A novel design of a low-voltage low-loss T-match RF-MEMS capacitive switch

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Abstract

This paper presents a novel design, optimization and analysis of capacitive radio frequency (RF) micro-electromechanical system (MEMS) switch. The design incorporates a novel membrane and beams' structure with two short high-impedance transmission-line (T-line) sections added on either side of the switch (namely T-match switch) to improve its RF performance, while maintaining low-actuation voltage. The short high-impedance T-line section has narrower width and higher impedance than the coplanar waveguide (CPW)'s signal line, behaves as series inductor to compensate the switch's up-state capacitance and provides excellent matching at the design frequency. This high-impedance T-line section was designed, simulated and optimized using finite-element-modelling (FEM) tool of electromagnetic (EM) simulator of AWR Design Environment(TM). The optimized T-line section's width and length is 10 A mu m and 70 A mu m, respectively. The RF-MEMS switch is actuated by electrostatic force with low-actuation voltage of 2.9 V, has maximum von Mises stress of 13.208 MPa which is less than aluminium's yield stress and can be operated in robust conditions. Compared to the normal capacitive RF-MEMS switch, this T-match capacitive RF-MEMS switch with two sections of optimized high-impedance T line has improved the performance of return loss and insertion loss, at switch-on state, by 45.83% and 55.35%, respectively; while at the switch-off state, the isolation is increased by 24.05%; only the switch-off return loss is degraded by 11.7% but the value (- 0.5519 dB) is still located in the range of design specifications. The RF-MEMS switch's actuation time was simulated to be similar to 27 A mu s with amplitude of 5 V up-step voltage.

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