Electronics II
Transistors

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Semiconductors

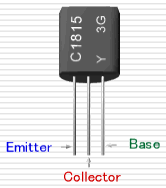
- Material that can either be a conductor or an insulator
- Silicone is the main material in semiconductors
- Silicone is doped to create an insulator or conductor

Transistor Defined

- Transistor:
  - Electronic device which controls high amperage circuits with a low amperage control.
  - "Trans"= transfer
  - "Sistor"= resistance
  - Loosely similar to a mechanical relay in operation. Where as relays are mechanical and transistors are solid-state.
  - Solid-state: No moving parts.

Relay vs. Transistor

- Similarities
  - Uses low current to control high current

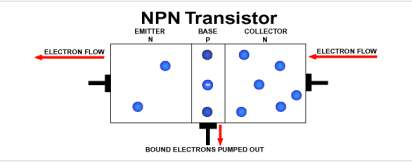


- Differences:
  - Transistors are solid-state
  - Transistors are exceedingly faster
  - Relays have almost zero voltage drop, where as transistors may have up to .8 volts dropped.
  - A relay's control side and load side may be separate.

Why not use transistor for everything?

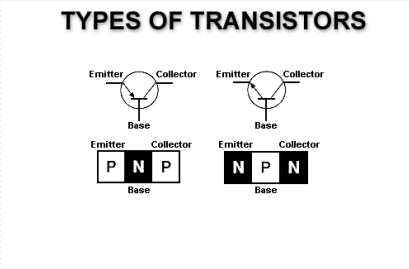
- Transistors have only a few free electrons therefore they are not great conductors.
- Relay contacts are metal and have many more available electrons for current flow, therefore they are great conductors.

Transistor Components



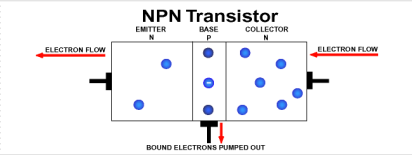
- Collector:
  - High current connector
- Emitter:
  - High current connector
  - Terminal with arrow
- Base:
  - Terminal which changes the transistor from an insulator to a conductor.
- Electrons
- Holes
- Depletion zone

