An Analog RF System with High Isolation for Simultaneous Transmit and Receive (STAR)

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With the exponential growth of wirelessly connected devices engineers and researchers are seeing the rapid crowding of the limited frequency bands which are commercially available for the development and deployment of wireless devices. Much like traffic on a highway this crowding of limited lanes of communication can mean serious slowdowns, interference and limitations to the number of devices that maybe used in a particular space. As a result, Full-duplex radios, also known as Simultaneous Transmit and Receive (STAR) system, are attracting significant attention. In current devices the transmit and receive signals must occur either at different frequencies or at different times to avoid the transmitted signal interfering with the received signal. These multiple-input multiple-output designs are reaching their limit, but recent advancements in passive self-interference suppression designs are significantly reducing the amount of self-interference present in full-duplex models, making the possibility of simultaneous transmit and receive antennas more likely. This study proposes a compact microstrip antenna design with high isolation accompanied by an analog cancellation circuit for full-duplex operation

In this paper, we present a patch antenna that has high isolation (S_{21} < -45dB) and low cross polarization (approximately -20 dB) with a matched flexible analog cancellation circuit that provides and additional -15dB of cancellation for use in a STAR system. The design consists of two substrate layers with a defected ground structure in between. The antenna presented is a three-layer board with the top layer being a patch antenna tuned to 2.45 GHz, the middle layer being the ground plane with an aperture, and the bottom layer being a microstrip line fed orthogonally with respect to the top feeding line. The analog circuit consists of a balun on the transmit transmission line to provide a 180˚ copy of the transmit signal which is then passed through two fixed attenuators and one variable attenuator. The attenuated signal is then combined with the receive signal in a power combiner where it is eliminated from the receive signal. The combination of the antenna structure with the analog circuit provides maximum self-interference suppression and ensures high isolation and low cross polarization at all frequencies. Parameters of interest such as bandwidth, gain, radiation patterns, efficiency, and circuit simulations with various antennas will be presented along with the critical parameters of isolation and cross polarization.