Technician License Course

Chapter 3

Section 3.2 – Components and Units

Electronics – Controlling the Flow of Current

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Electronics – Controlling the Flow of Current

- To make an electronic device (like a radio) and do something useful (like a receiver), we need to control and manipulate the flow of current.

- There are several different electronic components that are used to do this

Schematic Diagrams

- We can draw pictures of electronic components forming circuits, such as for the parallel and series circuit examples. This is too cumbersome for most circuits.

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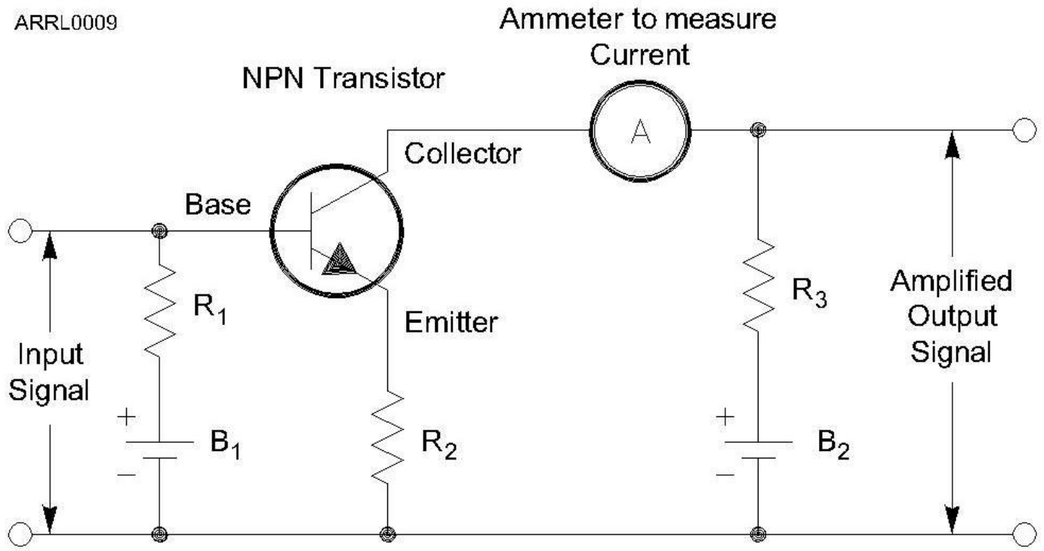
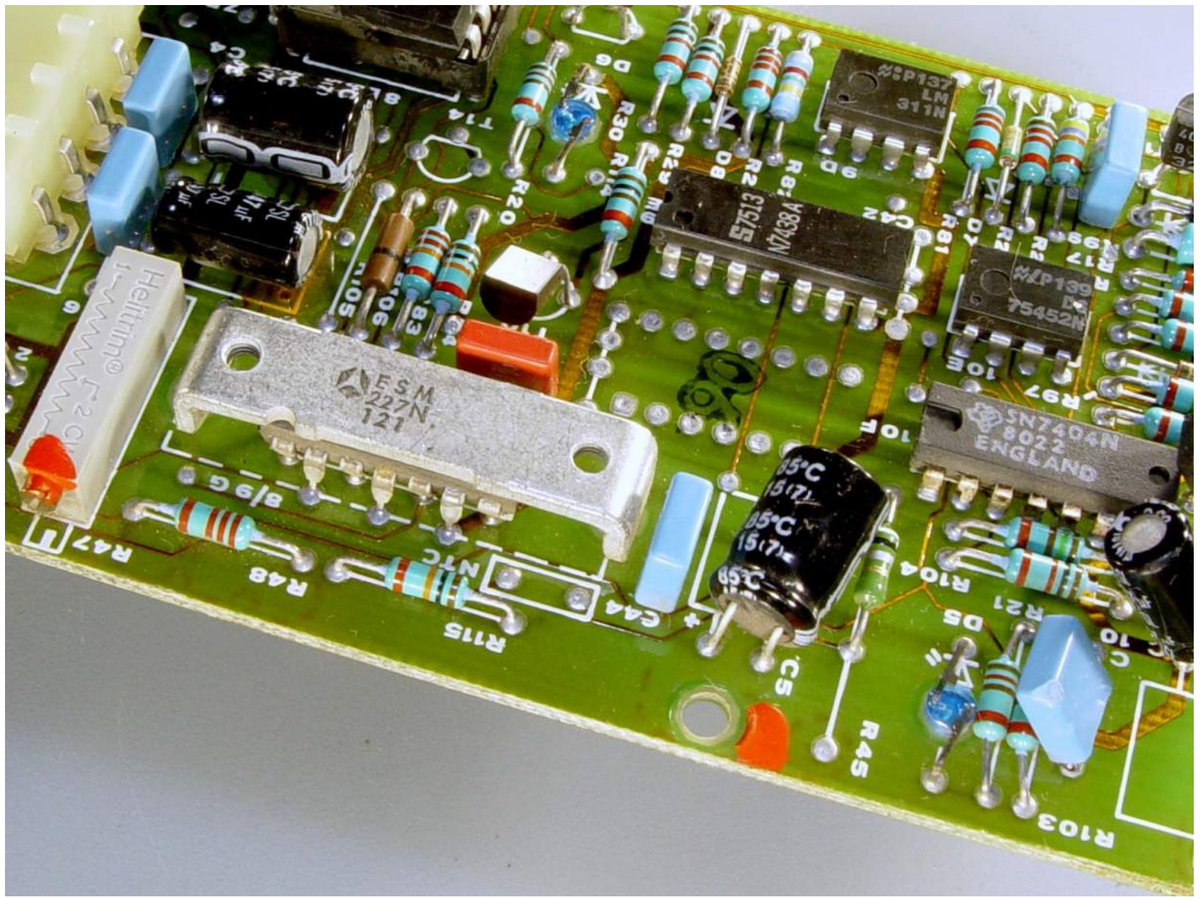
- We can draw pictures of electronic components forming circuits, such as for the parallel and series circuit examples. This is too cumbersome for most circuits.
- Schematic diagrams use symbols with different components, each having a different symbol.

