Liquid-Metal Reconfigurable RF Components and Antennas

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Reconfigurable RF components are attractive for changing key system parameters such as operating frequency and gain. Typical reconfigurable components use switches or solid-state devices. These methods assume that the metal elements of the circuit themselves cannot be altered. We present recent work from a differerent paradigm by substituting *liquid* metal for key metal elements to enable reconfigurability.

We present an overview of recent work in this emerging field, including a liquid-metal double-stub tuner, frequency selective surface (FSS), filters, and monopole arrays as proof-of-concept demonstrations using liquid metal in RF devices. This concept can be extended to many other RF devices.

In the case of a double-stub tuner, liquid metal is substituted for the two open-circuit stubs. By adjusting the lengths of the stubs, a broad range of tuning impedance is achieved. Compared to using switches for impedance matching, which only have a discrete number of states, liquid metal offers a continuous range of states because of its analog nature.

An FSS was created by interspersing liquid metal with mineral oil in periodically spaced tubes. By changing both the length of the liquid metal and the mineral oil spacing, two octaves of frequency tuning from 4 GHz to 17 GHz was demonstrated.

A third type of component that we describe is a tunable filter. The periodic lattices of a low-pass filter with a defected ground structure (DGS) were composed of liquid metal. Liquid metal could then either fill or evacuate a DGS lattice to achieve cutoff-frequency tuning from 1.9 GHz to 3 GHz.

Finally, recent work in S-band Yagi-Uda monopole arrays is presented. Tubes of liquid metal were used as the fed, parasitic, and director elements. By adjusting the length of liquid metal inside of the elements both the operating frequency and endfire directions can be changed over an octave.