Abstract

Recent progress in wireless communication technology demands high performance, compact RF/microwave passive components like a filter, diplexer, multiplexer, power divider/combiner and various types of antennas. For circuit implementation of the passive components, various circuit technologies are available since more than last fifty years. The bulky rectangular waveguides and planar circuit technologies like microstrip, CPW and grounded CPW are well established in microwave circuit designing. The waveguide offers lower loss but they are bulky whereas above mentioned planar technologies offer compact size at the expense of a total loss.

In last two decade, a circuit technology that can be considered as a bridge between the air filled waveguide and other planar circuit technologies, called Substrate Integrated Waveguide (SIW) has drawn the great attention of microwave and millimeter wave circuit designers due to its compact size, lower loss, and moderate power handling capabilities. SIW is a planar form of the air filled waveguide which can be fabricated using printed circuit board (PCB) technologies. It can be easily integrated with other planar circuits.

In this thesis, designing of various microwave passive components using SIW technology have been presented. Compact and broad band coaxial line to SIW and empty SIW transitions are developed to minimize the transition loss. Study of losses, the design of high-performance filters, diplexers with improved isolation, self diplexing antenna with orthogonal radiation, and compact multi way power dividers are presented. Full wave simulator Ansoft's HFSS® is used to carry out the parametric studies and design optimization.

The passive components are presented in this thesis are listed below.

***1. Wideband Coaxial line to SIW and ESIW transition*:** A direct SMA connector to SIW transition is presented. The proposed transition eliminates the losses associated with existing planar circuits like microstrip, CPW or Grounded CPW to SIW transitions. The bandwidth of this transition covers the whole X-band with minimum transition loss and

area. Further, the design is used to implement SMA-empty SIW (ESIW) transition in X-band. The transitions have the advantages of compact size and minimum transition loss.

***2. High-Performance Bandpass filters*:** Dual band, narrow band, and cross coupled bandpass filter in multilayer configuration, are presented. A dual band filter using the fundamental TE_{110} and next higher order TE_{210} modes of a single rectangular SIW cavity is presented. The filter offers independent bandwidth control even when the center frequency ratio is 1.1. A sharp cut off narrow band filter is designed for satellite transponder application. To improve the pass band insertion loss, only three resonators are used. To improve the stop band rejection, transmission zeros (TZs) near the pass band edges are created by the higher-lower order mode and bypass coupling. A wideband SIW filter is presented in multilayer configuration to reduce the circuit footprint. Both the electric and magnetic couplings are suggested in multilayer configuration. TZs near the band edges at both the stop bands improve the selectivity of the proposed filter.

***3. Filter integrated with SPDT switches*:** A dual mode square cavity is used to realize a band pass filter integrated with single-pole double-throw (SPDT) switches. RF power can be transferred to any of the two output ports by controlling the switching states.

***4. Dual mode filters and diplexers with improved port isolation*:** A dual mode SIW filter with tunable TZs is presented. Tuning of transmission zeros position over a wide range of frequencies has been discussed in detail. Finally, two diplexers are designed with improved channel isolation utilizing the zero tuning property of the proposed dual mode filters.

***5. Self diplexing antenna with orthogonal radiation*:** A self diplexing antenna that offers orthogonal radiation at two frequencies while excited at two orthogonal ports with a minimum port isolation of 29 dB is designed. The dual resonance property of a square dual mode cavity is utilized for dual frequency radiation. A rectangular ring slot on the top plane of a square dual mode SIW resonator is used to excite the dual modes and radiation. Further improvement of port isolation is also discussed.

***6. Miniaturized SIW multi way equal and unequal split power dividers*:** To make the SIW components more compact, a miniaturized $1/32^{th}$ mode SIW is proposed. The

proposed SIW is then used to develop compact equal split 4-way, 8-way, and two unequal split 4-way power dividers. An easy tuning method of output power level is also suggested.