Electronics Capacitors

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Capacitor

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Capacitor

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- value, capacitance, is proportional to the surface area of the plates and inversely proportional to the distance between the plates
Capacitance

- **Capacitor**
  - An electronic device which consists of two conductive plates separated by an insulator.
  - Value, capacitance, is proportional to the surface area of the plates and inversely proportional to the distance between the plates, measured in Farads.

- Farads are usually microfarad (µF) or picofarad (pF) values.
Capacitor

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Farads are *big*
Capacitor

- an electronic device which consists of two conductive plates separated by an insulator
- value, capacitance, is proportional to the surface area of the plates and inversely proportional to the distance between the plates measured in Farads
  Farads are *big*
  usually microfarad (\(\mu F\)) or picofarad (pF) values are used
Various capacitors
Capacitor uncharged
Capacitor charging; charge on opposite plates is equal and opposite.
Capacitor charging; charge on opposite plates is equal and opposite.
Capacitor charged; no more change
Capacitors

Capacitor Labeling

- purpose is to store electrical charge.
• purpose is to store electrical charge.
• current starts large, voltage starts at zero
• purpose is to store electrical charge.
• current starts large, voltage starts at zero
  as charge is stored, voltage increases and current decreases
  until the voltage equals the applied voltage, when current
  becomes zero
The charge on a capacitor is given by
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\[ Q = CV \]
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\[ E = \frac{1}{2} CV^2 \]
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The energy stored in a capacitor is given by
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A capacitor’s voltage may not exceed the maximum for which it is rated. **Big capacitors often have low maximum voltages.**
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Capacitors may retain charge long after power is removed.
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Place $1k\Omega \rightarrow 10k\Omega$ resistor across the terminals to discharge.
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Place $1\,\text{k}\Omega \rightarrow 10\,\text{k}\Omega$ resistor across the terminals to discharge.

High voltage capacitors should be stored with terminals shorted.
$I = 0$

$t = 0, \text{ switch } \textbf{open}$

$Q = 0$

$V_c = 0$

$V_s$

$R$
\[ I = \frac{V_s}{R} \]

\[ Q = 0 \quad V_c = 0 \]

\[ t = 0, \text{ switch closed} \]
Capacitors

Capacitor Labeling

\[ I < \frac{V_s}{R} \]

\[ Q > 0 \quad V_s > V_c > 0 \]

\[ t \approx RC \]
Capacitors

Capacitor Labeling

\[ I = 0 \]

\[ Q = CV_s \]

\[ V_c = V_s \]

\[ t \gg RC \]
Some capacitors are unpolarized (like resistors);
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Other types, (such as “electrolytics”), must be placed in a particular direction (indicated by a “+” sign at one end.)

Big capacitors ($\gtrsim 1\mu F$) are usually electrolytic.
Small electrolytic capacitor
- Big electrolytic capacitor
• Big electrolytic capacitor (top view)
Big electrolytic capacitor label
Non-polarized capacitor
Polarized capacitor connected the right way
Polarized capacitor connected the wrong way
Don’t do this!!!
Capacitor Labeling

Unfortunately, capacitor labels are much less standardized than resistor labels. This has the value, $10 \mu F$, written on it.
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This has the value, $10\mu F$, written on it.
Capacitors

Capacitor Labeling

This one indicates 68 pF. (The p to the right means the decimal is to the right and it's in picoFarads.)
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This one indicates 0.68 nF, (or 680 pF). (The n to the left means the decimal is to the left and it's in nanoFarads.)
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This one indicates 0.68 nF, (or 680 pF). (The *n* to the left means the decimal is to the left and it’s in nanoFarads.)
Capacitor Labeling

This one indicates 1.0 nF.

(The n in the middle means the decimal is in the middle and it's in nanoFarads.)

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This one indicates 1.0 nF.
This one indicates 1.0 nF. (The \textit{n in the middle} means the decimal is in the middle and it’s in nanoFarads.)
Capacitors

Capacitor Labeling

This one indicates 10 nF. (The n to the right means the decimal is to the right and it's in nanoFarads.)
This one indicates 10 nF.
This one indicates 10 nF. (The *n to the right* means the decimal is to the right and it’s in nanoFarads.)
This is a 0.01 µF capacitor. The “K” indicates a 10% tolerance.
This is a 0.01\(\mu\)F capacitor. The “K” indicates a 10% tolerance.
Capacitors

Capacitor Labeling

This is a 0.68 µF capacitor. The “J” indicates a 5% tolerance.

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This is a 0.68$\mu$F capacitor. The “J” indicates a 5% tolerance.
Capacitor Labeling

This one gives the value in picoFarads, with the 3 numbers handled as for resistors.

10 × 10³ pF or 10nF.

The "J" indicates a 5% tolerance.
This one gives the value in picoFarads, with the 3 numbers handled as for resistors.
This one gives the value in picoFarads, with the 3 numbers handled as for resistors. $10 \times 10^3$ pF or 10nF.
This one gives the value in picoFarads, with the 3 numbers handled as for resistors. $10 \times 10^3$ pF or 10nF. The “J” indicates a 5% tolerance.