

Rarely Asked Questions

Strange but true stories from the call logs of Analog Devices

Half Full or Half Empty? Thoughts on Capacity.

Q. Are all components with just two wires as complicated as the resistors we discussed recently?

A. Capacitors certainly are.

If you put a pint of liquid into a quart pot, the optimist will declare it half full, but on the other hand the pessimist will complain that it's half empty.

Engineers, on the gripping handⁱ, know that the glass is too large.

It's a matter of capacity. Capacitors, like the resistors we discussed recently, are more complex than the simplicity of their two leads suggests, and bigger is not necessarily better.

A capacitor has more characteristics than its capacity and maximum operating voltage. In parallel with the nominal capacity there will be leakage resistance and dielectric absorption. In series, there will be inductance and effective series resistance (ESR). ESR is important; the largest unintentionalⁱⁱ explosion I ever caused occurred when I was working on ultrasound cleaners and replaced a faulty mica high-frequency (HF) capacitor in the tank circuit of a 5-kW ultrasonic generator with a high-ESR oil-filled capacitor. I was lucky to survive, but the ultrasonic generator didn't.

Even low-frequency integrated circuits (ICs) contain transistors with a frequency response of hundreds or thousands of MHz. If the supply pins of the IC are not short-circuited at HF, the parasitic components formed by the printed circuit board tracks may create resonators and oscillate—possibly at such a high frequency that the oscillation is not visible on an oscilloscope. The capacitor used to create this HF short-circuit must have low inductance—and short leads. Too large a capacitance is unlikely to have sufficiently low inductance, and some types of small capacitors (such as spiral-wound plastic film) may still be unsuitable. On the other hand the precision and stability of such decoupling capacitors are comparatively unimportant.



In active filters, precision and stability are of overriding importance. In low-frequency supply decoupling, the ability to handle high ripple currents without overheating limits the types we may use.

Fifteen or twenty years ago the dielectric absorption of capacitors for use in sample and hold (SHA, S/H or, sometimes, T/H [track and hold]) circuits was very important. It is still important for SHAs that use discrete capacitors, but today these capacitors are usually integrated onto a chip, and are not separate components. Leakage is still important in RC timing circuits, though.

Even the difference between polarized and unpolarized capacitors is important in ac applications.

Choosing capacitors involves a lot more than simply calculating the required capacitance. The linked article discusses the issues in much more detail.

ⁱ To learn about the Motie race, and their additional gripping hand, read "The Mote in God's Eye" (ISBN 0-671-21833-6) and its sequel "The Gripping Hand" (ISBN 0-671-79573-2) by Larry Niven and Jerry Pournelle or see http://en.wikipedia.org/wiki/Gripping_hand

ⁱⁱ Don't ask about my experiences with pyrotechnics and blasting gelatine.



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