MEMS Tunable Bandstop and Bandpass Filters

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Advanced radios need to support an increasing number of frequencies and standards. Current technologies based on fixed components are not scalable and integration of fixed modules into the radio results in increased complexity and cost. For these reasons, there is an increasing demand for reconfigurable/tunable front-end modules. As one of the front ends of RF front-ends, pre-select filters need to be reconfigurable to allow selection of different radio bands.

Microelectromechanical systems (MEMS) have been most commonly used to tune the frequency of the filters. Some of the common techniques include adjusting the capacitance of cavity filters using MEMS tuners, and employing tunable capacitors (e.g., varactors) and/or MEMS switches in the resonator tank of lumped or distributed filters. Despite advances in MEMS and general perception of RF community, there are great challenges in developing high-Q lumped element resonators and filters. As a result, the performance of the reported lumped-element tunable filters have been limited and off-chip components have been used where filter Qs higher than 50-80 were needed.

In this talk, a platform is introduced that offers most necessary components of RF front-ends integrated on the same substrate, including high-performance tunable passives, switches, and high-Q inductors. Using this technology platform, a lumped-element tunable filter is demonstrated, which covers the frequency range of 600 MHz to 1 GHz with an insertion loss of less than 3.6 dB. This is believed to be one of the highest performance fully-integrated filters operating at sub-gigahertz frequencies. Electrostatic actuation mechanism for tuning the value of passives is discussed in detail. In addition, the same technique is used to implement a tunable notch filter for removing in-band interferences in wideband radios. Some of the challenges and fabrication and design considerations in developing such high-performance lumped-element filters are discussed. The measurement results of devices are presented, and a number of research directions to improve the performance of passive lumped-element filters are also presented.