Analysis of the Linearity and Tuning Range of Frequency Reconfigurable Antennas Using Liquid Metals

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The integration of microfluidic devices within electronics systems has gained interest in recent years. One emerging application is the use of liquid metals (LM) for reconfigurable RF devices, including antennas. Recent results have shown that these LM devices can be controlled electronically, and can potentially offer not only a high degree of tunability, but also highly linear performance at medium power. Still, the linearity of these LM devices remains unexplored, and questions remain about the effects of several potential sources of non-linear distortion (oxide-metal interface, self-biasing resulting in impedance modulation).

In this paper, we characterize the non-linear distortion produced by four kinds of monopoles: a passive copper monopole, an active varactor-tuned copper monopole, an active electronically-controlled LM monopole, and a passive LM monopole. The reflected third-order intermodulation products (IM3) are measured to characterize the monopole linearity using an analog canceler system. Measurements reveal that the passive LM monopole has similar linearity and power handling capability as a passive copper monopole. The active LM monopole generates slightly higher nonlinear distortion, characterized by IM3 product level, than the passive LM monopole. Nevertheless, the IM3 level generated by the active LM monopole is at least 40 dB lower than that of the varactor-tuned monopole. At the same time, the active LM monopole has a much wider tuning range than the varactor-based monopole. While the varactor-loaded antenna can be made more linear by careful choice of the loading position on the monopole, our results indicate that to achieve this higher linearity, we must also sacrifice tuning range. This tradeoff will also be explored in the presentation.