Schematic Diagrams



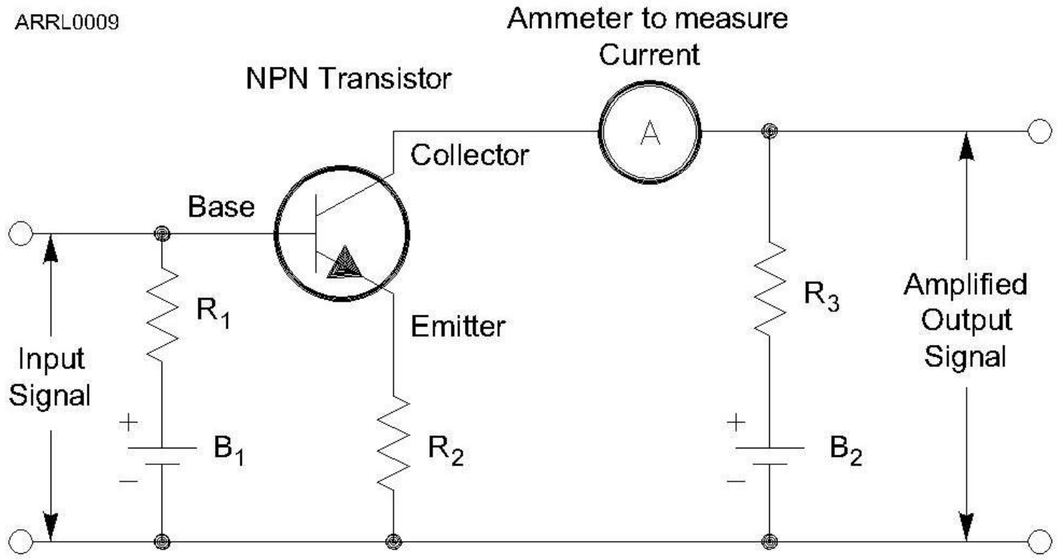
The lines and dots on schematics represent electrical connections between the components.

Component Designators



Component Designators

- Each schematic symbol has a *designator* to denote which component it refers to. For example, the 10th resistor in a circuit is R10.
- Resistors (R), capacitors (C), inductors (L).



The Resistor

The Resistor

- The function of a resistor is to restrict the flow of current.
- Schematic symbol
- Remember Ohm's Law:

  $I = E / R$

  $E = I \times R$

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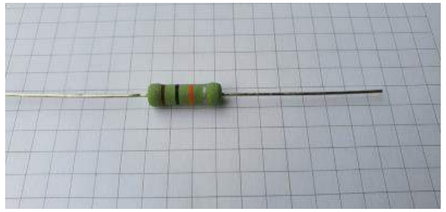

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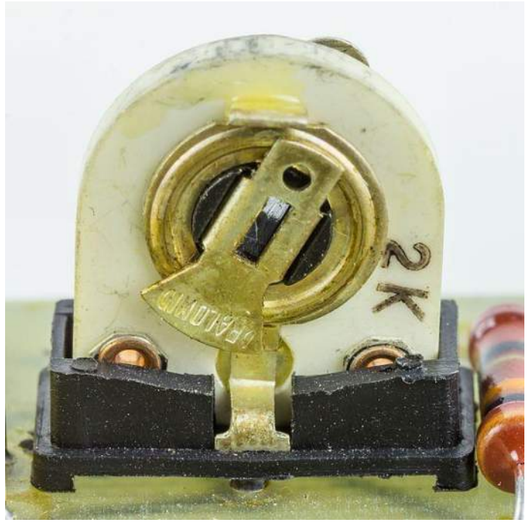
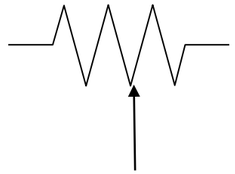
The Variable Resistor

- A resistor that you can change the value of.

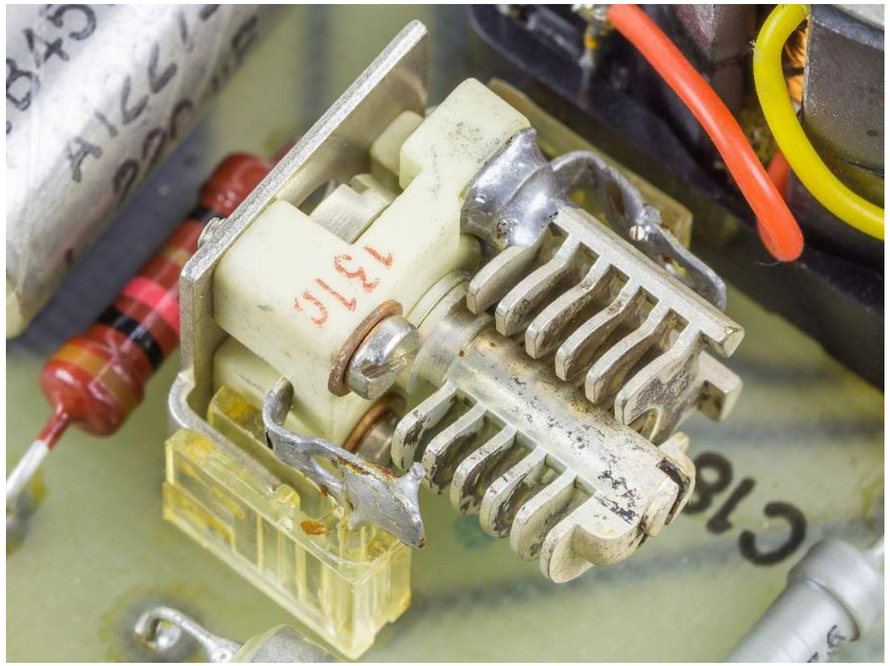


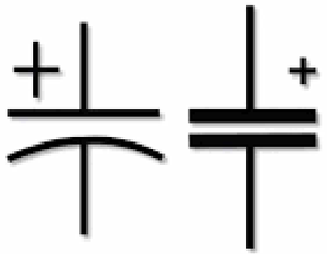


Potentiometer or “Pot”

Arrow indicates adjustable value, such as for a volume control.

