

Electronic Basics Part V

Capacitor

There are four major electronic components in electronic equipment. These are capacitors, inductors, resistors and solid state devices such as diodes, transistors and integrated circuits. This part will discuss capacitors. In future parts we will discuss each of these components and how they work together to produce transmissions that can be heard and receive transmitted signals.

Capacitors in their simplest form consist of two metal plates separated by an insulating material. The material between the plates can be air, plastic or even certain liquids. This insulating material is often referred to as a dielectric.

Capacitors can take several forms. Most are cylindrical tubes or flat squares. However, some are rectangular. They range in size from as small as a grain of sand to several feet in size. Most have only a fixed size but some are variable.

The electrical size of a capacitor known as capacity. This capacity is measured in farads. In practical applications a capacitor with a one farad capacity would be as large as say a large sport utility vehicle. Capacitors are usually rated in microfarads or picofarads as well as the maximum voltage they can withstand without damage. The size of the plates, their spacing from each other and the type of insulation material between the plates determines the capacity of a capacitor.

In an earlier part we mentioned that the term “micro” is one millionth of one part and “pico” is one millionth of a millionth. One micro in numbers is represented by the number 0.000001....that is five zero's between the decimal and number one. One pico is represented by 0.000000000001....that is eleven zeros between the decimal and the number one. When writing microfarad it is abbreviated with the letters “ufd” or “Mfd.” Picofarads are abbreviated with “pfd.” Not all are lower case and are not capitalized.

There are two major groups of capacitors. Polarized capacitors must have their negative lead connected to the ground in an electrical circuit. The positive lead in turn is connected to a more positive voltage. Nonpolarized capacitors can have either lead connected to either the positive or negative side of a circuit. Polarized capacitors are somewhat limited in their usefulness by being polarized. However, they are much less expensive to manufacture than their nonpolarized counterparts. Their insulator is less expensive than that needed in a nonpolarized capacitor.

Capacitors do not have a complete circuit through them. However, they have the ability to pass certain voltages and block other voltages. When a voltage source is applied to the two plates of a capacitor current begins to flow into the plates. The plate connected to the negative part of the circuit begins to receive an excess of electrons. In the meantime the plate connected to the positive side of the circuit

begins to lose electrons. Due to their proximity the built up of electrons on the negative plate, through electrostatic pressure, forces electrons off the positive plate. This is not done instantly. It takes time. The term “time constant” refers to the length of time required to charge a capacitor to 63 percent of its capacity. This time constant is directly related to the capacity of the capacitor. A second time constant is again 63 percent above the level reached in the first time constant. The third is based on the second time constant and so on. Each time constant is the time it takes for a charge to reach 63 percent of the available charge starting at the peak level of the last time constant.

On a practical basis in electronics we consider a capacitor to have been charged to full capacity when five time constants have transpired. This is greater than 99.5 percent of full capacity. This time is measured usually measured in microseconds.

Note that for current to flow through a capacitor the source supplying the voltage be able to supply current at the five time constant rate. If this does not happen current will not flow through the capacitor and it will be blocked from flowing in the circuit. This means that a small capacity capacitor can pass higher frequencies and block lower frequencies. This is because much less time is required to charge or move electrons in and out of a smaller capacitor than a larger one.

From this we can conclude that capacitors block DC voltages and pass AC voltages. The smaller the capacitor the higher the frequency it will pass. On a practical basis the blocking and passing of AC voltages doesn't magically start and stop at a certain frequency. With the use a mathematical formula we can determine the impedance of a capacitor with any stated amount of capacity.

An important concept in AC circuits is the phase relationship between the flow of current and voltage. Remember that radio frequencies are AC frequencies. Since it takes time as we have seen for electrons, that is current, to flow into a capacitor we say that current lags voltage in a capacitive circuit. This lag can be up to 90 degrees. Remember a complete cycle is 360 degrees. Later we will combine this concept with a similar property for coils to determine the actual phase relationship in a circuit. This relationship is important as it determines how efficiently a circuit handles AC voltages.

That concludes this discussion of capacitors. Next we will look at the properties of inductors.