Reconfigurable Antennas with Integrated RF MEMS Switches for Military MIMO Applications

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This work describes the design and development of a pattern reconfigurable antenna with integrated RF MEMS switches for military MIMO applications. Many MIMO system antenna configurations have been proposed previously, such as arrays of monopoles, dipoles, spiral antennas, and "cube antennas" consisting of dipoles. As portable devices decrease in size and get more intricate with multiple connections, these proposed antenna configurations cannot be easily integrated into small devices. Also, since each system employs a fixed configuration, they cannot respond to changing propagation environments. Arrays can be a solution to this problem, but again, the size of a beam steering array becomes an issue with small portable devices.

The proposed design for this reconfigurable antenna incorporates integrated RF MEMS switches. The antenna structure consists of microstrip traces on a liquid crystal polymer (LCP) substrate, which has a relative permittivity of approximately 3.05. Because of the limitations of off-the-shelf, general purpose RF MEMS switches, the current switches and antenna are integrated in a single fabrication process with direct RF MEMS switch fabrication on the LCP. The current process results in an RF MEMS switch with an actuation voltage in the 80 to 120 volt range. At an operating frequency in the Ka-band, specifically 30 GHz, a relatively thin substrate of 0.8 mm provides the required impedance bandwidth for reconfiguration. The antenna traces including all biasing traces fit into a space of 6 mm by 7 mm on the top side of the substrate with a conductor plated back side acting as a ground plane. The present design includes two vias, one from the trace to the ground plane and the other acting as a probe feed. Changing the states of the switches supports pattern reconfiguration from broadside to endfire over a common impedance bandwidth. Simulated and measured results of return loss and radiation patterns for both broadside and endfire states will be presented.