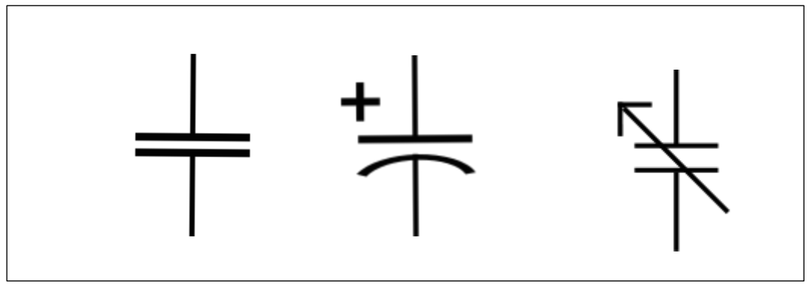
The Capacitor





The Capacitor

- The function of a capacitor is to store electrical energy – called *capacitance*.
- Schematic symbols



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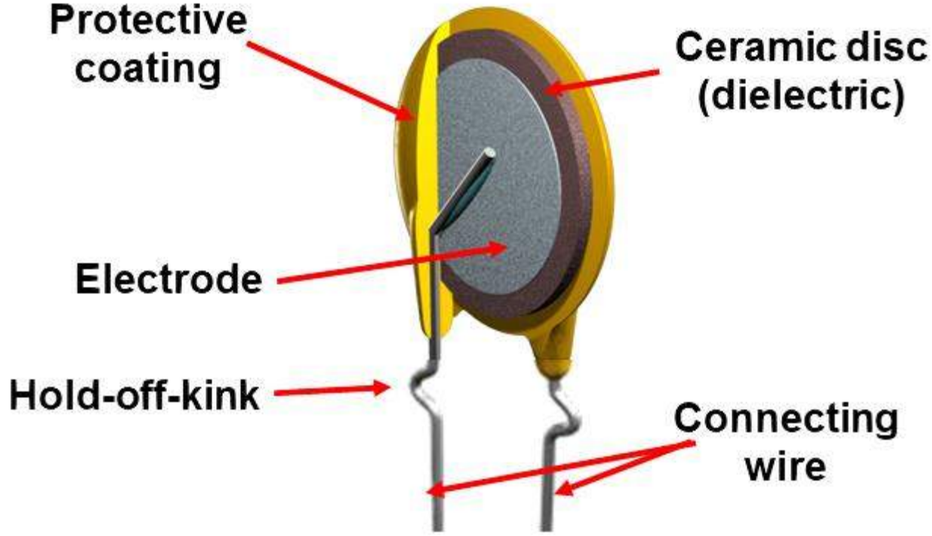
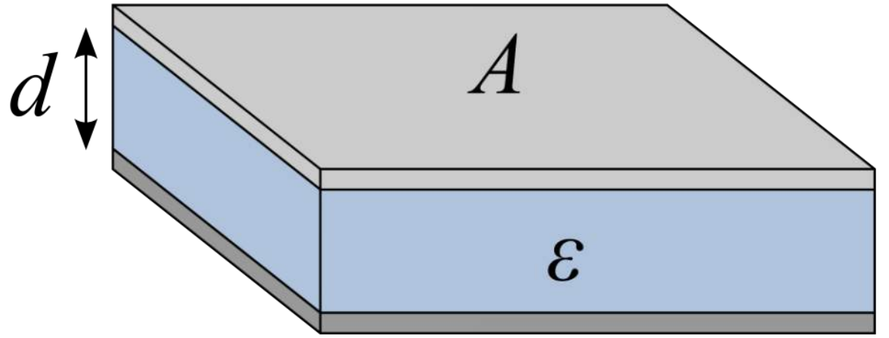
  Acts like a battery



The Capacitor

- The function of a capacitor is to store electrical energy – called *capacitance*.
- Schematic symbol
  - Acts like a battery
  - Stores energy in an electric field created by voltage between the electrodes



with insulating material between them

The Inductor

- Schematic symbol

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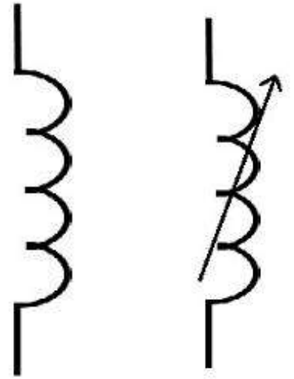

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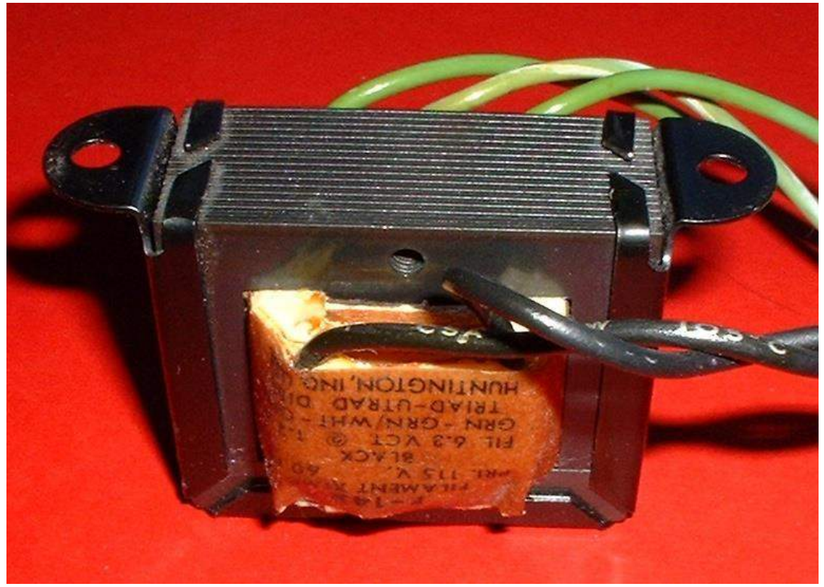
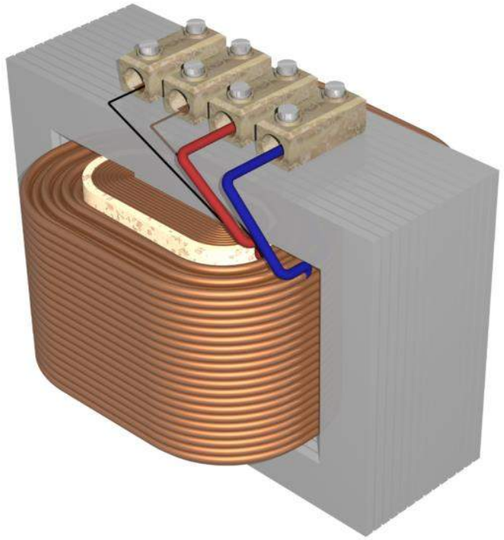
- A coil of wire around a *core* of air or magnetic material like iron or ferrite
- Stores energy in a magnetic field created by current in the wire

