DESIGN AND DEVELOPMENT OF PLANAR MULTIBAND MULTI-ELEMENT ANTENNAS FOR ENHANCED DATA RATE WIRELESS COMMUNICATIONS

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Abstract

Planar, compact and low-profile multiband antennas find numerous applications in modern wireless communication system according to the requirements and specifications. This thesis solely focuses on different design aspects of planar multiband antennas based on microstrip and substrate integrated waveguide (SIW) technologies. Moreover, the research work finally aims to design planar multiband multi-element antennas, which offer transmission at higher data rate compared to the conventional single antennas.

The application of composite right/left handed (CRLH) unit cell, derived from the concept of the metamaterial transmission line, is a very efficient way to design multiband antennas. Along with the conventional resonant frequency, zeroth order and negative order resonant frequencies are obtained in CRLH unit cell. CRLH unit cell loaded triple-band and quad-band antenna are presented in the thesis. The triple-band antenna is designed by loading the CRLH unit cell in a rectangular loop, which has its own resonant frequency. In case of the quad-band antenna one monopole is loaded with a CRLH unit cell to generate three resonant frequencies. The fourth one is obtained by adding one monopole to this antenna.

Two compact designs microstrip multiple-input-multiple-output (MIMO) antennas are presented. The dual-band MIMO antenna has the advantage of design simplicity as the isolation network is designed using three simple open-ended slots. The property of CRLH unit cell is exploited to design the triple-band MIMO antenna. Slot-based simple and efficient isolation network is designed for this antenna too.

Two SIW antennas, based on bow-tie shaped slots, are realized. A novel technique is adopted to design triple band SIW antennas, where metallic shorting pins or vias are used to generate multiple radiating modes. Moreover, by moving these metallic vias along a particular direction the corresponding resonant frequencies can be changed. This, consequently, leads to achieve the frequency tunability.

The judicious application of transverse slots on SIW cavity leads to the antennas with self-diplexing property. Two designs of self-diplexing antennas are presented. In the first design two parallel transverse slots of different lengths are used to obtain two closely spaced resonant frequencies at the corresponding ports. A plus-shaped slot with two unequal orthogonal arms is used in the second design. Both the designs possess the advantage of design simplicity. Moreover, the inherent isolation between the ports is good

enough and frequency tunability is achieved in both the cases too. The self-diplexing antennas eliminate the use of complex diplexers.

The concept of MIMO and self-diplexing is combined together to exploit the features of both technologies. A four-port microstrip self-diplexing MIMO antenna is designed. A pair of self-diplexing antennas is placed in such a way that MIMO characteristic is also achieved simultaneously. This antenna not only discards the use of diplexers at the RF front-end but also leads to enhancement in the data transfer rate as well as spectral efficiency.