allows this current to flow when enough current flows into the base (making the base voltage positive relative to the emitter).
- PNP is less common. The current flows from emitter to collector. The transistor only allows this current to flow when current is pulled out of the base (making the base voltage negative relative to the emitter).



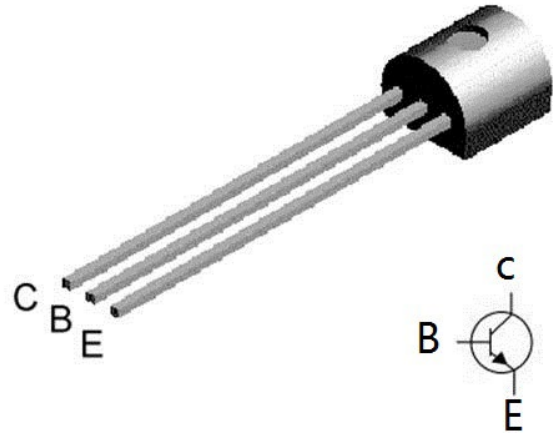
Bipolar Junction Transistor (BJT)

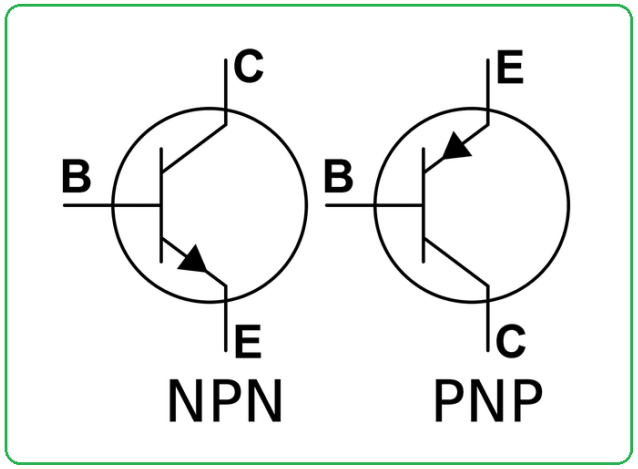
- BJTs are a type of transistor that allow us to control a large current flow with a small current flow
- As BJTs are current controlled they have a higher power usage than other transistors
- They are also much slower than other types of transistors
- However, as they allow a small current to control a large current, they are perfect for amplifiers where you want a very small current to become a much larger current



Bipolar Junction Transistor (BJT)

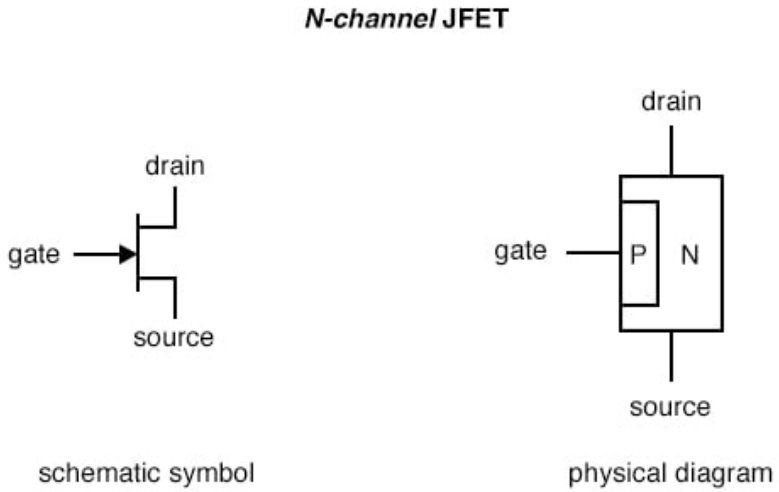
- In the NPN configuration of a BJT we can put current into the base to allow current to flow from emitter to collector
- In the PNP configuration of a BJT we can ground the base meaning current flows out of it allowing the current to also flow from the collector to the emitter





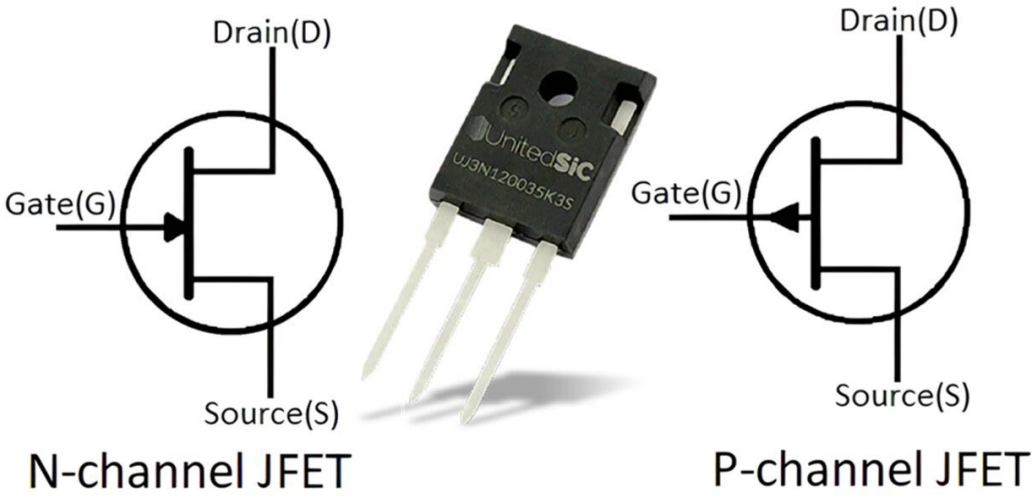
JFETs

- JFETs allow a voltage at the gate to control a current flow through the transistor
- When we put no voltage into the gate on the JFET it allows current to flow normally
- When we put a small voltage (below the threshold/pinch-off) into the gate on the JFET it reduces the current through the JFET
- When we put a large voltage (above the threshold/pinch-off) into the gate on the JFET it blocks current from flowing through the JFET



JFETs

- Again, JFETs have an NPN and PNP configuration.
- The NPN configuration is as we have just described and the PNP is the opposite
- So, it only allows current flow when we have a voltage difference from the gate



MOSFETs

- MOSFETs are very similar to JFETs in operation and construction
- They differ to JFETs as they have a small oxide layer on the gate which acts like a good insulator
- This insulator means the power consumption of the MOSFET is very small when compared to all other transistors