Design and Analysis of Feed Techniques for Reconfigurable Liquid-Metal Monopole Antennas

Jonathan T. Thews[1], Alan J. Michaels[1], and William Davis[2]

[1] Hume Center for National Security and Technology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA.
[2] Department of Electrical and Computer Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA.

Liquid metal antennas are a relatively new technology and are being studied because of their inherent reconfigurable nature. While previous researchers studied different types of antennas, the electrical feed methods for these antennas have not been studied extensively. This paper describes the simulation and experimental results for different electrical feeds for a liquid metal monopole antenna, while still retaining the ability to reconfigure the height of the antenna and maintain acceptable RF performance. A prototype liquid metal monopole antenna was built, and three different electrical feed methods were constructed, comparing the experimental results to simulation produced in EM modeling software. Each of the different feed methods is mechanically feasible, however the offset feed below the ground plane in particular is believed to be easiest to scale to a more complex array that will utilize a common liquid metal reservoir between them. This is due to the ability to both inject and retract liquid metal from the antenna without the use of a needle. From the simulation and experimental results, the bottom fed and bottom fed with injection stub antennas performed well across the entire band. The offset fed below the ground plane performed well at lower frequencies, but as the amount of metal above the ground plane approached the amount of metal below the ground plane, the gain of the antenna dropped significantly. The offset fed antenna is the optimal choice for the next step forward, which would be creating an array with a common reservoir due to it's mechanical advantage.