

SP.764, Practical Electronics
Dr. James A. Bales
Lecture 5: Relays and Transistors

Topics:

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

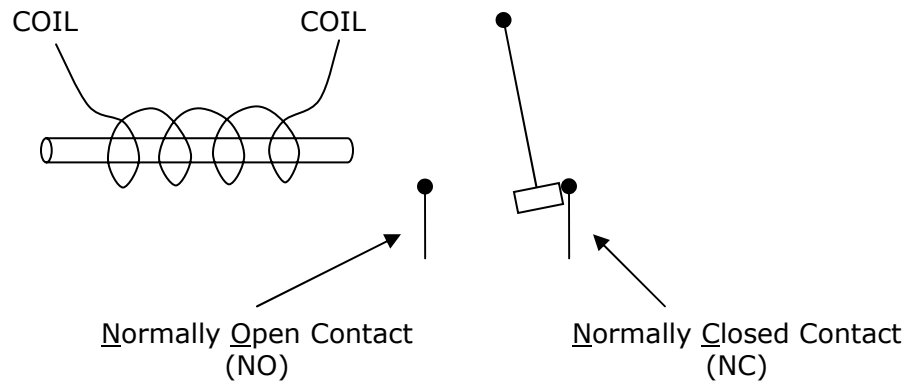
Relays:

What is a relay?

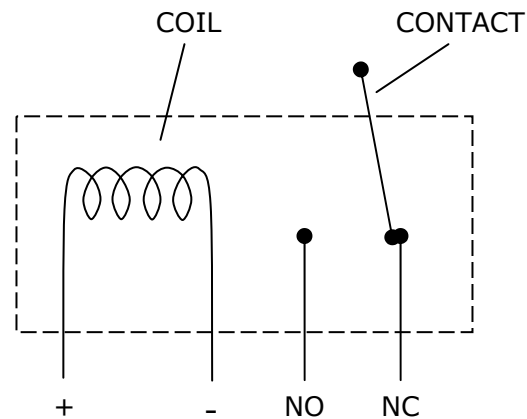
- It's a switch.
- No person is needed to flip the switch.
- Uses one electrical signal turn another on or off.
- Where is the energy coming to flip the switch?
 - o Solenoid
 - o How does that make a switch?
 - Creates a magnetic field which moves a mechanical switch.



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



Schematic:



Single Pole Double Throw (SPDT)

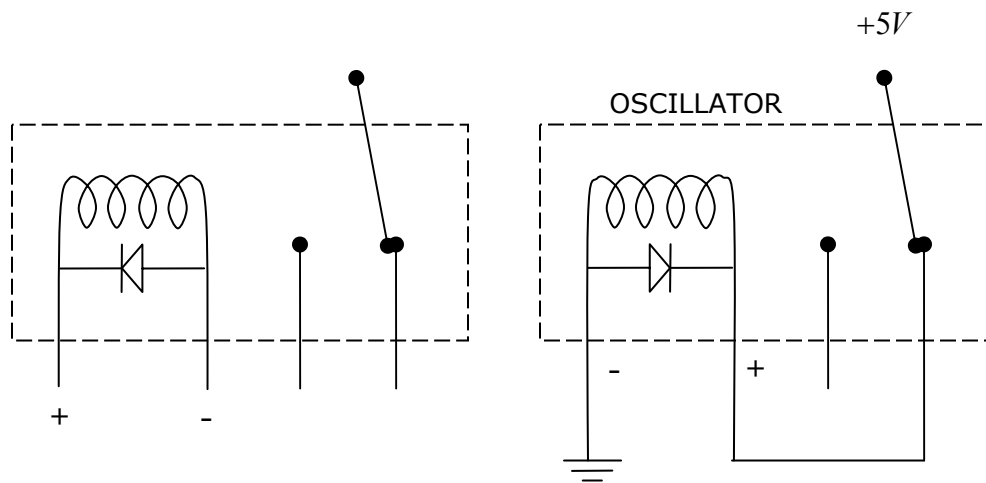
Relay Specifications:

