ELTN 115

UNIT 13
Capacitors

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Capacitors – what are they?

- Capacitors are passive devices – they cannot provide “gain” in a circuit.
- Capacitors have 2 leads or wires
- Capacitors are either “non polarized” or “polarized” Polarized mean they have +/- terminals.

Capacitors – applications

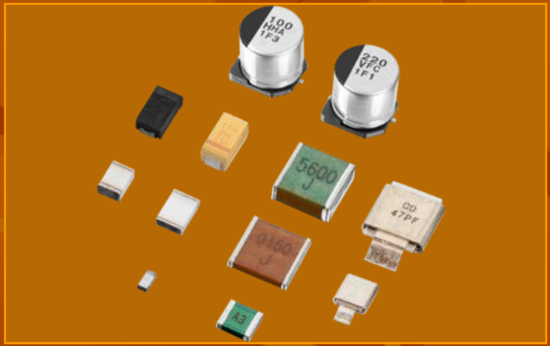
- Capacitors can store energy for short periods of time.
- Capacitors can filter AC or “noisy” signals
- Capacitors can be used for timing circuits.

Packages

- Capacitors come in a variety of packages:

Electrolytic
(polarized)

Polyester
(Non-polarized)

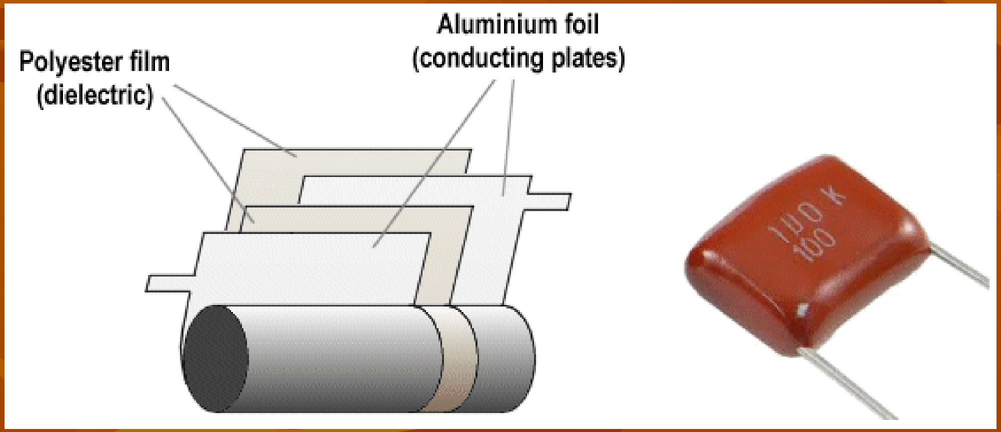


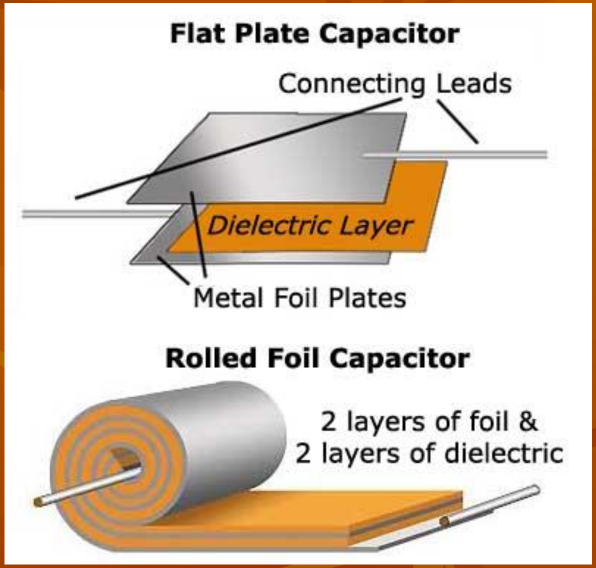
Surface Mount

Note – SMT Capacitors <u>typically</u> do NOT have numbers / values, except for polarized types (positive and negative leads)

Capacitors - Internal construction

What is a capacitor made of?





- Layers of conductors and Insulators
- Insulators are called *dielectric*
- The dielectric affects the sensitivity to temperature and other effects. There are LOTS of different types of dielectrics, often plastics are used.

