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Power Efficient In Band Full Duplex System for Wi-Fi Application

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As the number of Internet of Things (IoT) devices continues to rise, 5G has emerged as the essential network to handle the real-time transfer of large volumes of data. However, to reap the potential advantages of 5G-enabled IoT, such as smart vehicle infrastructure, smart cities, and more, 5G antenna technologies must progress at the same rate as IoT. By 2025, the number of IoT devices will reach a ratio of four gadgets per person on the planet [1], implying unparalleled wireless data use throughout the world in conjunction with other mobile technologies. First and foremost, rising bandwidth demand will result in an even more overstressed RF spectrum. The RF spectrum's utilization has been constrained throughout the years due to its dependency on duplexing technologies, Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD), for communication. These communication methods lead to a waste of time and frequency. Nevertheless, the mutually exclusive use of time and frequency has been inevitable because the implementation of full duplex schemes is complex. For proper operation, full duplex designs require high self-interference cancellation (SIC); otherwise, the high-powered transmitted signal will render the design useless, as the received signal can become corrupted [2,3]. Therefore, antenna systems with sufficient SIC are the future to satisfy the network user increment and prevent further waste of the scarce spectrum resources.

In this work, we present a simple, yet novel design to target self-interference (SI) in narrow bandwidths by using two circulators, a hybrid coupler, and FIR filter circuit. Foremost, the second circulator and the FIR filter enable the creation of a quasi-replica of the leaked transmitted signal for passive symmetric cancellation. The results of the preliminary design intended for the 450 MHz Ultra High Frequency Band (UHF) showed an average cancellation of 55 dB across a 20 MHz bandwidth. Additionally, the scaled design for the Short Wave (S) band, targeting 2.45 GHz, showed that depending on the order of the FIR filter, it can provide up to 70 dB of isolation. Lastly, our system is power efficient as it achieves high isolation with a minimal power loss of the Tx signal, whereas other designs lose an additional 3dB at both the Tx and Rx signal. Overall, the symmetrical design is simple, yet novel as it only requires two circulators and a hybrid FIR resonator topology to provide up to 70 dB in isolation across the operational bandwidth. As a result, this scalable and efficient design will be able to alleviate the congested spectrum and maximize the applications of 5G.

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3. S. J. Watt, E. A. Alwan and J. L. Volakis, "Cascaded network analysis of a wideband RF self-interference cancellation (RF-SIC) filter for STAR systems," *2016 IEEE International Symposium on Antennas and Propagation (APSURSI)*, 2016, pp. 2117-2118, doi: 10.1109/APS.2016.7696765.