The Transformer

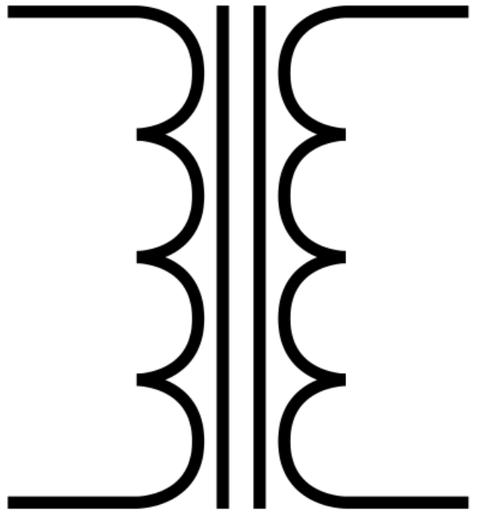


The Transformer

- A pair of inductors sharing a common core



- Schematic symbol



The Transformer

- A pair of inductors sharing a common core
- Also share their magnetic field

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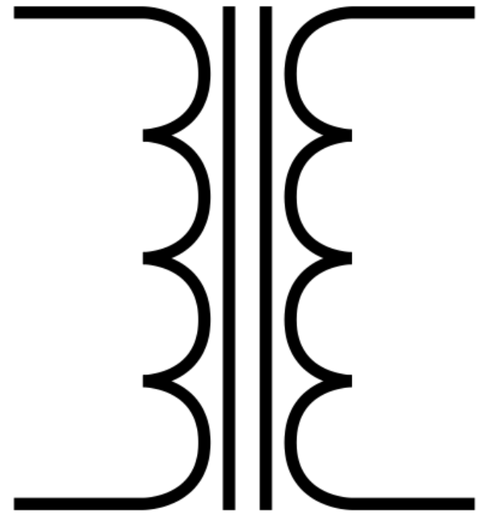
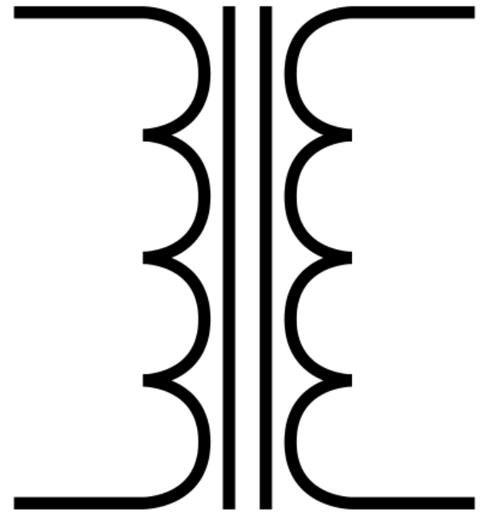


The Transformer

- A pair of inductors sharing a common core
- Also share their magnetic field
- Used to transfer energy from one circuit to another without a direct connection (isolation)
- Changes the ratio of voltage and current (step-up, step-down)

- Schematic symbol



Electrical Units

- Each type of component has a value measured in specific units:
  - Resistors > resistance > ohms (Ω)
  - Capacitors > capacitance > farads (F)
  - Inductors > inductance > henrys (H)

Indicators and Displays

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Indicators and Displays

- Indicators communicate status
  - ON/OFF, ready/stand-by, left/right
  - LEDs, light bulbs, symbols, audio tones
- Displays communicate values or text
  - Numeric values, warnings, messages
  - Digital and analog meters, LCD screens

Reactance

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  - Inductors create inductive reactance (X_L)
  - The effects of each are complementary

Impedance

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- Impedance represents a circuit's opposition to both ac and dc currents.

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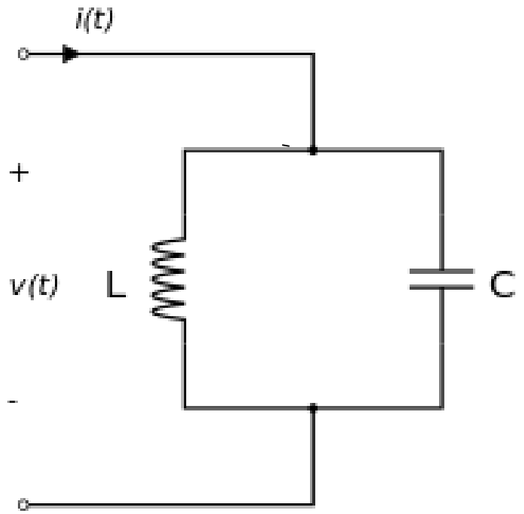
- At the frequency for which a circuit's X_L and X_C are equal, their effects cancel. This is the circuit's *resonant frequency*.
- At *resonance*, a circuit has only resistance, which affects ac and dc current equally.

Resonant or Tuned Circuit

- Capacitors and inductors connected together create a *tuned circuit*.
- When X_L and X_C are equal, the circuit is *resonant*.
- If C or L are adjustable the resonant frequency can be varied or tuned.



Semiconductor Components

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(*N*-type) and fewer than usual (*P-type*) electrons.
- Structures of N and P material can control current flow through the semiconductor.

The Diode

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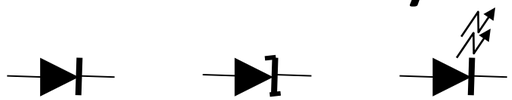
- Schematic symbols

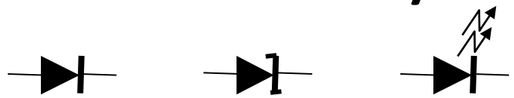


- Designator
- (D or CR)

The Diode

- Allows current to flow in only one direction.

- Schematic symbols



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The Diode

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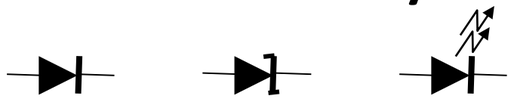
  - Two electrodes: *anode* and *cathode*

- Schematic symbols



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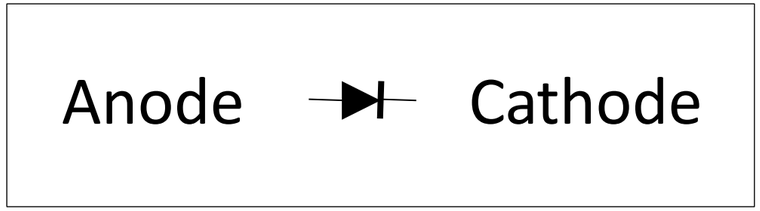
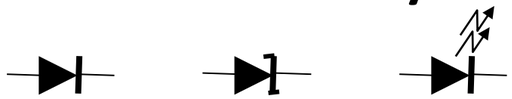


