Three-state RF Switch based on MEMS Technology

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With recent rapid developments of Micro-Electro-Mechanical Systems (MEMS), every product category will be revolutionized by bringing together silicon-based microelectronics and micromachining technologies. Any progress in MEMS technology is a step towards the integration of microelectronics with active perception and control functions, which is in fact the realization of a complete system on a chip. MEMS technology has proven its revolutionary capability in many different fields especially in space and radio frequency (RF) systems. RF systems are expanding at an incredible pace with smart phones, high-speed Internet access, Bluetooth, and so on. The RF MEM switches, in particular, are poised to be a key enabler in these wireless applications and especially in communication satellites because of their ideal characteristics such as reduced size and weight, lower cost and power consumption, and higher performance and reliability [1].

In this paper a novel three-state RF MEM switch with thermal actuators is introduced. The three-state RF switch has four contacts (A, B, C, D) and at each state it takes one of the three possible configurations. The three states comprise of any possible connections between A and the other three contacts. These three configurations are: (A-B), (A-C), and (A-D). The proposed mechanism of the RF switch is composed of a movable polysilicon rectangle, two arrays of thermal actuators and four contacts A, B, C and D. The structure of the three-state RF switch is shown in Figure 1.

As seen in the figure, the movable polysilicon rectangle is supported by four guides for limiting its motion to one axis. Also it is connected to two rods at each end for providing the mobility it requires for a three state switch. The actuators on both sides of the rectangle are responsible to place the switch in a desired state. The closed up of one of the actuators is shown in Figure 2. Although different actuators can be used for this design, thermal actuators are employed because of their advantages including large force to size ratio and simplicity.

The thermal actuators generate a motion that is relatively parallel to the axis of the switch motion and the frictional forces between the actuators tip and the rectangle's rods will be sufficient to move the switch [2]. The actuators play also the role of a braking system so that the switch will be locked while there is no power to the actuators.

The lines shown on the rectangle generate three connection patterns for the contacts A, B, C, and D. For example, in Figure 1 the switch connects A to D. Moving the switch to the left and right will produce the other two possible states. Currently, simulation of the switch is underway and it is expected that the overall size of the switch be less than 1 mm^2.

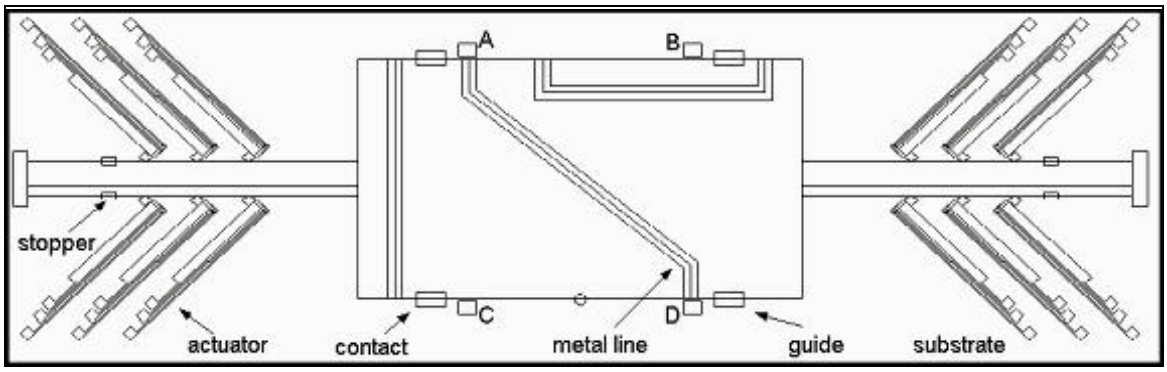

Figure 1. Three-state RF MEM Switch

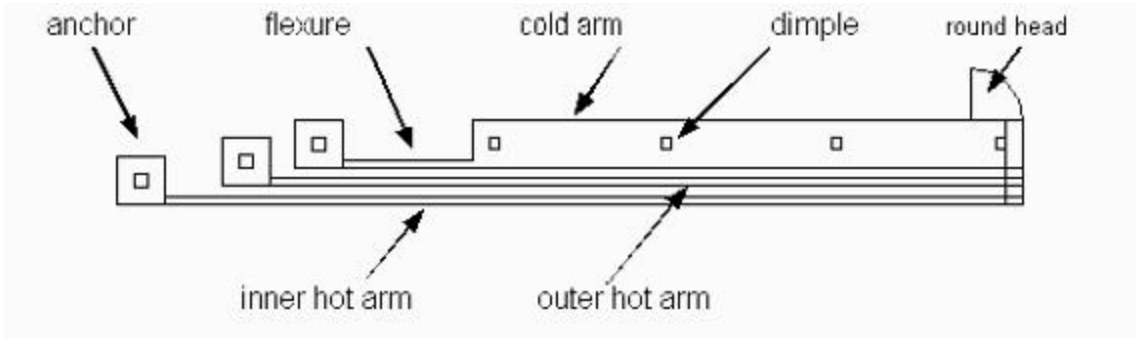

Figure 2. The Layout of Thermal Actuator

References:

[1] Francois-Xavier Musalem, "MEMS-based RF switches", *Mechanical Engineering Design*, pp. 22-25, March 2001.

[2] David M. Burns and Victor M. Bright, "Design and performance of a double hot arm polysilicon thermal actuator", *Proc. SPIE*, vol. 3224, pp. 296 –306, 1997.