Tech Note - Theory - 06 Antenna under Receive Conditions

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Assume that the dipole is cut to the proper length, its operation will be somewhat as follows. The incoming wave from the transmitting antenna is alternating at a frequency and this in turn means that similar field conditions will reoccur every wavelength.

The resonant dipole is cut to be an electrical half-wave long. As the wavefront crosses the antenna wire, its fields moving past, induce a current flow in the wire, (a difference of potential exists from one end of the antenna to the other). This current made up of electrons, flows from one end of the wire to the other. When they reach the open end, they can go nowhere, so pile up there as shown in fig. A and bounce back or start to flow in the opposite direction.

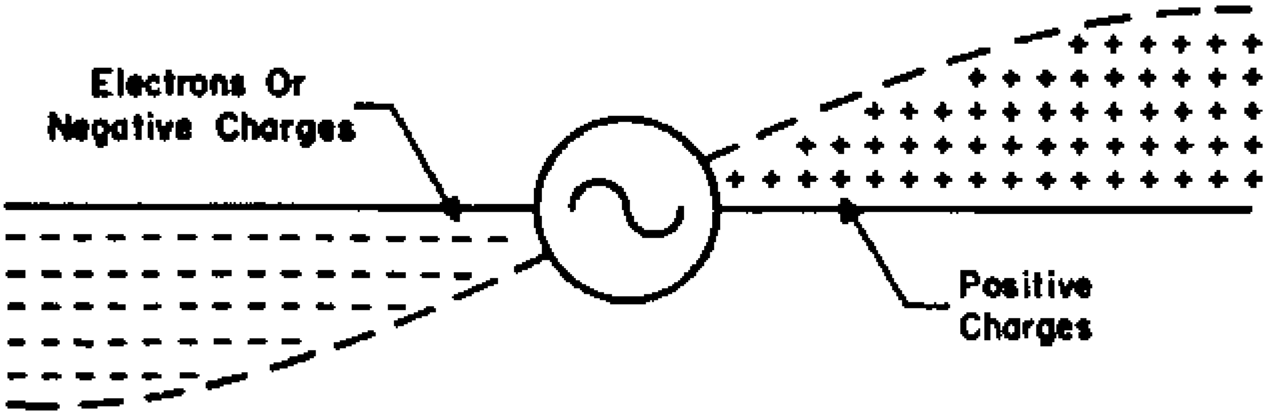

Fig A

As this reverse flow of electrons begins, the second half of the wave moves past the antenna. This second half is identical to the first half except that its polarity is reversed (making electrons flow in the opposite direction than the previous half cycle). However, the electrons from the first half which have bounced off the open end of the antenna are now flowing in the same direction as those being induced to move for the first time by the second half of the wave. Since both groups are going in the same direction, their efforts add and the total current is increased (this is resonance).

When this flow reaches the other end of the antenna it "piles up" and bounces back again. By this time the full wave has moved by and a new wave is just starting to move by, so this cycle of events is repeated as long as the wave front is in some contact with the antenna. The passing waves deposit or leave some of their energy behind in the antenna. This is known as energy extraction from a passing wave.

This continued reinforcement of the current flow in the antenna wire by each passing wave continues until no more energy can be extracted from the wave.

If the antenna wire happened to be just a bit too long (inductive with XL), the timing between the first group of electrons and the second would not be correct to add up (reinforce) and the efficiency would suffer (actually this would result in a mismatch and we would read it as VSWR.). Similarly if the antenna wire were too short (capacitive with Xc), the timing would be upset (again a mismatch read as VSWR). Both the frequency of the signal and the length of the antenna must match for the antenna to function properly. If either is incorrect the action just described will not proceed as efficiently as desired. (resonance > VSWR etc.).because a half wave antenna acts as a resonant circuit, current is continuously flowing from one end of the antenna to the other at the source frequency. The sinusoidlal oscillations cause one end of the antenna to become positive and the other negative during one half of the input cycle: during the other half cycle the polarities reverse.

Reciprocity in Receiving and Transmitting: for all practical purposes the properties of a resonant antenna used for reception are the same as its properties in transmission. It has the same directive pattern in both cases, and so will deliver maximum signal to the receiver when the signal comes from the direction in which the antenna transmits best. The impedance of the antenna is the same, at the point of measurement, in receiving as in transmitting.

In the receiving case, the antenna is to be considered as the source of power delivered to the receiver, rather than as the load for a source of power as in transmitting. Maximum output from the receiving antenna is secured when the load to which the antenna is connected is matched to the impedance of the antenna. Under these conditions half of the total power picked up by the antenna from the passing wave is delivered to the receiver and half is reradiated into space.

Impedance matching in the case of a receiver antenna does not have quite the same meaning as in the transmitting case.

Pickup Efficiency: Although the transmitting and receiving properties of an antenna are in general, reciprocal, there is another fundamental difference between the two cases that is of very great practical importance. In the transmitting case all the power supplied to the antenna is radiated (assuming negligible ohmic resistance) regardless of the physical size of the antenna system. For example, a 300 MHz half wave radiator, which is only about 50 cm (19 inches) long, radiates every bit as efficiently as a 3.5 MHz half-wave antenna, which is about 41 metres (134 feet) long. But in receiving, the 300 MHz antenna does not abstract anything like the amount of energy from passing waves that the 3.5 MHz antenna does.

This is because the section of wave front from which the antenna can draw energy extends only about a quarter wave length from the conductor. At 3.5 MHz this represents an area roughly 1/2 wavelength or 41 metres in diameter, but at 300 Mhz the diameter of the area is only � metre. Since the energy is evenly distributed throughout the wave front regardless of the wavelength, the effective area that that the receiving antenna can utilize varies with the SQUARE of the wavelength. A 3.5 MHz half-wave antenna therefore picks up something like 7000 times as much energy as 300 MHz half-wave antenna, the field strength being the same in both cases.

The higher the frequency, consequently, the less energy a receiving antenna has to work with. This, it should be noted, does not affect the gain of the antenna. In making gain measurements, both the antenna under test and the comparison antenna are working at the same frequency. Both, therefore, are under the same handicap with respect to the amount of energy that can be intercepted. Thus the effective area of an antenna at a given wavelength is directly proportional to its gain. Although the pickup efficiency decreases rapidly with increasing frequency, the smaller dimensions of antenna systems in the VHF and UHF regions make it relatively easy to obtain gain. This helps to overcome the loss of received signal energy.