Simulation and Experimental Results for a Planar Strip Dipole over PEC and Ferrite-Metamaterial Groundplanes

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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 groundplane. However, if the antenna could be matched even to the low radiation resistance, the gain increases as the antenna gets close assuming low antenna ohmic losses. For low-loss ferrite PEC (Perfect Electrical Conductor) backed groundplanes, 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 following performance characteristics such as the real part of input impedance (radiation resistance), gain, VSWR (Voltage Standing Wave Ratio), and bandwidth are investigated for a planar strip dipole. Results are given for simulations involving the antenna in free space and at various heights over a PEC and over a low-loss metamaterial ferrite 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 groundplane, 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 groundplane with a thin layer of specially formulated isotropic metamaterial ferrite with low-loss characteristics. This was further verified by obtaining results that are in agreement for three different simulation codes. 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 metamaterial ferrite. This innovative and breakthrough metamaterial antenna design will allow antennas to be very conformal to metallic groundplanes (vehicles and airborne platforms).

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