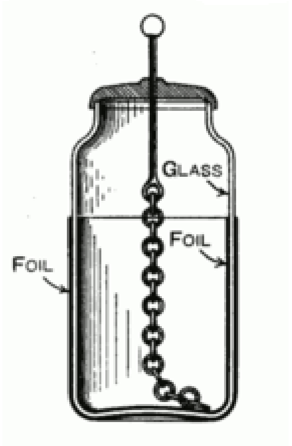
Basic Electronics Part 3
Capacitors & Inductors

- Hamtronics
- Basic Electronics Part 3
- “DOC” Cunningham WA7PLC
- December 7, 2020 @Sunlife ARC

Basic Electronics 3

- The capacitor has a long history in electronics. Ben Franklin used a capacitor as part of his famous Kite Experiment. It was called a Leyden Jar. It is used to store electrical charge

Franklin was instrumental in much of early electrical work, + and – attached to charge, direction of current (flow of + charge), and by connecting several jars in series the term electrical battery (after a series of cannon as a battery).



Source: en.wikipedia.org/wiki/Leyden_jar

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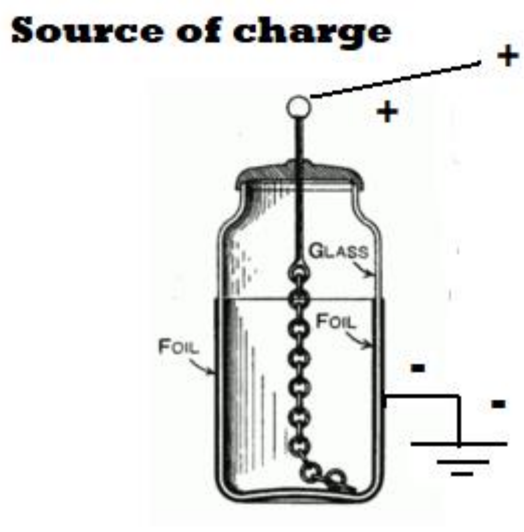
It stores charge by placing one charge on the inside and it draws the opposite charge to the other side of the glass.



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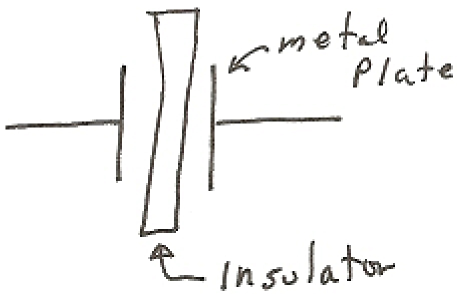
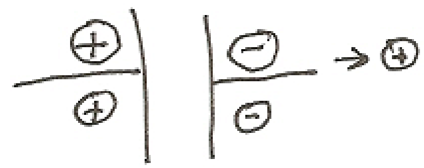
- Modern Capacitors use the same principle.