The Diode

- Allows current to flow in only one direction.
  - Two electrodes: *anode* and *cathode*
  - AC current is changed to varying pulses of DC – called *rectification*

- Schematic symbols



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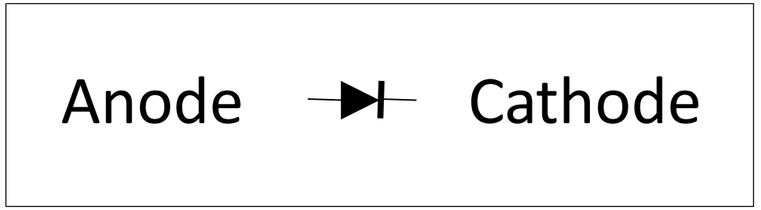

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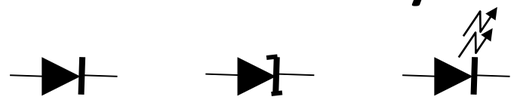
  - AC current is changed to varying pulses of DC – called *rectification*
  - Diodes used to change AC power to DC power are called *rectifiers*

- Schematic symbols



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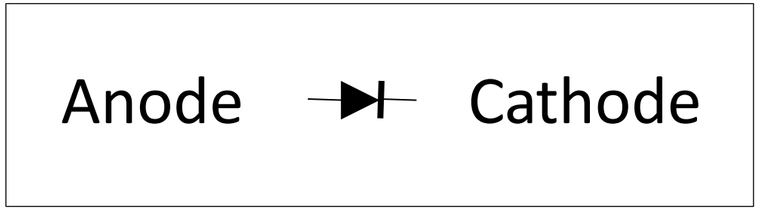

The Transistor

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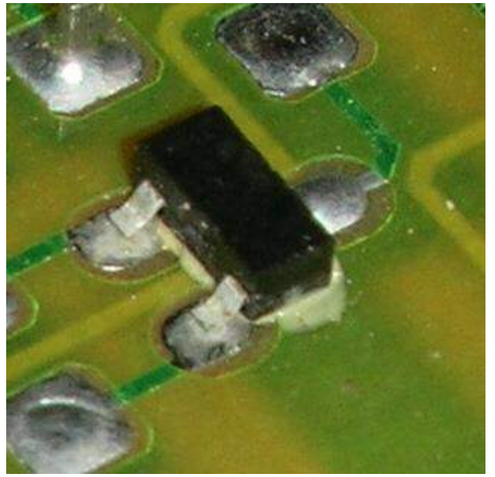

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The Transistor

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The Transistor

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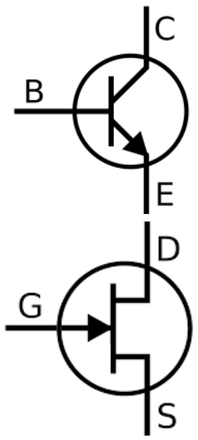
- An “electronically controlled current valve”

- Schematic symbol
- Designator (Q)



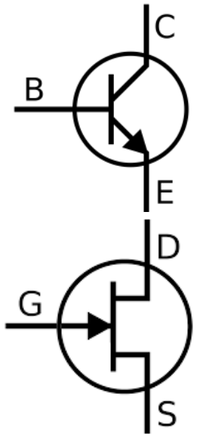
Bipolar Junction Transistor (BJT)

Field-Effect Transistor (FET)

The Transistor

- The function of a transistor is to control large signals with small ones.
  - An “electronically controlled current valve”
  - When used as an amplifier a transistor produces *gain*

- Schematic symbol
- Designator (Q)



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Field-Effect Transistor (FET)

The Transistor

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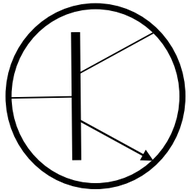
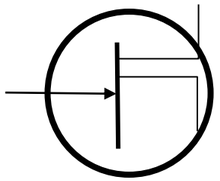
  - An “electronically controlled current valve”
  - When used as an amplifier a transistor produces *gain*
  - Transistors can also be used as a switch

- Schematic symbol
- Designator (Q)



Bipolar Junction Transistor (BJT)



Field-Effect Transistor (FET)

The Transistor

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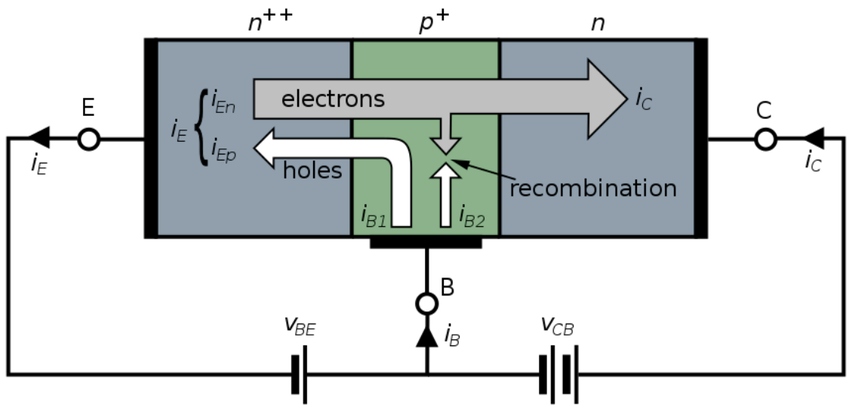
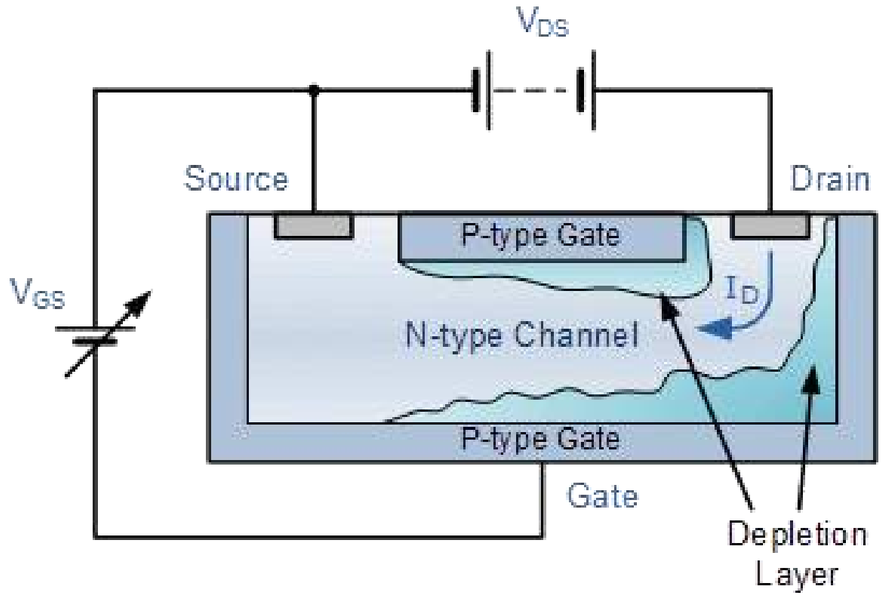


- Depending on the arrangement of layers, a BJT is either an NPN or PNP transistor.

