DEMONSTRATION 3

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This is the third in a series of demonstrations to allow the reader to build a very simple and very inexpensive EH Antenna and experience the performance parameters of this new concept in antenna theory.

This demonstration is designed to explore the efficiency of the EH Antenna. Unfortunately, this demonstration is more a lecture on theory than hands on. However, it is the only way for the reader to gain a complete understanding of his antenna. It uses information previously collected on the antenna.

DEMONSTRATION 3: To achieve high efficiency in an antenna, there must be high radiation resistance relative to the loss resistance. Efficiency is defined as the power output divided by the power input. This is expressed as Radiation Resistance (representing output) divided by the sum of the radiation resistance and the loss resistance (representing the input). You might also think of it as radiation divided by radiation plus heat. We have shown that the resistance is very high before we build a matching network to interface to 50 ohms. We can say that there is virtually no resistive loss in the dipole elements. Therefore, the only loss in the EH Antenna is the resistive loss in the tuning coil. If that coil has a Q > 200, then the resistance of the coil can be calculated from Xc/R. (Note that Xc=XL for resonance). On 40 meters the typical capacity of the dipole is about 12 pFd and there is about that much distributed capacity across the coil for a total of approximately 20 pFd. This is equivalent to a reactance of about 1200 ohms. Therefore, the resistance = 1200/200 = 6 ohms.

EFFICIENCY: Previously we discussed how to measure the +/- 3 dB bandwidth of the antenna. This was a way to convey the definition. The following defines the parameters that control bandwidth. One definition of antenna performance is the Q of the antenna. Antenna Q is defined as the operating frequency divided by the bandwidth. On 40 meters the measured +/- 3 dB bandwidth = 360 KHz. Therefore Q = 7000/360 = 19.5. Another definition of Q is X_L/R where R is the total resistance of the circuit. . We estimated the reactance of the capacity of the antenna to be about 1200 ohms. Because in a parallel circuit the reactance of the capacitor and inductor are the same, then R = XL/Q, or 1200/19.5 = 62 ohms. We previously determined the resistance of the coil to be about 6 ohms. Therefore, if we subtract the loss resistance from the total resistance we are left with the radiation resistance, which is 62-6 = 56 ohms. Please do not confuse this with a matching impedance of 50 ohms, the two are not related.

Now we can determine the efficiency of the antenna, which is = radiation resistance divided by total resistance. This is another way to say efficiency = radiated power divided by applied power. For our miniature antenna efficiency = 56/62 = 90%. That is very good for a small antenna. In fact, that is very good even for a large wire antenna. If you increase the length of our play antenna, the capacity will increase. This leads to more bandwidth, requires less tuning coil and thus less loss resistance, and therefore higher efficiency. An EH Antenna for 75 meters having a diameter of 4 inches and each cylinder being 4 feet long will have very high efficiency. The efficiency will further increase if the wire size and optimum size of the tuning coil is chosen. Compare that to a center loaded standard mobile antenna for 75 meters that has an efficiency of less than 4 %. In other words, a 4 watt transmitter applied to an EH Antenna on 75 meters will produce the same radiation as a standard mobile whip with 100 watt transmitter.

EMI: Electromagnetic Interference (EMI) is a major concern in the proximity of large AM broadcast antennas. This is due to the E field, not the radiation. If the E field is reduced, then the EMI is also reduced. By comparing the EH Antenna to a "standard" antenna, we can see the difference. For example, a good 40 meter EH antenna has a total length of less than 18 inches, or a radius of about 9 inches in which the E field is mostly contained. A 40 meter Hertz antenna would have a very strong E field at the far field distance which is about 1/3 wavelength = 47 feet. Therefore, that is a ratio of 47*12/9 = 63, which is about 36 dB. That is a significant difference between the two antennas.

This document was primarily intended to discuss efficiency of the antenna. Consider this: if there is a strong E field over a large area, and there is some type of conductive and lossy material, then the E field will couple to that object and cause circulating currents in it. This is reflected to the antenna as a loss resistance. If the antenna is a loop, then the magnetic field will do the coupling in the near field. With a loop, a chain link fence ¼ wavelength from the antenna will cause a large change in VSWR. This is most easily noted if the loop is mounted vertically and rotated. We can not rotate a vertical whip and see this effect, but it is still there. This just says that even lossy ground will absorb some energy from a standard Hertz antenna. This has been proven by elevating the radials of a vertical and comparing the resistance to the antenna with buried radials.

With that in mind, you will not see a change in the resistance of a EH Antenna with lossy objects brought close to it. By close, we mean about one diameter of the antenna, rather than ¼ wavelength. This can be readily observed by watching the VSWR while bringing a large piece of iron close to the antenna.

Now you know another reason the EH Antenna is more efficient than a Hertz antenna.

RECEIVING: We now have a very small antenna with high efficiency and wide bandwidth. What else could you ask for? Perhaps you also want it to be a good receiving antenna? When you talk about conventional antennas there is a relationship of size to capture area. That does not apply to the EH Antenna, because it has full capture area capability due to the fact that a passing wave will provide full coupling. This is due to the efficient integration of the E and H fields developed at the antenna due to proper phasing and proper physical relationships.

For the same reasons the EH Antenna has very little EMI, it is also true that the EH Antenna does not respond to separate E or H field noise. In other words, if the noise creates only one field and no radiation, the EH Antenna will not respond by forcing current into the receiver antenna terminal. On the other hand, if the antenna is a standard Hertz antenna in the presence of noise (either an E field or an H field) current will flow into the receiver antenna terminal. The ratio of noise rejection is the same as the EMI ratio.

Next – we believe many want specific dimensions to allow them to build a very good Ham antenna. We will present some of that data in the next demonstration.