Capacitor values

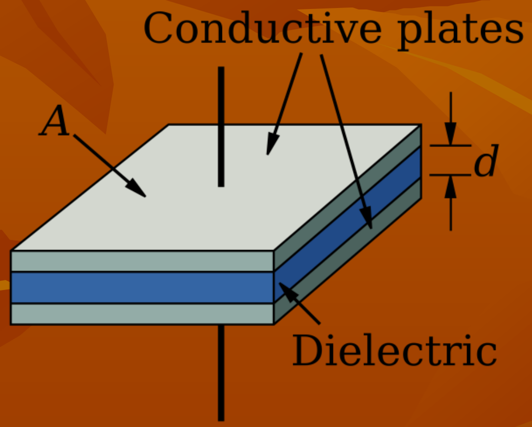
- Some small capacitor values are listed with numbers, not a color code: In this example, the number 104 is equal to 1×10^4 picofarads, which translates to 0.1µF.

- Larger Electrolytic (polarized) capacitors have value printed on the case - This example shows 120µF, 400V

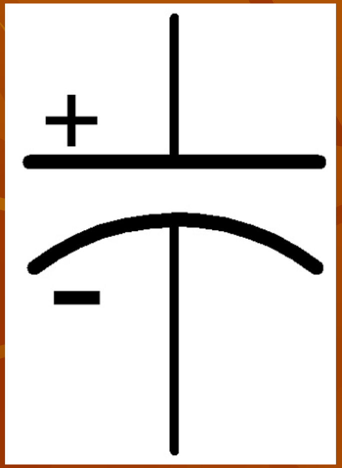
Power storage:

Capacitors can charge up to a value equal to the source voltage and store the charge for a period of time.

