

RF MEMS SWITCH

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Introduction: The actuation voltage of the RF MEMS switch is the most important for compatible with modern electronic control circuits and improve lifetime. This paper mainly investigates the influence of the shape of the RF MEMS switches on the actuation voltage and the method to reduce the squeeze film damping effect by introducing holes on the beam.

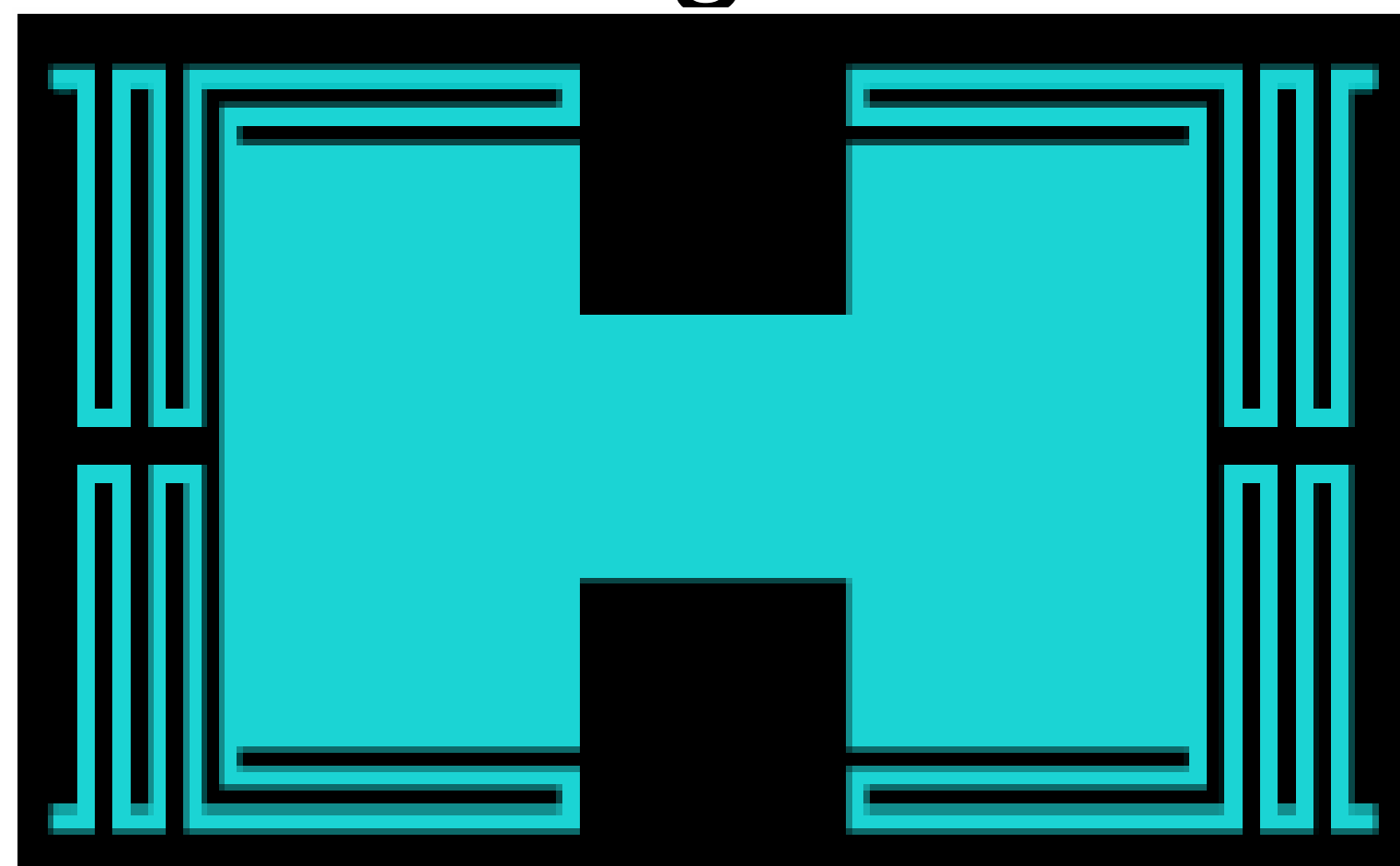


Figure 1. Switch with folded springs

Principles: Generally RF MEMS switches are actuated by electrostatic forces. When the voltage is applied between a fixed-fixed or cantilever beam and the pull-down electrode, an electrostatic force is induced on the beam. The electrostatic force applied to the beam is found by considering the power delivered to a time-dependent capacitance and is given by

