CAPACITOR & CAPACITANCE - APPLICATIONS

Applications

Capacitors have various uses in electronic and electrical systems.

Energy storage

A capacitor can store electric energy when disconnected from its charging circuit, so it can be used like a temporary battery. Capacitors are commonly used in electronic devices to maintain power supply while batteries are being changed. (This prevents loss of information in volatile memory.)

Power conditioning

Capacitors are used in power supplies where they smooth the output of a full or half wave rectifier. They can also be used in charge pump circuits as the energy storage element in the generation of higher voltages than the input voltage.

Capacitors are connected in parallel with the power circuits of most electronic devices and larger systems (such as factories) to shunt away and conceal current

fluctuations from the primary power source to provide a "clean" power supply for signal or control circuits. Audio equipment, for example, uses several capacitors in this way, to shunt away power line hum before it gets into the signal circuitry. The capacitors act as a local reserve for the DC power source, and bypass AC currents from the power supply. This is used in car audio applications, when a stiffening capacitor compensates for the inductance and resistance of the leads to the lead-acid car battery.

Power factor correction

Capacitors are used in power factor correction. Such capacitors often come as three capacitors connected as a three phase load. Usually, the values of these capacitors are given not in farads but rather as a reactive power in volt-amperes reactive (VAr). The purpose is to counteract inductive loading from electric motors and fluorescent lighting in order to make the load appear to be mostly resistive.

Filtering

Signal de-coupling

Because capacitors pass AC but block DC signals (when charged up to the applied dc voltage), they are often used to separate the AC and DC components of a signal. This method is known as *AC de-coupling*. Here, a large value of capacitance,

whose value need not be accurately controlled, but whose reactance is small at the signal frequency, is employed.

Noise filters, motor starters, and snubbers

When an inductive circuit is opened, the current through the inductance collapses quickly, creating a large voltage across the open circuit of the switch or relay. If the inductance is large enough, the energy will generate a spark, causing the contact points to oxidize, deteriorate, or sometimes weld together, or destroying a solid-state switch. A snubber capacitor across the newly opened circuit creates a path for this impulse to bypass the contact points, thereby preserving their life; these were commonly found in contact breaker ignition systems, for instance. Similarly, in smaller scale circuits, the spark may not be enough to damage the switch but will still radiate undesirable radio frequency interference (RFI), which a **filter** capacitor absorbs. Snubber capacitors are usually employed with a low-value resistor in series, to dissipate energy and minimize RFI. Such resistor-capacitor combinations are available in a single package.

In an inverse fashion, to initiate current quickly through an inductive circuit requires a greater voltage than required to maintain it; in uses such as large motors, this can cause undesirable startup characteristics, and a **motor starting capacitor** is used to increase the coil current to help start the motor.

Capacitors are also used in parallel to interrupt units of a high-voltage circuit breaker in order to equally distribute the voltage between these units. In this case they are called grading capacitors.

In schematic diagrams, a capacitor used primarily for DC charge storage is often drawn vertically in circuit diagrams with the lower, more negative, plate drawn as an arc. The straight plate indicates the positive terminal of the device, if it is polarized.

Signal processing

The energy stored in a capacitor can be used to represent information, either in binary form, as in DRAMs, or in analogue form, as in analog sampled filters and CCDs. Capacitors can be used in analog circuits as components of integrators or more complex filters and in negative feedback loop stabilization. Signal processing circuits also use capacitors to integrate a current signal.

Tuned circuits

Capacitors and inductors are applied together in tuned circuits to select information in particular frequency bands. For example, radio receivers rely on variable capacitors to tune the station frequency. Speakers use passive analog crossovers, and analog equalizers use capacitors to select different audio bands.

In a tuned circuit such as a radio receiver, the frequency selected is a function of the inductance (L) and the capacitance (C) in series, and is given by:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

This is the frequency at which resonance occurs in an LC circuit.

Other applications

Sensing

Most capacitors are designed to maintain a fixed physical structure. However, various things can change the structure of the capacitor — the resulting change in capacitance can be used to sense those things.

Changing the dielectric: the effects of varying the physical and/or electrical characteristics of the **dielectric** can also be of use. Capacitors with an exposed and porous dielectric can be used to measure humidity in air.

Changing the distance between the plates: Capacitors are used to accurately measure the fuel level in airplanes. Capacitors with a flexible plate can be used to measure strain or pressure. Capacitors are used as the sensor in condenser microphones, where one plate is moved by air pressure, relative to the fixed position of the other plate. Some accelerometers use MEMS capacitors etched on a

chip to measure the magnitude and direction of the acceleration vector. They are used to detect changes in acceleration, eg. as tilt sensors or to detect free fall, as sensors triggering airbag deployment, and in many other applications. Also some fingerprint sensors. Additionally, a user can adjust the pitch of a theremin musical instrument by moving his hand since this changes the effective capacitance between the user's hand and the antenna.

Changing the effective area of the plates: capacitive touch switches.

Pulsed power and weapons

Groups of large, specially constructed, low-inductance high-voltage capacitors (*capacitor banks*) are used to supply huge pulses of current for many pulsed power applications. These include electromagnetic forming, Marx generators, pulsed lasers (especially TEA lasers), pulse forming networks, radar, fusion research, and particle accelerators.

Large capacitor banks(Reservoir) are used as energy sources for the exploding-bridgewire detonators or slapper detonators in nuclear weapons and other specialty weapons. Experimental work is under way using banks of capacitors as power sources for electromagnetic armour and electromagnetic railguns or coilguns.

Source: http://www.juliantrubin.com/encyclopedia/electronics/capacitor.html