Basic Electronics Part 17

by

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In the last installment we talked about the quality of components and the Q of a circuit. This raises the question of why we don't use the highest quality components in every circuit we construct. We realize that the higher the quality of a component, the more expensive that component will be. Also, higher quality components may not be readily available. To decide what quality our components should be we consider several trade-offs. What is the circuit function? What purpose does a component serve in the circuit? What will be the frequency of signals applied to the component? As we answer these questions we can decide how to select the proper components for our circuit.

For example, suppose we decide to construct a power supply that converts 120 v ac to 12 v dc. We use a transformer to reduce the voltage from 120 volts to 12 volts and we use a rectifier to convert the 12 volts ac to 12 volts dc. The output of the rectifier may have 60 Hz or 120 Hz ripple, therefore, we need to add a filter capacitor to smooth the ripples. We don't need to worry about the high frequency characteristics of the capacitor in this situation and we don't need to worry about a small energy loss either. On the other hand, a capacitor that will be used in the RF portion of a VHF receiver must meet other requirements. Any signal loss in this circuit should be minimized.

Aluminum electrolytic capacitors are usually used as power supply filters. They have a large amount of capacitance in a small package. They do have higher losses, especially at high frequencies; therefore, they have a lower Q than some other types of capacitors. As we mentioned above, that is not a serious problem for a power supply. For higher frequency circuits we use mica or ceramic capacitors. These dielectric materials have lower loss therefore they make higher-Q capacitors.

To reduce an inductor's losses we use a larger diameter wire and we put more space between the turns. Unfortunately, in some cases we don't have room in a circuit to insert a large coil. If the circuit doesn't require a high-Q coil, then we can use smaller wire and a small diameter coil form.

For example, suppose we consider the output network of a high-power RF amplifier. Since we have worked very hard to create the RF energy, we don't want to lose any of it in a low Q output network. The output inductor must be able to carry several amperes of RF current for a large amplifier and it should have a high Q. In this case we might use large diameter wire or copper tubing to minimize conductor resistance and to carry high RF current. The capacitors in the output network should also use low-loss dielectric materials.

On the other hand, if we place an inductor in series with the power-supply lead to an RF amplifier, this inductor will carry a small direct current from the power supply. At dc, the inductor has a small reactance, but is has a large reactance at the amplifier's radio frequency. This means that it blocks any RF current from flowing back into the power supply. A coil of this type is called a choke. You don't need a high-Q inductor for a choke. You just use a power supply that can supply the current needed by the amplifier and the losses in the coil.

In the above discussion we talked about using a transformer to reduce the voltage from 120 volts to 12 volts. In the next installment we will talk about how such transformers are constructed. We will also discuss the construction of other transformers for other uses.