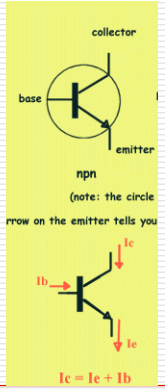
Transistor Types



- PNP: controlled by applying ground
- NPN: controlled by applying power

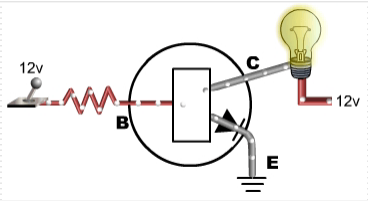
NPN Operation

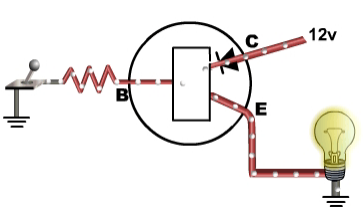


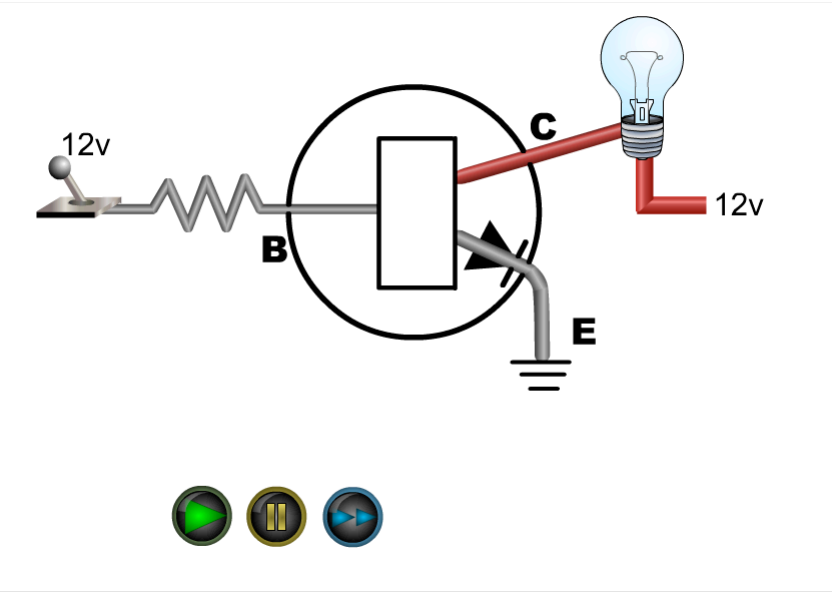


- When power is applied to the base current is allowed to flow from the emitter to the collector.
- The positive charge from the circuit forces the holes in the P to the two depletion zones.
- Which terminal has the highest amperage?
- The emitter has the highest amperage of the three legs.

NPN PNP Operation

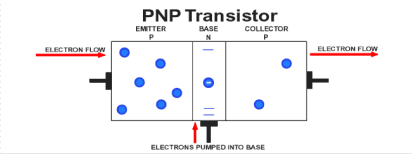


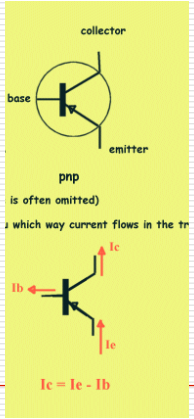




Amplifier Operation

PNP Operation

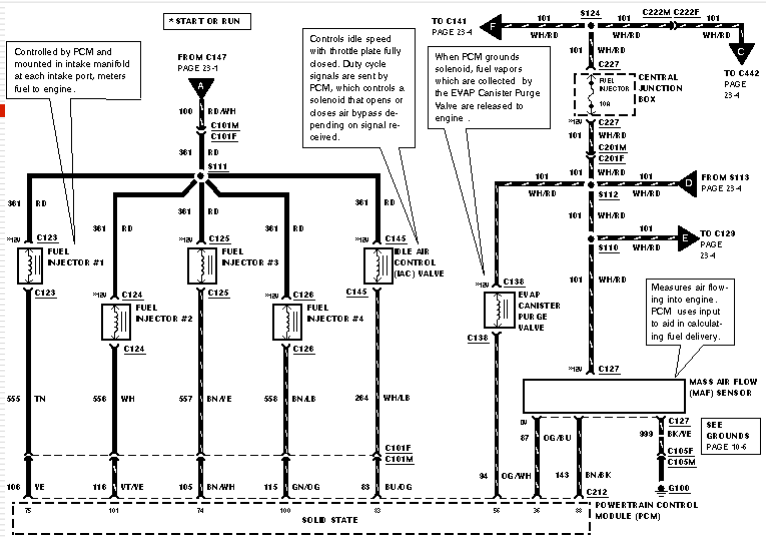




- When ground is applied to the base current is allowed to flow from the emitter to the collector.
- The negative charge from the circuit forces the electrons in the N to the two depletion zones.
- The emitter has the highest amperage of the three legs.

Transistor Uses

- Fuel injectors driver
- Ignition coils driver
- Evap. Canister solenoids
- Solenoids (general)
- Door lock actuators
- Shift solenoids
- Relay control
- Indicator lamps
- Amplification of current
- Oscillation of current



Transistor failures

- Shorting
  - Caused by excessive current or voltage
  - ESD (ElectroStatic Discharge)
- Open
  - Caused by excessive current or voltage
  - ESD (ElectroStatic Discharge)
- De-soldering
  - Caused by insufficient heat dissipation.

Transistor repairs

- For the most part if a transistor fails it is replaced by installing a new module.

ESD

- Electrostatic Discharge:
  - Static electricity built-up on you which is then transferred to the module when you pick it up.
  - Prevent it by touching grounded metal before handling modules.