ABSTRACT

Comprehensive studies on Radio Frequency Micro Electro Mechanical Systems (RF MEMS) based devices followed by implementation of novel design and fabrication process to optimize the performances of these devices are presented in this thesis. The work aimed at development of RF MEMS shunt switches, switch based MEMS phase shifter, tunable capacitor and bulk-micromachined inductors to be implemented in the futuristic next generation systems for airborne applications.

To start with Tri-layer (nitride-metal-nitride) membrane rather than all metal membrane have been investigated to enhance the membrane properties and to realize the stress free, thermally stable, and stictionless structure. The process flow was optimized as per the established MEMS process of the Indian foundry named Semiconductor Technology & Applied Research Centre, STAR-C (formerly known as Society for Integrated Circuit and Applied Research, SITAR), Bangalore. All these structures are fabricated on high resistivity Silicon substrate to ensure low RF loss as well as low parasitic capacitance.

Chapter 2 presents an electrostatic RF MEMS shunt switch using the novel tri-layer membrane which results low actuation voltage less than 15V, high isolation better than 35 dB and has stictionless operation. Inductance tuning is implemented by creating the narrow trench in the CPW ground to lower the resonant frequency and enhance the isolation.

Chapter 3 presents the MEMS shunt switch based low actuation voltage, wideband Distributed MEMS Transmission Line (DMTL) phase shifter which exhibit a highly linear phase shift through the entire band. The phase shifter uses the same switch developed during the research. This 1-bit phase shifter can be cascaded with the other bits and can be used in phased array based systems.

Keeping the requirements of tunable devices in futuristic wireless communication architecture in view, two basic components such as tunable capacitor and inductors are developed with enhanced linearity and improved Q factor respectively as mentioned in chapter 4 and chapter 5. The same tri-layer membranes were used to realize capacitor plate and the inductor coil. The thesis concludes by suggesting the room for improvement of these devices as well as the future task directions in this field.