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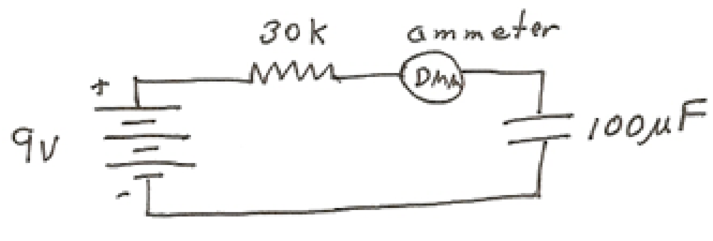
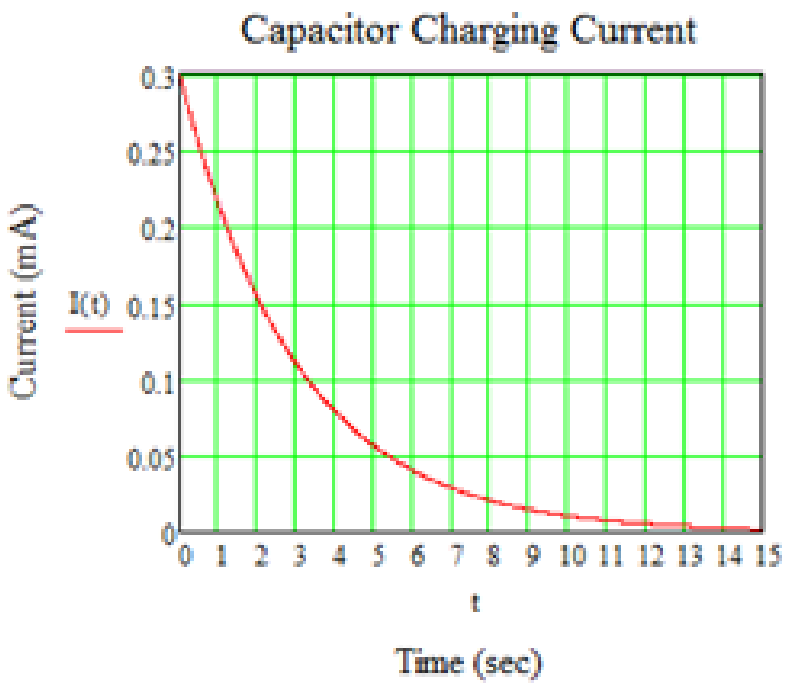


Fig. 2



Cap in typical circuit.

The resistor is to limit the amount of current that can flow.

The 0.3 mA is the max current at the start. An uncharged cap acts like a short circuit for a short time.

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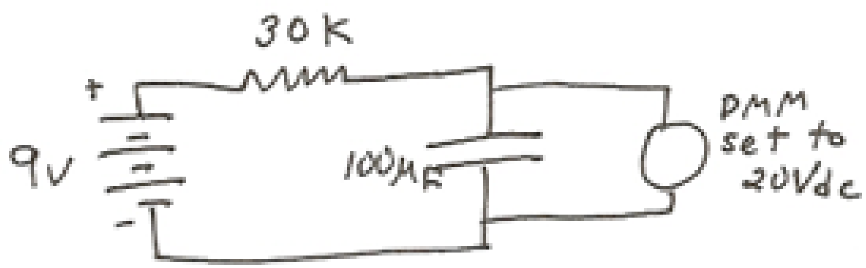
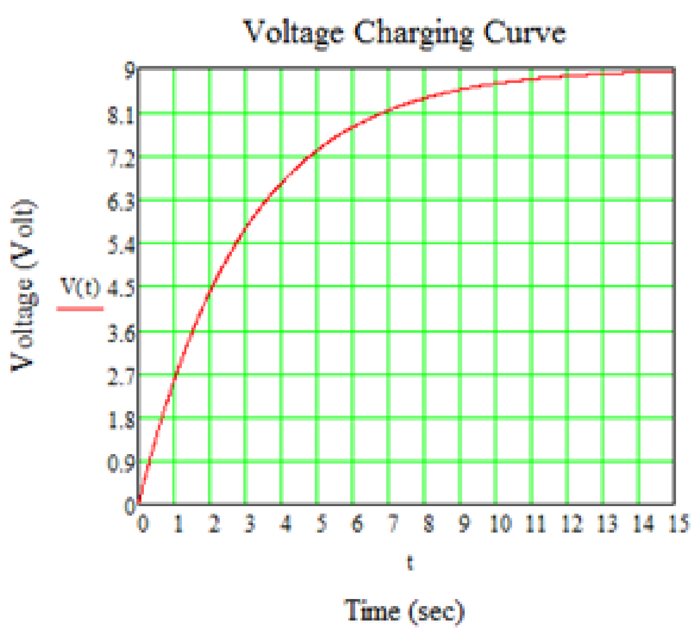


Fig. 4

Voltage on the cap in same circuit.



Initially the cap has no voltage on it. As the current "fills" the cap with charge the voltage rises.