$$F_e = \frac{1}{2} V^2 \frac{dC(g)}{dg} = -\frac{1}{2} \frac{\epsilon_0 W W V^2}{g^2}$$

Actuation voltage of the switch is given by

$$V_p = V(2g_0/3) = \sqrt{\frac{8k}{27\epsilon_0 W W} g_0^3} = \sqrt{\frac{8k}{27\epsilon_0 A} g_0^3}$$

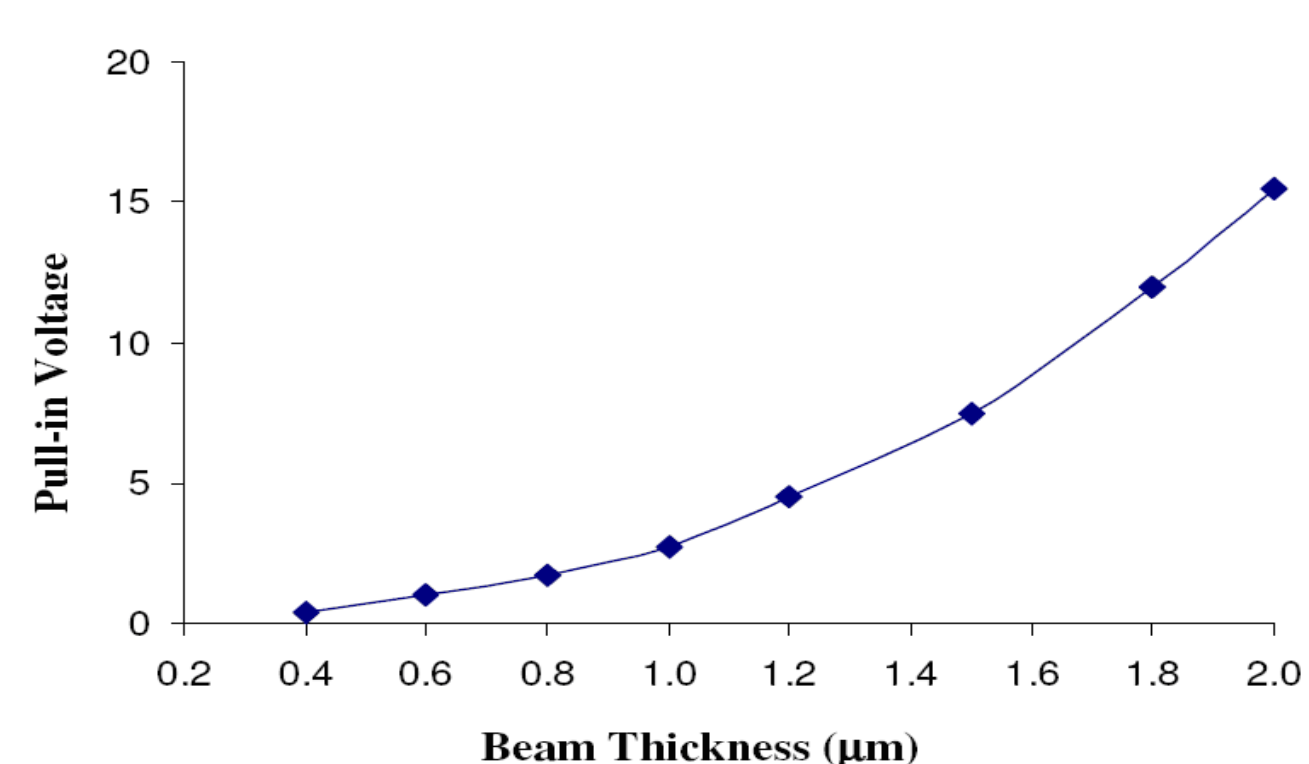


Figure 3. Influence of beam thickness on pull – in voltage

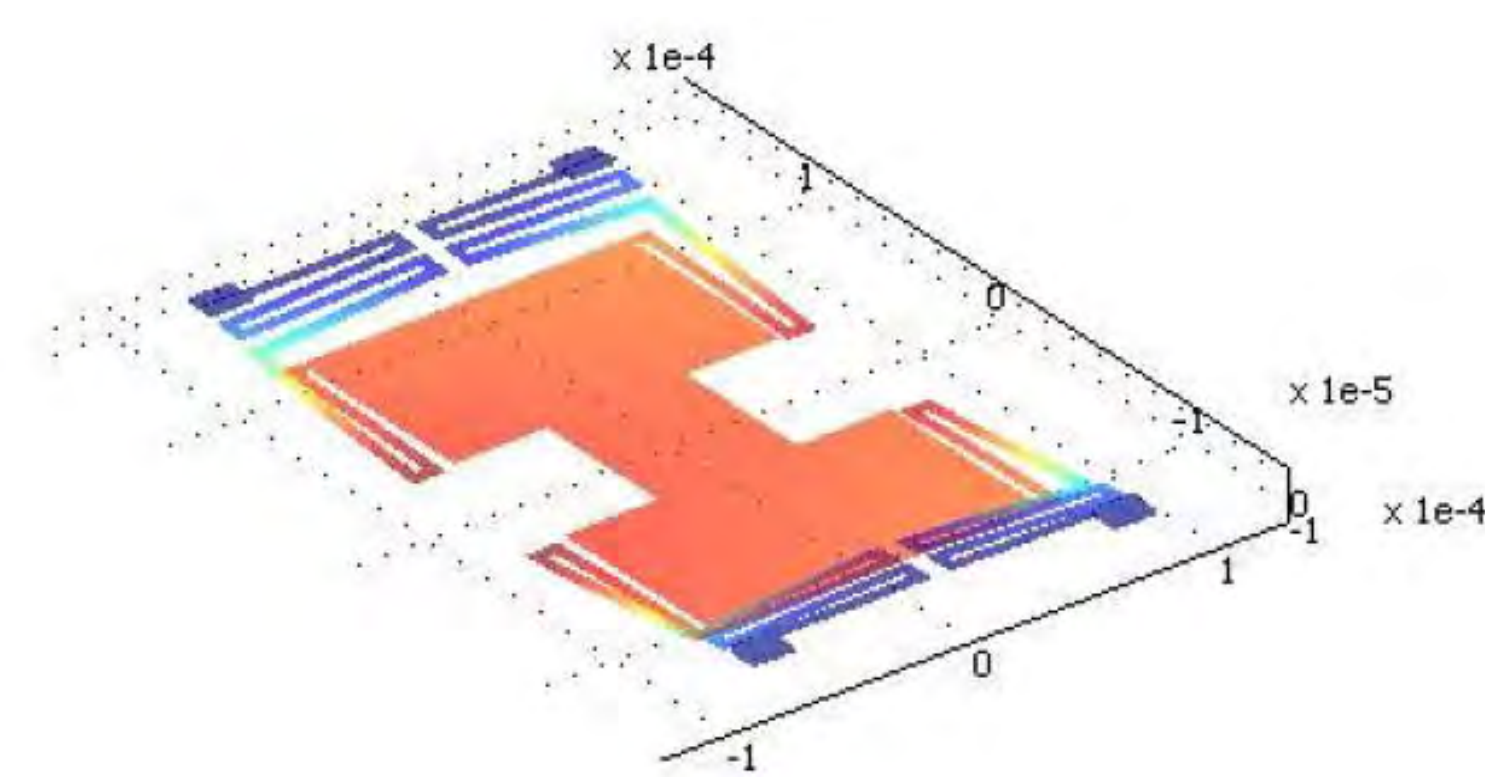


Figure 2. Switch is in OFF state

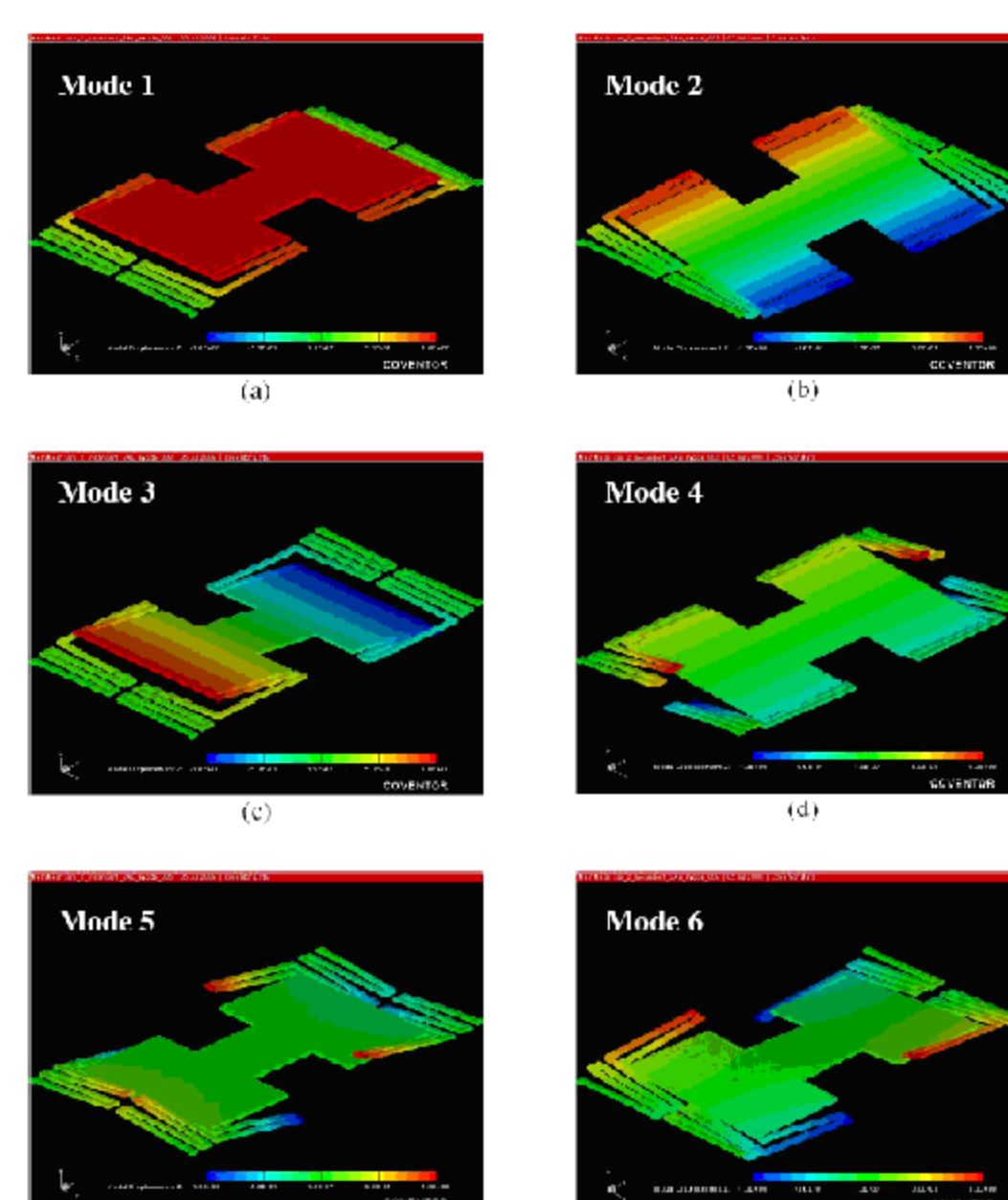


Figure 4. Modal Analysis

Results: Pulling voltage analyses is done for various thickness of the beam as shown in fig3. Modal analyses is done to analyze the behavior of the switch in present of noise as shown in fig 3 and fig 4 shows the damping effect on switch.