- For our relay:
 - o Coil takes
 - $5V \text{ \& } 20mA = 100mW$
 - o Contacts can handle
 - $30V \text{ \& } 2A = 60W$

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:

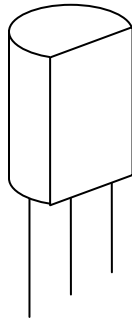
- Electrical Isolation: No electrical connection between coil and contact sides.
- High Voltage & Current (on contact side)

Cons:

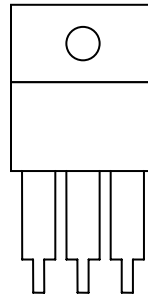
- Power Lost in Coil
- Size: Big and bulky.
- SLOW!
- Expensive

Transistors:

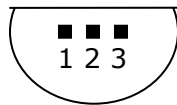
- The first transistor was developed by William Shockley and John Bardeen.
- Transistors are semiconductor devices.
- What do they look like?



-OR-

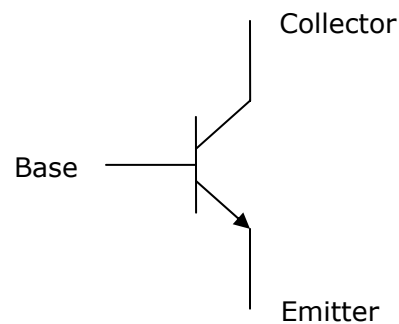


Bottom View



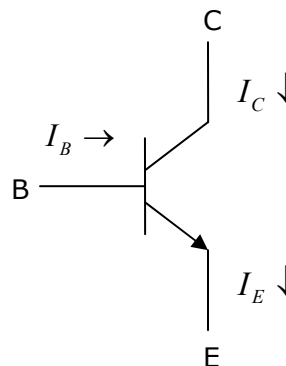
- 1 = EMITTER
2 = BASE
3 = COLLECTOR

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 $I_B > 0$

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

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

Analysis:

Assume $I_B > 0$, then

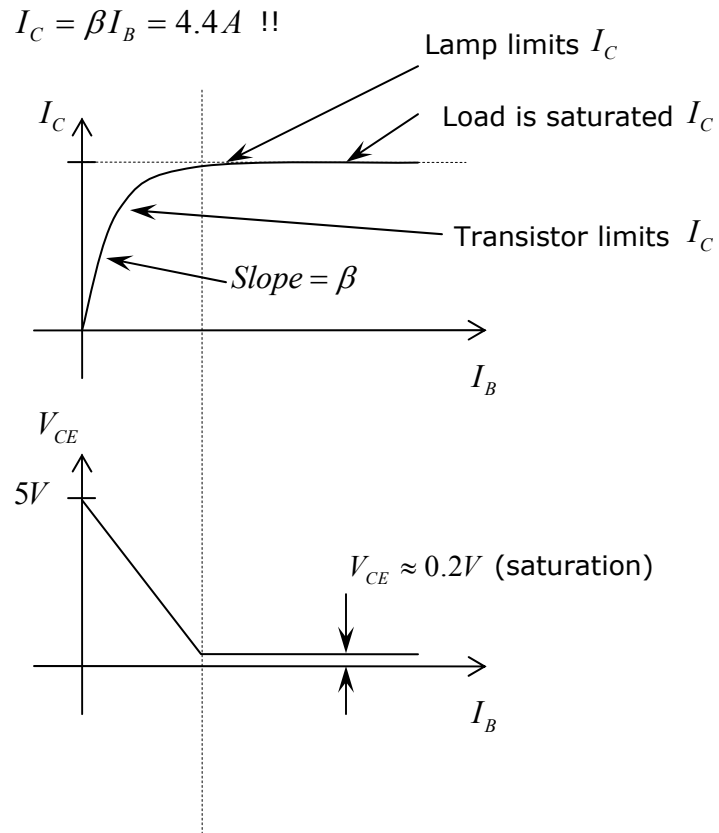
$$V_{BE} = 0.6V = V_B - \cancel{V_E}^0$$

$$\Rightarrow V_B = 0.6V$$

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