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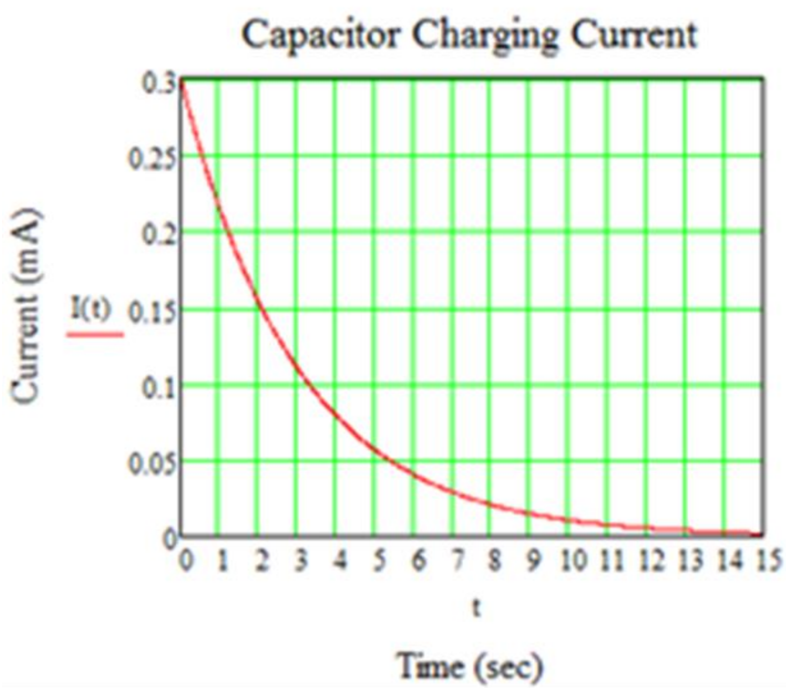

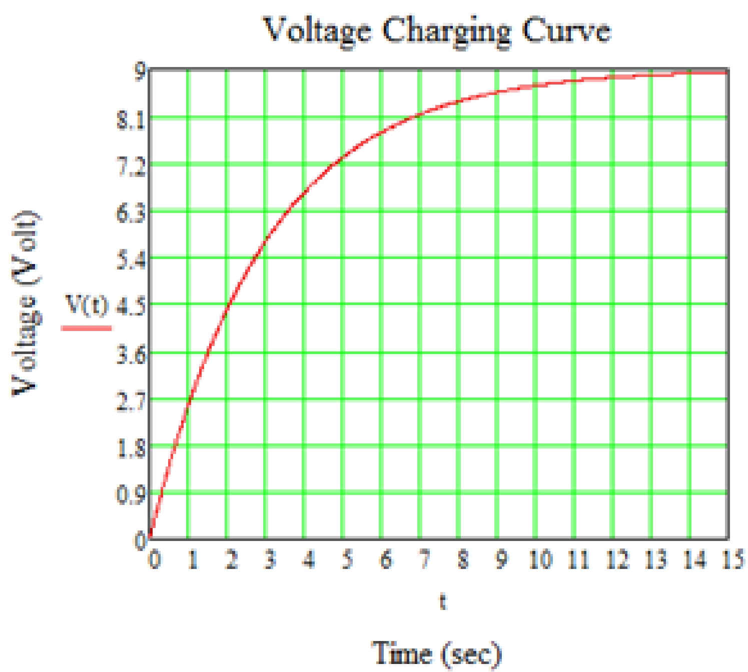

Note as the current goes down the voltage on the cap goes up.