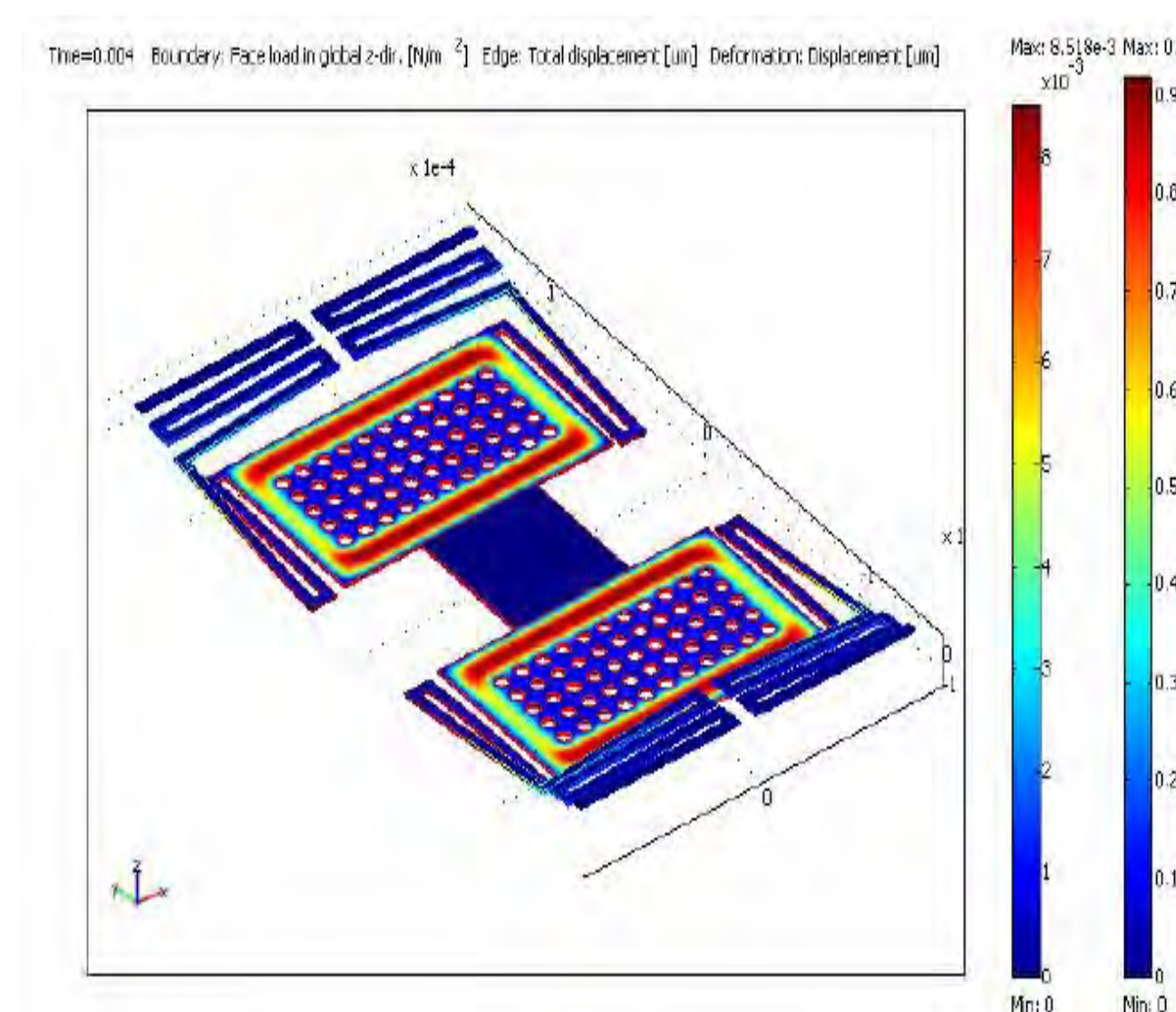


Figure 5. Damping effect analysis

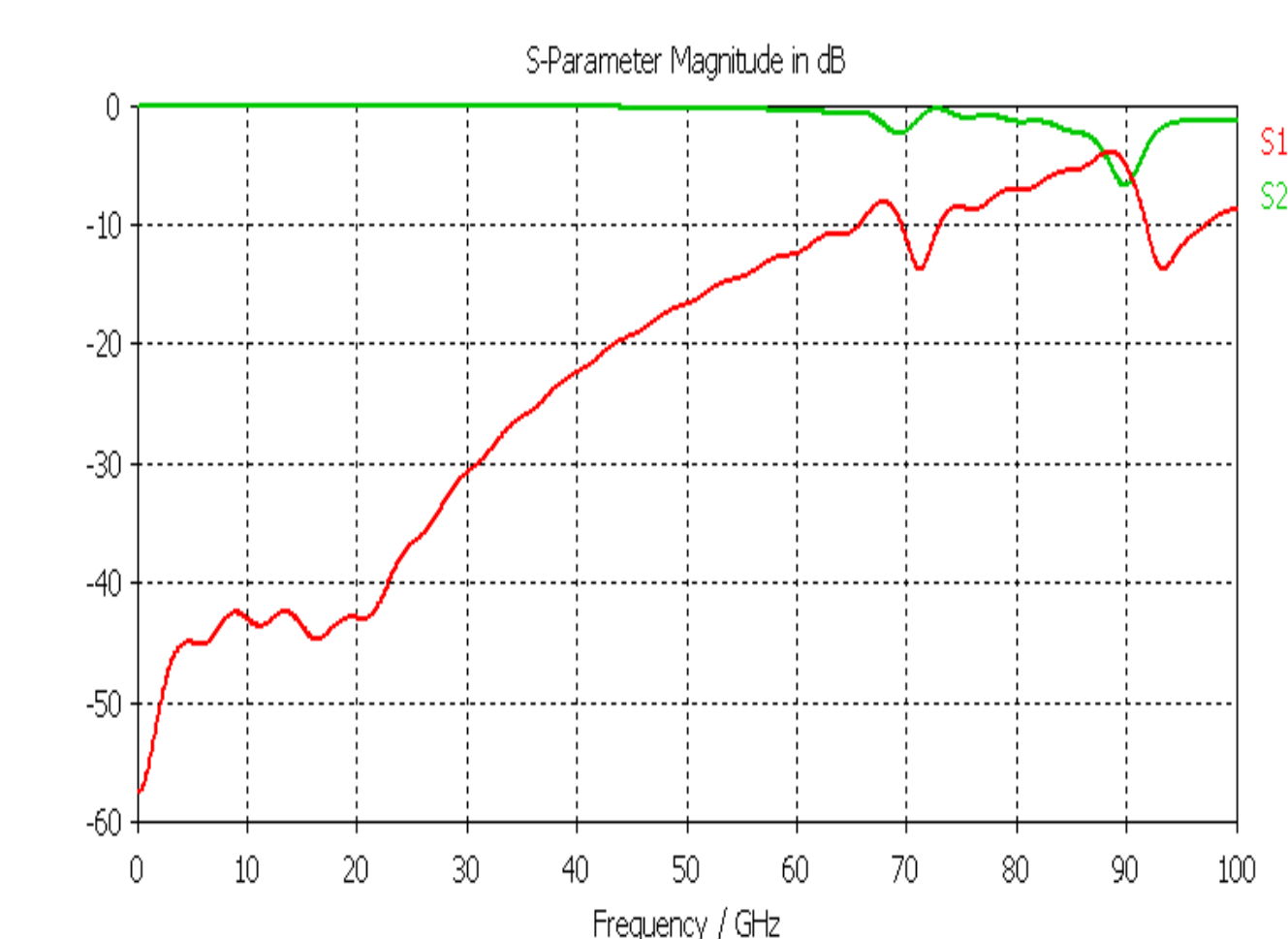


Figure 6. RF characteristics

Conclusion:

- The actuation voltage of the switch is reduced by increasing the length of the spring.
- The modal analysis shows all resonant frequencies are so extraordinary high (10^4 Hz) that the system of the switch is rarely disturbed.
- Squeezed film damping effect is reduced by making holes on the beam.

References:

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