Electronic Fundamentals – Part VII

Combining Capacitors, Coils and Resistors

In preceding tech talks we discussed several aspects of electronic fundamentals. Most recently we discussed capacitors and coils. We learned that each has up to a ninety degree phase shift between the voltage and current in each device. Current leads voltage in a coil and current lags voltage in a capacitor. This is the most important concept in understanding how capacitor, coils and resistors work together in an electronic circuit.

Capacitors, coils and resistors can be combined in either series or parallel circuits. When in series the current supplied by the voltage source flows through each of the components in turn. In parallel circuits the current is divided among the different components as they are connected in such a way that each component forms a separate path for part of the current to flow back to the voltage source. Some circuits may be deceiving so perform a careful analysis of the way the components are arranged before pronouncing the circuit as being either series or parallel.

In electronic ac circuits a factor known as "Q" is very important. It is the ratio of the reactance to the resistance in a circuit. For example, a circuit having a combined reactance of 500 ohms and 5 ohms of resistance will have a "Q" of 100. Frequently, a "Q" of 500 or more is not uncommon. Typically, the higher the "Q" the more efficient a circuit will be. However, as in most things there is also a tradeoff. For example, a high "Q" antenna will have a more narrow bandwidth that an antenna with a lower "Q". Within that narrow bandwidth the "gain" will be higher that in wider bandwidth of an antenna with a lower "Q".

Series resonant circuits have high current flow in the circuit. This is due to the fact that at resonance the inductance and capacitance are offering little or no resistance to current flow. The reactance of the inductance and capacitance cancel each other as they are essentially 180 degrees apart due to the phase shift we just discussed. So the resistance, which is usually low, is the only factor that controls current flow. Thus, with low resistance the current flow in a series circuit is usually high. The "Q" of the circuit will determine the current flow in a series circuit.

Parallel resonant circuits when viewed from the outside of the circuit in many ways a exactly the opposite of series circuits. A parallel circuit has a capacitor and inductor in parallel with each other and with the source voltage. This parallel combination of capacitor and inductor is frequently referred to as a "tank" circuit. It has this name because once it is filled like a water tank no additional amount can be put in or taken out. Current flow from the AC or RF source of voltage is very low in a parallel circuit. Therefore, very little can be added or taken out of a "tank" circuit. This is because the capacitive and inductive reactance again cancel each other and <u>inside</u> the tank circuit there is high current flow again controlled only by the "Q" of the circuit. Outside of the tank circuit the flow is very low because very

little current is needed to keep the tank circuit filled.   It can be said that a tank circuit has a very high "Q" because it greatly limits the current flow into it and subsequently out of it.

In the next tech talk we will continue this very interesting and important subject. We will discuss a phenomena called Series Resonate Voltage Step-up. The subject of combining capacitor, coils and resistance in a circuit is so importance and admittedly complex that it was decided to make it into two tech talks rather than trying to combine it into one.