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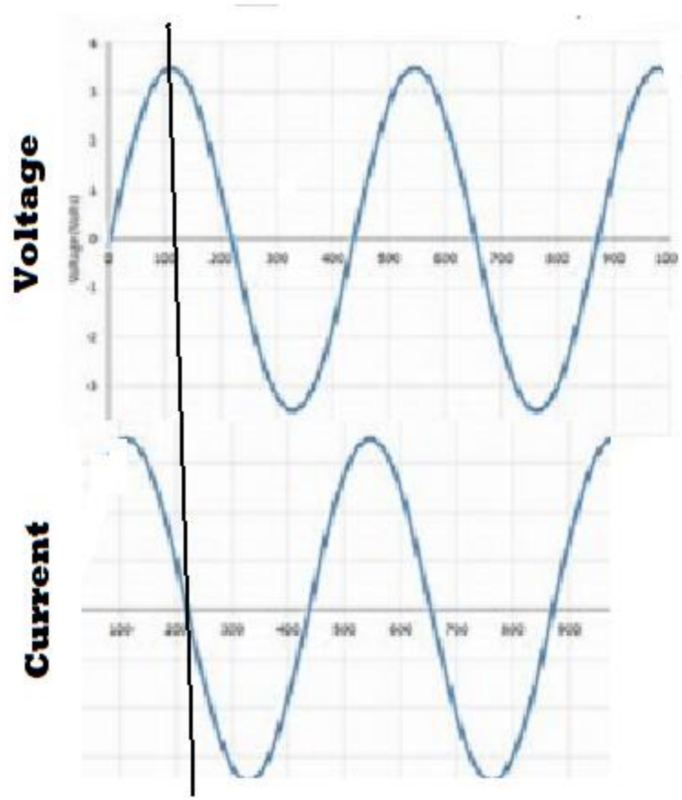
- Now the implication of this is that the current and
  voltage in a cap are “out of phase”.
- What happens when a sine wave is put across the cap?

Phase refers to the position of the peaks of the voltage with respect to the current peaks. Here they are 90 degrees apart.



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- What about the current voltage magnitude relationship. Capacitors have a “resistive” like property called reactance and is measured in Ohms.
  - Impedance - the opposition to flow in an active device as a capacitor or inductor.
  - Capacitive reactance – the impedance in a capacitor in a circuit with Frequency f.
  - $X_c = 1/(2\pi f C)$ the unit will be Ohms. And C is in Farads

Basic Electronics 3 - Capacitors

Reactance of Capacitor XC

$$f := 1000$$

$$C := .05 \cdot 10^{-6}$$

$$XC := \frac{1}{2 \cdot \pi \cdot f \cdot C}$$

$$XC = 3183.0989$$

Source: Smath program

$$\pi = 3.1416$$

Capacitance is in Farads

XC is in Ohms

frequency,f,
is in Hertz

Basic Electronics 3 - Capacitors

$$f := 60$$

$$C := .05 \cdot 10^{-6}$$

$$XC := \frac{1}{2 \cdot \pi \cdot f \cdot C}$$

$$XC = 53051.6477$$

Here you see the effect of frequency in the reactance of a cap.

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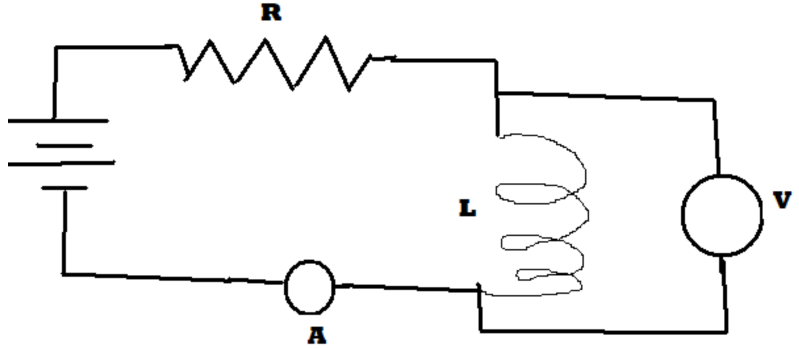
In addition to Capacitors, Inductors (or coils) are important to radio systems.



When first connected the coil acts unlike the cap. It resists changes in the current.

As the current tries to rise, the coil induces a current in the opposite direction.

