Simulation and Experimental Results for a Planar Strip Dipole over PEC and Ferrite Nanoparticle Composite Ground Planes

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An important antenna design goal is to have a dipole-like antenna operating close to a metallic groundplane (structure or platform). Unfortunately, the characteristics such as radiation resistance and bandwidth reduce dramatically as the antenna approaches closely to the ground plane. However, if the antenna could be matched even to the low radiation resistance, the gain increases as the antenna gets closer to the ground plane assuming low antenna ohmic losses. For low-loss ferrite nanoparticle composite backed ground planes, completely opposite behavior occurs in that the radiation resistance and bandwidth increase as the dipole moves closer. In the practical world an antenna should include a matching circuit to prevent serious mismatch loss to circumvent lower realized gain that would result for the unmatched case.

In this paper the geometry of a low-loss ferrite nanoparticle composite backed ground plane is optimized for a planar strip dipole. The radiation resistance, gain, VSWR (Voltage Standing Wave Ratio), and bandwidth are investigated for this magneto-dielectric based antenna. Results are given for simulations involving the antenna in free space and at various heights over a PEC and over a low-loss ferrite nanoparticle composite medium. It is found that the radiation resistance and bandwidth are similar for the dipole in free space and at a height of .25λ over a PEC ground plane. As the dipole is lowered closer to the ground plane, the radiation resistance and bandwidth both reduce and the gain improves. Bandwidth is defined between the VSWR = 2.0 upper and lower frequencies with the antenna matched to the radiation resistance at the center frequency.

The same planar strip dipole was modeled with simulation software over a finite size PEC ground plane inserted with a thin layer of specially formulated isotropic magnetic nanoparticle composite with low-loss characteristics. Experimental measurements were also obtained in an anechoic chamber and agreed with simulation results. Impedance, VSWR, gain, and bandwidth results will be presented for both the simulation modeling and the experimental measurements. It was found that all of the performance characteristics were greatly improved by utilizing the magnetic nanoparticle composite. This innovative and breakthrough ferrite nanocomposites backed antenna design will allow antennas to be very conformal to metallic groundplanes (vehicles and airborne platforms).