Tech Note - Theory - 12 Xc and All That Stuff

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Capacitive reactance: lets do some basic review . What is an electron*? Imagine that a golf ball is an electron We throw it into a large glass jar that by some magic has a perfect vacuum in it. What will happen to that electron (same page)**? Suppose, we throw another golf ball into the jar. What will happen inside the jar? What is happening on the outside of the jar? Lets throw more and more and more electrons into the jar. What will happen now?

Now lets call this jar a capacitor***! And the glass the dielectric. We are attempting to place a charge on it with an electric potential (voltage). Remember what happens when you bring two similarly charge particles together?

We now have thousands, millions of charged particles being forced (electromotive force) or stuffed into the jar (capacitor).

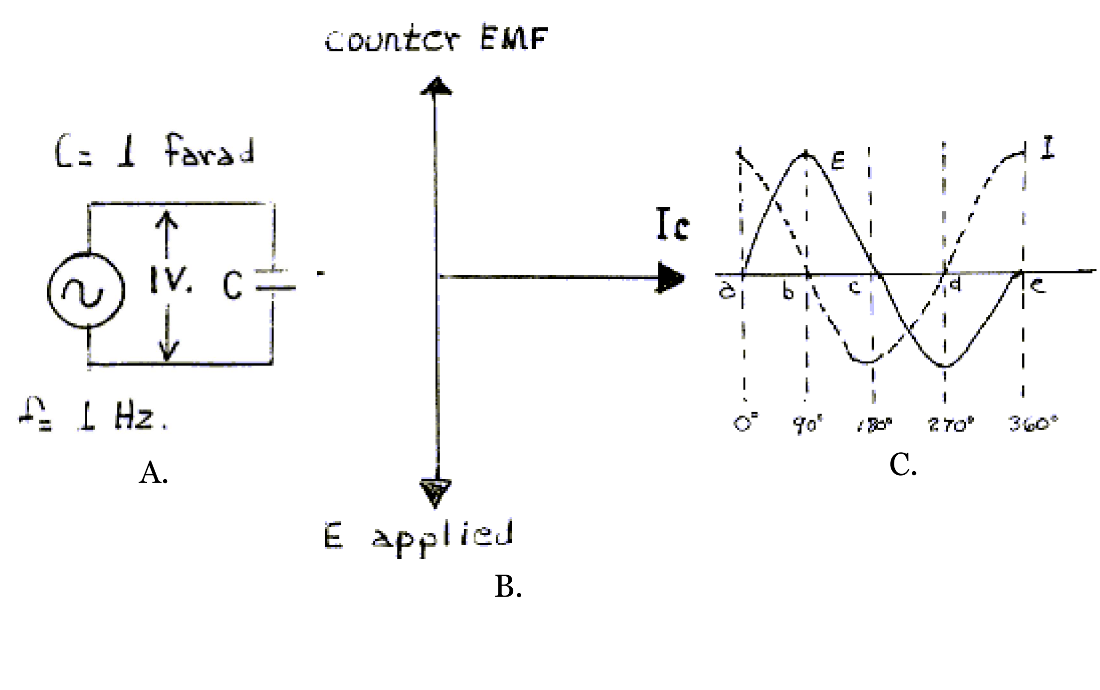
The particles (electrons), are going to RESIST being stuffed together by their very nature. With DC this stuffing is almost instantaneous. However with AC time is involved and the direction that the electrons are stuffed in is changing with time. As a consequence, this resistance to stuffing, measured in ohms, will vary with how fast or slowly the attempt to stuff is made****. Two is the time part of the formula, F is the number of times per second we try to stuff the electrons, and C is the size of the glass jar we are trying to stuff with electrons. Remember what happened to the outside of the jar?

We can continue to stuff electrons into the jar. Liken the voltage to a large piston that is pushing down on the electrons forcing more electrons in and closer and closer together as the stuffing continues. We will eventually reach a point where the internal counter electric pressure will burst or fracture the jar (capacitor). We now have a short circuit between the negative charges of the electrons and positive charge on the outside of the jar (lack of electrons). The charge is equalized and if we continue to stuff electrons into the fractured jar, the net result would be heat and smoke. The 1 over portion of the formula is because Xc varies inversely with frequency.

R. A. C. Study Guide - Basic Qualification: * Pg 2-1 Para. 2.2; ** Pg 2-2 Para.2.2; *** Pg 4-9 Para. 4.6; **** Pg 4-15 Para 4.12.

Since electron drift is only a few cm.per second, no single electron makes it around the circuit, however electrons are in motion in all parts of the circuit and all electrons are identical in charge, this is of no consequence as the net effect is as if a electron/s had moved through the circuit completely anyway, the direction is reversed before an electron moves very far and it drifts in the opposite direction.

Figure 1



Since one ampere is the rate of flow when 1 coulomb per/sec passes a given point, 4 amps (average) have moved.

Since E/I=R, then 1/4=0.25 ohms is the reactance of the capacitor. Or, it has a Susceptance of 4 Siemans. Increasing the size of the capacitor will increase the Susceptance (more charge) thereby decreasing the R (substitute Xc) also increasing the frequency increases the number of charges per second, increasing the Susceptance therefore decreasing the Xc. It should now be clear that Xc is INVERSELY proportional to both frequency and capacity!

Effective E=0.707 of peak E
Average E=0.637 of peak E

Reference: R.A.C. Study Guide - Basic Qualifications, Pg. 2-18