The Transistor

- The Field-Effect Transistor (FET) has a conducting path or channel of N and P material connected to the drain and source electrodes.



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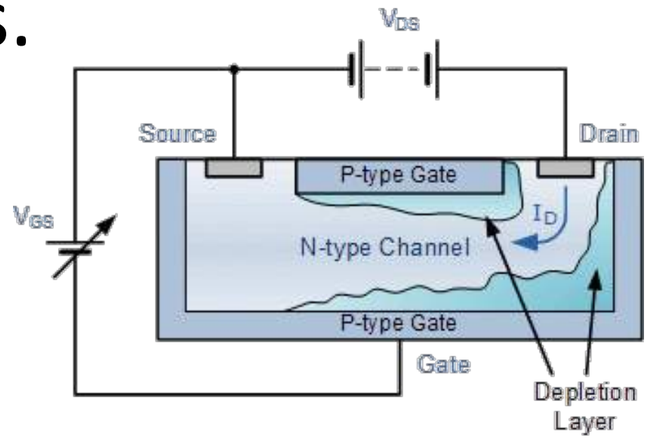
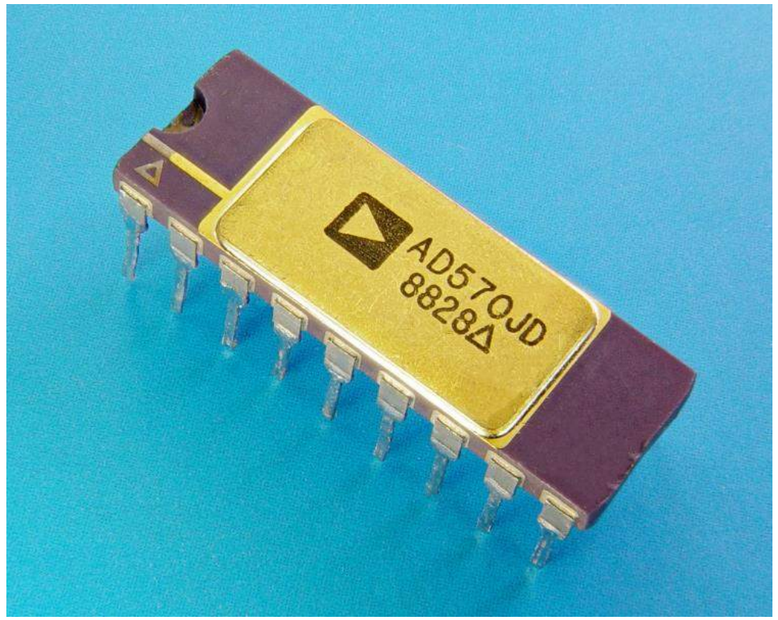


- Voltage applied to the gate electrode controls current through the channel.

The Integrated Circuit



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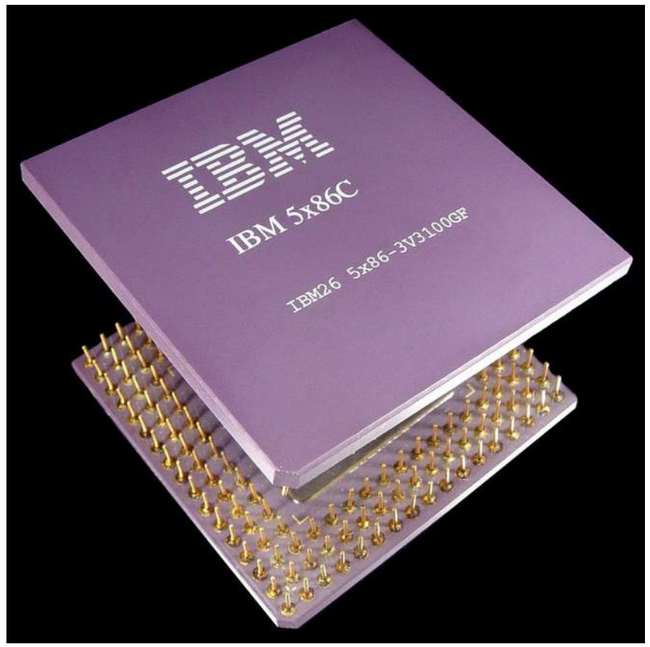

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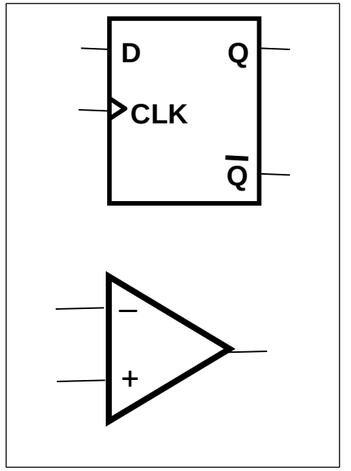
The Integrated Circuit

- The integrated circuit is a collection of components contained in one device that accomplishes a specific task.

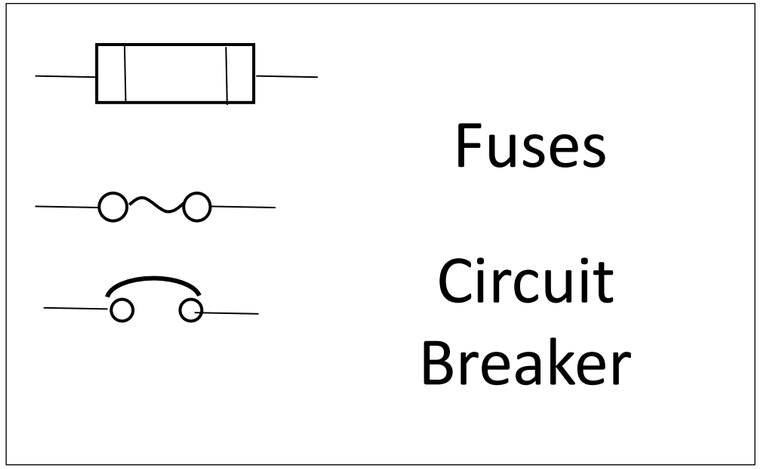
- Schematic symbol
- Designator (IC or U)



Protective Components

Protective Components

- Fuses and circuit breakers are designed to remove power in case of a circuit overload.
- Schematic symbol
- Designator (F or CB)



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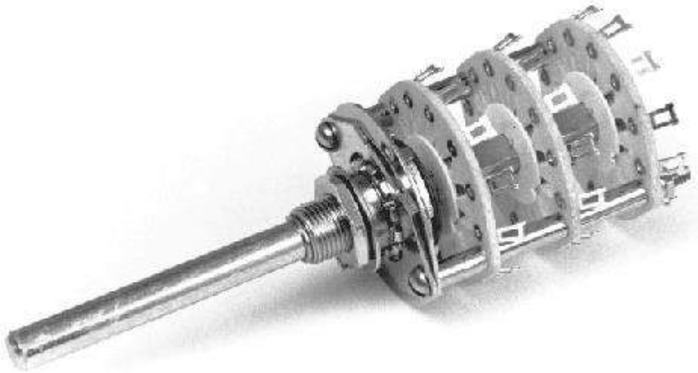
  - Fuses blow – one time protection
  - Circuit breakers trip – can be reset and reused
  - Always use proper rating

Switches



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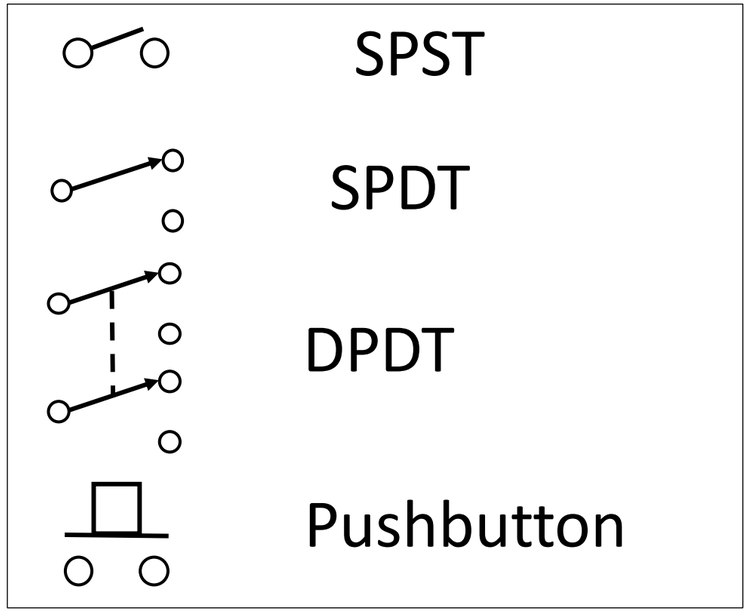
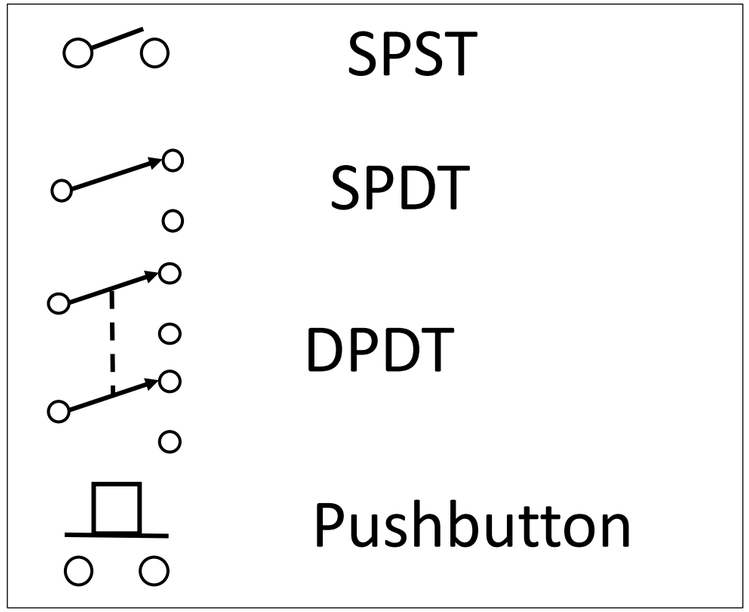
Switches

- Switches are used to interrupt or allow current to flow.
- Designator (S or SW)
- Schematic Symbol:



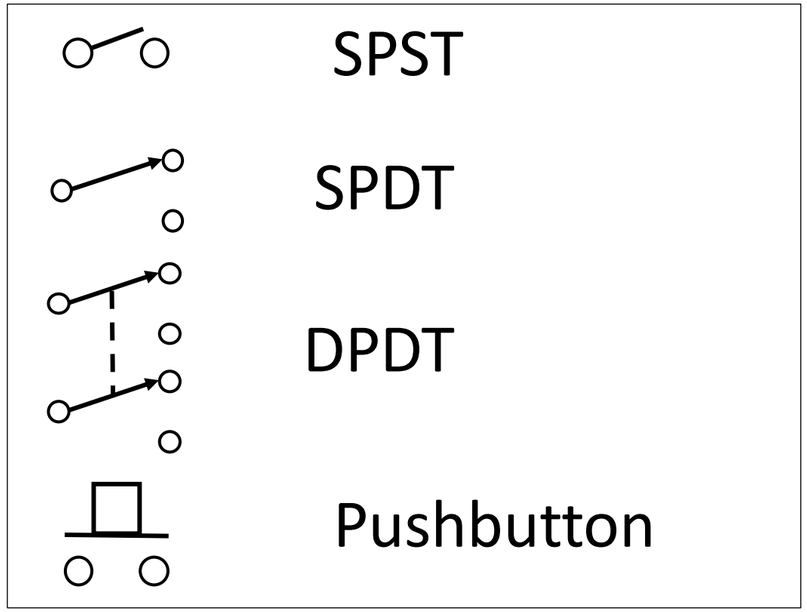
Switches

- Switches are used to interrupt or allow current to flow.
- Each circuit controlled by the switch is a *pole*

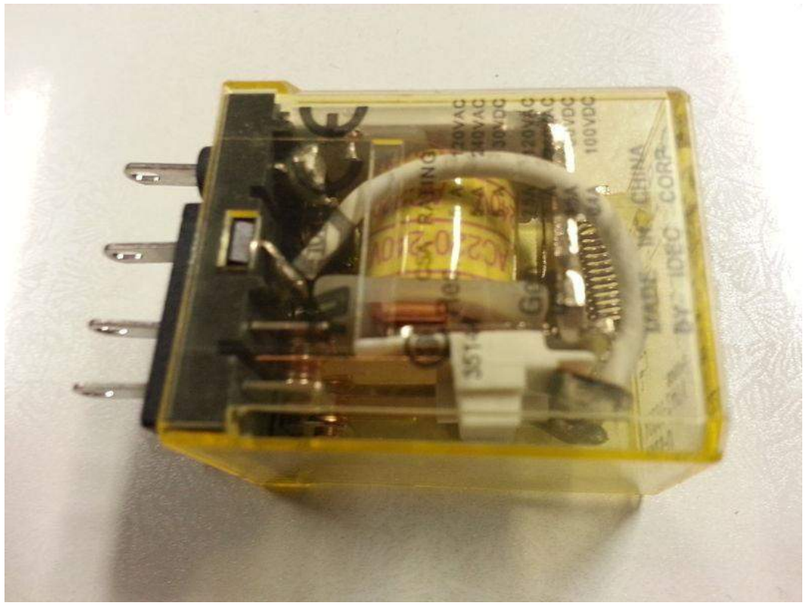


Switches

- Switches are used to interrupt or allow current to flow.
- Each circuit controlled by the switch is a *pole*
- Each position is called a *throw*



Relays



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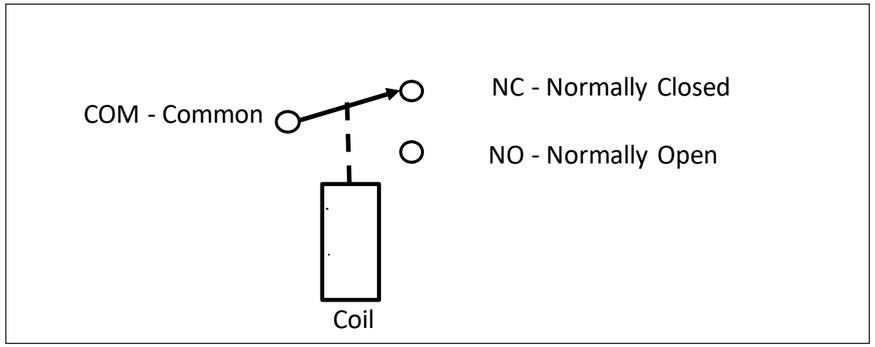
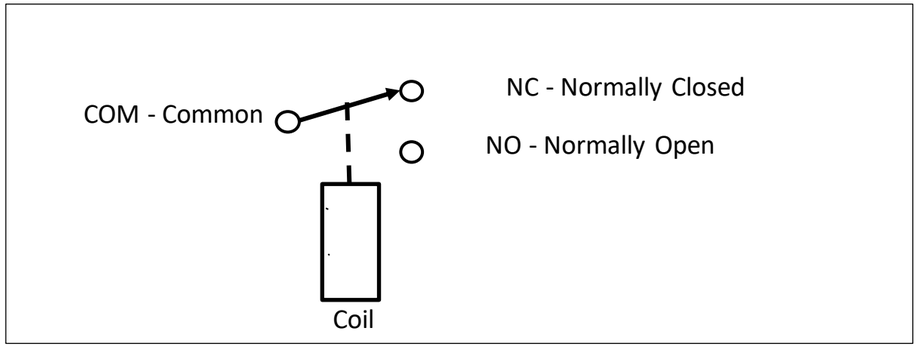
Relays

- Relays are switches activated by current in a coil (electromagnet)
  - Designator (K or RLY)
  - Schematic Symbol



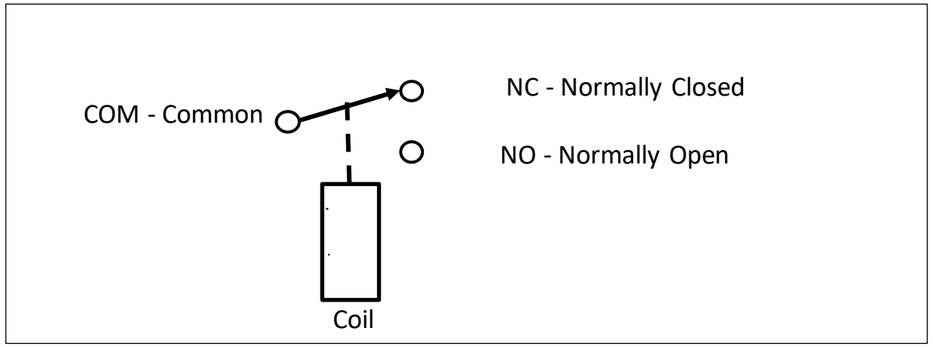
Relays

- Relays are switches activated by current in a coil (electromagnet)
- Relays use the same pole/throw names as switches



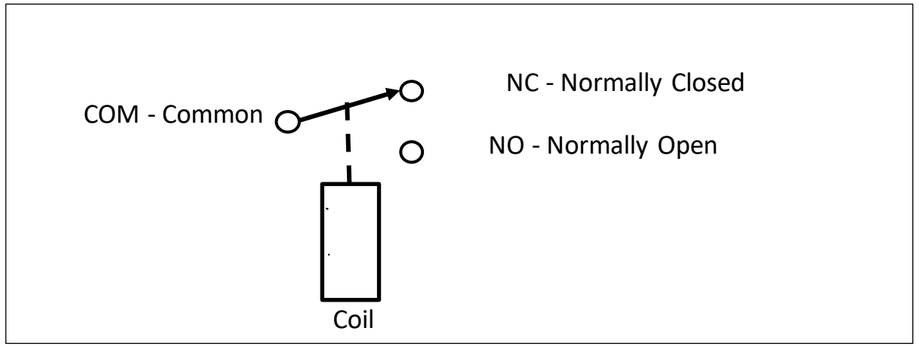
Relays

- Relays are switches activated by current in a coil (electromagnet)
- Relays use the same pole/throw names as switches
- The moving switch is called the *armature*



Relays

- Relays are switches activated by current in a coil (electromagnet)
- Relays use the same pole/throw names as switches
- The moving switch is called the *armature*
- *Contacts* are named by when they are connected



Are there any questions?