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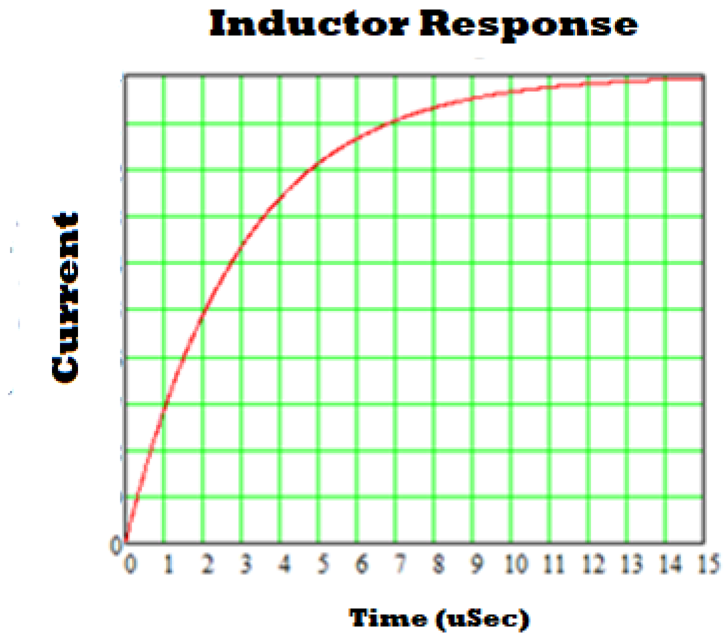

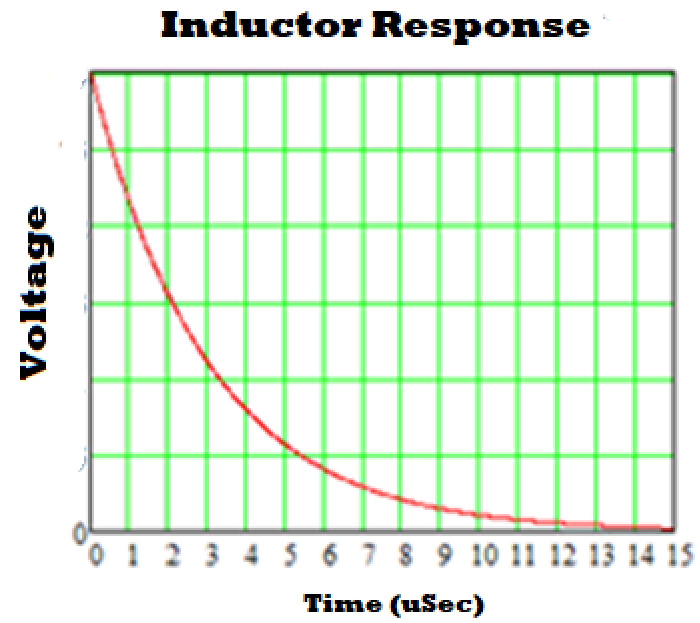

Note this is the opposite of the capacitor.

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This leads to the phrase ...

ELI the ICE man

In inductors the voltage, E, leads the Current, I
And
In capacitor the current, I, leads the voltage, E

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Inductors also have a reactance in Ohms

Impedance of Inductor (coil), XL

$$f := 1000$$

$$L := 1 \cdot 10^{-3}$$

$$XL := 2 \cdot \pi \cdot f \cdot L$$

$$XL = 6.2832$$

$$\pi = 3.1416$$

L is in Henrys

f is in Hertz

XL is in Ohms

Basic Electronics 3

$$f := 60$$

$$L := 1 \cdot 10^{-3}$$

$$XL := 2 \cdot \pi \cdot f \cdot L$$

$$XL = 0.377$$

Again we see a frequency dependance on the reactance.

These concepts are in the extra class exam, and are of importance to both receiver and transmitter circuits.

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In a later presentation we will look at how coils, resistors and capacitors interact in radio circuits.

All equations will be posted as an Smath file at ...
www.drcunningham.us/hamtronics/

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