Polarized Capacitor

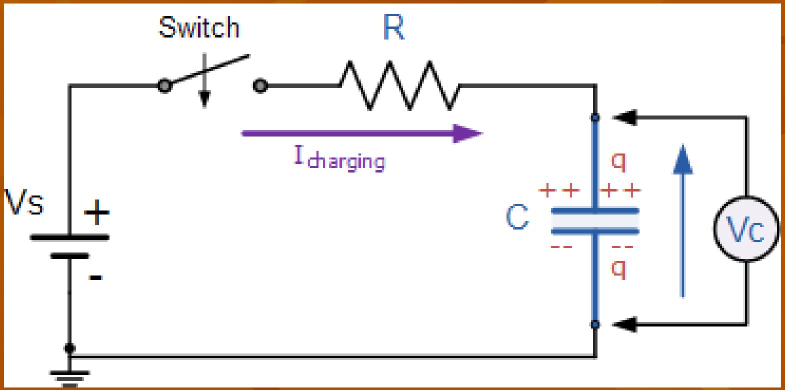


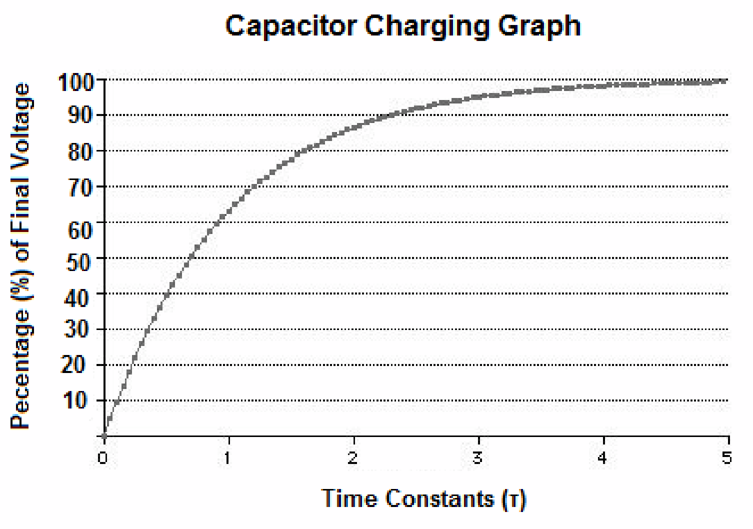
Physical construction



Schematic Symbol

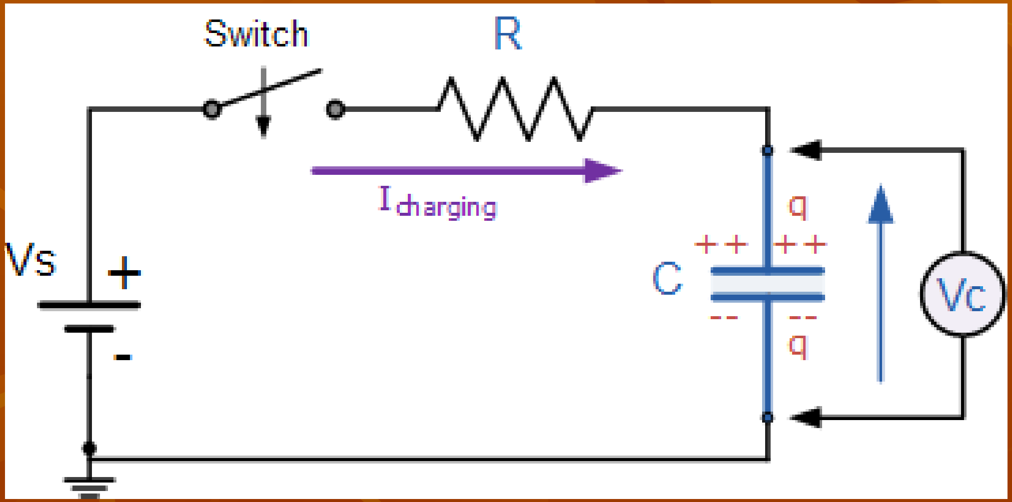
When a voltage is applied across a capacitor it charges exponentially:

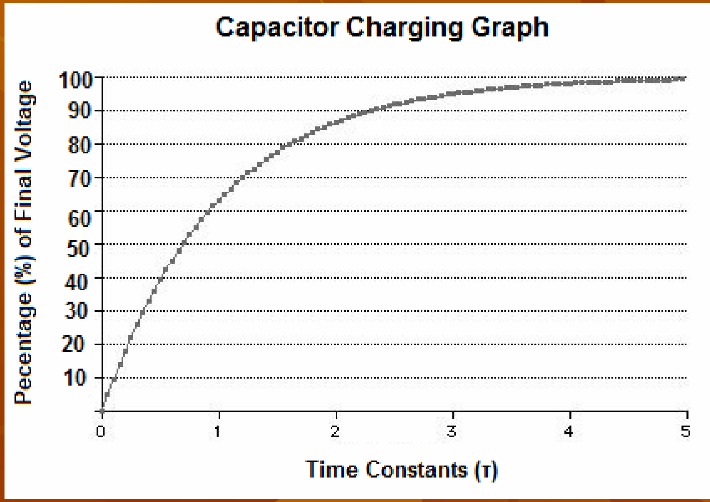




The rate that a capacitor charges is called tau (τ), and equals the product of the capacitor value and resistor value:

$$\tau = R \times C$$





The units of tau are seconds.

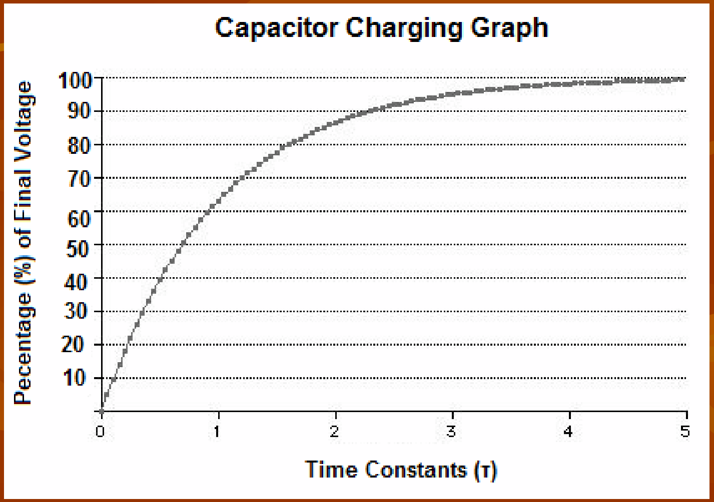
- **For** many circuits tau has a value in milliseconds.
- A capacitor charges to the source voltage in approximately 5 time constants, or 5τ. For example:

$$\tau = R \times C$$

If R = 1KΩ and C = 50μF,

R × C = (1K Ω) x (50 x 10^{-6} μF) = 50 millisecond

So, in 250 milliseconds (1/4 second), the capacitor is fully charged.



Filtering application

- Because capacitors take time to charge, they "resist" changes in voltage.
- If a "noisy" signal is applied across a capacitor, it doesn't have time to charge to the maximum value, so it "flattens" the output voltage: