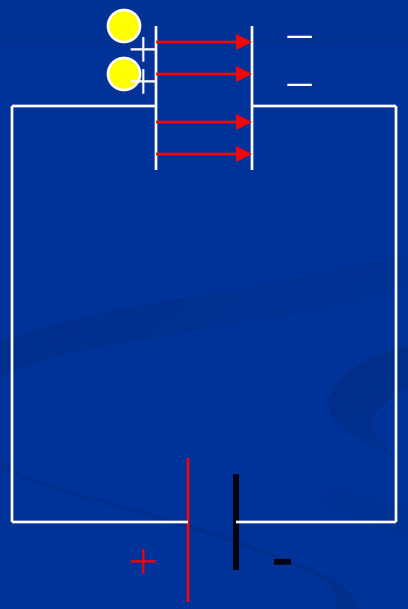
Capacitors

- A basic capacitor has two parallel plates separated by an insulating material
- A capacitor stores an electrical charge between the two plates
- The unit of capacitance is Farads (F)
- Capacitance values are normally smaller, such as μF, nF or pF

Capacitors

Storing a charge between the plates

- Electrons on the left plate are attracted toward the positive terminal of the voltage source
- This leaves an excess of positively charged holes
- The electrons are pushed toward the right plate
- Excess electrons leave a negative charge



Parallel plate Capacitor

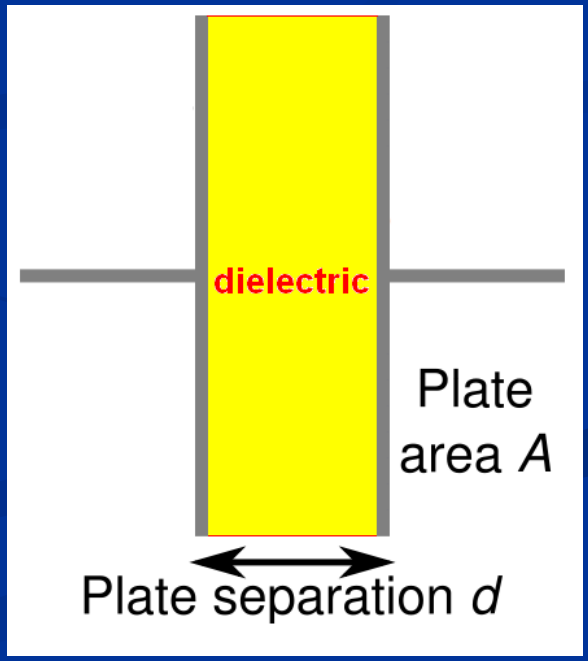
- Composed of two conductive plates separated by an insulator (or dielectric).
  - Commonly illustrated as two parallel metal plates separated by a distance, d.

$C = \varepsilon A/d$

where $\varepsilon = \varepsilon_r \varepsilon_o$

ε_r is the relative dielectric constant

ε_o is the vacuum permittivity



Types of Capacitors

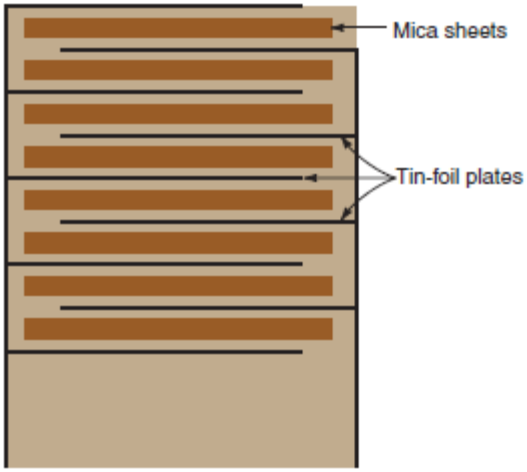
- Fixed Capacitors
  - Nonpolarized
    - May be connected into circuit with either terminal of capacitor connected to the high voltage side of the circuit.
      - Insulator: Paper, Mica, Ceramic, Film
  - Electrolytic(Polarized)
    - The negative terminal must always be at a lower voltage than the positive terminal
      - Plates or Electrodes: Aluminum, Tantalum
- Variable Capacitors

Mica Capacitors

Thin mica sheets as the dielectric are stacked between tinfoil sections for the conducting plates to provide the required capacitance. Alternate strips of tinfoil are connected and brought out as one terminal for one set of plates, and the opposite terminal connects to the other set of interlaced plates.

Capacitance->10–5000 pF

Breakdown voltage->500–20,000V



Physical construction

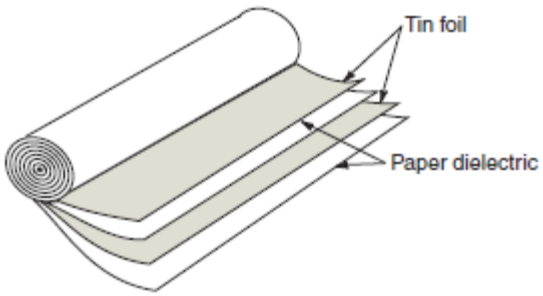
Example of a mica capacitor

Paper Capacitors

Two rolls of tinfoil conductor separated by a paper dielectric are rolled into a compact cylinder. Each outside lead connects to its roll of tinfoil as a plate. The entire cylinder is generally placed in a cardboard container coated with wax or encased in plastic.

Capacitance-> 0.001–1μ F

Breakdown voltage-> 200–1600V



A black or a white band at one end of a paper capacitor indicates the lead connected to the outside foil.

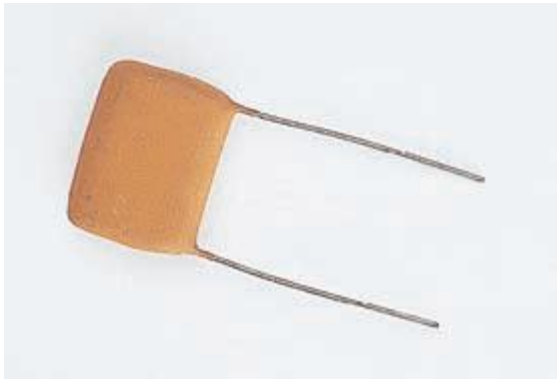
Film Capacitors

Film capacitors are constructed much like paper capacitors except that the paper dielectric is replaced with a plastic film such as polypropylene, polystyrene, polycarbonate, or polyethelene terepthalate (Mylar).

There are two main types of fi lm capacitors: the foil type and the metallized type. The foil type uses sheets of metal foil, such as aluminum or tin, for its conductive plates.
The metallized type is constructed by depositing (spraying) a thin layer of metal, such as aluminum or zinc, on the plastic fi lm. The sprayed-on metal serves as the plates of the capacitor.

Capacitance-> 100 pF–100 µF

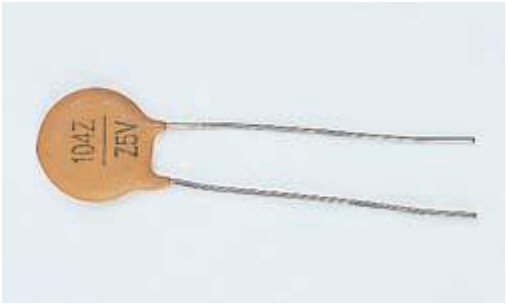
Breakdown voltage-> 50–600V



Ceramic Capacitors

Ceramic capacitors come in disk form. In the disk form, silver is deposited on both sides of the ceramic dielectric to form the capacitor plates. Ceramic capacitors are available with values of 1 pF (or less) up to about 1 µ F.

Breakdown voltage->500–20,000V



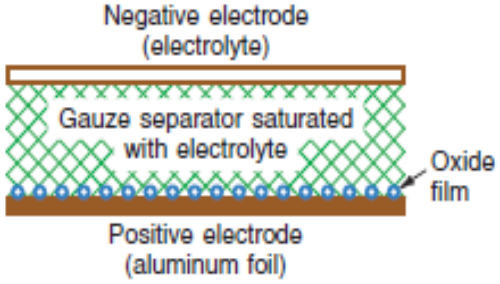
Surface-Mount Capacitors

Surface mounted capacitors are often called *chip capacitors.* Chip capacitors are constructed by placing a ceramic dielectric material between layers of conductive fi lm which form the capacitor plates.

Electrolytic Capacitors

Aluminum-foil type

The two aluminum electrodes are in an electrolyte of borax, phosphate, or carbonate. Between the two aluminum strips, absorbent gauze soaks up electrolyte to provide the required electrolysis that produces an oxide fi lm.



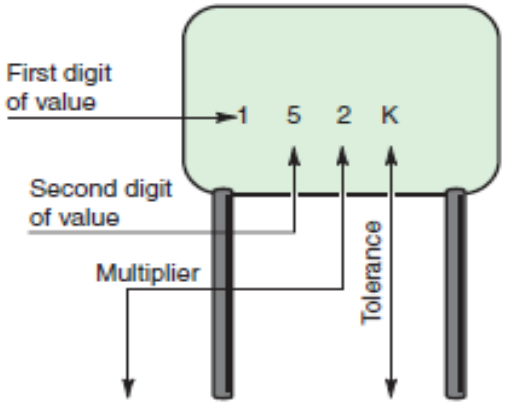
Tantalum Capacitors

This is another form of electrolytic capacitor, using tantalum (Ta) instead of aluminum.

1. Larger *C* in a smaller size
2. Longer shelf life
3. Less leakage current

Capacitor Coding

Film-Type Capacitors



Multiplier		Tolerance of Capacitor		
For the Number	Multiplier	Letter	10 pF or Less	Over 10 pF
0 1	1 10	B C	±0.1 pF ±0.25 pF	
2 3	100 1,000	D F	±0.5 pF ±1.0 pF	±1%
4 5	10,000 100,000	G H	±2.0 pF	±2% ±3%
8	0.01	J K		±5% ±10%
9	0.1	M		±20%

Examples:
152K = 15 × 100 = 1500 pF or 0.0015 μF, ±10%
759J = 75 × 0.1 = 7.5 pF, ±5%

Example 16–7

Determine the value of capacitance for the film capacitors in Fig. 16–12*a* and *b*.

Figure 16–12 Film capacitors for Example 16–7.