fun.cap Capacitors

Capacitors have two terminal and are composed of two conductive surfaces separated by some distance. One surface has charge q and the other $-q$. A capacitor stores energy in an electric field between the surfaces.

Let a capacitor with voltage v across it and charge q be characterized by the parameter capacitance C, where the constitutive equation is

capacitance

(1)

The capacitance has derived SI unit farad (F), where $F = A \cdot s/V$. A farad is actually quite a lot of capacitance. Most capacitors have capacitances best represented in μF, nF, and pF. The time-derivative of this equation yields the v-i relationship (what we call the "elemental equation") for capacitors.

farad (F)

Equation 2 capacitor elemental equation

A time-derivative! This is new. Resistors have only algebraic i-v relationships, so circuits with only sources and resistors can be described by algebraic relationships. The dynamics of circuits with capacitors are described with differential equations.

Capacitors allow us to build many new types of circuits: filtering, energy storage, resonant, blocking (blocks dc-component), and bypassing (draws ac-component to ground).

Capacitors come in a number of varieties, with those with the largest capacity (and least expensive) being electrolytic and most common

electrolytic capacitor

being ceramic. There are two functional varieties of capacitors: bipolar and polarized, with circuit diagram symbols shown in Fig. cap.1. Polarized capacitors can have voltage drop across in only one direction, from anode (+) to cathode (−)—otherwise they are damaged or may explode. Electrolytic capacitors are polarized and ceramic capacitors are bipolar. So what if you need a high-capacitance bipolar capacitor? Here's a trick: place identical high-capacity polarized capacitors cathode-to-cathode. What results is effectively a bipolar capacitor with capacitance half that of one of the polarized capacitors.

ceramic capacitor

bipolar capacitor

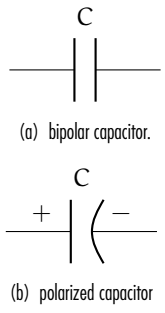
polarized capacitor

anode

cathode

explosion

cathode−to−cathode



(a) bipolar capacitor.

(b) polarized capacitor

Figure cap.1: capacitor circuit diagram symbols.