Fixed-Fixed MEMS Switch Simulated With Flexures and Perforation

Ankur Saxena, Dr. Kulwant Singh

Abstract*: As MEMS technology is innovative process to combine the properties of electrical and mechanical. The paper explores the concept of two types of perforation rectangular and cylindrical with serpentine meanders. The Fixed –Fixed beam or RF MEMS used flexures to provide the support the beam. At both ends Fixed-Fixed beam are fixed middle part is movable due to electrostatic actuation force .The flexures are support to pull down actuation voltages between two electrodes. The perforation concept reduces the mass of the switch and reduces the effect of fringing field. These both techniques provides high switching speed and low power consumption or while electrostatic actuation process power consumption is almost zero .The simulation is done COMSOl MULTIPHYSICS software by measuring displacement and capacitance of switches. The rectangle and square perforation with 2-micrometer size is diffused in the middle part of the switch. The simulation result produced by applying various voltages on the switch due to this it will be deflect from their position and moves downward to the ground electrode .

***Keywords*: Fixed Fixed Beam, perforation, actuation, stiction, material**

I. INTRODUCTION

Micro-Electro-Mechanical System (MEMS) is integrated micro device or system, is fastest growing technology. MEMS is used in various types of application accelerometers, pressure, chemical, micro optics, sensor, military, biomedical, resonator, communication etc. MEMS is a combination of solid state device with electromechanical system [1][2].

The sensing of force , acceleration or any mechanical changes employ MEMS capacitive sensor [1][3].The microwave industry working various types of device FET, Pin diode ,waveguides, coaxial mechanical switches .

Mechanical switches have some disadvantage over semiconductor switches i.e. bulky, heavy, slow, high insertion loss, high power consumption and expensive [4]. The paper represent the design and simulation of Fixed–Fixed switch with serpentine meanders .It calculate the pull in voltage and displacement of switch. The rectangle and square perforation are used for reduction in pull in voltage.

II. PARAMETER THEORY

The Radio Frequency MEMS switch: work in two segments:-

(i) Actuation segment

(ii) Electrical segment

Actuation segment of RF MEMS switch can be managed using four mechanisms, which is electrostatic, thermal, magnetic, and piezoelectric. This paper describes the RF MEMS design using electrostatic mechanism with better flexibility. RF MEMS switch provides displacement i.e. vertically or laterally, depends on the necessity and it can also be designed in series or shunt configurations which use metal-to-metal or capacitive contact. The paper characterize shunt configuration switch [5]. The dielectric material Hafnium oxide have various properties [6].

Parameter		
	Youngs moduls (E)	*Poisson's ratio(v)*
HfO_2	0.48	0.5032

III. GEOMETRY OF SWITCH

The metal bridge suspended on a top of CPW signal line of shunt switch A and switch B. The switch has very low loading effect on a signal line. The shunt switch exerts a force due to this pulled down a switch, when a voltage exceeding electrostatic pull-in voltage, which is applied on the beam top

The incident signal are reflected due to low impedance path between two electrodes [7]. Fig.1 represent the Switch A with rectangular perforation and serpentine meanders. The dielectric material insert HfO_2 in the switch A and switch B .The DC voltage is applied on the movable beam. At starting very low changes in displacement towards in z direction. When pulll in voltage achevied, movable part contact with ground substrate and switch will start to conduct. The sensitivity of the beam changes with the change is shape of the Fixed-Fixed beam. It designs with material HfO_2. As selection of material is depend on the properties of material as dielectric constant, band gap and thermal stability.

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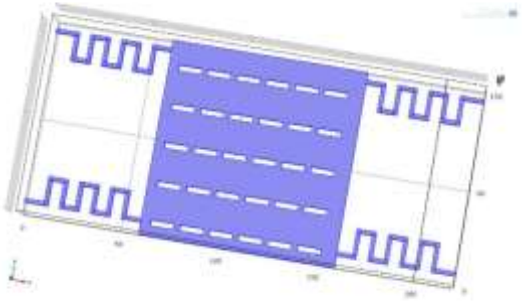

Fig. 1. Switch A design with menders and perforation

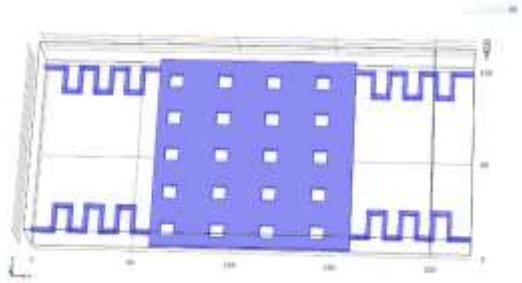

Fig. 2. Switch B design with menders and perforation

IV. SIMULATION OF SWITCH

In the simulation of Switch A and Switch B at 30.1 volt represented in which provides maximum displacement. The z-component displacement curve at various applied voltages is also shown by graphical representation. The dark red color represents maximum displacement and dark blue color represents minimum displacement. As both switch show various characteristics at applied voltages.

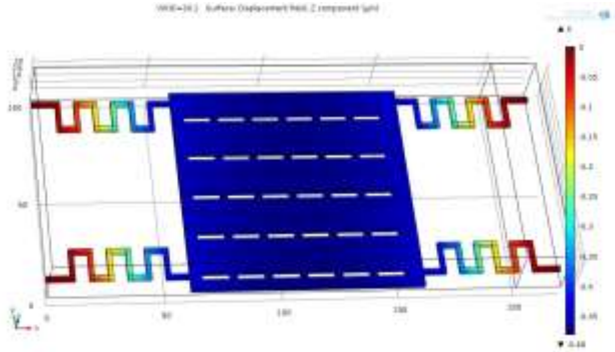

Fig. 3. Simulated Switch A at voltage at 30.1volt

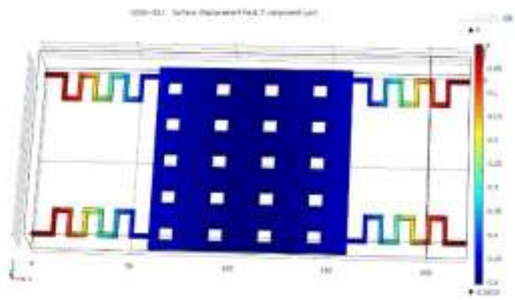

Fig. 4. Simulated Switch B at voltage 30.1 volt

V. RESULT & DISCUSSION

The comparative study of various types of switches with material hafnium dioxide gives different displacement at the pull in voltage. Table I shows all the comparison with various types of switches. The Switch A gives 0.48 μm displacements at 30.1 volt. At same voltage achieved 0.5032μm z-component displacement of switch B. The switch B is more flexible and high switching speed than to other switch A.

Table- I: Displacement of switch at applied voltage

Voltage	z-component displacement (μm)	
	Switch A	*Switch B*
30.1	0.48	0.5032

VI. CONCLUSION

MEMS technologies basically use for reduction in size of switch. The both switch A and switch B provide different displacement. The switch employed serpentine meanders for providing greater flexibility and high switch speed. The perforation square and rectangle are used, to reduce the mass of the switch and also reduction in power consumption. Now it concludes from this paper the Switch B provide more displacement so it is more flexibility and higher actuation voltage.

A. References

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