SP.764, Practical Electronics
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Lecture 5: Relays and Transistors

Topics:

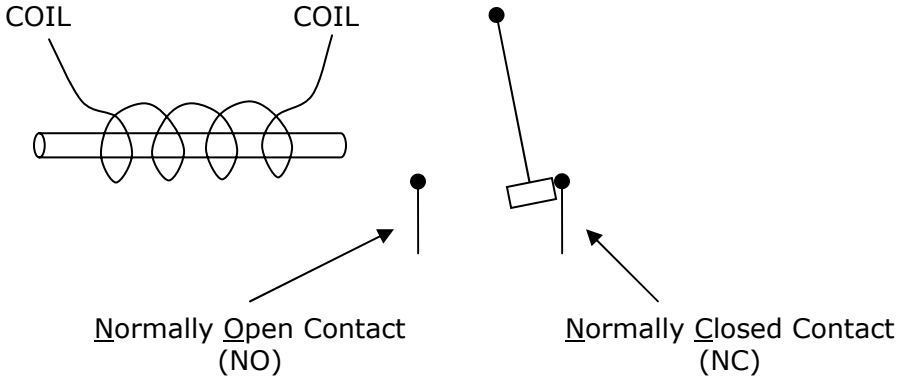
1) Relays
   - What they are
   - How they work
   - Pros & Cons
2) Transistors
   - How they work
   - Example
   - Pros & Cons

Relays:

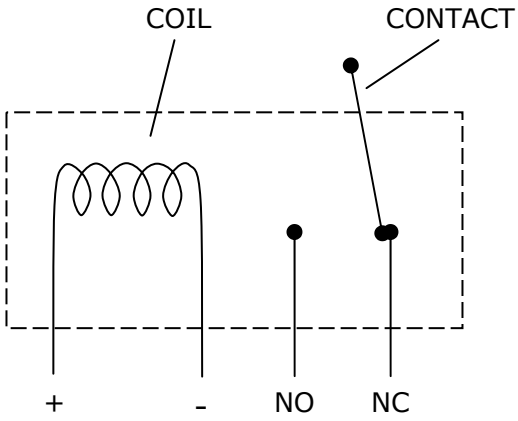
What is a relay?

- It's a switch.
- No person is needed to flip the switch.
- Uses one electrical signal turn another on or off.
- Where is the energy coming to flip the switch?
  - Solenoid
  - How does that make a switch?
    - Creates a magnetic field which moves a mechanical switch.

- Electromechanical relay rated to a few thousand volts.
    - If current flows through the solenoid, the switch makes contact.
    - Two independent circuits: COIL and CONTACT.



Schematic:



Single Pole Double Throw
(SPDT)

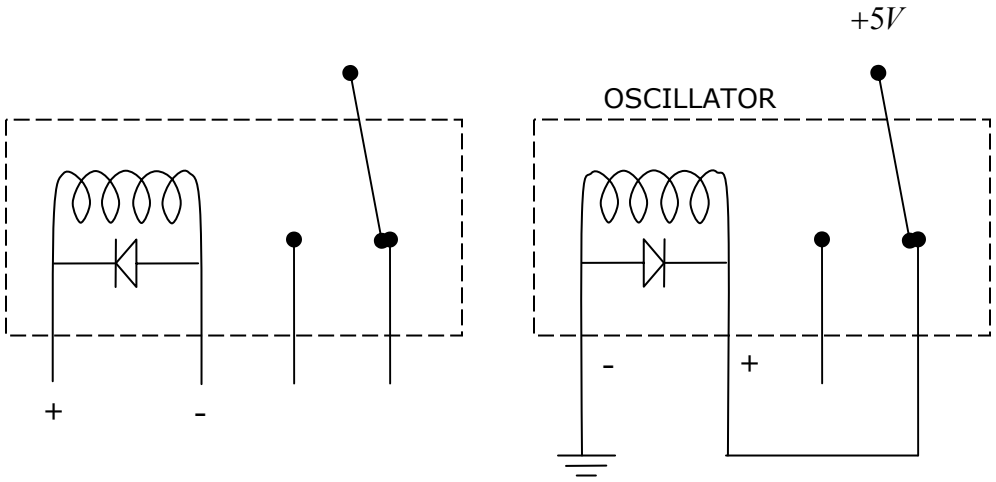
Relay Specifications:

- For our relay:
    - Coil takes
        - 5V & 20mA = 100mW
    - Contacts can handle
        - 30V & 2A = 60W

Coil	Contact
Nominal Voltage	Max Voltage
Resistance	Max Current
Current	
"Pick-Up" Voltage or Current	
"Hold"	

Needed to maintain position

Needed to move switch



A better representation of the relay includes a diode. The diode eliminates voltage spikes produced by the inductor when current suddenly stops flowing. An oscillator can be created by tying the + side of the coil with the Normally Closed contact together, and powering the contact with 5 volts.

Pros:

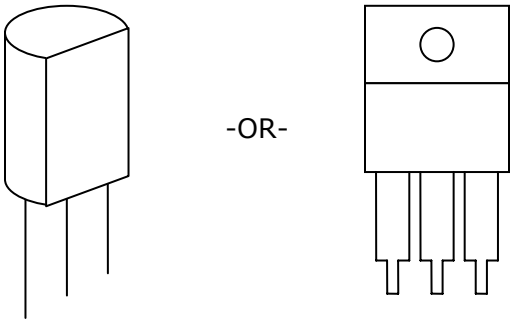
- Electrical Isolation: No electrical connection between coil and contact sides.
- High Voltage & Current (on contact side)

Cons:

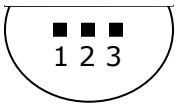
- Power Lost in Coil
- Size: Big and bulky.
- SLOW!
- Expensive

Transistors:

- The first transistor was developed by William Shockley and John Bardeen.
- Transistors are semiconductor devices.
- What do they look like?

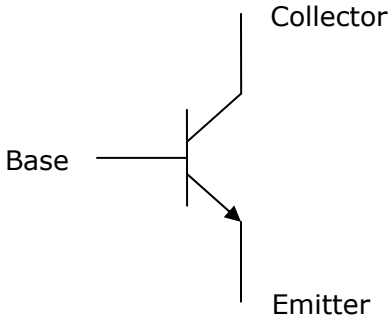


Bottom View



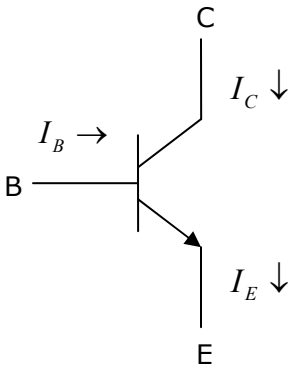
1 = EMITTER
2 = BASE
3 = COLLECTOR

Schematic



Measurable V's & I's

- $V_{CB} = V_C - V_B$ (Collector to Base)
- $V_{BE} = V_B - V_E$ (Base to Emitter)
- $V_{CE} = V_C - V_E$ (Collector to Emitter)



Rule 1:

$$I_C = \beta I_B$$

constant for the transistor

Value = 10 to 200.

Transistor gives current gain.

$$\therefore I_E = I_B + I_C = (\beta + 1) I_B$$

Rule 2:

If $I_B > 0$

$$V_{BE} \simeq 0.6V$$

(i.e. the base-emitter junction looks like a diode)

Analysis:

Assume $I_B > 0$, then

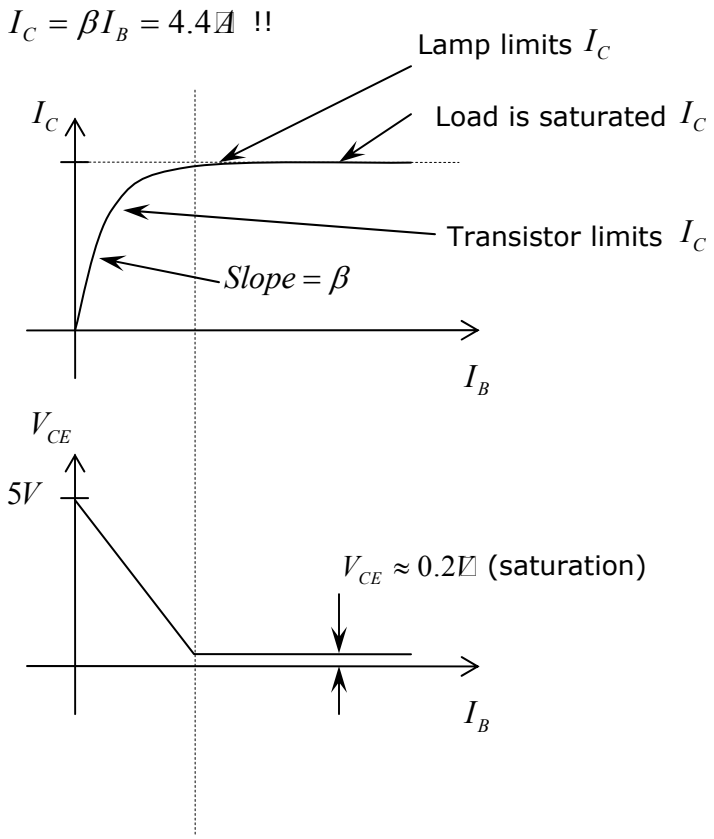
$$V_{BE} = 0.6V = V_B - \cancel{V_E}^{0}$$

$$\Rightarrow V_B = 0.6V$$

Current through 100Ω resistor is:

$$I = \frac{\Delta V}{R} = \frac{5V - 0.6V}{100\Omega} = 0.044A = 44mA$$

Then,



Pros:

- Small and handy
- Cheap
- FAST!

Cons:

- No Electrical Isolation
- Cannot work with High Voltages & Currents

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